Evaluation of Four Tax Reforms in the United States: Labor Supply and Welfare Effects for Single Mothers*

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Abstract

An emerging consensus is that labor force participation is more responsive to taxes and transfers than hours worked. To understand the implications of participation responses for the welfare analysis of tax reform, this paper embeds this margin of labor supply in an explicit welfare theoretic framework. We apply the framework to examine the welfare effects on single mothers in the United States following four tax acts passed in 1986, 1990, 1993, and 2001. We propose a simulation method combining features of fully structural microsimulation studies and simple deadweight loss calculations. Our approach accounts for the observed heterogeneity in the microdata, but is simple to implement because we do not need to specify utility functions and estimate utility parameters. We find that each of the four tax acts created substantial welfare gains, and that the gains were concentrated almost exclusively on the participation margin. Our results imply that standard approaches not modeling the participation decision can make large errors. (*JEL* H21, J22)

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1 Introduction

The last two decades represent an unusually active period in the modern history of the United States tax system. A series of tax acts—passed in 1981, 1986, 1990, 1993, 2001 and 2003—has dramatically changed the federal income tax code. These tax acts differed substantially in their scope and coverage, but all had important effects on the tax liabilities and incentives faced by taxpayers. For low-income taxpayers, the primary effect of these reforms has been to reduce income tax liabilities through a combination of provisions, but mainly through the expansion of the Earned Income Tax Credit (EITC). A relatively modest program until 1986, the EITC has since evolved into the single largest cash transfer program for low-income families at the federal level. In fact, the EITC now implies negative tax liabilities on labor income (including all federal, state, and social security taxes) for a representative single mother.

This paper evaluates the welfare effects on single mothers from the tax acts passed in 1986, 1990, 1993, and 2001. We take note of recent empirical evidence showing strong labor force participation responses to EITC expansions, unmatched on the hours-worked margin even though the changes in incentives on that margin have been substantial (Eissa and Liebman, 1996, Meyer and Rosenbaum, 2001). These recent findings are consistent with earlier Negative Income Tax experiments showing that participation was more sensitive than hours worked for both single female heads and married women (Robins, 1985), as well as with indirect evidence showing larger estimated elasticities for *all* than for *working* married women (Mroz 1987, Triest 1990).

Recent work on optimal income taxation has shown that the policy recommendations change once participation responses are explicitly introduced (Saez, 2002). More precisely, it may be optimal to impose negative marginal tax rates at the bottom of the earnings distribution, similar to an EITC. By contrast, an EITC would be inefficient in a standard model with only intensive responses. These results on optimal taxation suggest that a correct modelling of labor supply behavior will also be important for tax reform analysis.

Our paper examines the impact of participation responses on the welfare evaluation of tax reforms. We set up a welfare theoretic framework with labor supply responses along both the extensive (participation) and intensive (hours worked) margins. We model labor supply in a manner consistent with the empirical distribution of hours worked showing very few workers at low annual or weekly hours of work. This requires we drop the standard convex framework, which implies that small increases in after-tax wages induce entry at small (infinitesimal) hours of work. Our framework allows for discrete labor market entry by way of non-convexities in preferences and budget sets created by fixed costs of work (as in Cogan, 1981). We show that such non-convexities allow first-order welfare effects along the extensive margin.

Our model identifies the parameters that are important for evaluating the welfare effects of tax reform. Welfare effects are shown to depend on elasticities along each of the two margins of labor supply; on the initial tax-benefit position of each individual; and on the reform-induced changes in tax rates. The distinction between the two margins of labor supply is crucial because each margin has a different tax wedge. As in traditional analysis, the welfare effect on the intensive margin depends on the effective marginal tax rate (including the marginal phase-out rate applied to any benefits). Along the extensive margin, however, the welfare effect depends on the effective average tax rate (including the average reduction rate on benefits). Our results show that conflating these two tax wedges in the welfare analysis can be fundamentally misleading. The reason is simple and intuitive. Programs such as the EITC, TANF, Food Stamps and Medicaid generate highly non-linear and discontinuous tax-transfer schedules that imply substantially different tax rates on participation and on hours worked.

Our simulations account for all relevant changes to the federal income tax code introduced by the four tax acts. The tax simulations are based on Current Population Survey (CPS) data and NBER's TAXSIM model. Because of the central role of the public assistance system, we also construct a benefit calculator incorporating cash assistance as well as Food Stamps and Medicaid to characterize fully the extensive and intensive tax wedges for each observation in the sample.

We find that all four tax reforms created substantial welfare gains for single mothers, but the largest gain was found for the 1986 reform. Moreover, for all four reforms, we show that almost all of the welfare gain is generated along the extensive margin. Perhaps surprisingly, this concentration of welfare gains occurs even with identical participation and hours-worked elasticities. The reason is that nonlinearities and discontinuities create different tax distortions along the two margins, and that the tax acts changed the average tax rate (for example, -11.9 percentage points in 1993) more than the marginal tax rate (-3.0 percentage points). These features of the tax schedule render the composition of the total labor supply elasticity a crucial element for the welfare evaluation of tax reform. In fact, we find that conflating the participation and hours-worked elasticities may lead to the wrong sign on the welfare effect, and conclude that the composition of the labor supply elasticity may be as important as its size.

Our paper contributes to the large literature on the welfare costs of taxation and tax reform.[1] A common feature in this literature is the assumption of a standard convex labor supply model, ruling out (discrete) participation responses. A recent exception is the paper by Immervoll *et al.* (2007), which incorporates the participation response in its analysis of hypothetical tax and welfare reform in European countries. We extend and generalize their method to analyze the effects of actual tax reforms, and propose a simple and transparent simulation method which combines features of fully structural microsimulation studies and simple deadweight loss calculations. Our approach accounts for the observed heterogeneity in taxes, benefits, participation and hours worked at the individual level, but is simple to implement because it does not require that we specify functional form for utility and estimate utility parameters, nor that we estimate fixed costs of work.

The paper is organized as follows. Section 2 describes some of the major changes in tax laws during the past two decades, and reviews very briefly the empirical labor supply literature studying the impact of tax reforms. Section 3 presents a welfare theoretic framework distinguishing explicitly between the intensive and extensive margins of labor supply. Section 4 applies the theory to data from the Current Population Survey, and evaluates the welfare implications from the changes in the tax treatment of single mothers. Section 5 concludes.

2 Two Decades of US Tax Reform

A worker filing a head of household tax return in 2004 would face a federal income tax schedule with six brackets, with rates ranging from 10 to 35 percent. Some of her earnings would be shielded from taxes by the standard deduction ($7,150) and by the personal exemption ($3,100 per person). If the taxpayer has two children, she would pay 10 percent in federal income taxes on earnings above $16,450, and anywhere from no state income tax (Florida or Texas) to a 5 percent state income tax (Massachusetts or Oregon). Additionally, this taxpayer would pay

[1] This literature includes theoretical papers (e.g. Allgood and Snow, 1998; Dahlby, 1998), microsimulation studies (e.g. Browning and Johnson, 1984; Triest, 1994; Bourguignon and Spadaro, 2005), and Computable General Equilibrium analyses (e.g. Ballard *et al.*, 1985; Ballard, 1988).

social security payroll taxes of 7.65 percent on her first dollar of earnings.

A head-of-household tax filer could also be eligible for the EITC if her Adjusted Gross Income (AGI) is below $33,692 (and she has at least two children). The size of the credit would depend on her earned income and the number of qualifying children who meet certain age, relationship and residency tests. The EITC schedule has three regions. The initial phase-in region transfers an amount equal to a subsidy rate of 40 percent times earnings. Over a range of earnings, she receives the maximum credit ($4,204), after which the credit is phased out at a rate of 21 percent. The credit is refundable, so this taxpayer would receive the full amount of the credit if she had no federal tax liability.

Twenty years earlier, this taxpayer would have faced a very different tax scheme, with a much smaller EITC and 15 brackets, ranging from zero to 50 percent. A series of tax acts passed in 1986, 1990, 1993 and 2001 substantially changed the federal income tax system, resulting in large changes in the tax liabilities of single women with children. With both the Tax Reform Act of 1986 and the Omnibus Budget Reconciliation Acts of 1990 and 1993, tax liabilities were changed primarily through expansions of the EITC. The 2001 tax act, on the other hand, did not affect the credit for single parents, but rather reduced the rates on the lowest income tax bracket and increased the size of tax credits. To outline the major features of the tax changes, Table I presents federal income tax parameters from 1984 to 2002. The table highlights the continuous and dramatic changes to the federal income tax schedule over the period.

< Table I >

The 1986 expansion of the EITC, passed as part of the Tax Reform Act of 1986 (TRA86), increased slightly the phase-in rate and region, resulting in a higher maximum. The higher maximum credit and a lower phase-out rate combined to extend eligibility to workers earning $18,576 by 1988 (from $11,000 in 1986). These changes were reinforced by increases in the standard deduction and the dependent exemption to reduce income tax liabilities for taxfilers at the bottom of the income distribution. Finally, the tax schedule was collapsed to two brackets, and most head of household taxfilers were shielded from the higher 28 percent bracket

The Omnibus Budget Reconciliation Acts of 1990 and 1993 (OBRA90 and OBRA93) further expanded the EITC for all eligible families. The largest single expansion of the EITC was contained in OBRA93. This reform increased the additional maximum benefit for taxpayers with two or more children to \$1,400 by 1996, and doubled the subsidy rate for the lowest-income recipients from 19.5 to 40 percent for larger families (18.5 to 34 percent for families with one child). These changes combined to dramatically expand eligibility for the EITC, such that by 1996 a couple with two children would still be eligible at incomes of almost \$30,000. Other than the expansions to the EITC, there was little in the way of changes to the federal income tax for lower-income individuals in OBRA93.

The Economic Growth and Tax Relief Reconciliation Act of 2001 (EGTRRA2001) reduced further the tax liabilities of low-income taxpayers by cutting the bottom tax bracket rate from 15 to 10 percent, as well as increasing (and making refundable) the Child Tax Credit from \$500 to \$1,000.

On the whole, the past two decades have been unusually active for the tax system in the United States. As a consequence, this period has proven especially useful for understanding labor supply behavior. To motivate the main finding in the empirical work most relevant for this paper, Figure I presents the employment population rate over time for single mothers in the United States. The strong increase in the participation rates during a time coincident with reductions of tax liabilities is striking and difficult to dismiss. To identify participation responses to taxes, studies have used both quasi-experimental methods (Eissa and Liebman, 1996; Eissa and Hoynes, 2004; Hotz, Mullin and Scholz, 2002) as well as more structural methods (Dickert, Houser and Scholz, 1995; Meyer and Rosenbaum, 2001). What is notable about this work is that the findings are consistent across the different methods and reforms, and show very strong participation effects by female household heads. The estimated participation elasticities have been in the interval from 0.35 to 1.7, with a central value of about 0.7.

< Figure I >

3 A Framework to Evaluate Tax Reform

3.1 Welfare Analysis with Extensive Labor Supply Responses

Following Harberger (1964), numerous studies have attempted to measure the distortions to the labor-leisure choice induced by labor income taxes (e.g. Ballard *et al.*, 1985; Ballard, 1988; Triest, 1994; Browning, 1995). A common feature of these papers is the assumption that preferences and budget sets are convex. This assumption is problematic for two reasons. First, although a convex model is not inconsistent with the presence of labor supply adjustments along the extensive margin, the model implies that these adjustments occur in a continuous manner. Therefore, any individual entering the labor market following a small tax change will choose to work an infinitesimal number of hours. The empirical distribution of hours worked, however, generally shows very few workers at low annual or weekly hours worked (see Figure II).

< Figure II >

Second, the convex framework cannot provide a reasonable approximation for welfare analysis. To see the point, consider a standard labor supply model where individuals have identical preferences but heterogeneous productivities distributed continuously on an interval (such as Mirrlees, 1971). In that framework, there would be a common reservation wage determining labor force participation. A reform which reduces the taxes of low-wage individuals (i.e., around the reservation wage) would raise the number of workers by a small amount. In the convex model, these new entrants would work only a few hours. More precisely, a marginal change in the tax system would induce an infinitesimal number of individuals to join the labor market, at infinitesimal hours of work. By implication, the effect on tax revenue of these behavioral responses is second order. Since the welfare effect of tax reform is determined exactly by the behavioral effects on tax revenue (e.g., Kleven and Kreiner, 2005), adjustments in labor supply along the extensive margin create no first-order welfare effects. Thus, because it models entry-and-exit behavior incorrectly, the convex framework cannot provide a reasonable approximation of the welfare effects of tax reform.

To summarize, the evaluation of tax reforms affecting entry and exit decisions requires a framework that explicitly distinguishes between the two margins of labor supply. Moreover, a type of non-convexity is required to obtain both a realistic description of participation responses and the correct welfare effects. The next section sets up a framework along these lines.[2]

[2] A framework for welfare analysis with discrete choice was provided by Small and Rosen (1981). Their framework is different from ours in two important respects. First, they considered a different type of discreteness, where the consumption of certain goods are mutually exclusive. Examples include housing which may be purchased in either the owner or the rental mode or the choice between different types of transportation (car, train, bus, etc.). By contrast, we consider a situation where non-convex preferences lead the individual to prefer either a corner solution with no demand/supply or an interior solution with substantial demand/supply to the in-between solution with a little demand/supply. While this type of model is particularly relevant for the work decision, it can be applied to other areas as well (say, travel demand). Second, while Small and Rosen considered only linear consumption taxes, we incorporate non-linear taxation in the analysis. This aspect is very important in our context as we demonstrate below.

3.2 The Model of Labor Supply Behavior

The most common explanation for discrete behavior along the extensive margin is the presence of non-convexities in preferences or budget sets due to fixed work costs (Cogan, 1981) or concave work cost functions (Heim and Meyer, 2004). These work costs may be monetary costs (child care, transportation, clothing, etc.) or they could come in the form of time losses (e.g., commuting time and the time used preparing for and recovering from work). Just as important perhaps are emotional costs due to stress and additional responsibilities associated with work. The various types of work costs may be fixed or they may depend in complex ways on working hours. But in general they tend to create economies of scale in the work decision, implying that very low working hours become non-optimal for the individual. We adopt a framework incorporating fixed work costs, denoted by q, which captures the essential elements of the factors mentioned above.[3]

For the fixed work costs, we adopt a stochastic formulation where each individual i draws a fixed cost q_i from a distribution $P_i(q_i)$ with density $p_i(q_i)$. As we shall see, this formulation implies that each individual in the population has a probability of labor market participation, which may be interpreted as an individual participation rate. The formulation is consistent with the empirical part of the paper, where we estimate the individual participation probabilities from a probit regression. The main advantage of the stochastic formulation is that it generates a smooth participation response at the individual level, where small changes in wages or taxes create small changes in the probability of participation. Hence we may capture the sensitivity of entry-exit behavior by setting elasticity parameters for each individual. Although the participation response is smooth in this way, it is also discrete in the sense that, conditional on entry, the individual never chooses very low hours of work. This aspect of the model is very important as pointed out in the previous section.

Individuals choose labor supply behavior after the realization of their fixed cost of working. The labor earnings of individual i is given by $w_i h$, where w_i is the individual productivity level and h denotes working hours. The tax system is described by a function $T(w_i h, \theta)$, where θ is a shift-parameter that we later use to capture policy reform. The tax function is a net payment to the public sector, embodying taxes as well as transfers. For our purpose, it is important that the

[3] We incorporate as well non-convexities in the budget set due to the design of the tax-transfer system. These are mostly due to phase-outs and discontinuities in transfer programs.

specification of the tax/transfer system retains sufficient flexibility for the empirical application. In particular, we allow for nonlinearities and the possibility of discontinuities. Attention is restricted, however, to the case of piecewise linearity where individuals face marginal tax rates which are locally constant.

Individual utility is specified in the following way

$$u_i(c,h) = v_i(c,h) - q_i \cdot 1(h>0), \tag{1}$$

where c is consumption, $v_i(.)$ is a well-behaved utility function, and $1(.)$ denotes the indicator function. In contrast to other welfare analyses incorporating discrete participation behavior (Saez, 2002; Immervoll *et al.*, 2007), our formulation accounts for the presence of income effects. The fixed work cost is incurred only at positive hours of work ($h>0$), and it is assumed to be additively separable in utility. As we shall see below, the separability assumption simplifies the analysis considerably by implying that hours of work for those who are working is independent of the fixed cost. That is, while the fixed cost will affect the choice to participate in the labor market, it will not affect the choice of working hours conditional on participation. For the welfare analysis of tax reform, which depends on labor supply elasticities, the substantive assumption we are making is that intensive labor supply elasticities do not depend on fixed costs.[4] As we are not aware of evidence that intensive elasticities correlate with fixed costs one way or another, this assumption does not seem too restrictive for the empirical application. Notice also that, even though intensive elasticities do not vary with the size of fixed costs, the model does allow for elasticities to vary across individuals due to heterogeneity of preferences and wage rates.

The budget constraint is given by

$$c \leq w_i h - T(w_i h, \theta). \tag{2}$$

The household maximizes (1) subject to (2). The maximization may be solved in two stages. First, we solve for the optimal hours of work conditional on labor force participation and, second, we consider the choice to enter the labor market at the optimal working hours. Given participation, $h>0$, the optimum is characterized by the standard first-order condition

$$(1-m_i) w_i \frac{\partial v_i(c_i,h_i)}{\partial c} = -\frac{\partial v_i(c_i,h_i)}{\partial h}, \tag{3}$$

[4] The assumption of additive separability of fixed costs is stronger than we need. A specification with weak separability, where utility is given by $v_i(f(c,h), q_i \cdot 1(h>0))$, would leave the analysis unchanged.

where c_i and h_i denote consumption and hours of work at the optimum, and $m_i \equiv \partial T(w_i h_i, \theta)/\partial(w_i h_i)$ is the marginal tax rate on earnings. Since the T-function embodies transfers, the marginal tax rate includes the marginal claw-back on any benefits that the individual is receiving. The above expression confirms that the optimal solutions do not depend on the fixed cost q_i, and therefore the utility level (exclusive of fixed costs) $v_i = v_i(c_i, h_i) = u_i + q_i$ will also not depend on the fixed cost. This becomes useful later on.

In the second stage, we solve for labor force participation. For the individual to enter the labor market, the utility from participation must be greater than or equal to the utility from non-participation. This constraint implies a cut-off for the fixed cost given by

$$\bar{q}_i = v_i(c_i, h_i) - v_i\left(c^0, 0\right), \tag{4}$$

where $c^0 \equiv -T(0, \theta)$ denotes consumption for those who are not working. Individuals with a fixed cost below the threshold-value $\bar{q}_i$ decide to enter the labor market at h_i hours, while those with a fixed cost above the threshold choose to stay outside the labor force. The threshold value determining the entry-exit choice reflects in part the difference between consumption for participants and consumption for non-participants. It is useful to write the consumption for participants in the following way

$$c_i = w_i h_i - T(w_i h_i, \theta) = c^0 + (1 - a_i) w_i h_i, \tag{5}$$

where $a_i \equiv [T(w_i h_i, \theta) - T(0, \theta)]/(w_i h_i)$ defines a tax rate on labor force participation. This tax rate is an effective *average* tax rate, including the benefit reduction from entry in proportion to earnings (i.e., the average claw-back rate). For a policy reform affecting only taxes and benefits for workers (such as an EITC), c^0 is constant and labor force participation is affected only through the change in the participation tax rate a_i. Changes in the marginal tax rate m_i will affect optimal working hours h_i, but these changes in h_i is of no consequence for the participation response due to the envelope theorem.

The welfare analysis of tax reform should be based on the dual rather than the primal approach to the individual's problem. In the dual approach, we minimize expenditures to obtain a given utility level. This problem is more involved than usual due to the non-convexity created by fixed work costs. The problem may be written in the following way

$$\min_{c,h} \{c - w_i h + T(w_i h, \theta)\} \text{ st. } v_i(c, h) - q_i \cdot 1(h > 0) \geq u_i, \tag{6}$$

where u_i is a fixed utility level. In the following, we let u_i denote the equilibrium utility level obtained from the primary problem. This implies that the solutions to the expenditure minimization problem (the compensated values of c and h) will be consistent with the solutions to the utility maximization problem (the uncompensated values of c and h).

Again, we may solve the problem in two stages. Conditional on participation, the problem simplifies to

$$\min_{c,h} \{c - w_i h + T(w_i h, \theta)\} \text{ st. } v_i(c,h) \geq u_i + q_i, \tag{7}$$

where q_i is now written on the right-hand side, since it is exogenous at this stage. The solution to this problem $\left(\tilde{c}_i, \tilde{h}_i\right)$ is characterized by the first-order conditions

$$(1-m_i) w_i \frac{\partial v_i\left(\tilde{c}_i, \tilde{h}_i\right)}{\partial c} = -\frac{\partial v_i\left(\tilde{c}_i, \tilde{h}_i\right)}{\partial h} \quad \text{and} \quad v_i\left(\tilde{c}_i, \tilde{h}_i\right) = u_i + q_i. \tag{8}$$

From these equations, we obtain a function for compensated hours of work given by $\tilde{h}_i = \tilde{h}_i((1-m_i) w_i, u_i + q_i)$, and a function for compensated consumption, $\tilde{c}_i = \tilde{c}_i((1-m_i) w_i, u_i + q_i)$. By inserting these functions in eq. (7), we obtain the expenditure function conditional on participation

$$E_i^p(\theta, u_i + q_i) = \tilde{c}_i(\cdot) - w_i \tilde{h}_i(\cdot) + T\left(w_i \tilde{h}_i(\cdot), \theta\right). \tag{9}$$

We write $E_i^p(\cdot)$ as a function of θ to reflect that expenditures are evaluated at the current tax-benefit system. Notice that the θ-parameter enters directly (in the tax function) as well as indirectly, because the compensated variables are functions of the marginal tax rate. We suppress the wage rate w_i as a function argument in the expenditure function, because it is exogenous in the model. Notice finally that the expenditure function $E_i^p(\cdot)$ is increasing in the fixed cost q_i.

If the individual does not enter the labor market, the dual problem is to minimize $c + T(0, \theta)$ with respect to c and subject to $v_i(c, 0) \geq u_i$. The first-order condition is given simply by

$$v_i\left(\tilde{c}_i^0, 0\right) = u_i, \tag{10}$$

which defines a function $\tilde{c}_i^0 = \tilde{c}_i^0(u_i)$. Hence the expenditure function conditional on not working is given by

$$E_i^n(\theta, u_i) = \tilde{c}_i^0(u_i) + T(0, \theta). \tag{11}$$

At the given utility level, labor market participation is optimal if $E_i^p(\theta, u_i + q_i) \leq E_i^n(\theta, u_i)$ whereas non-participation is optimal if the opposite holds. Accordingly, we may characterize the expenditure function in the following way

$$E_i(\theta, u_i, q_i) = \min\left[E_i^p(\theta, u_i + q_i), E_i^n(\theta, u_i)\right]. \tag{12}$$

The comparison of expenditures at participation versus non-participation depends on the size of the work costs q_i. The higher the cost, the higher the value of $E_i^p(\cdot)$, and the less likely it becomes that the individual would want to participate. We may define a threshold value, denoted by $\tilde{q}_i$, where expenditures in the two states are equal, i.e. $E_i^p(\theta, u_i + \tilde{q}_i) = E_i^n(\theta, u_i)$. From eqs (9) and (11), this condition implies

$$\tilde{c}_i = \tilde{c}_i^0 + (1 - a_i) w_i \tilde{h}_i, \tag{13}$$

where a_i is the participation tax rate defined previously.

The participation decision in the dual approach should be consistent with the decision in the primal approach in the sense that the solutions are the same at the actual utility level u_i. To see that this is indeed the case, notice that the first-order conditions (8) and (10) evaluated at $\tilde{q}_i$ implies

$$\tilde{q}_i = v_i\left(\tilde{c}_i, \tilde{h}_i\right) - v_i\left(\tilde{c}_i^0, 0\right). \tag{14}$$

Given the optimal hours of work $\tilde{h}_i$ and consumption for non-participants $\tilde{c}_i^0 = \tilde{c}_i^0(u_i)$, eqs (13) and (14) solve for the compensated threshold value $\tilde{q}_i$ and compensated consumption $\tilde{c}_i$. It is immediately clear that these equations are consistent with (4) and (5) in the primal approach.

Having described the individual's optimization, we are ready to write down aggregate (compensated) labor supply L. Each individual works $\tilde{h}_i((1 - m_i) w_i, u_i + q_i)$ hours if his realized fixed cost q_i is less than or equal to $\tilde{q}_i$. Otherwise he stays out of the labor market. As the probability distribution function for the fixed cost is denoted $p_i(q_i)$, we obtain

$$L = \sum_{i=1}^{N} \int_0^{\tilde{q}_i} \tilde{h}_i((1 - m_i) w_i, u_i + q_i) p_i(q_i) dq_i, \tag{15}$$

where N is the total number of individuals. At this point, we may use the separability of fixed costs to simplify the expression. As explained previously, the separability implies that the equilibrium utility level exclusive of fixed costs, i.e. $v_i = u_i + q_i$, is independent of the realization of the fixed cost. An increase in the cost leads to an offsetting decline in u_i. Hence working hours may be moved outside the integral in the above expression such that we get

$$L = \sum_{i=1}^{N} P_i\left(\tilde{q}_i\right) \tilde{h}_i\left(\left(1 - m_i\right) w_i, v_i\right), \tag{16}$$

where $P_i\left(\tilde{q}_i\right) = \int_0^{\tilde{q}_i} p_i\left(q\right) dq$ is the individual probability of participation, which may be interpreted as an individual participation rate. The above expression emphasizes the joint role of the intensive and extensive margins in determining aggregate labor supply behavior, and it shows that the two margins are related to different tax/transfer parameters. While the choice of working hours depends on the effective marginal tax rate m_i, the participation rate is determined by the cut-off fixed cost $\tilde{q}_i$ which is related to the effective average rate of taxation a_i (the participation tax rate).

From eq. (16), the effect of tax reform on labor supply may be decomposed into its effect on hours of work for those who are working and its effect on labor force participation. As a measure of the sensitivity along the intensive margin, we define the compensated hours-of-work elasticity with respect to the marginal net-of-tax rate, $1 - m_i$, i.e.

$$\varepsilon_i \equiv \frac{\partial \tilde{h}_i}{\partial\left(1 - m_i\right)} \frac{1 - m_i}{\tilde{h}_i}. \tag{17}$$

The sensitivity along the extensive margin is captured by a participation elasticity, defined as the percentage change in the participation rate P_i created by a one percentage change in the average net-of-tax rate, $1 - a_i$, i.e.

$$\eta_i \equiv \frac{\partial P_i\left(\tilde{q}_i\right)}{\partial\left(1 - a_i\right)} \frac{1 - a_i}{P_i\left(\tilde{q}_i\right)}. \tag{18}$$

Notice that each elasticity is defined with respect to the net-of-tax rate which is relevant for the margin in question. For the purpose of empirical application, one should bear in mind that both elasticities are compensated. However, this matters mostly for the hours-of-work elasticity. In fact, for the participation elasticity, one can show that the compensated elasticity η_i is identical to the uncompensated elasticity as long as we are considering a change in taxes for workers only (such that $T\left(0, \theta\right)$ is constant). The reason is that the derivative of the compensated cut-off $\tilde{q}_i$ (from eqs 13 and 14) is the same as the derivative of the uncompensated cut-off $\bar{q}_i$ (from eqs 4 and 5) as long as non-participants are unaffected, so that out-of-work consumption levels are constant in compensated *and* uncompensated terms. To obtain the result, we need also to invoke the envelope theorem, implying that any income effects on hours of work does not matter for the change in the threshold $\bar{q}_i$. The equivalence of compensated and uncompensated participation responses is important, since it implies that participation elasticities estimated from tax-benefit reform affecting only workers (say the EITC) can be interpreted as compensated elasticities and may be used as an input in the welfare analysis.

3.3 The Welfare Analysis of Tax Reform

To study the relationship between tax reform and efficiency, we start by defining the excess burden of taxation on a single individual. Several different measures involving consumers' surplus or Hicksian variations have been proposed in the literature (cf. Auerbach and Rosen, 1980, and Auerbach, 1985). We adopt a measure based on the equivalent variation, defining the excess burden as the amount—in excess of government revenue—that the individual would be willing to pay to get rid of all taxes and transfers. In other words, how much additional revenue could be collected, with no loss in utility for the individual, if the distortionary tax were to be replaced by a lump sum tax. Hence, the excess burden on individual i from a tax-benefit system θ is given by

$$EB_i\left(\theta, u_i, q_i\right) = E_i\left(\theta, u_i, q_i\right) - E_i\left(0, u_i, q_i\right) - R\left(\theta, u_i, q_i\right), \tag{19}$$

where $E_i\left(\theta, u_i, q_i\right)$ denote expenditures at the existing tax-benefit system, $E_i\left(0, u_i, q_i\right)$ denote expenditures in the absence of taxes and transfers, and u_i has been defined above as the post-tax level of utility. The net tax payment of individual i, $R\left(\theta, u_i, q_i\right)$, is equal to $T\left(w_i \tilde{h}_i\left(\cdot\right), \theta\right)$ conditional on working ($q_i \leq \tilde{q}_i$) and $T\left(0, \theta\right)$ conditional on not working ($q_i > \tilde{q}_i$).

The aggregate excess burden is defined as the sum of the individual excess burdens (Auerbach, 1985), i.e.,

$$EB = \sum_{i=1}^{N} \int_0^{\infty} \left[E_i\left(\theta, u_i, q_i\right) - E_i\left(0, u_i, q_i\right) - R\left(\theta, u_i, q_i\right)\right] p_i\left(q_i\right) dq_i. \tag{20}$$

Because of heterogeneity in wages, tax rates, tastes, and fixed costs, individual excess burdens of taxation vary across the population. Thus, the aggregate excess burden measure compares the revenue from individual lump sum taxes, keeping each individual at her post-tax level of utility, to the actual revenue collected by the distortionary tax system.[5]

[5] With heterogeneous agents, aggregation problems can arise (see Auerbach 1985). In particular, any measure

By using eq. (12) and the definition of $R(\theta, u_i, q_i)$, we may rewrite the aggregate excess burden to

$$\begin{aligned} EB &= \sum_{i=1}^{N} \left[\int_{0}^{\tilde{q}_i} \left(E_i^p (\theta, u_i + q_i) - T\left(w_i \tilde{h}_i (\cdot), \theta \right) \right) p_i (q_i)\, dq_i \right. \\ & \left. + \int_{\tilde{q}_i}^{\infty} \left(E_i^n (\theta, u_i) - T(0, \theta) \right) p_i (q_i)\, dq_i - \int_0^{\infty} E_i (0, u_i, q_i)\, p_i (q_i)\, dq_i \right]. \end{aligned} \tag{21}$$

To derive the consequences of a tax reform, we consider the effect on EB of a marginal change in the θ-parameter. Because of the envelope theorem, any changes in behavior induced by the reform does not affect the expenditure functions. Thus, from eqs (9) and (11), the changes in expenditures are given simply by the *mechanical* changes in taxes and benefits, $\partial E_i^p (\theta, u_i + q_i) / \partial\theta = \partial T\left(w_i \tilde{h}_i (\cdot), \theta \right) / \partial\theta$ and $\partial E_i^n (\theta, u_i) / \partial\theta = \partial T(0, \theta) / \partial\theta$. Using these relationships, we may differentiate eq. (21) to obtain

$$\frac{\partial EB}{\partial\theta} = -\sum_{i=1}^{N} \left[m_i w_i \frac{\partial \tilde{h}_i}{\partial\theta} P_i (\tilde{q}_i) + a_i w_i \tilde{h}_i \frac{\partial P_i (\tilde{q}_i)}{\partial\theta} \right], \tag{22}$$

where we have also used the definition of the participation tax rate a_i, the relationship $\partial P_i (\tilde{q}_i) / \partial\theta = p_i (q_i) \cdot \partial q_i / \partial\theta$ and the fact that $E_i^p (\theta, u_i + q_i) = E_i^n (\theta, u_i)$ at the threshold level $\tilde{q}_i$. This equation shows that the marginal deadweight burden of tax reform is given by the effect on government revenue from behavioral responses. The expression reflects that the behavioral revenue effect is related to the two different margins of labor supply response. The first term captures the revenue effect from the change in the optimal hours of work for those who are working. The second term gives the effect on revenue brought about by the tax-induced change in labor force participation. While the second effect on efficiency is related to the tax rate on labor force participation a_i, the efficiency effect from changed working hours depends on the tax burden on the last dollar earned m_i.[6]

The equality of the welfare effect with the behavioral effect on government revenue reflects a general insight from models with no externalities besides those created by taxes and transfers. In the present context, one should bear in mind that the model features no imperfections in

of aggregate excess burden will depend on the initial distribution of income. To generate a distribution-neutral measure of excess burden, one would have to impose strict conditions on preferences such as no income effects [quasilinear utility] or constant income effects [Gorman Polar form].

[6] Using expression (22), we can confirm that the welfare effects from extensive responses disappear in a convex framework (see Section 3.1). The reason is that new workers enter at infinitesimal hours, $\tilde{h}_i \approx 0$, with the consequence that $T\left(w_i \tilde{h}_i, \theta \right) - T(0, \theta) = a_i w_i \tilde{h}_i \approx 0$ for these individuals. The revenue effect created by such participation responses (the second term in eq. 22) equals zero to a first order.

the labor market. Thus, since non-employment is voluntary, the marginal entrant is indifferent between working and not working. If a small tax reform induces additional entry, the new entrants obtain no first-order utility gains, but they create a positive externality on everybody else through the government budget. Likewise, the hours-of-work responses for those who are employed create no direct utility gains, but they give rise to an externality through the government budget.

The effect of the reform on working hours may be obtained from the compensated labor supply function, $\tilde{h}_i\left(\left(1-m_i\right)w_i, v_i\right)$. The participation response depends on the change in the threshold value $\tilde{q}_i$, which may be derived from total differentiation of eqs (13) and (14). By inserting the derivatives in (22) and using the elasticity definitions (17) and (18), the marginal excess burden in proportion to aggregate income may be written as (see Appendix A)

$$\frac{\partial EB/\partial\theta}{\sum_{i=1}^{N} w_i\tilde{h}_i P_i\left(\tilde{q}_i\right)} = \sum_{i=1}^{N}\left[\frac{m_i}{1-m_i}\frac{\partial m_i}{\partial\theta}\cdot\varepsilon_i + \frac{a_i}{1-a_i}\frac{\partial a_i}{\partial\theta}\cdot\eta_i\right]s_i, \tag{23}$$

where $s_i \equiv w_i\tilde{h}_i P_i\left(\tilde{q}_i\right)/\left(\sum_{i=1}^{N} w_i\tilde{h}_i P_i\left(\tilde{q}_i\right)\right)$ is the (expected) wage share of individual i, and where $\partial a_i/\partial\theta \equiv \left[\frac{\partial T\left(w_i\tilde{h}_i,\theta\right)}{\partial\theta} - \frac{\partial T(0,\theta)}{\partial\theta}\right]/\left(w_i\tilde{h}_i\right)$ is the impact on the effective average tax rate (the participation tax) from the reform. The first term in the bracketed expression looks familiar, since it reflects a classic Harberger-style formula for the marginal deadweight burden of taxation. It shows that the welfare loss created on the intensive margin depends on the level of the marginal tax rate, the change in the marginal tax rate due to the reform, and the elasticity of hours of work. The second component in the expression reflects the deadweight loss due to changed labor supply behavior along the extensive margin. This effect is related to the level of the participation tax rate, the change in the participation tax as well as the sensitivity of entry-exit behavior as measured by the participation elasticity. Hence, the welfare effects created on the two margins of response may be expressed in similar ways, except that they are related to different tax and elasticity parameters. Finally, since the individual effects are weighted by individual earnings shares, the initial income distribution matters for the marginal excess burden of the reform.

A priori one might have wondered whether the standard convex framework could be saved by a reinterpretation of the labor supply elasticity. Following this interpretation, one would introduce extensive responses into the framework simply by using estimates of the *total* labor supply elasticity including both margins of response. The above analysis demonstrates that, in general, this approach is not correct, since labor force participation is related to a different tax wedge than are working hours. The analysis also shows that the size of the error made by the conventional model depends on the degree to which the observed variation in aggregate labor supply is concentrated on the extensive margin.

Having said that, it should be noted that there is one special case for which a reinterpretation of the conventional model is valid. This is the case of a linear Negative Income Tax (NIT), which grants a lump sum transfer B to all individuals in the economy (participants and non-participants) and then imposes a constant marginal tax rate on labor income, $m_i = m \ \forall i$. In this case, the tax burden on labor market entry for individual i becomes $T\left(w_i\tilde{h}_i, \theta\right) - T\left(0, \theta\right) = mw_i\tilde{h}_i$, which implies a participation tax rate $a_i = m$. Moreover, if the tax reform is simply a change of tax/transfer parameters within the framework of the NIT, we would have $\frac{\partial a_i}{\partial \theta} = \frac{\partial m}{\partial \theta}$. Inserting in eq. (23), we get

$$\frac{\partial EB/\partial \theta}{\sum_{i=1}^{N} w_i\tilde{h}_i P_i\left(\tilde{q}_i\right)} = \frac{m}{1-m}\frac{\partial m}{\partial \theta} \cdot \left(\varepsilon + \eta\right), \tag{24}$$

where $\varepsilon \equiv \sum_{i=1}^{N} \varepsilon_i s_i$ and $\eta \equiv \sum_{i=1}^{N} \eta_i s_i$ are weighted averages of individual elasticities. This corresponds to a standard Harberger-type formula, with the intensive and extensive elasticities being lumped in a total labor supply elasticity $\varepsilon + \eta$.[7]

Although the above special case is theoretically interesting, its practical applicability is limited. It requires that the entire tax and welfare system is a linear NIT, which is never satisfied in reality. For example, it does not apply to situations with gradual phase-out of benefits (as with cash benefits and food stamps in the US) and/or if there are discontinuities in benefits (as with medicaid). Nor will it apply if the income tax system involves in-work benefits like the EITC and/or increasing marginal rate structures. Our empirical application will account for all these factors in the simulation of tax wedges on the two margins.

[7] In this special case, it does not cause problems that the intensive and extensive elasticities were defined with respect to different net-of-tax rates. With an NIT, the average and marginal tax rates are identical implying that $1 - m_i = 1 - a_i$ for $\forall i$.

4 Evaluating Tax Reforms: The Case of Single Mothers

4.1 Simulation Method

This section applies the welfare formulae derived above to the evaluation of tax reforms. In particular, we evaluate the welfare effects of four tax reforms in the United States passed in 1986, 1990, 1993, and 2001. We focus on single mothers, because empirical evidence suggests strong participation responses for this population. Since the results from Section 3 were based on a small reform approach, the computed welfare effects represent first-order approximations to the true effects. We come back to the implications of second-order effects below. The big advantage of the small reform method is its simplicity and transparency. To evaluate the reforms, we need only to estimate earnings and tax rates and to set elasticities based on the empirical literature. This is because the welfare effect of tax reform reflects the externalities created by changes in government revenue, a results that follows from the definition of excess burden and the application of envelope theorems. Hence, we do not need to specify utility functions or estimate (or calibrate) utility parameters. Neither do we need to estimate fixed costs of working. Our approach is therefore very nonstructural.

Our simulation procedure consists of several steps. First, we estimate the likelihood of labor market participation and earnings for each individual in a baseline year (usually the year prior to the tax change). For nonparticipants, the imputation of earnings is necessary to calculate labor income and tax liability if they choose to enter following a reform. To be consistent, we use imputed earnings for workers as well. The imputation of earnings is based on a simple log earnings regression, specified as

$$\log(y_i) = X_i\alpha + \hat{P}_i\beta + \nu_i,$$

where y is earned income (for the sample of workers), and X represents demographic characteristics, including age, education, age-education interactions, race, state of residence, and family size. To control for the self-selection of workers, we include a propensity score—the predicted probability of employment $\hat{P}_i$—as a regressor in the earnings equation. This probability of employment is estimated from a first-stage probit

$$P(lfp_i = 1) = \Phi(Z_i\gamma),$$

where lfp is labor force participation and Z includes all demographic characteristics, including family size *and* the number of preschool children. We therefore identify the selection effect using the number of preschool children. It does not seem unreasonable to assume that children under 6 affect the likelihood of a mother working but do not affect her labor-market earnings.[8]

We use predicted earnings to simulate individual marginal and average tax rates (pre-reform levels), as well as changes in *federal* tax rates implied by the reforms. By simulating the actual individual tax changes induced by the reforms, our methodology differs from most numerical studies of tax reform, which consider simple hypothetical reforms.[9] Section 4.3 describes the tax simulations in detail.

To simulate welfare benefits, we create a benefit calculator that includes the major programs of the welfare system (cash assistance, food stamps, and medicaid). Our benefit calculator accounts for the main features of these programs, including the income-dependent reduction rates, state, and number of dependent children.

Using simulated tax and benefit rates, we calculate effective marginal and average tax rates for each individual (both baseline levels and reform-induced changes). Finally, we compute welfare effects based on assumed elasticities and the formulae derived in Section 3.

The fact that our welfare simulations build on a small reform approach is a potential source of error. Of course, since we do welfare simulations for each of the four reforms separately (re-estimating the baseline each time), we do not assume that the four reforms collectively are small, only that each reform separately is small. Nevertheless, because some of the reforms we consider were quite substantial, especially TRA86, second-order effects may be important. We make two potential errors by ignoring second-order effects. One is that we evaluate the revenue and welfare effects using pre-reform tax rates even though the reforms discretely changed tax rates. Specifically, because the reforms reduced tax rates, we tend to overstate the welfare gains by evaluating revenue effects at tax rates that are too high. However, our simulation experiments show that the sensitivity of welfare effects to the size of pre-reform tax wedges is not strong enough to make this effect quantitatively important.

A second type of error can arise because we evaluate the welfare effect at given labor supply

[8] In an earlier version of the paper, we used the number of children to identify the participation effect and found unchanged results. This result suggests that our findings in this paper are not driven by the predicted earnings distribution. We argue later that the primary factors behind our conclusions are the characteristics of the tax schedules and tax reforms.

[9] Papers considering hypothetical tax reforms include Browning and Johnson (1984), Ballard (1988), Triest (1994), Browning (1995), Liebman (2002), and Immervoll *et al.* (2007).

elasticities. A big enough reform may change labor supply elasticities and evaluating the entire effect at given elasticities is not exact. A recent paper by Heim (2006) suggests that the labor supply elasticities of married females have been shrinking over the 1980s and 1990s. It is perceivable that a similar phenomenon has been occurring for the group of single mothers that we analyze, and the effect could be related in part to the changing tax and welfare systems over the period. However, notice that we may capture this type of effect, at least in part, by setting different elasticities for different reforms. Our simulation method is designed exactly to use elasticities estimated elsewhere in the literature relevant to the different reforms and time periods under consideration.[10]

4.2 Data and Regression Results

The data for the simulations come from the 1986, 1991, 1994 and 2001 March Current Population (CPS) Surveys. The March CPS is an annual demographic file of nearly 60,000 households, with information on labor market and income outcomes for the previous year. Therefore, the data we use are for tax years 1985, 1990, 1993 and 2000.

The CPS reports income and demographic information on households, families and individuals. We note this fact because families and households may be different from the relevant unit of observation for our exercise—the tax-filing unit—if there are subfamilies (children and/or grandchildren). We base our tax-filing units on CPS families, and allocate subfamilies (both related and unrelated) to separate tax-filing units from the primary family. We consider any member of the tax-filing unit who is under the age of 19 (or less than 24 and a full-time student) to be a dependent child for tax purposes. We also assume that any taxpayer with a child meeting the age criteria also meets both the dependent child and EITC child requirements.

The sample includes unmarried females (widowed, divorced, and never-married) who are between 18 and 49 years old and have children. It does not include older women, primarily to avoid complications related to modeling retirement decisions. Nor does it include any female who was ill or disabled, in the military, or reported herself retired during the previous year. Finally, we exclude observations with negative earned income (due to negative self-employment income), negative unearned income, or with positive earned income but zero hours of work.

[10] In the simulations below, we do not assume that elasticities are necessarily shrinking over time. But we present a sensitivity analysis with respect to the elasticity for each reform, making it possible to compare welfare effects if the elasticity has indeed been declining.

The resulting sample sizes are in the range of 4,000 to 5,000 individuals across the years.

Summary statistics of the data (shown in Eissa *et al.*, 2004) suggest that the typical unmarried mother looks only slightly different from 1985 to 2000. While she is between 32 and 33.5 years old, she is clearly aging over the 15-year period, and has fewer children by the end of the period. With high school education, her earnings amount to $7,922 in 1985 ($12,674 in 2000 dollars). Over time, she has slightly more education as well as higher earnings, due to both increases in gross hourly wages and more hours worked.

Our results for the first-stage probits and the earnings regressions are very consistent for 1985, 1990 and 1993, and show that the propensity score adjustment for selection into the labor market is significant in the earnings regressions. The propensity score correction for selection into the labor force is quite a bit weaker in 2000, however. One reasonable explanation of this finding could be the success of welfare reform in encouraging mothers into the labor force. Nonetheless, we find that the distribution of predicted relative to actual earnings looks similar for all years.

4.3 Tax and Benefit Calculations

This section describes our method of calculating tax and benefit parameters. To start, we note that the appropriate measure of the tax wedge encompasses the entire effect of behavioral responses on revenue, and therefore must include all taxes and transfers (benefits). Our computations of individual effective tax rates include federal, state and payroll taxes, as well as cash assistance, Food Stamps and Medicaid.[11] Individual tax rates are computed using predicted earnings, CPS-measures of non-labor income (including social insurance benefits and unemployment insurance benefits) and demographic characteristics such as number of children and state of residence. Because the CPS does not ask about itemized deductions, we make the reasonable assumption that all female heads take the standard deduction.

The tax parameters for the sample of female heads are calculated using the Tax Simulation Model (TAXSIM) of the National Bureau of Economic Research (NBER).[12] To compute pre-

[11] Because payroll taxes are shared by the employee and the employer, we have to decide how to treat the incidence of these taxes. We make the (reasonable) assumption that workers bear the full incidence of employer payroll taxes. This implies that, in the absense of a payroll tax, wages would have been higher by the employer share of the payroll tax. Hence, the appropriate measure of pre-tax wages equals observed wages multiplied by the factor $(1 + 0.5 \times \text{payroll tax rate})$, and we then have to divide all tax rates by this factor. This adjustment reduces the effective taxation implied by all the different taxes and benefits, not just the payroll tax.

[12] See Feenberg and Coutts (1993) for an introduction to TAXSIM.

reform marginal and average tax rates on labor income,[13] we use estimated earnings $(\hat{y}_i)$ and other CPS-data relevant for tax liability (I_i). TAXSIM calculates marginal tax rates as the tax owed on an additional 10 cents of earnings, i.e. $\left[T\left(\hat{y}_i + 10 \text{ cents}, I_i\right) - T\left(\hat{y}_i, I_i\right)\right] / (10 \text{ cents})$. It also calculates total liabilities, which may be used to derive an average tax rate relevant for participation. This average tax rate is defined as the difference between tax liability at predicted earnings $T(\hat{y}_i, I_i)$ and at zero earnings $T(0, I_i)$ in proportion to predicted earnings, i.e. $[T(\hat{y}_i, I_i) - T(0, I_i)]/\hat{y}_i$.

TAXSIM-generated tax rates do not include any transfer components. In the United States, lower-income families are eligible to receive cash assistance from the Temporary Assistance to Needy Families (TANF), previously Aid to Families with Dependent Children (AFDC) program. In addition, eligible families may receive in-kind benefits in the form of food vouchers (Food Stamps) and health insurance (Medicaid). To incorporate benefits, we augment tax data from TAXSIM with information on AFDC, Food Stamps and Medicaid. Because transfer programs have differing eligibility and benefit structures at the federal and state levels, we treat each program separately. In particular, the benefit calculations account for the dependence of benefits on the state of residence and on the number of dependent children.

Calculations of effective average tax rates account for benefits lost with labor market entry, including AFDC (TANF), Food Stamps, and Medicaid. Where appropriate, calculations of effective marginal tax rates account for TANF/AFDC and Food Stamps benefit reduction rates. A concern that arises here is the bias that occurs from less than 100 percent take-up of welfare benefits (see Moffitt, 1992). Because not all eligibles receive benefits, our calculations as such would overestimate "true" benefits on average. To correct this bias we apply an empirical take-up rate, calculated from our CPS data as the share of the eligible population that reports positive benefits during the year. We apply a take-up rate of 54 percent, calculated using our 1993 March CPS data. This take-up rate is consistent with empirical evidence in the welfare literature (Moffitt, 1992).

Figure III shows sample means for the marginal and average tax rates in the four pre-reform years (1985, 1990, 1993, 2000). The figure illustrates the dramatic changes in the tax treatment of single mothers. Most notable is the decline in the overall tax burden—captured by the

[13] With the exception of TRA86, pre-reform tax rates are calculated for the year in which the reform was enacted. We use the previous year as baseline for TRA86 to account for the fact that the reform was extensively discussed and potentially anticipated.

average tax rate—from 1985 to 2000. For a representative single mother, the average tax rate (exclusive of benefits) dropped from 14 percent to *minus* 4 percent over this period, while the benefit-adjusted average tax rate went from 54 percent to 30 percent. The marginal tax rate shows a more moderate and less systematic decline than the average tax rate. This pattern is not surprising given the large expansions of the EITC during this period. An expansion of the EITC reduces unambiguously the tax burden, whereas its impact on the marginal tax rate depends on the distribution of individuals on the different income intervals of the EITC (phase-in, plateau, and phase-out). The figure shows that accounting for benefits and transfers is very important. In fact, the pattern showing greater marginal than average tax rates is reversed when the impact of benefits and transfers is included.

< Figure III >

In Figure III, the changes in tax rates across the different pre-reform years reflect all changes in the tax and welfare system taking place at the federal and state levels over the period, and they incorporate as well any behavioral responses to these tax and benefit changes as well as macro/time effects on income variables. To isolate the impact of the federal tax reforms on tax rates (exclusive of behavioral responses feeding back into tax liabilities), we measure the difference between imputed post-reform tax rates and pre-reform rates. The post-reform tax rate is imputed by using federal tax rules applying after the reform have been fully phased in. The post-reform years for the four tax acts we consider are 1988, 1993, 1996 and 2002. Using the TAXSIM model, we combine post-reform federal tax rules with pre-reform earnings (adjusted for inflation) to obtain new federal tax liabilities. The post-reform tax rates to be used in the simulations are then constructed from the new federal taxes combined with the pre-reform state taxes, payroll taxes and benefits.

Figure IV confirms that the decrease in effective tax rates over the 15-year period has been driven to a large extent by tax changes at the federal level. This was particularly the case for the 1986 and 1993 reforms, which reduced the average tax rate by 7 and 12 percentage points, respectively.

< Figure IV >

As a final note, we point out the heterogeneous effects of the tax laws on single mothers.

The data reveals substantial variation in the different tax parameters (see Eissa *et al.*, 2004). This heterogeneity highlights the need for using microsimulations to evaluate the tax reforms. Large errors may occur in more aggregate studies because of the correlation between earnings, tax rates and tax changes, a point which we come back to below.

4.4 The Welfare Effects of Tax Reform

In this subsection, we present simulated welfare effects for all four tax reforms. Our simulations are based on assumptions about the elasticities along the two margins of labor supply response. Given existing empirical evidence, we assume that participation is more elastic than hours worked. In our benchmark scenario, we set the participation elasticity equal to 0.40 and the (compensated) hours-of-work elasticity equal to 0.10, implying a total labor supply elasticity equal to 0.50. Subsequently, we carry out a sensitivity analysis where we alter the size of the total elasticity, as well as its composition.

Table II summarizes the welfare effects for all four reforms under the benchmark scenario. The total welfare gain as a percentage of aggregate labor income is reported in column (3), and can be decomposed into the effect created along the intensive margin (column 1) and along the extensive margin (column 2). We find substantial welfare gains for all the reforms, especially for the 1986 reform, which created a welfare gain of 5.47 percent of labor income. The effects were also high for the 1990 and 1993 reforms (2.09 and 2.18 percent), which contained the largest expansions of the EITC. The welfare gain was more modest for the 2001 reform. But, as shown in column (5), this reform was also smaller in terms of the total tax cut for single mothers, and this makes the welfare gains difficult to compare across reforms. To facilitate comparison, we therefore report the welfare gain per dollar spent in column (6). These numbers confirm that TRA86 created much larger efficiency gains than the subsequent reforms.

$<$ Table II $>$

For all four reforms, most of the total welfare gain is generated on the extensive margin. While 4/5 of the gain from TRA86 is created by labor market entry, essentially all of the positive effect from OBRA90 is driven by labor force participation. For this reform, the intensive welfare effect is around zero because negative effects in the phase-out region cancel out positive effects in the phase-in region of the EITC. For OBRA93, the welfare gain is a result of the extensive margin dominating welfare losses created on the intensive margin. With EGTRRA in 2001, the difference between the intensive and extensive welfare effects are less pronounced. This occurs for two reasons. First, the 2000 tax cuts reduced average tax rates only slightly. More interesting is that by 2000, previous reforms seem to have eliminated much of the inefficiency along the extensive margin (cf. Section 4.3).

Our results demonstrate the importance of accounting for individual heterogeneity in tax simulations. As examples, the 1990 and 1993 reforms created zero or negative welfare effects along the intensive margin despite the fact that both reforms introduced significant reductions in the marginal tax rate of the representative individual (see Figure IV). Hence, a simple representative agent approach would have implied welfare gains rather than losses. The results in the table can be explained by the fact that the changes in marginal tax rates from the expanded EITC were strongly heterogeneous *and* correlated with the levels of earnings and tax rates. For instance, following the 1993 reform, some individuals experienced large reductions in their marginal tax rates from a higher EITC phase-in rate, whereas other individuals experienced increases in their marginal tax rates due to an increased claw-back rate and an expanded phase-out region for the EITC. The increases in the phase-in rate were large enough that the population of single mothers as a whole got lower effective marginal tax rates. However, the marginal rate reductions from a steeper phase-in of the EITC were relatively unimportant for efficiency because they were occurring at very low wage levels, where only small behavioral revenue effects can be generated.

One might argue that our findings regarding the relative sizes of the extensive and intensive welfare effects were to be expected under the assumed elasticity scenario. Notice, however, that the difference between extensive and intensive welfare effects cannot be explained exclusively by elasticities, since the two kinds of welfare effects are related in different ways to the tax-transfer system. For example, for the tax act of 1990, increasing the hours-of-work elasticity would leave the intensive welfare effect more or less unchanged since the losses in the phase-out region would continue to cancel out the gains created in the phase-in region. For OBRA93, increasing the intensive elasticity would simply exacerbate the welfare loss along that margin, thereby reinforcing the point regarding the difference of welfare effects along the two margins.

Our finding that the extensive responses drive most of the welfare effects for the four reforms reinforces the relevance of this margin of labor supply. However, we cannot conclude that the large extensive effects necessarily capture the size of the error committed by the standard (convex) policy simulation. There are two reasons for this. First, previous studies considered other (hypothetical) reforms. The error made by leaving out the participation margin depends crucially on the details of the tax reform and the tax-transfer system in place at the time of the reform. Second, it is not always clear how to interpret elasticities used in the studies that do not model the participation margin. A common approach in the literature was to set labor supply parameters based on total elasticities, hence ascribing all of the extensive response to the intensive margin. We explore the consequences of this approach in column (4), called 'traditional' for lack of a better word. The numbers demonstrate clearly the large error made by ascribing an empirical response to the wrong margin in policy analysis. For example, for the 1993 reform, the error thus committed is larger than ignoring the response altogether.

These errors reflect that the two margins of labor supply response depend on taxes and transfers in different ways. While the intensive margin depends on the effective marginal tax rate, the extensive margin is related to the effective average tax rate. By implication, the size of the error depends crucially on the properties of the tax-transfer programs being analyzed. For example, if one were to consider a change in a proportional tax rate, and if the existing tax-transfer system is also proportional, lumping margins together would create no error in the welfare analysis. Likewise, one would create no error in the case of a linear NIT system (cf. Section 3.3). However, linear taxation is not a realistic description of the actual tax-transfer policies which involve nonlinearities as well as discontinuities. The discrepancy between the numbers in columns (3) and (4) reflects the importance of these aspects for the welfare analysis.

In Table III we explore the sensitivity of the results to alternative elasticity assumptions. The scenario considered above ('Middle') is compared with 'Low' and 'High' scenarios to get a range for the likely effects. In the Low scenario, the intensive elasticity ε is set equal to 0.05 while the extensive elasticity η is equal to 0.20, implying a total elasticity equal to 0.25. In the High scenario, the intensive and extensive elasticities are 0.15 and 0.60, respectively, such that the total elasticity is 0.75. Notice that the Low, Middle, and High scenarios all reflect the same composition of labor supply responses, with the intensive elasticity being one-fifth of the total elasticity. Finally, we compare the Middle scenario to one with identical elasticities along the intensive and extensive margins ($\varepsilon = \eta = 0.25$). The Identical scenario has the same total elasticity as the Middle scenario (0.50) so as to isolate the effect of composition.

< Table III >

As we would expect, the size of the welfare effect is quite sensitive to the size of elasticities. From the welfare theory, we know that the sensitivity of marginal excess burden functions with respect to elasticities depends on the level of tax rates at the time of the implementation of the reform. The higher the initial tax rate, the greater the sensitivity of the results to the elasticities. Therefore, one would expect the sensitivity to be highest for the 1986 reform. To see that this is indeed the case, one should compare the welfare gains per dollar spent across reforms to account for the different sizes in the revenue costs. For TRA86, it is interesting to note that a total elasticity of 0.75—not out of bounds of the empirical estimates—implies Laffer curve effects. In this scenario, the large tax reductions granted to single mothers were recouped entirely from the labor supply responses created by the reform.[14]

An advantage of our approach is that it allows a sensitivity analysis with respect to the composition of the total elasticity, not just its size. The results in Table III demonstrate very clearly that welfare effects may be very sensitive to the composition of the elasticity. The sensitivity will be especially high for reforms that affect the two margins of response in very different ways. In particular, this was the case for OBRA90 and OBRA93 which introduced big improvements in the returns to entry from the EITC, while at the same time worsening the incentives along the intensive margin for many people due to the phase-out of the credit. Consequently, the composition of the elasticity becomes crucial for the welfare effects of these two reforms. For the 1993 reform, changing the benchmark composition ($\varepsilon = 0.10$; $\eta = 0.40$) to one with identical elasticities ($\varepsilon = \eta = 0.25$) reduces the welfare gain from 2.18 percent of labor income to 1.02 percent. This reduction in the welfare gain is larger than what would be obtained by halving the total labor supply elasticity without changing composition, i.e., going from the Middle scenario to the Low scenario.

Despite the sensitivity of the results with respect to both size and composition of the elasticity, Table III displays significant gains across all elasticity scenarios and for all four reforms. In every scenario, the welfare gain per dollar spent is larger than one. This implies that the

[14] A randomized social experiment in Canada also indicates that Laffer effects may occur at the bottom of the income distribution. The Canadian Self-Sufficiency Project (SSP) provides a time-limited earnings supplement to single parents who find full-time work after having been on welfare for at least a year. The analysis by Michalopoulos *et al.* (2005) show that, at the end of the period examined, the SSP program was paying for itself through increased tax revenues.

tax cuts to single mothers are generating pure efficiency gains. That is, if one were to finance the tax cuts through lump sum taxation, which involves a marginal cost of funds (MCF) less than or equal to one, the reforms would increase aggregate utilitarian welfare.[15] In reality, the EITC is financed, not by lump sum taxes, but through higher distortionary taxes on middle- and high-income earners, which implies a marginal cost of funds above one. For the EITC to create efficiency gains in this case, the marginal cost of funds would have to be lower than the welfare gains per dollar spent reported in the table. This is difficult to say something about because MCF estimates are highly sensitive to the design of the tax increases (e.g. Kleven and Kreiner, 2006). However, it is interesting to note that if MCF is 1.4, a reasonably high value given the existing estimates, then the tax cuts to single mothers are creating pure efficiency gains for all reforms in our benchmark scenario. This is a strong result since it indicates that one does not even have to rely on higher social welfare weights for the EITC recipients (single mothers) than for the rest of population to justify the reforms.

In all of the scenarios considered so far, elasticities were uniform across the population of single mothers. It is difficult to evaluate the empirical validity of this assumption, since empirical evidence on labor supply elasticities across the income distribution is limited and only suggestive at best. Eissa and Liebman (1996), for example, find that behavioral responses were strongest for the least educated (i.e. lowest potential earnings). We relax the assumption of a uniform participation elasticity and allow it to decline with predicted income: women who are predicted to enter the labor market at higher incomes (say the phase-out region of the EITC) should be less sensitive to a given change in tax-transfer schemes than women predicted to enter at lower incomes (phase-in region). Table IV presents welfare effects with a decreasing profile for the participation elasticity, keeping the average elasticity for single mothers as a whole equal to 0.4 as in Table II. The results show that our conclusions are robust to the introduction of heterogeneous participation elasticities. In particular, total welfare gains are substantial and are created mostly along the extensive margin. While total gains are somewhat lower for the 1986 and 2001 reforms, the gains created by the 1990 and 1993 reforms are higher compared to the uniform-elasticity scenario. These results reflect offsetting effects. Concentrating the extensive response at low earnings means that labor-market entry generates less government

[15] The marginal cost of funds for lump sum taxation is generally below 1 because, assuming that leisure is a normal good, such taxes make individuals work more (Ballard and Fullerton, 1992). In the absence of income effects (quasi-linear utility), the marginal cost of funds is exactly 1.

revenue and, therefore, lower welfare gains. On the other hand, more of the responsiveness is concentrated along the margin most affected by those tax acts that expanded the EITC and reduced participation taxes (OBRA90 and OBRA93). For OBRA93, the latter effect dominates the dampening effect of the earnings-elasticity correlation, creating larger gains.

< Table IV >

4.5 The Interaction Between Tax Reform and Welfare Reform

Over the period we analyze, state-level Welfare Demonstrations and the Welfare Reform Act of 1996 changed dramatically the nature of transfer programs in the United States. Our simulations isolate the impact of tax changes by fixing transfer programs for each reform, but allows the baseline transfer system to change from one reform to the next. There are two channels through which the transfer system in place at the time of each tax reform may affect the tax simulations: (*i*) the size of labor supply elasticities, and (*ii*) the size of effective tax wedges and hence the revenue and efficiency effects at given elasticities. The first effect can only be captured in an ad hoc way, because our method uses elasticities estimated in the literature. To gauge the impact of the second effect, we simulate tax rates and welfare effects holding constant transfer programs in a base year, 1985. Table V presents effective tax rates and welfare effects for the four reforms, using 1985 transfer benefits, and compares (in parentheses) to the results from Table II based on the actual welfare system in each year.

< Table V >

To carry out this type of simulation, we have to decide what it means to keep benefits at their 1985 level. Holding constant nominal values does not seem like the most natural benchmark, because this would imply *effective* benefit cuts over time as prices and wages increase. We therefore consider two other possibilities: holding constant real benefits (price indexation) and fixing benefits in proportion to the wages of single mothers (wage indexation). For the period we analyze, the two forms of indexing transfers turn out to be very similar, because the real wages of single mothers did not change much. The table shows that, with constant (indexed) transfers, effective marginal and average tax rates would have been higher than their actual levels. But the difference between hypothetical and actual tax rates is not drastic, likely because lower AFDC/TANF benefits were partly offset by expansions in Medicaid. Only for the 2001 reform, do we see a substantial difference between actual and hypothetical tax rates of about 4-5 percentage points for the marginal tax and 3-4 percentage points for the average tax. For that reform, we conclude that the welfare gain would have been quite a bit larger had the transfer-program reforms not been implemented.

5 Concluding Remarks

This paper has examined the welfare effects of tax reform in the United States using a welfare theoretic model incorporating both the intensive and the extensive margins of labor supply. We find that large efficiency gains have been generated by the participation responses of single mothers. The welfare gains per dollar spent are substantially larger than one for all reforms and all elasticity scenarios, implying that the tax cuts have created pure efficiency gains. These pure gains suggest that the tax cuts could potentially be justified even with distortionary financing and without incorporating social welfare weights that are higher for single mothers than for the rest of the population.

Our analysis has demonstrated the need to distinguish explicitly between labor supply responses along the intensive and extensive margins, and to account for the difference between the associated tax wedges. Because the welfare effects created on the two margins are related to different tax rates and different tax rate changes, the composition of the labor supply elasticity becomes crucial for the effects of tax reform. Recent empirical literature has reinforced the view that participation responses are larger than hours-of-work responses. On the other hand, papers on the effect of marginal tax rates on taxable income suggest that intensive responses may be important once they are interpreted more broadly than hours worked (Feldstein, 1995). Our study demonstrates the need for empirical research to pin down the composition of the labor supply elasticity into the two types of response.

Related to our work, Liebman (2002) uses a microsimulation model calibrated to 1999 CPS data to illustrate the trade-offs in the design of an EITC—including the optimal maximum credit, phase-in and phase-out rates—with fixed costs and participation effects. Liebman therefore extends on the work of Saez (2002) on optimal income taxation. This paper takes a different approach by analyzing actual tax reforms rather than optimal design. Moreover, since the four tax reforms we consider changed several different components of the federal tax code—including exemptions, deductions, and marginal tax rates—the estimated effects reflect more than just the EITC.

Recent work by Fullerton and Gan (2004) argues for incorporating directly the stochastic nature of estimated labor supply models when calculating the welfare effect of tax changes. The expected welfare effect from a tax change (accounting for the uncertainty about the location on the budget set) will be different from the welfare cost at the expected point, due to the fact that welfare cost functions are convex in tax rates. Our empirical application follows the standard approach of using point estimates, and hence does not incorporate such uncertainty in the welfare analysis. While the Fullerton-Gan framework incorporates discrete labor supply choices along both the intensive and extensive margin, their empirical applications exclude the participation margin by looking at married women working full time. Our main concern has instead been with the participation response which we believe is more important, especially for the population of single mothers.

A Derivation of the Marginal Excess Burden in Eq. (23)

We start by deriving the effect of the reform on the number of working hours, $\partial\tilde{h}_i/\partial\theta$, and on the labor market participation rate, $\partial P_i\left(\tilde{q}_i\right)/\partial\theta$. The impact on the number of working hours is found by differentiating the compensated labor supply function $\tilde{h}_i\left(\left(1-m_i\right)w_i, v_i\right)$. This gives

$$\frac{\partial\tilde{h}_i}{\partial\theta}=-\frac{\partial\tilde{h}_i\left(\left(1-m_i\right)w_i,v_i\right)}{\partial\left[\left(1-m_i\right)w_i\right]}w_i\frac{\partial m_i}{\partial\theta}=-\frac{1}{1-m_i}\cdot w_i\tilde{h}_i\cdot\frac{\partial m_i}{\partial\theta}\cdot\varepsilon_i, \tag{25}$$

where the last equality follows from the definition of the hours-elasticity in eq. (17).

To derive the impact on labor market participation, we first analyze how the fixed cost cut-off value is affected by the reform. The change in the cut-off is found by differentiating eq. (14) which gives

$$\frac{\partial\tilde{q}_i}{\partial\theta}=\frac{\partial v_i\left(\tilde{c}_i,\tilde{h}_i\right)}{\partial\tilde{c}_i}\frac{\partial\tilde{c}_i}{\partial\theta}+\frac{\partial v_i\left(\tilde{c}_i,\tilde{h}_i\right)}{\partial\tilde{h}_i}\frac{\partial\tilde{h}_i}{\partial\theta}, \tag{26}$$

where we have used eq. (10) implying that the consumption level of a non-participant is fixed. The change in the consumption level of a working individual is obtained by inserting the definition of the participation tax rate, $a_i\equiv\left[T\left(w_ih_i,\theta\right)-T\left(0,\theta\right)\right]/\left(w_ih_i\right)$, in eq. (13) and differentiate with respect to the reform parameter. This gives

$$\begin{aligned}\frac{\partial \tilde{c}_i}{\partial \theta} &= (1-m_i)\, w_i \frac{\partial \tilde{h}_i}{\partial \theta} - \frac{\partial T\left(w_i \tilde{h}_i, \theta\right)}{\partial \theta} + \frac{\partial T(0,\theta)}{\partial \theta} \\ &= (1-m_i)\, w_i \frac{\partial \tilde{h}_i}{\partial \theta} - w_i \tilde{h}_i \frac{\partial a_i}{\partial \theta}, \end{aligned} \tag{27}$$

where the last equality follows from the definition $\partial a_i/\partial\theta \equiv \left[\frac{\partial T(w_i h_i,\theta)}{\partial \theta} - \frac{\partial T(0,\theta)}{\partial \theta}\right] / (w_i h_i)$. By substituting (27) into (26) and using the first-order condition (8), we obtain

$$\frac{\partial \tilde{q}_i}{\partial \theta} = -\frac{\partial v_i\left(\tilde{c}_i, \tilde{h}_i\right)}{\partial \tilde{c}_i} w_i \tilde{h}_i \frac{\partial a_i}{\partial \theta}. \tag{28}$$

This change in the fixed cost threshold may be converted into a change in the participation rate through the relationship $\partial P_i(\tilde{q}_i)/\partial\theta = p_i(\tilde{q}_i) \cdot \partial \tilde{q}_i/\partial\theta$. This implies

$$\frac{\partial P_i(\tilde{q}_i)}{\partial \theta} = -p_i(\tilde{q}_i) \frac{\partial v_i\left(\tilde{c}_i, \tilde{h}_i\right)}{\partial \tilde{c}_i} w_i \tilde{h}_i \frac{\partial a_i}{\partial \theta}. \tag{29}$$

We wish to relate this reform-induced change in labor market participation to the participation elasticity in eq. (18). In order to do so, we use eq. (28) to derive a relationship between the fixed cost cut-off value and the net-of-participation-tax rate:

$$\frac{\partial \tilde{q}_i}{\partial (1-a_i)} = \frac{\partial \tilde{q}_i/\partial\theta}{\partial (1-a_i)/\partial\theta} = -\frac{\partial \tilde{q}_i/\partial\theta}{\partial a_i/\partial\theta} = \frac{\partial v_i\left(\tilde{c}_i, \tilde{h}_i\right)}{\partial \tilde{c}_i} w_i \tilde{h}_i.$$

By inserting this derivative in the definition of the participation elasticity in eq. (18), we obtain

$$\eta_i \equiv p_i(\tilde{q}_i) \frac{\partial \tilde{q}_i}{\partial (1-a_i)} \frac{1-a_i}{P_i(\tilde{q}_i)} = p_i(\tilde{q}_i) \frac{\partial v_i\left(\tilde{c}_i, \tilde{h}_i\right)}{\partial c_i} w_i \tilde{h}_i \frac{1-a_i}{P_i(\tilde{q}_i)}.$$

This expression for the participation elasticity may be substituted into (29) thereby giving

$$\frac{dP_i(\tilde{q}_i)}{d\theta} = -\frac{1}{1-a_i} P_i(\tilde{q}_i) \cdot \frac{\partial a_i}{\partial \theta} \cdot \eta_i. \tag{30}$$

Now, the expression for the marginal excess burden in (23) may be obtained by substituting eqs (25) and (30) into (22) and divide by aggregate labor income.

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TABLE 1
FEDERAL INCOME TAX AND EITC PARAMETERS, 1984-2002

Year	Federal Income Tax Parameters		EITC Parameters			
	[lowest, highest marginal tax rate)] (number of brackets)	Personal Exemption, Standard Deduction[a/, b/]	Phase-In Rate	Maximum Credit	Phase-Out Rate	Maximum Earnings
			(family with one child; family two or more children)			
1984	[0.000; 0.500] (15)	$1,000 ; $0	0.100	$500	0.125	$10,000
1985	[0.000; 0.500] (15)	$1,040 ; $0	0.110	$550	0.122	$11,000
1986	[0.000; 0.500] (15)	$1,080 ; $0	0.110	$550	0.122	$11,000
TRA86						
1987	[0.110; 0.390] (5)	$1,900 ; $2,540	0.140	$851	0.100	$15,432
1988	[0.150; 0.330] (2)	$1,950 ; $4,400	0.140	$874	0.100	$18,576
1989	[0.150; 0.330] (2)	$2,000 ; $4,550	0.140	$910	0.100	$19,340
1990	[0.150; 0.330] (2)	$2,050 ; $4,750	0.140	$953	0.100	$20,264
OBRA90 [c/]						
1991	[0.150; 0.310] (3)	$2,150 ; $5,000	0.167; 0.173	$1,192; $1,235	0.119; 0.124	$21,250
1992	[0.150; 0.310] (3)	$2,300 ; $5,250	0.176; 0.184	$1,324; $1,384	0.126; 0.130	$22,370
1993	[0.150; 0.396] (5)	$2,350 ; $5,450	0.185; 0.195	$1,434; $1,511	0.132; 0.139	$23,050
OBRA93 [d/]						
1994	[0.150; 0.396] (5)	$2,450 ; $5,600	0.263; 0.300	$2,038; $2,526	0.160; 0.177	$23,755; $25,296
1995	[0.150; 0.396] (5)	$2,500 ; $5,750	0.340; 0.360	$2,094; $3,110	0.160; 0.202	$24,396; $26,673
1996	[0.150; 0.396] (5)	$2,550 ; $5,900	0.340; 0.400	$2,152; $3,556	0.160; 0.211	$25,078; $28, 495
1997	[0.150; 0.396] (5)	$2,650 ; $6,050	0.340; 0.400	$2,210; $3,656	0.160; 0.211	$25,750; $29,290
2000	[0.150;0.391] (5)	$2,900; $6,650	0.340; 0.400	$2,353; $3,888	0.160; 0.211	$27,450; $31,152
EGTRRA2001						
2001	[0.100; 0.386] (5)	$3,000 ; $6,900	0.263; 0.300	$2,428; $4,008	0.160; 0.211	$28,250; $32,100
2002	[0.100; 0.386] (6)	$3,050 ; $7,000	0.340; 0.360	$2,547; $4,204	0.160; 0.211	$30,200; $33,150

a/ The standard deductions are given for head of household tax return.
b/ In 1984-1986, there were no standard deductions because of the zero bracket. The 15 brackets include the zero bracket.
c/ Basic EITC only. Does not include supplemental young child credit or health insurance credit.
d/ Introduced a small benefit for taxpayers with no qualifying children, phased-in at 0.0765 up to a maximum credit of $306.

Source: The Green Book and authors' calculations from Internal Revenue Service (IRS) forms and publications.

TABLE II

Welfare effects from the changed taxation of single mothers

Hours-of-work elasticity equal to 0.1 and participation elasticity equal to 0.4

	The welfare gain from tax reform				Reduction in	Welfare gain
Tax reform	Intensive	Extensive	Total	"Traditional"	tax burden	per $ spent
	(1)	(2)	(3)	(4)	(5)	(6)
1986 reform	0.98	4.48	5.47	4.92	7.39	3.84
1990 reform	0.04	2.06	2.09	0.20	4.15	2.02
1993 reform	-0.18	2.36	2.18	-0.90	7.39	1.42
2001 reform	0.28	0.64	0.92	1.39	2.55	1.57

Note: The welfare gain is measured in percentage of wage income and is calculated using equation (23) in the text. The total welfare gain is calculated as the sum of the intensive and extensive gains. The "traditional" welfare gain is calculated assuming that the total labor supply elasticity is entirely along the intensive margin. The reduction in tax burden measures the decrease in tax liabilities in percentage of wage income and before any behavioral responses. The welfare gain per dollar spent equals RTB/(RTB-EG) where EG is the efficiency gain and RTB is the reduction in tax burden. Data come from the March Current Population Surveys.

TABLE III
Welfare effects from the changed taxation of single mothers
Different scenarios for the size and composition of elasticities

	Elasticity scenario			The welfare gain from tax reform				Welfare gain
	ε	η	Total	Intensive	Extensive	Total	"Traditional"	per $ spent
1986 reform								
Low	0.05	0.20	0.25	0.49	2.24	2.73	2.46	1.59
Middle	0.10	0.40	0.50	0.98	4.48	5.47	4.92	3.84
High	0.15	0.60	0.75	1.48	6.73	8.20	7.38	Laffer
Identical	0.25	0.25	0.50	2.46	2.80	5.26	4.92	3.47
1990 reform								
Low	0.05	0.20	0.25	0.02	1.03	1.05	0.10	1.34
Middle	0.10	0.40	0.50	0.04	2.06	2.09	0.20	2.02
High	0.15	0.60	0.75	0.06	3.08	3.14	0.29	4.12
Identical	0.25	0.25	0.50	0.10	1.28	1.38	0.20	1.50
1993 reform								
Low	0.05	0.20	0.25	-0.09	1.18	1.09	-0.45	1.17
Middle	0.10	0.40	0.50	-0.18	2.36	2.18	-0.90	1.42
High	0.15	0.60	0.75	-0.27	3.53	3.26	-1.35	1.79
Identical	0.25	0.25	0.50	-0.45	1.47	1.02	-0.90	1.16
2001 reform								
Low	0.05	0.20	0.25	0.14	0.32	0.46	0.69	1.22
Middle	0.10	0.40	0.50	0.28	0.64	0.92	1.39	1.57
High	0.15	0.60	0.75	0.42	0.97	1.38	2.08	2.19
Identical	0.25	0.25	0.50	0.69	0.40	1.10	1.39	1.76

Note: The welfare gain is measured in percentage of wage income and is calculated using equation (23) in the text. The parameter ε denotes the hours-of-work elasticity with respect to the net-wage, while η is the participation elasticity with respect to the net-income gain of participation. The total welfare gain is calculated as the sum of the intensive and extensive gains. The "traditional" welfare gain is calculated assuming that the total labor supply elasticity is entirely along the intensive margin. The welfare gain per dollar spent equals RTB/(RTB-EG) where EG is the efficiency gain and RTB is the reduction in tax burden in Table II. A Laffer curve effect arises if EG>RTB implying that the reduction in tax burden creates a net-tax revenue. Data come from the March Current Population Surveys.

TABLE IV
Welfare effects with a decreasing profile for the participation elasticity

Tax reform	Intensive	Extensive	Total
1986 reform	0.98	3.03	4.01
1990 reform	0.04	2.13	2.17
1993 reform	-0.18	2.41	2.23
2001 reform	0.28	0.43	0.71

Note: The hours-of-work elasticity is equal to 0.1. The participation elasticity of each individual is set equal to 0.6, 0.4, 0.3 or 0.1 depending on whether the predicted income falls in the Phase-in, Plateau, Phase-out or Beyond region of the EITC. The average participation elasticity across all individuals is equal to 0.4. Data come from the March Current Population Surveys.

TABLE V

Effective tax rates and welfare effects when benefits are kept at their 1985 levels indexed by prices or wages

	1986 reform	1990 reform	1993 reform	2001 reform
Effective marginal tax rate				
- price indexation	0.469	0.402 (0.394)	0.387 (0.369)	0.377 (0.339)
- wage indexation	0.469	0.404 (0.394)	0.386 (0.369)	0.395 (0.339)
Effective average tax rate				
- price indexation	0.536	0.509 (0.508)	0.431 (0.427)	0.330 (0.302)
- wage indexation	0.536	0.511 (0.508)	0.430 (0.427)	0.347 (0.302)
Welfare gain: Intensive margin				
- price indexation	0.98	0.05 (0.04)	-0.19 (-0.18)	0.42 (0.28)
- wage indexation	0.98	0.05 (0.04)	-0.19 (-0.18)	0.50 (0.28)
Welfare gain: Extensive margin				
- price indexation	4.48	1.97 (2.06)	2.38 (2.36)	0.70 (0.64)
- wage indexation	4.48	1.99 (2.06)	2.37 (2.36)	0.78 (0.64)
Welfare gain: Total				
- price indexation	5.47	2.01 (2.09)	2.19 (2.18)	1.13 (0.92)
- wage indexation	5.47	2.04 (2.09)	2.18 (2.18)	1.28 (0.92)
Welfare gain per $ spent				
- price indexation	3.84	1.94 (2.02)	1.42 (1.42)	1.79 (1.57)
- wage indexation	3.84	1.97 (2.02)	1.42 (1.42)	2.01 (1.57)

Note: The numbers for the 1990, 1993 and 2001 reforms are calculated by adjusting all nominal values in the 1985 welfare system to the corresponding levels in the reform years. The nominal values are indexed by either the consumer price index (price indexation) or by the earnings of single mothers (wage indexation). The numbers in parentheses are based on the actual welfare system and are taken from Figure III and Table II. Data come from the March Current Population Surveys.

Figure I
Labor Force Participation of Unmarried Females: 1989-2000

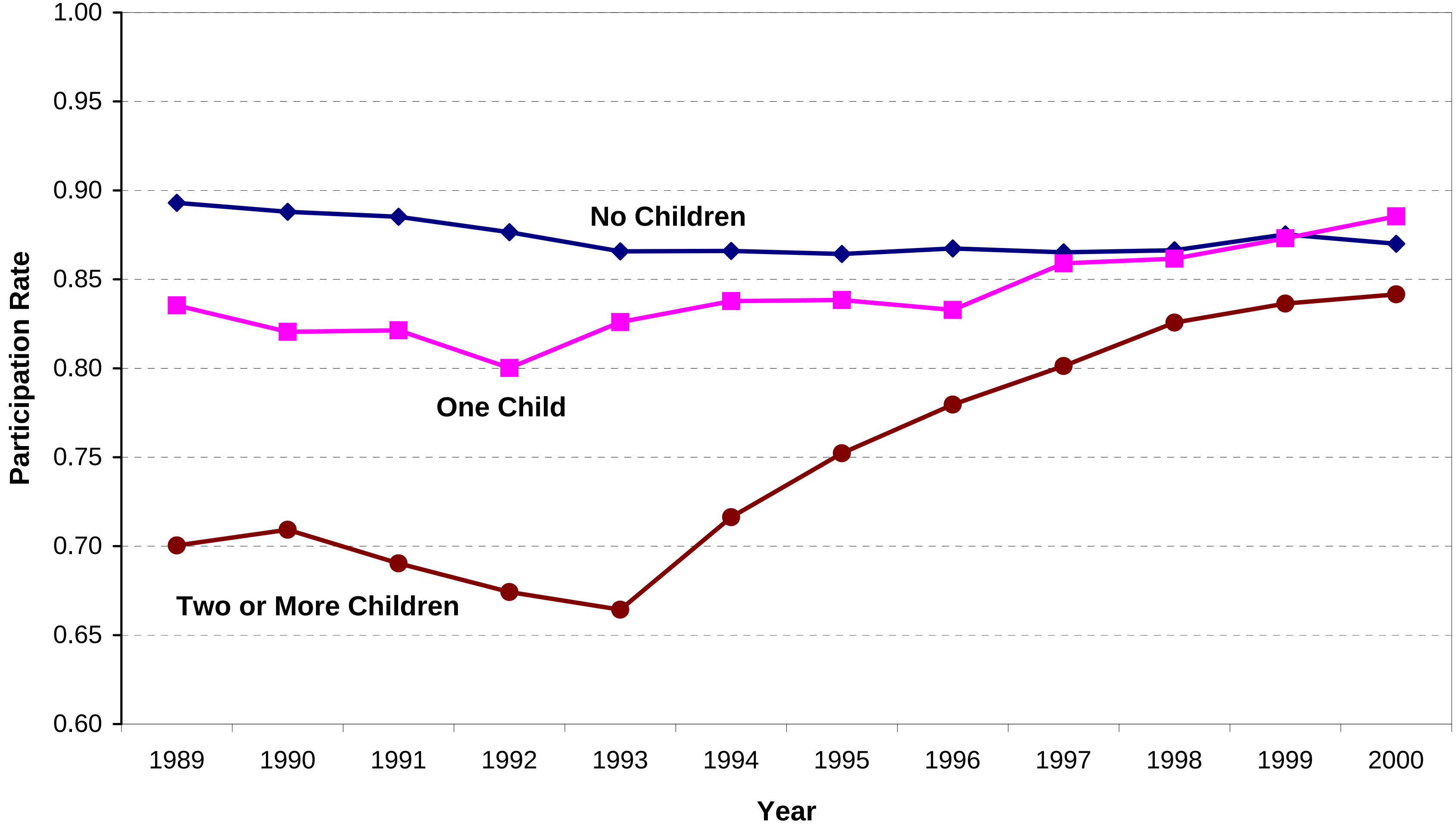
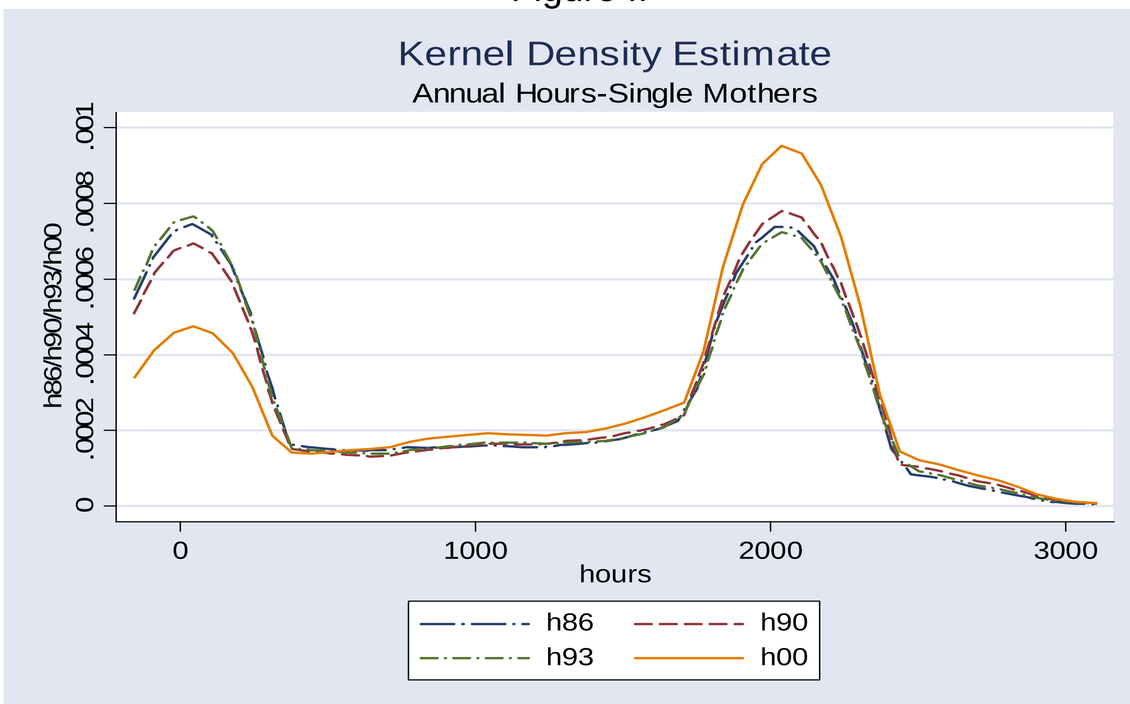


Figure II



Kernel Density Estimate
Annual Hours-Single Mothers
h86/h90/h93/h00
0
.0002
.0004
.0006
.0008
.001
0
1000
2000
3000
hours
h86
h90
h93
h00

Figure IIIa. Marginal tax rate (pre-reform)

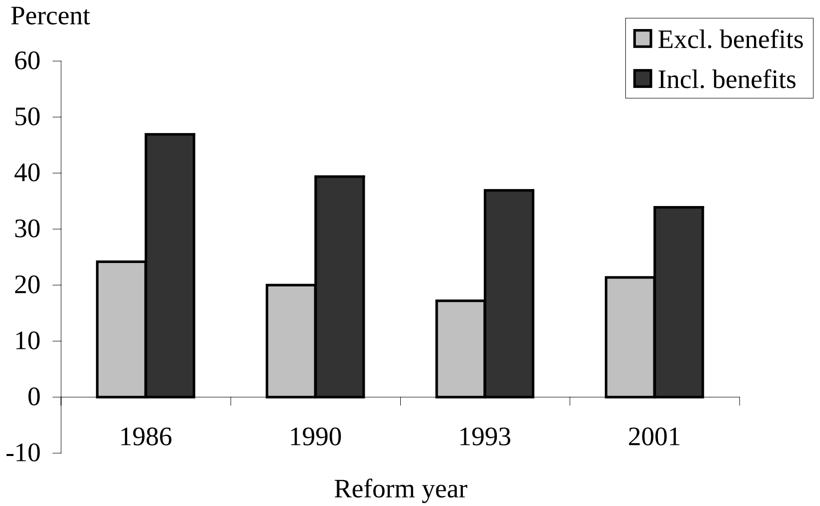
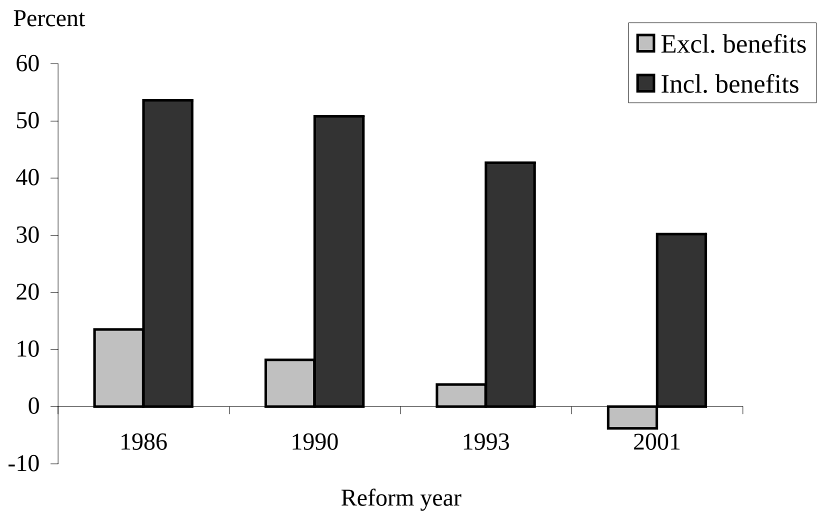
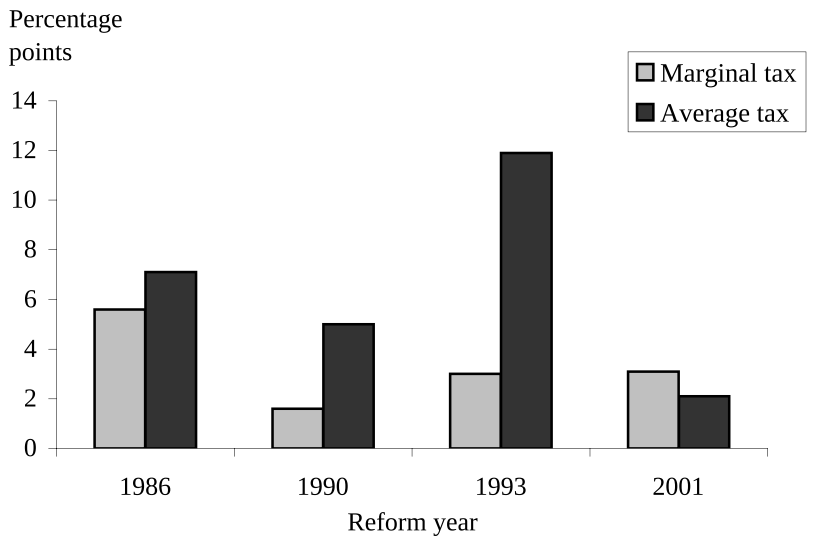


Figure IIIb. Average tax rate (pre-reform)



Note: The marginal tax rates and average tax rates are calculated for pre-reform years (1985, 1990, 1993, 2000). Tax parameters without benefits are calculated using NBER's tax simulation model (TAXSIM). The marginal tax rate includes federal, state and social security payroll rates. The average tax rate is derived by first calculating the TAXSIM federal, state and social security tax liability when an individual is working and not working, respectively. We then derive the average tax rate as the difference in total tax liabilities when working and not working divided by earnings. The tax rates with benefits include cash assistance (AFDC/TANF), Food Stamps and Medicaid adjusted by an empirical 54% take-up rate. Each parameter is calculated as an average for all individuals in the sample. The data come from the March Current Population Surveys.

Figure IV. Reform-induced reductions in tax rates



Note: The changes in marginal and average tax rates reflect only changes at the federal level. These changes are calculated as the difference between the post- and pre-reform rates. The pre-reform tax rate is calculated for the years 1985, 1990, 1993 and 2000, respectively. The post-reform tax rate is imputed for federal tax rules that apply in 1988, 1993, 1996 and 2002, respectively, to allow for the phase-in of the reforms. Tax rate changes are calculated as an average for all individuals in the sample. The data come from the March Current Population Surveys.