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A DYNAMIC MODEL OF WELFARE REFORM

BY MARC K. CHAN[1]

A dynamic structural model of labor supply, welfare participation, and food stamp participation is estimated using the 1992, 1993, and 1996 panels of the Survey of Income and Program Participation. Details of various policies including welfare time limits, work requirements, and Earned Income Tax Credit (EITC) are incorporated formally in the budget constraint. Policy simulations reveal that the economy accounts for half of the increase in the labor supply of female heads of family between 1992 and 1999. A time limit results in a larger efficiency gain than a work requirement or a direct reduction in welfare benefits. A reform package can lead to both a reduction in the government expenditure and an improvement in utility. The EITC expansion results in a substantial efficiency gain among individuals with the lowest expected wage. These individuals are almost unaffected by the economic expansion, but their income and utility increase significantly under the reform package.

KEYWORDS: Welfare reform, female labor supply, multiple program participation, discrete choice dynamic programming, time limit.

1. INTRODUCTION

THE PERSONAL RESPONSIBILITY AND WORK OPPORTUNITY ACT (PRWORA) of 1996 fundamentally changed the method and goal of federal cash assistance to poor female-headed families in the United States. Under PRWORA, the longstanding Aids to Families with Dependent Children (AFDC) program was replaced by the Temporary Assistance for Needy Families (TANF) program. States were given much greater flexibility to design the rules of their welfare programs such as earnings disregards, work requirements, and time limits. Time limits were arguably one of the most controversial components of the reform. PRWORA stipulates a lifetime limit of 5 years of federal cash assistance, but states can implement more lenient limits with state-funded support or stricter limits. During the first half of the 1990s, the Earned Income Tax Credit (EITC) program expanded at an unprecedented rate. The above changes were accompanied by one of the longest economic expansions in U.S. history.

Numerous studies have focused on specific components of welfare reform, and yet only a few attempts have been made to unify these components under a single analytical framework. Such a framework allows for a convenient

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comparison among different policy components, and is critical to understanding how the policies interact with one another and the welfare implications of implementing these policies. Among reduced-form studies that use microlevel data, Grogger (2003) and Fang and Keane (2004), for instance, provided comprehensive static analysis on the role of policy and the economy behind the substantial changes in employment and welfare participation during the 1990s. This line of research treats the policy components to be largely independent of one another and is limited by the variety of counterfactual simulations that can be performed. In addition, as demonstrated in Ziliak, Figlio, Davis, and Connolly (2000), Keane and Wolpin (2002), and Haider and Klerman (2005), among others, it is particularly important to incorporate dynamics that are driven by state dependence or forward-looking behavior. As a whole, the literature has yet produced conclusive evidence on how welfare reform affected behavior dynamically.[2] Dynamics are particularly relevant to individuals who face time limits, as time limits generate intertemporal trade-offs between participating in welfare now and conserving the remaining eligible months for the future.[3] Swann (2005), Fang and Silverman (2009), and Keane and Wolpin (2010) used structural life-cycle models estimated on pre-reform data to simulate the effects of time limits and other policies, but the structural estimates generally find mixed results. By contrast, modest effects are generally found in existing reduced-form studies.[4] Given the apparent divergence, it will be useful to spend effort to reconcile both sets of results in a quantitative manner. The major technical challenge, however, is that the pre-reform and post-reform environments were vastly different from each other. It has been recognized that the complex policy structure and substantial policy heterogeneity were major impediments to the effective forecast of behavior under TANF using

[2]Ziliak et al. (2000) estimated a dynamic welfare case-load model using state-level panel data from 1987 to 1996. Haider and Klerman (2005) estimated a model of welfare entry and exit, but their analysis is limited to California. Keane and Wolpin (2002) estimated logit models with dynamic controls, but they focused on the effects of welfare benefit levels prior to 1991.

[3]With forward-looking individuals and liquidity constraints, Grogger and Michalopoulos (1999) showed theoretically that time limits generate a dynamic behavioral incentive to bank, or conserve, benefits. Several papers, such as Grogger (2003, 2004), Fang and Keane (2004), and Mazzolari (2007), tested a reduced-form implication of this theory—the effects of a time limit should be larger among families with younger children. Mazzolari (2007) also tested the hypothesis that the effects are larger among families that have less remaining eligible months of welfare under a time limit. Ziliak et al. (2000) did not test the above hypotheses, but they included variables that capture implementation lags of time limits in their model.

[4]For instance, Keane and Wolpin (2010) found that a 5-year lifetime limit can cause welfare use to drop by 60 percent, but the effects are much more modest if a partial instead of full sanction is applied to the limit. While they found a modest effect of EITC on employment, the effect is much stronger in the structural model of Keane (1995). A number of reduced-form studies find that time limits account for 10–15 percent of the decline in welfare use in the 1990s. Section 6.1.1 contains a detailed discussion of existing findings in the literature.

pre-reform models (e.g., Keane and Wolpin (2010)).[5] The structural studies have also overlooked the economy, which has been argued to be a major contributing factor behind the large changes in behavior during the 1990s.

This article estimates a discrete choice dynamic programming model of labor supply, welfare participation, and food stamp participation using data from the 1992, 1993, and 1996 panels of the Survey of Income and Program Participation (SIPP). It attempts to synergize the methodological approaches undertaken by existing reduced-form and structural studies. The model is a dynamic extension of earlier static models such as Hoynes (1996) and Keane and Moffitt (1998), and is in a similar vein to Swann (2005) and Keane and Wolpin (2010). It is distinct from the above structural work in that it models multiple program participation dynamically and bases estimation on newer data.[6] The data cover a period of progressively radical changes in the welfare system, from the introduction of AFDC waiver programs as early as 1992 to the implementation of TANF in various states between 1996 and 1999. The budget constraint captures in detail the rules of the welfare program including time limits and work requirements, as well as food stamps, federal and state EITC, payroll tax, and federal and state income taxes.[7] Changes in welfare policies, EITC, and other conditions during the sample period serve to identify the parameters of the structural model.

The model finds larger effects of time limits, smaller effects of EITC, and larger effects of the economy relative to existing reduced-form estimates. Between 1992 and 1999, time limits and EITC explain 5.8 and 4.5 percent of the increase in employment and 16.0 and 3.4 percent of the decline in welfare participation, respectively. During the same period, policy and the economy explain one-sixth and one-half of the increase in labor supply and one-quarter and one-sixth of the decline in program participation, respectively. These results are still roughly in line with existing reduced-form work, which confirms the validity of the a priori assumptions in the structural model.

[5]Note that in a structural model, the effects of a policy will typically depend on what else is in place. Different policies may offset or reinforce one another. Therefore, the reduced-form and structural estimates are not directly comparable unless the rest of the environment is the same.

[6]My model advances the work by Swann in several aspects such as introducing unobserved heterogeneity and probabilistic job offer arrivals, but it does not endogenize marriage. Its choice structure is simpler than Keane and Wolpin (2010), who modeled labor supply, welfare participation, education, marriage, and fertility: their work focuses on explaining the differences in behavior among black, hispanic, and white young women, while I model the structure of the welfare system in greater depth. As for data, Hoynes (1996) and Keane and Moffitt (1998) used the 1984 SIPP panel, Swann (2005) used the Panel Study of Income Dynamics (PSID) from 1968 to 1992, and Keane and Wolpin (2010) used the National Longitudinal Survey of Youth (NLSY) from 1979 to 1991 for estimation. I focus on the cohorts who are subject to the newer rules in the 1990s.

[7]Keane (1995) and Keane and Moffitt (1998) also accounted for EITC in the budget constraint, but in their sample period, the benefits provided by EITC were trivially small, so they did not discuss this in detail.

We conclude that it is highly inefficient to further expand welfare and food stamps from the baseline sample. By contrast, an EITC expansion can result in an efficiency gain as it offsets the disincentives created by other transfer programs. Policy simulations using the environment in 1992 as the baseline reveal that a 5-year lifetime limit can cause the cumulative years of welfare use to drop by 37 percent within the first 10 years of implementation. The reduction is mostly due to behavioral incentives to bank welfare, which results in relatively few individuals hitting the limit. The effects of a work requirement sanction are similar to a 30-percent reduction in welfare benefits. Both policies generate larger initial effects than the time limit, but their effects are smaller than the time limit subsequently. In all of the above scenarios, the food stamp program acts as an important buffer: roughly half of the individuals who leave welfare remain on food stamps. Although government expenditure reduces by a similar magnitude, the time limit results in a larger efficiency gain than the other two policies; the opposite result occurs if individuals are uninformed of the time limit and fail to optimize their behavior accordingly. The expansion of EITC to the scale as in 1999 has similar effects to a 1 percentage point reduction in the unemployment rate. A reform package consisting of a time limit, a work requirement, and an EITC expansion leads to both a reduction in the government expenditure and an improvement in utility.

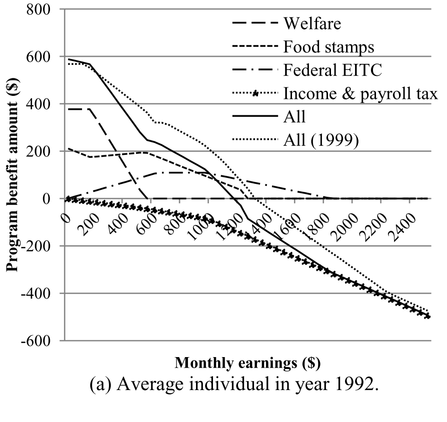
Further analysis reveals that the effects of the above policies on labor supply and earnings are almost exclusively concentrated among individuals with the lowest expected wage. By contrast, their effects on program participation are spread more evenly across the sample, and the economic expansion primarily affects individuals with higher expected wage. The EITC expansion results in a substantial efficiency gain among individuals with the lowest expected wage and no efficiency gain in the rest of the sample. Under the reform package, individuals with the lowest expected wage experience large changes in labor supply and program participation, as well as significant increases in earnings, income, and utility.

This paper proceeds as follows. Section 2 provides a brief summary of welfare reform. Section 3 describes the model. Section 4 discusses the estimation procedure and model identification. Section 5 describes the basic properties of the data. Section 6 presents estimation results and counterfactual policy simulations. The last section gives concluding remarks. Additional figures and tables, and data and programs are provided as Supplemental Material (Chan (2013)).

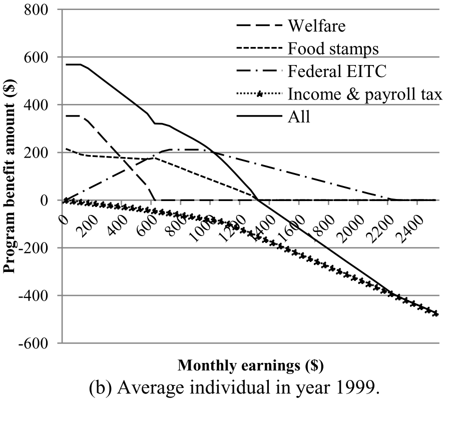
2. INSTITUTIONAL BACKGROUND

The AFDC program was the primary source of assistance to female-headed families in the United States. In the early 1990s, in an effort to reduce welfare case load and promote work, many states began AFDC waiver programs that allowed them to deviate from federal AFDC rules. In 1996, Congress enacted PRWORA, which replaced AFDC with TANF. Under TANF, states had much greater flexibility to design their welfare rules, such as setting the level of earnings disregards. While federal authority diminished, the key features of PRWORA also included much stricter work requirements and a 5-year lifetime limit on federal cash assistance. In particular, time limits represented a departure from traditional assistance in terms of aim and philosophy. The above changes in the welfare program were accompanied by one of the longest economic expansions in U.S. history: the national unemployment rate reached 8 percent in 1992 and dropped below 4 percent in 2000. As a whole, the 1990s were marked by a significant change in the system of means-tested transfers. AFDC was the second largest means-tested transfer program in 1990, but it was surpassed by food stamps and EITC by 1996 (Moffitt (2003)). In particular, EITC expenditure tripled during this period, partly as a result of a major expansion of the program that began in the 1993 budget bill. Welfare reform also resulted in substantial policy heterogeneity among states. For instance, states could set time limits that were different from the federal limit: some states implemented stricter limits, while others used state funds to support more lenient limits such as longer lengths of assistance, removing the adult's portion of benefits only, or allowing families that had hit the limit to be eligible for welfare again after a certain period of time.

To provide a more complete picture of the evolution of the welfare system in the 1990s, Figure 1(a) and (b) plots the program benefit functions of the average individual in my sample in 1992 and 1999, respectively.[8] In each graph, the net benefit amounts received from welfare, food stamps (assuming the in-



(a) Average individual in year 1992.

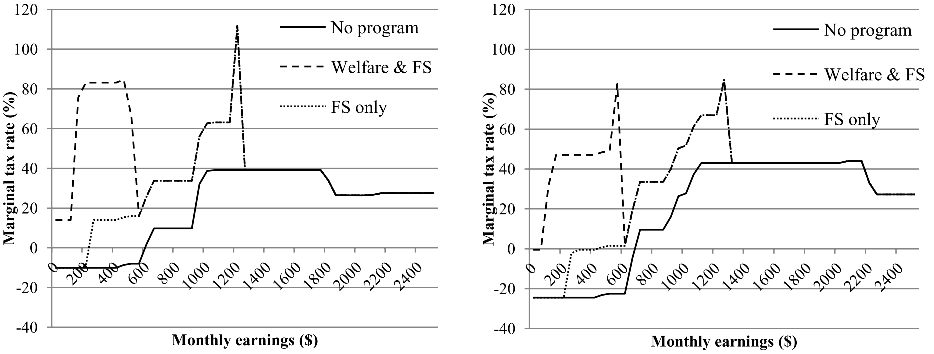


(b) Average individual in year 1999.

FIGURE 1.—Program benefit functions of the average individual in the sample.

[8]The data section contains more details on sample construction and the Appendix contains the formulas. In both parts of the figure, function parameters are taken as year-specific averages of the sample. In addition, work requirement sanctions and time limits are not included in the formulas, and state income tax is assumed to have three brackets only.

dividual participates in welfare), federal EITC, and income and payroll taxes (which includes state EITC) are plotted as functions of monthly gross earnings. The total net benefit amount received from all the programs combined is also presented. Between 1992 and 1999, welfare benefits became slightly less generous and this decline was accompanied by a decrease in the benefit reduction rate. Federal EITC expanded substantially both in terms of the level of benefits and the range of eligibility. The structures of food stamps and taxes both changed very slightly. In 1992, the average individual would receive almost 600 dollars of benefits if she had no earnings; benefits and taxes would break even if she earned 1150 dollars; she would pay 500 dollars of taxes if she earned 2500 dollars. In other words, for the first 2500 dollars of earnings, the average benefit reduction rate was 44 percent $((500 + 600)/2500)$. In 1999, the shape of the aggregate program benefit function was much more linear: there was a decrease in slope in the low earnings range and an increase in slope in the high earnings range. The total benefit was more generous, and the break-even point of benefits and taxes increased to 1300 dollars. Figure 2(a) and (b) plots the marginal tax rates (MTR) faced by the average individual in 1992 and 1999, respectively. In each graph, the MTRs for three possibilities of program participation (no programs, welfare and food stamps, food stamps only) are plotted. The MTRs differ widely by the level of earnings and the choice of program participation. As expected, the typical MTR faced by the average welfare recipient in 1992 was quite high (over 80 percent), but it fell below 50 percent in 1999. Between 1992 and 1999, the MTRs faced by low-income nonrecipients of welfare also dropped substantially as a result of the EITC expansion. Although the MTRs for low-income nonrecipients of welfare were very low or negative, individuals with more than 1000 dollars of earnings typically faced much higher MTRs due to income taxes and the phase-out region of the EITC program.



(a) Average individual in year 1992.
(b) Average individual in year 1999.

FIGURE 2.—Marginal tax rates of the average individual in the sample.

3. MODEL SPECIFICATION

In this section, a discrete choice dynamic programming model of labor supply and multiple program participation for female heads of family is presented. The basic model is described first, followed by a multiperiod model with welfare time limits. The full model with time limits as well as state dependence in work and program participation is then presented.

In the model, an individual i receives a job offer with probability θ_{it} in each decision period t. Given the data structure, it is assumed that a decision is made every 4 months. All variables are expressed on a monthly basis. If the individual has a job offer, she chooses the alternative that yields the highest utility among the following eight mutually exclusive choice combinations of labor supply and program participation: (i) no work, no welfare, and no food stamps; (ii) part-time work, no welfare, and no food stamps; (iii) full-time work, no welfare, and no food stamps; (iv) no work, welfare, and food stamps; (v) part-time work, welfare, and food stamps; (vi) no work and food stamps only; (vii) part-time work and food stamps only; (viii) full-time work and food stamps only. There are other logical choice combinations, but since they are seldom chosen in the data, they are reclassified into the above eight alternatives.[9] If the individual does not have a job offer, she chooses the best alternative among (i), (iv) and (vi). I assume that full-time (FT) work is twice as many hours as part-time work, and a full-time (PT) worker works 160 hours per month.

The utility function is typical of random utility models, but is modified in several ways to deliver "structure" to the model. The utility of alternative k is

$$U_{ikt} = Y_{ikt} + \phi_0 Y_{ikt}^2 + \alpha_{ikt} + \varepsilon_{cikt}. \tag{1}$$

Utility is the sum of income Y_{ikt}, a quadratic term of income, preference parameter α_{ikt}, and choice-specific random shock ε_{cikt}. At zero income, the marginal utility of income is normalized to 1. There is an income effect that is generated by the parameter ϕ_0. Following Swann (2005), the vector of choice-specific shocks, denoted $\boldsymbol{\varepsilon}_{cit}$, follows an independent and identically distributed (i.i.d.) extreme value distribution with means at Euler's constant eu ≈ 0.5772 and standard deviations at $\frac{\pi}{\sqrt{6}}\sigma_c$, where $\frac{\pi}{\sqrt{6}} \approx 1.2825$ is a normalization constant.

[9]The smaller categories are excluded as they introduce numerical instability to the estimation procedure and substantially increase computational burden. All welfare recipients are assumed to receive food stamps (e.g., Hoynes (1996)). Since welfare recipients are categorically eligible for food stamps, the food stamp participation rate among welfare recipients has been close to 100 percent (e.g., U.S. Congress, Committee on Ways and Means (1998)). My data do not show any systematic change of this rate over time. Full-time workers are assumed to be ineligible for welfare (e.g., Swann (2005)). My data show that only 1 percent of full-time workers are eligible for welfare. In the data, full-time workers who receive welfare are reclassified into alternatives (iii) and (viii).

The preference parameters are normalized with respect to the first alternative, hence $\alpha_{i1t} = 0$. They are reparameterized to provide better economic interpretation[10]:

$$\alpha_{ikt} = \begin{cases} 0, & \text{if } k = 1 \text{ (no work; no programs)}, \\ \phi_{\mathrm{H}it}, & \text{if } k = 2 \text{ (PT work; no programs)}, \\ \phi_{\mathrm{H}it} + \phi_3, & \text{if } k = 3 \text{ (FT work; no programs)}, \\ \phi_{\mathrm{AF}it}, & \text{if } k = 4 \text{ (no work; welfare and food stamps)}, \\ \phi_{\mathrm{AF}it} + \phi_{\mathrm{H}it} + \phi_5, & \text{if } k = 5 \text{ (PT work; welfare and food stamps)}, \\ \phi_{\mathrm{F}it}, & \text{if } k = 6 \text{ (no work; food stamps only)}, \\ \phi_{\mathrm{F}it} + \phi_{\mathrm{H}it} + \phi_7, & \text{if } k = 7 \text{ (PT work; food stamps only)}, \\ \phi_{\mathrm{F}it} + \phi_{\mathrm{H}it} + \phi_3 + \phi_8, & \text{if } k = 8 \text{ (FT work; food stamps only)}. \end{cases}$$

Using the first alternative as the benchmark, the parameters $\phi_{\mathrm{H}it}$, $\phi_{\mathrm{AF}it}$, and $\phi_{\mathrm{F}it}$ are, respectively, interpreted as preferences for work, participation in both welfare *and* food stamps, and participation in food stamps *only*. The signs of these parameters should generally be negative, reflecting disutilities from work and program participation (e.g., Moffitt (1983)). As in Keane and Moffitt (1998), their values are allowed to vary in the population. The parameter ϕ_3 can be interpreted as the preference for full-time over part-time work. The interaction terms between program participation and work status (i.e., ϕ_5, ϕ_7, and ϕ_8) allow the disutilities from program participation to differ by work intensity.

[10]The utility function can also be written as

$$Y_{it} + \phi_0 Y_{it}^2 + \phi_{\mathrm{H}it}(P_{\mathrm{H}}^{\mathrm{pt}} + P_{\mathrm{H}}^{\mathrm{ft}}) + \phi_{\mathrm{AF}it} P_{\mathrm{AF}} + \phi_{\mathrm{F}it} P_{\mathrm{F}}$$
$$+ \phi_3 P_{\mathrm{H}}^{\mathrm{ft}} + \phi_5 P_{\mathrm{AF}} P_{\mathrm{H}}^{\mathrm{pt}} + \phi_7 P_{\mathrm{F}} P_{\mathrm{H}}^{\mathrm{pt}} + \phi_8 P_{\mathrm{F}} P_{\mathrm{H}}^{\mathrm{ft}},$$

where $P_{\mathrm{H}}^{\mathrm{pt}}$, $P_{\mathrm{H}}^{\mathrm{ft}}$, P_{AF}, and P_{F} are binary variables that, respectively, indicate whether the individual works part-time, works full-time, participates in both programs, and participates in food stamps alone. This specification is similar to Keane and Moffitt (1998). Note that Keane and Moffitt omited the interaction terms in the main model as they found that the coefficients are statistically insignificant in the initial estimates. Without the interaction terms, the disutilities from program participation become additively separable from other parts of the model (e.g., Moffitt (1983)).

The individual is assumed to consume all her income each period.[11] The income in each alternative is determined by a piecewise-linear budget constraint,

$$(2)\qquad \begin{aligned} Y_{ikt} = {} & E_{ikt} + \big(\tilde{B}_{\mathrm{A}ikt} + B_{\mathrm{F}}(E_{ikt}, N_{it}, \mathbf{Z}_{\mathrm{F}it}, \tilde{B}_{\mathrm{A}ikt})\big)P_{\mathrm{AF}ikt} \\ & + B_{\mathrm{F}}(E_{ikt}, N_{it}, \mathbf{Z}_{\mathrm{F}it}, 0)P_{\mathrm{F}ikt} + B_{\mathrm{E}}(E_{ikt}, \mathbf{Z}_{\mathrm{E}it}) \\ & - T(E_{ikt}, \mathbf{Z}_{\mathrm{T}it}) + N_{it}, \end{aligned}$$

where $E_{ikt} \equiv w_{it}(P_{\mathrm{H}ikt} + P^{\mathrm{ft}}_{\mathrm{H}ikt})$ and

$$\tilde{B}_{\mathrm{A}ikt} \equiv B_{\mathrm{A}}(E_{ikt}, N_{it}, \mathbf{Z}_{\mathrm{A}it}) - \mathbf{Z}_{\mathrm{R}it}\boldsymbol{\beta}_{\mathrm{R}} X^{e}_{\mathrm{R}it} P_{\mathrm{AF}ikt}(1 - P_{\mathrm{H}ikt}).$$

Under alternative k, the binary variables $P_{\mathrm{H}ikt}$, $P^{\mathrm{ft}}_{\mathrm{H}ikt}$, $P_{\mathrm{AF}ikt}$, and $P_{\mathrm{F}ikt}$ indicate whether the individual works, works full-time, participates in both programs, and participates in food stamps only. For instance, if $k = 8$, we have $P_{\mathrm{H}ikt} = 1$, $P^{\mathrm{ft}}_{\mathrm{H}ikt} = 1$, $P_{\mathrm{AF}ikt} = 0$, and $P_{\mathrm{F}ikt} = 1$. Gross earnings, denoted by E_{ikt}, is the product of the wage rate w_{it} and work intensity. The unit for wage is dollars earned per 80 hours (i.e., total monthly hours of part-time work). The variable N_{it} denotes nontransfer nonlabor income. The program benefit functions for welfare, food stamps and federal EITC are denoted by $B_{\mathrm{A}}(\cdot)$, $B_{\mathrm{F}}(\cdot)$, and $B_{\mathrm{E}}(\cdot)$, respectively. The tax function $B_{\mathrm{T}}(\cdot)$ gives the total amount of federal and state income taxes plus payroll tax minus state EITC. These functions are formally defined below and in the Appendix. They are parameterized by "policy rules" $\mathbf{Z}_{\mathrm{A}it}$, $\mathbf{Z}_{\mathrm{F}it}$, $\mathbf{Z}_{\mathrm{E}it}$, and $\mathbf{Z}_{\mathrm{T}it}$, which generally vary in the population according to family size, state of residence (if applicable), and calendar time.

The "net" welfare benefit $\tilde{B}_{\mathrm{A}ikt}$ is defined as the gross welfare benefit subtracted by the amount of sanction due to failure to meet a work requirement policy. It is assumed that the sanction amount is zero if a welfare recipient works.[12] The policy rule $\mathbf{Z}_{\mathrm{R}it} \in \{(0,0,0), (1,0,0), (0,1,0), (0,0,1)\}$ describes the sanction policy in place in the individual's state of residence and calendar time. The three elements of the vector are indicators of a lenient, intermediate and stringent sanction policy respectively. Hence there are four possible sanction policies: (i) no sanction (equivalent to no work requirement policy); (ii) lenient; (iii) intermediate; (iv) stringent. The three-dimensional parameter

[11]The literature finds extensive evidence that low-income female heads have very little assets (e.g., Hurst and Ziliak (2006)). Moreover, there is very limited access to credit (e.g., Sullivan (2008)).

[12]Depending on the state of residence, work-related activities such as community service, unpaid work, and participation in education, training, and job search programs may also count as work hours toward complying with work requirements. These are difficult to be incorporated formally because implementation is often very different from manual provisions. According to the data, relatively few welfare recipients are engaged in these work activities. For instance, data from the welfare reform topical module in wave 8 of the 1996 SIPP panel shows that only 10 percent of the nonworking welfare recipients participate in any education, training, or job search programs, and 5 percent are engaged in any community service or unpaid work.

vector $\boldsymbol{\beta}_{\mathrm{R}}$ denotes the sanction amount for each sanction policy. The binary variable $X^{e}_{\mathrm{R}it}$ indicates whether the individual is exempt from a work requirement policy due to having a young child. When this "age-related" exemption policy is in place, the individual is exempt if she has a child whose age is less than the threshold age described by the policy. The exemption status varies in the population according to the age of the youngest child, state of residence, and calendar time.

The basic properties of the welfare, food stamp, and tax functions are summarized below. As in typical public assistance programs, we have $B_{\mathrm{A}}(0, 0, \mathbf{Z}_{\mathrm{A}it}) > 0$, $\partial B_{\mathrm{A}}/\partial E_{ikt} \leq 0$, $B_{\mathrm{F}}(0, 0, \mathbf{Z}_{\mathrm{F}it}, 0) > 0$, and $\partial B_{\mathrm{F}}/\partial E_{ikt} \leq 0$. Welfare benefit is counted as income in the food stamp formula, that is, $\partial B_{\mathrm{F}}/\partial \tilde{B}_{\mathrm{A}ikt} \leq 0$. The income eligibility tests of welfare and food stamps may create points of discontinuity, resulting in notches in the budget constraint. The tax function is convex in earnings, except for the point where the state EITC benefit reduces to zero.

The federal EITC benefit function is defined as

$$B_{\mathrm{E}}(E_{ikt}, \mathbf{Z}_{\mathrm{E}it}) = \begin{cases} r_{\mathrm{E1}it} E_{ikt}, & \text{if } E_{ikt} < b_{\mathrm{E1}it}, \\ r_{\mathrm{E1}it} b_{\mathrm{E1}it}, & \text{if } b_{\mathrm{E1}it} \leq E_{ikt} < b_{\mathrm{E2}it}, \\ \max\{ r_{\mathrm{E1}it} b_{\mathrm{E1}it} - r_{\mathrm{E2}it}(E_{ikt} - b_{\mathrm{E2}it}), 0 \}, & \text{if } E_{ikt} \geq b_{\mathrm{E2}it}. \end{cases} \tag{3}$$

The federal EITC policy rule $\mathbf{Z}_{\mathrm{E}it}$ consists of the subsidy phase-in rate $r_{\mathrm{E1}it}$, phase-out rate $r_{\mathrm{E2}it}$, and the two bracket thresholds $b_{\mathrm{E1}it}$ and $b_{\mathrm{E2}it}$. The bracket thresholds are expressed on a monthly basis.

The wage w_{it} follows a log-normal distribution that is truncated from below by the federal minimum wage $\underline{w}_t$.[13] The log "latent" wage is subject to a normally distributed shock $\varepsilon_{\mathrm{w}it}$ which has standard deviation σ_{w} and is independent from the choice-specific shocks. The job offer arrival probability θ_{it} takes a logistic form, so its value is restricted between 0 and 1. The preference parameters $\phi_{\mathrm{H}it}$, $\phi_{\mathrm{AF}it}$, and $\phi_{\mathrm{F}it}$, wage, and the job offer arrival probability vary in the population as

$$\begin{aligned}
\phi_{\mathrm{H}it} &= \gamma_{\mathrm{H}} P_{\mathrm{H}i,t-1} + \mathbf{X}_{\mathrm{H}it}\boldsymbol{\beta}_{\mathrm{H}} + \mu_{\mathrm{H}i}, \\
\phi_{\mathrm{AF}it} &= \gamma_{\mathrm{AF}} P_{\mathrm{AF}i,t-1} + \mathbf{X}_{AFit}\boldsymbol{\beta}_{\mathrm{AF}} + \mu_{\mathrm{AF}i}, \\
\phi_{\mathrm{F}it} &= \gamma_{\mathrm{F}} P_{\mathrm{F}i,t-1} + \mathbf{X}_{\mathrm{F}it}\boldsymbol{\beta}_{\mathrm{F}} + \mu_{\mathrm{F}i}, \\
w^{*}_{it} &= \exp(\gamma_{\mathrm{w}} P_{\mathrm{H}i,t-1} + \mathbf{X}_{\mathrm{w}it}\boldsymbol{\beta}_{\mathrm{w}} + \mu_{\mathrm{w}i} + \varepsilon_{\mathrm{w}it}), \quad \varepsilon_{\mathrm{w}it} \sim N(0, \sigma^2_{\mathrm{w}}),
\end{aligned}$$

[13]In the model, the effect of minimum wage increases on employment represents an upper bound because job destruction is not considered. See for instance Card and Krueger (1997) and Flinn (2006) for more discussion on the mechanism of job destruction and its welfare implications.

$$w_{it} = \begin{cases} w_{it}^*, & \text{if } w_{it}^* \geq \underline{w}_t, \\ \underline{w}_t, & \text{otherwise,} \end{cases}$$

$$\theta_{it} = \frac{1}{1 + \exp(-\phi_{\mathrm{J}it})},$$

$$\phi_{\mathrm{J}it} = \gamma_{\mathrm{J}} P_{\mathrm{H}i,t-1} + \mathbf{X}_{\mathrm{J}it} \boldsymbol{\beta}_{\mathrm{J}} + \mu_{\mathrm{J}i}.$$

Lagged participation statuses $P_{\mathrm{H}i,t-1}$, $P_{\mathrm{AF}i,t-1}$, and $P_{\mathrm{F}i,t-1}$ affect current decisions via the parameters of state dependence γ_{H}, γ_{AF}, γ_{F}, γ_{w}, and γ_{J}. Lagged work status affects current work preference, wage, and job offer arrival; lagged program participation affects the current preferences for program participation. The covariates $\mathbf{X}_{\mathrm{H}it}$, $\mathbf{X}_{\mathrm{AF}it}$, $\mathbf{X}_{\mathrm{F}it}$, $\mathbf{X}_{\mathrm{w}it}$, $\mathbf{X}_{\mathrm{J}it}$, and their coefficients $\boldsymbol{\beta}_{\mathrm{H}}$, $\boldsymbol{\beta}_{\mathrm{AF}}$, $\boldsymbol{\beta}_{\mathrm{F}}$, $\boldsymbol{\beta}_{\mathrm{w}}$, and $\boldsymbol{\beta}_{\mathrm{J}}$ capture the effects of observed characteristics on preference, wage, and job offer arrival. The covariates include the unit constant, demographic characteristics, time dummies, local economic conditions, and policy variables that do not enter directly into the budget constraint. Some covariates are left out of some equations, forming exclusion restrictions. The inclusion of unobserved heterogeneity is essential for the consistent estimation of state dependence parameters (e.g., Heckman (1978)). Unobserved heterogeneity enters into the model via the permanent components $\mu_{\mathrm{H}i}$, $\mu_{\mathrm{AF}i}$, $\mu_{\mathrm{F}i}$, $\mu_{\mathrm{w}i}$, and $\mu_{\mathrm{J}i}$, which affect preference, wage, and job offer arrival in a similar manner to the covariates. The components can be correlated; for instance, an individual who has a high unobserved taste for work may also have a high unobserved tendency to have higher wage offers. Following Hoynes (1996) and Keane and Wolpin (2010), a discrete factor representation for unobserved heterogeneity is used (e.g., Heckman and Singer (1984)). The vector $(\mu_{\mathrm{H}i}, \mu_{\mathrm{AF}i}, \mu_{\mathrm{F}i}, \mu_{\mathrm{w}i}, \mu_{\mathrm{J}i})$ follows a discrete probability distribution with three points of support, each of which reflects the unobserved "type" of the individual. The probability that an individual is of type q, where $q = 1, 2, 3$, is denoted π_q. The unobserved characteristics of a type-q individual is denoted by the vector $\boldsymbol{\mu}_q \equiv (\mu_{\mathrm{H}q}, \mu_{\mathrm{AF}q}, \mu_{\mathrm{F}q}, \mu_{\mathrm{w}q}, \mu_{\mathrm{J}q})$. The discrete distribution is normalized with respect to type 1, that is, $\boldsymbol{\mu}_1 = 0$ and $\pi_1 = 1 - \pi_2 - \pi_3$. Hence the distribution contains 12 parameters, namely, π_2, π_3, $\boldsymbol{\mu}_2$, and $\boldsymbol{\mu}_3$.

The maximization problem is defined formally as follows. Let $\mathbf{d}_{it}$ be an eight-dimensional vector with $d_{ikt} \in \{0, 1\}$ as the kth element. Then the choice set is $D_1 \equiv \{\mathbf{d}_{it} | \sum_{k=1}^{8} d_{ikt} = 1\}$ if the individual has a job offer and is $D_0 \equiv \{\mathbf{d}_{it} | \sum_{k=1,4,6} d_{ikt} = 1\}$ otherwise. Suppose the individual is myopic, that is, she maximizes her contemporaneous utility only. Given the job offer arrival status, the maximization problem is $\max_{\mathbf{d}_{it} \in D} \sum_{k=1}^{8} d_{ikt} U_{ikt}$, where $D = D_1$ if the individual has a job offer and $D = D_0$ otherwise.

Time Limits

We first describe a multiperiod model with no state dependence in lagged participation. In this model, a forward-looking individual will act as if she is myopic in the absence of a welfare time limit. Suppose a lifetime limit of $\bar{M}_i$ periods is implemented starting from period t_{0i}. The time limit introduces an intertemporal budget constraint:

$$(4) \qquad M_{ik,t+1} = M_{it} + P_{\mathrm{AF}ikt}, \quad \text{and} \quad M_{it_{0i}} = 0.$$

The state variable M_{it} denotes the cumulative number of periods of welfare participation under the time limit. When $M_{it} = \bar{M}_i$, the individual hits the time limit and becomes ineligible for welfare thereafter. Since individuals are liquidity constrained, M_{it} is the only mechanism that they can use to smooth consumption. Then, as Grogger and Michalopoulos (1999) showed theoretically, the time limit generates an incentive to conserve, or bank, welfare benefits.[14] After the individual hits the limit, the choice set is denoted by $D_{1\bar{M}} \equiv \{\mathbf{d}_{it} | \sum_{k=1,2,3,6,7,8} d_{ikt} = 1\}$ if she has a job offer and $D_{0\bar{M}} \equiv \{\mathbf{d}_{it} | \sum_{k=1,6} d_{ikt} = 1\}$ otherwise. The planning horizon $\mathcal{T}_i$ is defined as the number of periods remaining (measured in period 1) until the individual's youngest child reaches 18 years of age.[15] The individual maximizes her expected stream of utility from period t_{0i} to $\mathcal{T}_i$:

$$\max E_{t_{0i}} \sum_{t=t_{0i}}^{\mathcal{T}_i} \delta^{t-t_{0i}} \sum_{k=1}^{8} d_{ikt} U_{ikt}.$$

The discount factor is denoted by δ and $E_{t_{0i}}$ is the expectation operator taken in period t_{0i}. The maximization problem can be written in recursive form as

$$(5) \qquad V_{it}(\mathbf{S}_{it}, \boldsymbol{\mathcal{E}}_{it}) \equiv \max_{\mathbf{d}_{it} \in D} \sum_{k=1}^{8} d_{ikt} \left(U_{ikt} + \delta E_t V_{i,t+1}(\mathbf{S}_{ik,t+1}, \boldsymbol{\mathcal{E}}_{i,t+1}) \right).$$

The value function $V(\cdot)$ has two sets of state variables. The error space $\boldsymbol{\mathcal{E}}_{it} \equiv (I_{\mathrm{J}it}, \boldsymbol{\varepsilon}_{\mathrm{c}it}, \varepsilon_{\mathrm{w}it})$ contains stochastic terms that are integrated out in each period of backward recursion. It includes job offer availability $I_{\mathrm{J}it}$, which equals 1 with probability θ_{it} and zero with probability $1 - \theta_{it}$, the choice-specific shocks $\boldsymbol{\varepsilon}_{\mathrm{c}it}$, and the wage shock $\varepsilon_{\mathrm{w}it}$. The deterministic part of the state space $\mathbf{S}_{it}$ is carried around explicitly as an argument in the expected value function and evolves according to the intertemporal budget constraint. In this model, $\mathbf{S}_{it} = (M_{it})$. The

[14]Their model does not incorporate disutility from welfare participation, but the analysis is similar. Although they focus on the consumption-smoothing motive, under linear utility the incentive to bank benefits still exists because the welfare benefit reduction rate is strictly positive. In this case, the individual has an incentive to avoid participating in welfare while working so that she can maximize her expected wealth.

[15]Beyond this horizon, the individual is no longer eligible for welfare, so she will act as if she is myopic.

choice set D equals $D_0, D_1, D_{0\bar{M}}$, or $D_{1\bar{M}}$, depending on job offer availability and whether the individual has hit the time limit.[16]

Benefit-reduction and periodic time limits are modeled as follows. When a benefit-reduction limit is in place (denoted by a binary variable I_{it}^{br}), the adult's portion of the family's welfare benefit is removed permanently once $M_{it} = \bar{M}_i$. Under a periodic limit, the individual becomes ineligible once $M_{it} = \bar{M}_i$, but after $\bar{m}_i$ periods of ineligibility, she becomes eligible again and M_{it} is reset to zero. The intertemporal budget constraints are

$$m_{i,t+1} = \begin{cases} m_{it} + 1, & \text{if } M_{it} = \bar{M}_i, \\ 0, & \text{if } M_{it} < \bar{M}_i, \end{cases} \tag{6}$$

$$m_{it_{0i}} = 0; \quad M_{i,t+1} = 0, \quad \text{and} \quad m_{i,t+1} = 0 \quad \text{if} \quad m_{it} = \bar{m}_i. \tag{7}$$

In this case $\mathbf{S}_{it} = (M_{it}, m_{it})$, which contains $\bar{M}_i + 1 + \bar{m}_i$ possible values.

The full model is described as follows. Due to state dependence in work and program participation, the maximization problem of a forward-looking individual is no longer static in the absence of a time limit. Moreover, M_{it} is no longer the only mechanism to smooth consumption. Suppose a time limit is implemented starting from period t_{0i}, where $t_{0i} > 1$. The expected value functions from period 1 to $t_{0i} - 1$ are computed by solving the dynamic programming problem in period 1 with planning horizon $\mathcal{T}_i$, assuming that the individual does not know a time limit will be in place in period t_{0i}.[17] In this case $\mathbf{S}_{it} = (P_{\text{H}i,t-1}, P_{\text{AF}i,t-1}, P_{\text{F}i,t-1})$, which has six possible values, namely, $(0, 0, 0)$, $(1, 0, 0)$, $(0, 1, 1)$, $(1, 1, 1)$, $(0, 0, 1)$, and $(1, 0, 1)$. The expected value functions from period t_{0i} onward are computed by solving the dynamic programming problem in period t_{0i} with a planning horizon of $\mathcal{T}_i - t_{0i} + 1$ periods. In this case, $\mathbf{S}_{it} = (P_{\text{H}i,t-1}, P_{\text{AF}i,t-1}, P_{\text{F}i,t-1}, M_{it})$ for individuals facing lifetime limits, and $\mathbf{S}_{it} = (P_{\text{H}i,t-1}, P_{\text{AF}i,t-1}, P_{\text{F}i,t-1}, M_{it}, m_{it})$ for those facing periodic limits.

In the model, work experience affects wage and job offer arrival through the lagged work status only. The literature has found mixed evidence of the persistence of the effects of work experience in our population of interest. For instance, Card and Hyslop (2005) analyzed the effects of an earnings subsidy that doubled the wage of welfare recipients in Canada. They found that the extra work effort induced by the subsidy has small long-run impacts on wage. In the structural model of Keane and Wolpin (2010), the stock of past work hours is included explicitly in the wage equation. Their estimates imply that 10 full years of work experience leads to an increase in the wage offer by roughly

[16]When the individual solves the dynamic programming problem, she perceives the variables outside $\mathbf{S}_{it}$ and $\mathcal{E}_{it}$ to remain unchanged over time. The Appendix contains more details about the numerical backward recursion procedure.

[17]Ideally, the end of the horizon should be the last year of life. To simplify computation and facilitate comparison with the simpler model, the horizon is truncated at $\mathcal{T}_i$.

25 percent.[18] This result is for young women in the NLSY79 sample, and the effect for low-income female heads of family could probably be smaller. In view of these findings and computational limitations, the stock of work experience is not modeled here, but is left for future research.

4. ESTIMATION STRATEGY

The model is estimated by the method of maximum likelihood. The likelihood function of the full model will be derived, followed by a discussion of identification. Basic features of the data will be discussed provided that they are crucial to the understanding of the estimation procedure. A detailed description of the data can be found in the next section.

The parameter set of the full model consists of state dependence parameters $\boldsymbol{\gamma} \equiv (\gamma_{\mathrm{H}}, \gamma_{\mathrm{AF}}, \gamma_{\mathrm{F}}, \gamma_{\mathrm{w}}, \gamma_{\mathrm{J}})$, coefficients of covariates $\boldsymbol{\beta} \equiv (\boldsymbol{\beta}_{\mathrm{H}}, \boldsymbol{\beta}_{\mathrm{AF}}, \boldsymbol{\beta}_{\mathrm{F}}, \boldsymbol{\beta}_{\mathrm{w}}, \boldsymbol{\beta}_{\mathrm{J}}, \boldsymbol{\beta}_{\mathrm{R}})$, utility function parameters $\boldsymbol{\phi} \equiv (\phi_0, \phi_3, \phi_5, \phi_7, \phi_8)$, standard deviations of shocks σ_{c} and σ_{w}, and parameters of unobserved heterogeneity π_2, π_3, $\boldsymbol{\mu}_2$, and $\boldsymbol{\mu}_3$. There are 84 parameters in total. Estimation of the discount factor will be discussed at the end of this section. For each individual in each period, the choice $\mathbf{d}_{it}$, state variables $\mathbf{S}_{it}$, covariates $\mathbf{X}_{it} \equiv (\mathbf{X}_{\mathrm{H}it}, \mathbf{X}_{\mathrm{AF}it}, \mathbf{X}_{\mathrm{F}it}, \mathbf{X}_{\mathrm{w}it}, \mathbf{X}_{\mathrm{J}it}, X^{e}_{\mathrm{R}it}, N_{it}, \mathcal{T}_i)$, and policy rules $\mathbf{Z}_{it} \equiv (\mathbf{Z}_{\mathrm{A}it}, \mathbf{Z}_{\mathrm{F}it}, \mathbf{Z}_{\mathrm{E}it}, \mathbf{Z}_{\mathrm{T}it}, \mathbf{Z}_{\mathrm{R}it}, \underline{w}_t, \bar{M}_i, \bar{m}_i, I^{\mathrm{br}}_{it}, t_{0i})$ are observed from the data. The wage w_{it} is observed for workers only. The wage equation is estimated jointly in the model. In each iteration in the parameter space, computation of the likelihood for individual i consists of three nested loops. In the inner loop, the likelihood is computed for each period t conditional on type q and the expected value functions. In the middle loop, the expected value functions in the dynamic programming problem are computed using backward recursion, conditional on type q. In the outer loop, the likelihood is computed as the weighted average of the type-specific likelihoods, where the weights are the type probabilities. For notational simplicity, $\mathbf{X}_{it}$ and $\mathbf{Z}_{it}$ are suppressed in subsequent discussions.

The likelihood function is derived below. Consider individual i of type q in period t facing a time limit and choosing the best alternative from the choice set D. Let D' be an index representation of D. For instance, if $D = D_0$ (i.e., no job offer, has not hit time limit), then $D'_0 = \{1, 4, 6\}$. As discussed in the previous section, the choice set depends on job offer availability $I_{\mathrm{J}it}$ and whether the individual has hit the time limit; it is written as $D'(I_{\mathrm{J}it}, \mathbf{S}_{it})$ to emphasize such a relationship. Suppose the wage, $\mathbf{S}_{it}$, and type are known. Let $\bar{V}_{ikt}$ denote the

[18]Both Swann (2005) and Fang and Silverman (2009) found positive and significant effects of work experience on wage. However, Swann did not include lagged work status in the model; he also noted that the estimates cannot be interpreted as "true" state dependence because unobserved heterogeneity is not included. In Fang and Silverman, age is not included in the wage equation. They also noted that the results of their model should best be interpreted qualitatively.

choice-specific value, *exclusive* of the choice shock, for alternative k:

$$\bar{V}_{ikt}(w_{it}, \mathbf{S}_{it}, q) \equiv Y_{ikt}(w_{it}) + \phi_0[Y_{ikt}(w_{it})]^2 + \alpha_{ikt}(\mathbf{S}_{it}, q) + \delta E_t V_{i,t+1}(\mathbf{S}_{ik,t+1}, \boldsymbol{\mathcal{E}}_{i,t+1}). \tag{8}$$

The above expression is obtained by combining equations (1) and (5). The intertemporal budget constraints (4), (6), and (7) determine $\mathbf{S}_{ik,t+1}$. Wage affects income, and both lagged participation status and type affect preference.[19] Due to the distributional assumption for the choice shock, the choice probability conditional on job offer availability, wage, $\mathbf{S}_{it}$, and type has a multinomial-logit closed form:

$$P_{ikt}(I_{\mathrm{J}it}, w_{it}, \mathbf{S}_{it}, q) = \begin{cases} \dfrac{\exp(\bar{V}_{ikt}(w_{it}, \mathbf{S}_{it}, q)/\sigma_{\mathrm{c}})}{\sum\limits_{j\in D'} \exp(\bar{V}_{ijt}(w_{it}, \mathbf{S}_{it}, q)/\sigma_{\mathrm{c}})}, & \text{if } k \in D'(I_{\mathrm{J}it}, \mathbf{S}_{it}), \\ 0, & \text{otherwise.} \end{cases}$$

Since $I_{\mathrm{J}it}$ and the wage for nonworkers are unobserved, they are integrated out in the likelihood function. Let $f(\cdot)$ and $F(\cdot)$ denote the probability density function (p.d.f.) and cumulative distribution function (c.d.f.) of the "latent" wage, respectively. The likelihood contribution, denoted L_{ikt}, of individual i in period t choosing alternative k consists of three cases: (i) work, the observed wage is higher than the minimum wage; (ii) work, the observed wage equals the minimum wage; (iii) not work, so wage is not observed:

$$L_{ikt} = \begin{cases} \theta_{it}(\mathbf{S}_{it}, q) P_{ikt}(1, w_{it}, \mathbf{S}_{it}, q) f(w_{it}|\mathbf{S}_{it}, q), & \text{if } P_{\mathrm{H}ikt} = 1 \text{ and } w_{it} > \underline{w}_t, \\ \theta_{it}(\mathbf{S}_{it}, q) P_{ikt}(1, \underline{w}_t, \mathbf{S}_{it}, q) F(\underline{w}_{it}|\mathbf{S}_{it}, q), & \text{if } P_{\mathrm{H}ikt} = 1 \text{ and } w_{it} = \underline{w}_t, \\ \theta_{it}(\mathbf{S}_{it}, q) \displaystyle\int P_{ikt}\bigl(1, \max\{w, \underline{w}_t\}, \mathbf{S}_{it}, q\bigr) f(w|\mathbf{S}_{it}, q)\, dw & \\ \quad + \bigl(1 - \theta_{it}(\mathbf{S}_{it}, q)\bigr) P_{ikt}(0, 0, \mathbf{S}_{it}, q), & \text{if } P_{\mathrm{H}ikt} = 0. \end{cases}$$

In cases (i) and (ii), the individual receives a job offer and accepts it. In case (iii), the individual either does not receive a job offer or receives a job offer but rejects it. The integral in case (iii) is computed by Gaussian–Hermite quadrature with five points (e.g., Butler and Moffitt (1982), Swann (2005)).

[19]The expected value function is also affected by type, but the notation is suppressed.

Suppose individual i is observed in the data for t_i periods and there are N individuals in the sample. The log likelihood function is

$$\mathrm{LL} = \sum_{i=1}^{N} \ln \sum_{q=1}^{3} \pi_q \prod_{t=2}^{t_i} \sum_{k=1}^{8} d_{ikt} L_{ikt}.$$

The standard errors are computed using the Berndt, Hall, Hall, and Hausman (1974) (BHHH) algorithm. In the full model, the first period is not used directly for likelihood computation as the participation status prior to period 1 is not observed. This method of conditional maximum likelihood estimation (CMLE) does not require specifying the distribution of initial conditions, but does incur a cost on statistical efficiency. In models without state dependence in lagged participation status, the first period is also included in the computation of the likelihood.

Identification

The arguments for model identification are given below. With the exception of Keane and Moffitt (1998), identification in a similar class of models has only been scantily discussed. Consider a modified version of the random utility model in equation (1):

$$U_{ikt} = \psi_k Y_{ikt} + \alpha_k + \varepsilon_{\mathrm{c}ikt}.$$

To facilitate discussion, let α_k be a pure intercept term and let $Y_{i1t} = 0$. The parameter ψ_k captures the "reduced-form" effect of various policy interventions. Assuming the interventions are exogenous, identification requires that (i) Y_{ikt} is known for all k, (ii) $\mathrm{var}(Y_{ikt}) > 0$ for all k, and (iii) Y_{ikt} is not perfectly multicollinear across k. Income can be calculated from the budget constraint in equation (2), satisfying condition (i). For the moment, wage is assumed to be exogenous and observed for everyone, but both assumptions will be relaxed later. Conditions (ii) and (iii) are satisfied due to the following features of the data:

- PT/FT work; no programs (ψ_2, ψ_3): The EITC expansion changes Y_{i2t} and Y_{i3t} disproportionately, allowing both parameters to be separately identified.
- No work; both programs (ψ_4): The maximum welfare benefit level varies by family size, state, and time. The work requirement sanction policy varies by state and time.
- PT work; both programs (ψ_5): States are allowed to set their own earnings disregards under AFDC waivers and TANF.
- No work; food stamps only (ψ_6): The maximum food stamp benefit level varies by family size and time.
- PT/FT work; food stamps only (ψ_7, ψ_8): The food stamp benefit varies by region due to differences in the deduction amount. In addition, the income

eligibility tests create kinks and notches in the budget constraint, allowing both parameters to be separately identified.

There are other variations in policy rules, which are further discussed in the data section and the Appendix. Note that many of these rules are de facto exclusion restrictions; for instance, the EITC expansion should not affect the utility of nonwork alternatives. In the structural model, the condition $\psi_1 = \psi_2 = \cdots = \psi_8$ represents overidentifying restrictions.[20] With normalization in income, the standard deviation of the choice shock σ_c captures the strength of the statistical relationship between income and choice. The analysis is similar with a set of covariates in α_k. The income effect can be identified by the region of the parallel outward shift of the budget constraint caused by the EITC expansion.

In the data, wage is observed for workers only. Endogeneity due to self-selection arises if the wage shock is correlated with other error terms in the model. In the model, unobserved heterogeneity takes the form of discrete types and the error terms are i.i.d. when conditioned on type. The panel structure of the data is sufficient to identify the parameters of unobserved heterogeneity; nevertheless, exclusion restrictions are included to facilitate estimation. The instruments for labor force participation include variables that affect the job offer probability or the relative utilities of work and nonwork alternatives but do not enter into the wage equation. They include contemporaneous and lagged local unemployment rates (in the job offer equation), program policy rules (in the budget constraint), and family structure (in the preference equations).[21] The wage instruments include the average wage of the local employed labor force and the share of local employment in the service industry (e.g., Keane and Moffitt (1998)). Moreover, changes in the minimum wage enter into the model through the wage equation only.

Although job offer availability is unobserved, the job offer probability can be identified in a similar spirit to Flinn and Heckman (1982) using information from the observed wage distribution. Intuitively, if the rate of employment is low, a relatively untruncated distribution of observed wages would imply a low job offer arrival probability, while a heavily truncated distribution would imply a low taste for work (i.e., high work reservation wage). The log-normal distributional assumption implies that the recoverability condition in Flinn and Heckman is satisfied, so the full wage distribution can be recovered from the truncated distribution of observed wages.

[20]The restrictions imply that income from all alternatives is treated equivalently. For discussions of the similarity of food stamp benefits to cash, see, for instance, Keane and Moffitt (1998) and Hoynes and Schanzenbach (2009). Also note that in structural models that use pre-reform data, ψ_4 and ψ_5 are primarily identified by state–year variations in the maximum welfare benefit level and "effective" benefit reduction rates. Moreover, separate identification of ψ_2 and ψ_3 is not possible without relying on exogenous wage variations.

[21]The program preference equations contain additional exclusion restrictions, which are explained further in the data section.

Identification of the discount factor arises from the observation that time limits create exclusion restrictions in the dynamic programming problem (e.g., Magnac and Thesmar (2002)). Consider the model without state dependence in lagged participation. Individuals who are under no time limits or have hit the limit face a static problem, while others face a dynamic problem. The difference in behavior between the two groups allows the discount factor to be identified. My estimate of the annualized discount factor in this model is 0.84 with a standard error of 0.01.[22] In the full model, all individuals face a dynamic problem. I set the annualized discount factor at 0.86, which is roughly in the middle of 0.81 in Swann (2005) and 0.93 in Keane and Wolpin (2010).[23]

5. DATA

The primary data set used for estimation is drawn from the 1992, 1993, and 1996 panels of the Survey of Income and Program Participation (SIPP). The 1992 and 1993 panels each contain a nationally representative sample of around 21,000 households. The 1996 panel is almost twice as large, containing around 40,000 households. In the SIPP, households are divided into four rotation groups and interviewed every 4 months. The 1992 and 1993 panels have 9 waves of data, and the 1996 panel has 12 waves. The 1992 panel has data from 1992 to 1994; the 1993 panel has data from 1993 to 1995; and the 1996 panel has data from 1996 to 1999.

I restrict the sample to all female heads of family who in wave 1 are aged between 18 and 53, have at least one child under 18, and are observed in the data for nine consecutive waves or more. An individual is excluded from the sample if she satisfies any of the following criteria: (i) resides in an unidentifiable state of residence; (ii) changes state of residence; (iii) becomes married; (iv) gives birth to a child; (5) has more than 50 dollars of asset income in any month; (6) earns more than 4000 dollars in any month.[24] Estimation bias can

[22]The discount factor does not converge in a model with full sets of covariates, but it converges in a smaller model where the covariates contain the constant only. My estimate is from the smaller model. The discount factor is 0.944 per decision period, yielding $(0.944)^3 \approx 0.84$ per annum.

[23]In the full model, the slope of the likelihood function is small around $\delta = 0.86$, so the estimation results are similar if the discount factor is set at 0.84 instead. The standard error of the discount factor reported in Swann is 0.014. Keane and Wolpin set the discount factor at 0.93. Fang and Silverman (2009) estimated both time-consistent and time-inconsistent models. In the time-consistent version of their model, the estimate of the discount factor is 0.41 with a standard error of 0.08.

[24]In the raw sample of female heads, around 60 percent are observed for nine consecutive waves or more. In the 1996 panel, Maine, North Dakota, South Dakota, Vermont, and Wyoming are not separately identifiable. In addition to these states, Alaska, Iowa, Idaho, and Montana are also not separately identifiable in the 1992 and 1993 panels. When the sample selection process is carried out sequentially in the order described above, the sample size reduces by 1.5, 3.5, 13, 6, 13, and 11 percent respectively.

occur if marriage and fertility are endogenous, but the literature finds inconclusive evidence about the effects of welfare reform on both outcomes (e.g., Blank (2009)).[25] Individuals with nonnegligible asset income are excluded because they are likely to fail the asset tests. In the data, almost none of these individuals participates in welfare or food stamps even though many of them have no other sources of income.[26] The cutoff point for earnings is quite high, as it is almost twice as large as the average EITC income eligibility threshold in 1996. The final sample consists of 2210 individuals and 22,647 observations (or 20,437 observations if wave 1 is excluded).

Relative to the PSID sample in Swann (2005) and NLSY79 sample in Keane and Wolpin (2010), an advantage of SIPP is that it contains a much larger sample of female heads. The PSID and NLSY samples consist of 1530 women and 2163 young women, respectively, but less than one-third of both samples are female heads.[27] Another advantage of SIPP is that it conducts interviews every 4 months instead of annually. SIPP is ideal for studying short-run dynamics, but it is less well suited for studying life-cycle behavior because individuals are tracked for a shorter period of time.

A substantial amount of information in SIPP such as program participation and earnings is collected at the monthly level by asking retrospective questions for each of the four reference months of the interview.[28] However, it is well known that SIPP is subject to "seam bias," that is, interviewees tend to report the same outcomes for all reference months of the interview (e.g., Blank and Ruggles (1996), Moore (2007)). To deal with this issue, I select data only

[25] For instance, using Vital Statistics, Bitler, Gelbach, Hoynes, and Zavodny (2004) found that welfare reform leads to fewer new marriages among female heads of family, but they also noted that the result is sensitive to specification and data choice. A simulation exercise in Swann (2005) suggests that welfare reform has a small effect on marriage.

[26] The SIPP data contain extensive information on asset income such as interest, bond, dividend, and rental income, but relatively little information on the stock of assets. The asset limit for welfare can be as low as 1000 dollars. Although the liquid asset and vehicle value tests for welfare are not modeled formally, Hurst and Ziliak (2006) and Sullivan (2006) suggested that it is valid to omit both tests, as they generate negligible incentive effects.

[27] In Keane and Wolpin (2010), the sample distribution by state and race (in the order of white, black, and hispanic) is California (276, 112, 445), Michigan (244, 77, 0), New York (139, 141, 128), North Carolina (133, 96, 0), and Ohio (258, 114, 0). Moreover, the distribution of the holdout sample used in Keane and Wolpin (2007) is Texas (133, 167, 270). I would like to thank Michael Keane for providing the above summary statistics. The average cohort in my sample is the 1960 cohort, which is close to the average NLSY79 cohort but is around 20 years younger than the average PSID cohort.

[28] Demographic variables such as age, family structure, and area of residence are reported on a monthly basis. Information on labor force activity (e.g., employment status) is recorded at the monthly or weekly level. Education, asset income, and job characteristics (e.g., paid by the hour, hourly wage (if paid by the hour), usual work hours) are recorded at the wave level. I disaggregate or aggregate all data to the monthly level. Nontransfer nonlabor income is defined as money from relatives or friends as well as various forms of nontransfer lump-sum payments.

from the most recent reference month in each interview to construct data for each decision period in the model. Data from earlier reference months are discarded. For instance, an individual is considered a welfare recipient in wave 1 if she participates in welfare in the most recent reference month of the wave 1 interview.[29] Likewise, lagged participation status refers to participation status in the most recent reference month of the previous interview.[30]

The work hour variable is computed as the sum of work hours from all jobs and self-employment held in the month.[31] The wage is computed as the sum of earnings from all jobs and self-employment divided by the total work hours. To remove outliers, the wage and work hour variables are truncated from above at 40 dollars per hour and 84 hours per week, respectively. The wage is also truncated from below at the federal minimum wage.[32] In the model, work hours must be discrete in the choice set. To facilitate comparability with existing work (e.g., Hoynes (1996), Keane and Moffitt (1998)), I define 0, 20, and 40 as the number of weekly hours for no work, part-time work, and full-time work, respectively. The raw work hours are categorized according to the definition from the Current Population Survey (e.g., Keane and Moffitt (1998)): weekly work hours of 35 or more are defined as full-time work, and work hours between 1 and 35 are defined as part-time work.

The SIPP data are then merged with policy and economic data from several data sets. Table I summarizes the main variables and data sets being merged in and the merging criteria. Data on welfare policy from 1996 onward are mainly extracted from Urban Institute's Welfare Rules Data Base (WRD), which records details on almost all aspects of welfare policy since 1996. Pre-1996 data are considerably simpler and are mainly extracted from Grogger and Karoly (2005). This includes, for example, the implementation dates of fi-

[29]Child-only welfare cases are indistinguishable from full-family cases before wave 10 of the 1996 panel. To ensure consistency in data definition, I follow existing studies (e.g., Mazzolari (2007)) and do not distinguish between the two types of cases.

[30]Similarly, cumulative periods of welfare use under a time limit is defined as the total number of previous welfare-receiving decision periods since the time limit policy started. For instance, if a time limit policy starts in wave 3 and the individual receives welfare in wave 3 but not wave 4, then the variable equals 0, 1, and 1 in waves 3, 4, and 5, respectively.

[31]Individuals with a total monthly earnings of less than 50 dollars are considered as nonworkers. Around 75 percent of the workers have a job that is paid by the hour. If a job is paid by the hour, monthly earnings from the job and its reported hourly wage are used to compute the number of work hours for the job during the month. If the job is not paid by the hour, the reported work hours for the job is used instead. Around 6 percent of workers have more than one job. For these workers, the calculation is similar for the second job. Around 2.5 percent of workers have income from self-employment. For these individuals, the reported work hours in self-employment are used.

[32]Around 2 percent of the workers who are paid by the hour report having wages strictly below the federal minimum wage. Between April 1, 1991 and September 30, 1996, the federal minimum wage was 4.25 dollars per hour. It rose to 4.75 dollars on October 1, 1996, and then to 5.15 dollars on September 1, 1997.

TABLE I

SOURCE OF POLICY AND ECONOMIC DATA AND MERGING CRITERIA[a]

Variable	Main data source	Merge with SIPP by
Welfare benefit and eligibility rules	Welfare Rules Database (WRD); Grogger and Karoly (2005); Welfare Benefits Data Base[b]	State, year, month, family size
Time limit	WRD; Grogger and Karoly (2005)	State, year, month
Work requirement sanction and age-related exemption	Grogger and Karoly (2005); WRD	State, year, month, age of youngest child (exemption)
Food stamp benefit and eligibility rules	Wilde (2001); Welfare Benefits Data Base[b]	Year, family size, region (shelter deduction)
Federal EITC and income tax rules	Tax tables	Year, family size
State EITC and income tax rules	NBER TAXSIM model	State, year, family size
Welfare adiministrative cost	Various years of the Green Book (e.g., U.S. Congress (1998))	State, year
Welfare diversion program	WRD	State, year, month
Food stamp recertification and EBT card policies	Kabbani and Wilde (2003)	State, year
Local unemployment rate	Local Area Unemployment Statistics (LAUS)	State or MSA (if applicable), year, month
Local average wage and industry share	Quarterly Census of Employment and Wages (QCEW)	State or MSA (if applicable), year, month

[a] Policy implementation dates instead of approval dates are used.

[b] Source: http://www.econ2.jhu.edu/people/moffitt/datasets.html.

nancial incentive waivers and the corresponding levels of earnings disregards, and the implementation dates and severity of work requirement sanction policies.[33] In general, a lenient sanction involves removing a portion of the family's welfare benefit; a stringent sanction removes the family's full benefits for life

[33]The pre-waiver standard percent disregard is 33 percent in the first 4 months of working while on AFDC and is zero percent afterward. The latter definition is used in the model. Since the dollar disregard is already included in the welfare benefit function, the effective benefit reduction rate is actually much lower than 100 percent. For instance, a typical dollar disregard of 120 dollars and maximum benefit level of 360 dollars would imply an effective benefit reduction rate of 75 percent ($360/(360 + 120)$), which is close to the 70 percent found in Fraker, Moffitt, and Wolf (1985). According to calculations from Keane and Moffitt (1998), the average child care deduction is very small, so it is not included in the benefit function.

or until compliance; an intermediate sanction is in between.[34] Some states implemented waivers that lowered the threshold age of the age-related exemption, and the exemption generally became more stringent under TANF. Data are extracted from Grogger and Karoly (2005) and WRD. Data on the types, lengths, and implementation dates of time limits in each state are mainly extracted from WRD. Since the data on welfare policy in each state are available on a monthly basis, they are merged with SIPP by state, year, month, and family characteristics if applicable. Policy data on food stamps, federal EITC, and federal income tax are merged in from various data sources by year and family size. The state income tax and EITC rules are extracted from the source codes of TAXSIM, a microsimulation model developed by the National Bureau of Economic Research (NBER) that computes income tax liabilities for different types of individuals in each state and year. These rules are merged in by state, year, and family size.

Four policy variables enter into the program preference equations as exclusion restrictions. As in Keane and Moffitt (1998), a variable that gives the average welfare administrative cost per welfare recipient in each state and year is included. Around half of the states under TANF implemented "diversion programs," which provided lump-sum payments (usually worth about 3 months of welfare payments) to welfare applicants in exchange for not officially enrolling them in welfare. In the 1990s, some states implemented short recertification periods (3 months or less) to reduce the error rates of food stamp benefit payments, and some started the electronic benefits transfer (EBT) card system (Kabbani and Wilde (2003)). Three state–year indicators of policy implementation are constructed accordingly.[35]

To control for economic conditions, data on the local unemployment rate, the average wage of the local employed labor force, and the share of local employment in the service industry are obtained from Local Area Unemployment Statistics (LAUS) and Quarterly Census of Employment and Wages (QCEW)

[34]These variables are further explained as follows. Before waivers were implemented, work requirements were already in place nationwide under the Job Opportunities and Basic Skills Training (JOBS) program, but JOBS sanctions were very lenient and not frequently enforced (e.g., Grogger and Karoly (2005)). Therefore, sanctions are assumed to be absent before waivers. States with JOBS sanction waivers were allowed to impose more severe sanctions for failure to meet work requirements. They are classified into three degrees of severity as described in the main text. Grogger and Karoly reported characterizations of TANF sanctions from four different studies, each of which categorizes sanctions in each state into three degrees of severity. A simple majority rule is used to determine severity. For instance, if three studies rate a state's sanction as stringent and one rates it as lenient, the sanction is classified as stringent. When there is a draw, the sanction is classified as intermediate.

[35]Some states have very restrictive diversion programs, for example, diversion payments are available once in the lifetime. These states are classified as not having a diversion program. I thank Kabbani and Wilde for providing the data on food stamp policy for analysis.

from Bureau of Labor Statistics, respectively. To capture dynamic macroeconomic performance, contemporaneous and the 3- and 6-month lagged unemployment rates are included (e.g., Ziliak et al. (2000), Fang and Keane (2004)). The above variables are merged with SIPP by year, month, and the individual's area of residence. Around half of the SIPP sample reside in an identifiable metropolitan statistical area (MSA). For these individuals, the data are merged by MSA; otherwise, the data are merged by state.

Table II reports summary statistics of the main variables in the sample. The results are reported separately for the 1992 and 1993 panel sample and the 1996 panel sample. On average, an individual is 37 years of age and has 1.5 children under age 18. More than 60 percent of the sample are white and almost 80 percent completed grade 12 or above. The mean hourly wage for workers is around 9 dollars. The mean income eligibility threshold for welfare is 550 dollars per month, which is roughly one-half of food stamps and one-fourth of EITC. Although the demographic characteristics are similar in both samples, the policy environments are quite different. For instance, in the 1996 panel sample, the mean welfare percent disregard is larger by almost 20 percentage points, reflecting a trend that is in line with Ziliak (2007), who used quality control data; the EITC maximum benefit level and phase-in rate are larger by one-half; 70 and 80 percent of the sample are subject to time limits and potential work requirement sanctions, respectively; the average threshold age for the age-related exemption is lower by 1 year.[36] The average local unemployment rate in the 1996 panel sample is lower by 2 percentage points.

Table III reports the participation rates and choice distribution by year. The choice distribution is relatively stable between 1992 and 1995.[37] Roughly speaking, 60 percent of the sample are workers, 40 percent work full-time, 30 percent are welfare recipients, and 45 percent are food stamp recipients. Around 85 percent of the welfare recipients do not work, but only half of the indi-

[36]The majority of the states started implementing time limits in 1996 and 1997. Slightly over half of the states implemented a 5-year lifetime limit; around 10 states implemented stricter limits and the rest of the states implemented more lenient limits or had no limits at all. Michigan did not have a time limit in the sample period. Time limits were implemented in Arizona, Connecticut, Delaware, Indiana, Iowa, Nebraska, and Virginia before 1996 as AFDC waivers. Arizona and Connecticut had statewide time limits before 1996 (November and December, 1995 respectively). I assume both states started time limits in wave 1 of the 1996 panel. Iowa had a complicated, individual-based time limit before January 1997, after which a lifetime limit was implemented. For simplicity, I assume Iowa's start date to be January 1997. None of the other states had a time limit that applied to more than half of the case load before 1996. The start dates in Delaware and Virginia are set as the dates on which the policy applied to at least half of the case load. In the rest of the states, statewide implementation dates are used.

[37]The Current Population Survey (CPS) records systematic changes in outcomes as early as 1993. However, the sample definition is different, as the SIPP observations in 1994 and 1995 refer to individuals who are sampled earlier. Differences in welfare entry and exit rates (e.g., Grogger, Haider, and Klerman (2003), Haider and Klerman (2005)) might also explain this discrepancy.

TABLE II

SUMMARY STATISTICS OF SELECTED VARIABLES[a]

Variable	1992 and 1993 Panels Mean	1992 and 1993 Panels Std. dev.	1996 Panel Mean	1996 Panel Std. dev.
Reside in census south region (%)	35.4	47.8	37.9	48.5
Grade 12 or above (%)	77.7	41.6	79.1	40.6
Age	36.5	7.4	37.7	7.7
White (%)	62.7	48.4	64.2	47.9
Number of children less than age 18	1.7	0.9	1.5	0.9
Age of youngest child	9.1	5.2	9.9	5.3
Metro area residence (%)	76.9	42.2	81.3	39.0
Nontransfer nonlabor income ($)	4.6	65.0	4.8	74.0
Weekly raw work hours[b]	36.9	12.7	37.2	14.0
Hourly wage ($)[b]	8.6	3.9	9.1	4.0
Local unemployment rate (%)	6.6	2.1	4.7	1.8
Local average wage (weekly, $)	535.3	97.1	612.3	122.9
Local employment share in service industry (%)	33.9	3.9	35.2	4.3
Welfare annual admin. cost per recipient ($)	646.3	319.6	806.3	369.6
Welfare diversion (%)	0.0	0.0	20.0	40.0
Food stamp short recertification period (%)	4.0	5.9	15.4	18.3
Food stamp EBT card (%)	0.9	8.7	25.8	41.9
Welfare maximum benefit ($)	373.3	163.8	361.6	163.9
Welfare benefit dollar disregard ($)	119.9	26.0	94.4	67.4
Welfare benefit percent disregard (%)	6.3	14.9	24.3	25.2
Welfare eligibility threshold ($)	534.6	180.0	560.5	228.7
Food stamp maximum benefit ($)	263.9	78.6	271.8	84.3
Food stamp shelter deduction ($)	64.3	23.5	67.6	24.4
Food stamp net income eligibility threshold ($)	955.3	189.2	999.8	200.9
EITC maximum benefit ($)	146.6	58.3	226.1	89.0
EITC phase-in subsidy rate (%)	22.8	8.0	34.0	9.5
EITC phase-out subsidy rate (%)	14.6	3.6	17.5	4.1
EITC bracket 1 ($)	616.3	124.0	632.6	138.4
EITC bracket 2 ($)	915.5	188.9	949.7	167.4
EITC bracket 3 ($)	1878.8	410.6	2170.6	479.9
Federal income tax deduction and exemption ($)	993.4	182.2	1075.2	198.2
State income tax (%)	85.6	35.2	85.1	35.6
State income tax deduction and exemption ($)	457.6	380.1	441.1	368.1
State income tax number of brackets	3.3	2.3	3.4	2.3
State income tax bracket 1 ($)[c]	537.1	497.5	518.2	500.6
State income tax bracket 2 ($)[c]	1642.8	1697.2	1552.2	1689.1
State income tax bracket 3 ($)[c]	1638.3	994.6	1621.6	1050.7
State income tax rate in bracket 1 (%)[d]	2.5	1.8	2.3	1.7
State income tax rate in bracket 2 (%)[d]	3.7	1.9	3.5	1.6
State income tax rate in bracket 3 (%)[d]	5.0	1.6	4.7	1.4
State EITC (%)	10.1	30.1	15.0	35.7
State refundable EITC (%)	8.7	28.1	4.6	20.9
State EITC amount as fraction of federal EITC (%)[e]	16.7	17.1	16.7	11.5
Age-related exemption from work requirement (year)	1.9	0.4	0.8	1.3

(*Continues*)

TABLE II—*Continued*

Variable	1992 and 1993 Panels Mean	1992 and 1993 Panels Std. dev.	1996 Panel Mean	1996 Panel Std. dev.
Lenient work requirement sanction (%)	4.7	21.2	22.1	41.5
Intermediate work requirement sanction (%)	1.9	13.6	37.1	48.3
Strict work requirement sanction (%)	0.2	4.1	19.7	39.8
Lifetime time limit (%)	0.0	0.0	37.4	48.4
Periodic time limit (%)	0.0	0.0	25.4	43.5
Benefit-reduction time limit (%)	0.0	0.0	9.0	28.6
Time limit length (year)[f]	–	–	3.8	1.4
Periodic limit ineligibility length (year)[g]	–	–	4.5	1.0

[a] Sample size for the 1992 and 1993 panels = 10,656; sample size for the 1996 panel = 11,991.
[b] Workers only.
[c] Value set to missing if bracket has no upper limit or if bracket does not exist.
[d] Value set to missing if bracket does not exist.
[e] Individuals with state EITC only.
[f] Individuals with time limit only.
[g] Individuals with periodic limit only.

viduals who receive food stamp only do not work. Less than 7 percent of the sample are "disconnected," that is, they neither work nor participate in any programs. Between 1995 and 1999, there is a large increase in labor supply and

TABLE III

SAMPLE PARTICIPATION RATES AND CHOICE DISTRIBUTION BY YEAR[a]

		Participation Rates (%)				Choice Distribution by Year (%): No Programs			Welfare & FS		FS Only		
Year	No. Obs	Work	FT	Welf.	FS	NW	PT	FT	NW	PT	NW	PT	FT
1992	1130	59.3	38.6	31.3	46.0	6.7	12.2	35.0	27.4	3.9	6.6	4.6	3.5
1993	2933	57.9	37.5	32.7	45.6	7.0	13.3	34.1	28.7	4.0	6.3	3.1	3.4
1994	3552	60.9	38.6	31.3	43.6	6.9	13.8	35.8	26.5	4.8	5.7	3.7	2.9
1995	1857	60.4	39.9	31.4	43.3	6.5	12.7	37.6	26.6	4.9	6.5	3.0	2.3
1996	1539	66.2	39.5	23.6	40.0	8.8	15.6	35.6	18.8	4.8	6.2	6.2	3.9
1997	3078	70.1	42.5	20.0	34.6	9.4	17.5	38.4	15.0	4.9	5.5	5.1	4.1
1998	3078	72.7	46.0	14.6	29.3	10.9	18.1	41.7	11.0	3.6	5.5	4.9	4.3
1999[b]	3270	74.7	48.3	10.8	24.9	11.4	18.8	44.9	7.5	3.3	6.4	4.3	3.4
All	20,437	66.1	41.9	23.4	37.2	8.7	15.7	38.4	19.2	4.2	6.0	4.3	3.5

[a] FT, full-time work; Welf., welfare; FS, food stamps; NW, no work; PT, part-time work. Numbers in choice distribution may not sum to 100 percent due to rounding error.
[b] Contains a small number of observations from January and February 2000.

an even larger decline in program participation.[38] In 1999, around 75 percent of the sample are workers, almost 50 percent work full-time, 10 percent are on welfare, and 25 percent are on food stamps. Only 75 percent of the welfare recipients do not work, and more than 11 percent of the sample are disconnected. The two categories in the choice distribution that experience the largest changes are full-time workers who do not participate in any programs and nonworking welfare recipients.

6. RESULTS

Table IV reports the estimates of the full model. Other things being equal, individuals who are white do not have significantly different taste for work, but they tend to have higher disutilities from program participation. Compared to nonwhites, their wage offers are on average 1.7 percent higher and they are more likely to receive job offers. Older individuals tend to have higher taste for work and higher disutilities from program participation. The wage offer increases by 0.8 percent for each year of increase in age. Individuals who have higher education or reside in the south have higher taste for work and better labor market opportunities. Mothers with more children have lower taste for work. Mothers with younger children have a higher tendency to participate in food stamps alone rather than in both programs. The year effects are significant in the work preference and wage equations only. Welfare administrative cost, diversion, food stamp short recertification, and EBT card implementation all have insignificant effects. Local economic conditions have significant effects on labor market opportunities. The contemporaneous unemployment rate has a significant negative effect on the job offer arrival probability, but the effects of the lagged unemployment rates are insignificant. The estimate implies that at the sample means, a 1 percentage point reduction in the contemporaneous unemployment rate results in a 1.6 percentage point increase in the job offer arrival probability.[39] Among nonworking welfare recipients who are not subject to the age-related exemption, an intermediate work requirement sanction is equivalent to an income reduction of 166 dollars. The effects of lenient and stringent sanctions are statistically insignificant.

The coefficient of the quadratic term of income is -9.0×10^{-5}. This implies that for every 1000 dollars of increase in income, the utility increase is smaller by an additional 9 percent relative to the case of linear utility. The preference parameter estimates indicate that full-time work is preferred to part-time

[38]The large difference in the outcomes between 1995 and 1996 is partly due to the omission of observations from wave 1 of the 1996 panel. Otherwise, between 1995 and 1996, the fractions of workers and welfare recipients should have changed by 4.5 and 6 percentage points, respectively.

[39]The marginal effect of covariates on the job offer probability is $\frac{d\theta_{it}}{d\mathbf{X}'_{\mathrm{J}it}} = \theta_{it}^2 \exp(-\phi_{\mathrm{J}it})\boldsymbol{\beta}_{\mathrm{J}}$. The mean $\phi_{\mathrm{J}it}$ is 1.68. Therefore, at the means, $\theta_{it}^2 \exp(-\phi_{\mathrm{J}it}) = (0.843)^2(0.186) = 0.132$. The marginal effect is then $(0.132)(-0.124) = -0.016$.

TABLE IV

ESTIMATION RESULTS OF THE FULL MODEL[a]

	Work (ϕ_H)	Welfare & FS (ϕ_{AF})	FS Only (ϕ_F)	Log Wage[b]	Job Offer (ϕ_J)[b]
Intercept	−378.3 (339.99)	−3607.1 (445.48)***	−2469.2 (318.00)***	5.18 (0.02)***	−1.08 (0.26)***
Lagged work status	−276.9 (311.30)			0.71 (0.08)***	49.15 (0.55)***
Lagged welfare status		4244.27 (584.75)***			
Lagged food stamp status			2809.62 (389.37)***		
White	−22.1 (46.34)	−167.29 (29.29)***	−117.02 (25.78)***	0.17 (0.03)***	2.18 (0.64)***
Age	9.22 (3.90)**	−6.53 (2.05)***	−4.59 (1.83)**	0.08 (0.01)***	0.06 (0.04)
Grade 12 or above	196.83 (62.38)***	62.78 (26.24)**	6.81 (23.27)	0.95 (0.05)***	8.01 (0.75)***
South residence	80.2 (48.47)*	−13.5 (32.84)	18.23 (23.63)	0.34 (0.03)***	1.37 (0.67)**
Number of children	−103.2 (27.96)***	−43.47 (15.24)***	32.03 (17.95)*		
Age of youngest child	2.51 (5.70)	−2.21 (3.16)	−14.88 (3.54)***		
Year 1994/1995	342.56 (163.55)**	−10.64 (100.85)	−114.08 (92.69)	0.33 (0.06)***	−1.62 (1.03)
Year 1996/1997	16.23 (68.86)	−23.86 (36.24)	−12.56 (32.97)	0.21 (0.05)***	1.02 (0.97)
Year 1998/1999	337.06 (122.21)***	−52.21 (55.47)	−37.77 (55.01)	0.76 (0.06)***	−0.06 (1.03)
Type 2 intercept	326.28 (447.96)	−443.45 (78.73)***	−1002.9 (178.63)***	0.83 (0.01)***	−1.14 (0.15)***
Type 3 intercept	553.57 (304.20)*	−199.75 (48.12)***	−176.37 (39.16)***	0.39 (0.01)***	−1.27 (0.12)***
Welfare admin. cost		−0.04 (0.03)			
Welfare diversion		−9.4 (61.45)			
FS short recertification			−1.72 (80.87)		
FS EBT card			6.77 (40.75)		
Metro area residence				0.51 (0.04)***	−0.59 (0.65)
Local average wage ($100)				0.46 (0.02)***	
Service industry share (10%)				0.35 (0.04)***	
Unemployment rate					−1.24 (0.37)***
Unemployment rate (−3 mon)					−0.21 (0.36)
Unemployment rate (−6 mon)					0.32 (0.35)

(*Continues*)

TABLE IV—*Continued*

Other preference parameters		*Work requirement sanction (nonexempt)*	
Quadratic term (ϕ_0)[c]	-0.90 (0.14)***	Lenient	35.97 (98.63)
FT work (ϕ_3)	231.48 (79.10)***	Intermediate	166.36 (69.22)**
PT work; welfare & FS (ϕ_5)	117.78 (52.24)**	Stringent	107.04 (95.24)
PT work; FS only (ϕ_7)	21.76 (39.38)		
FT work; FS only (ϕ_8)	-669.8 (128.71)***	*Type probabilities*	
		Type 2	0.22 (0.01)***
Standard deviations of errors		Type 3	0.45 (0.02)***
Choice ($\sigma_c \pi/\sqrt{6}$)	947.84 (129.8)***		
Log wage	0.24 (0.01)***		
		Parameters	84
χ^2 (choice–year, df = 63)	579.76***	Sample size	20,437
χ^2 (log wage, df = 12)	97.02***	Log likelihood	$-27{,}165$

[a]Standard errors are given in parentheses. FT, full-time work; PT, part-time work; FS, food stamps. *, Significant at the 10 percent level; **, significant at the 5 percent level; ***, significant at the 1 percent level.

[b]Estimates and standard errors are multiplied by 10.

[c]Estimates and standard errors are multiplied by 10,000.

work, and disutilities from program participation generally differ by work intensity. These estimates are small compared to the standard error of choice shocks. One-third of the individuals belong to type 1, 22 percent to type 2, and 45 percent to type 3. When compared to type 1, type 2 and 3 individuals have higher disutilities from program participation, higher wage offers, and lower probabilities of receiving job offers. There is only a weak relationship between the unobserved permanent components in the work preference and wage equations. There is substantial state dependence in the disutilities from program participation and labor market opportunities, but no state dependence in the taste for work. If an individual worked last period, the wage offer is 7.1 percent higher, and at the means, the job offer arrival probability is 65 percentage points higher.

Simulation of outcomes during the sample period suggests that job offer availability is an important predictor of employment.[40] More than 90 percent of the job offers are accepted. The mean job offer arrival probabilities for the full sample, workers, and nonworkers are 0.692, 0.907, and 0.256, respectively. By contrast, the wage offers between workers and nonworkers are similar: the mean wage offer for the full sample, workers, and nonworkers are 8.61, 8.82, and 8.18 dollars per hour, respectively.

The chi-squared goodness-of-fit tests on the choice–year and wage distributions both reject the null hypothesis.[41] Figure 3 plots the actual and predicted wage distributions of workers. Both distributions are similar at all wage levels including the minimum wages. However, the model underpredicts the fraction

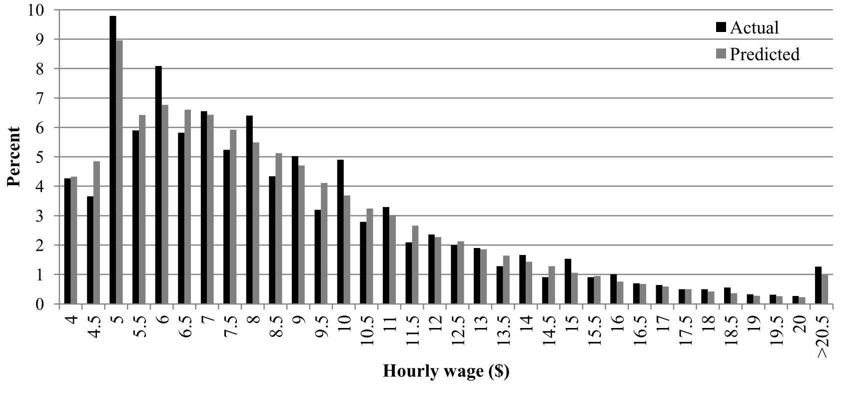


FIGURE 3.—Actual and predicted wage distributions for workers.

[40]All simulations and predictions in this article are carried out by simulating 10 paths per individual. The unobserved type is drawn from the type probability distribution at the beginning of each path.

[41]There are 64 cells (8 choices $\times$ 8 years) in the choice–year distribution. There are 13 cells (12 cells from 1.38 to 2.88 by 0.125 plus 1 cell 2.88+) in the log wage distribution of workers.

TABLE V

PREDICTED PARTICIPATION RATES AND CHOICE DISTRIBUTION BY YEAR[a]

	Participation Rates (%)				Choice Distribution by Year (%)							
					No Programs			Welfare & FS		FS Only		
Year	Work	FT	Welf.	FS	NW	PT	FT	NW	PT	NW	PT	FT
1992	59.6	36.6	30.0	41.6	10.2	14.2	33.9	24.9	5.1	5.3	3.6	2.7
1993	59.3	37.1	29.9	41.1	10.7	14.0	34.2	25.1	4.8	4.9	3.4	2.9
1994	61.4	37.7	27.5	37.5	12.6	14.7	35.2	21.9	5.6	4.1	3.3	2.6
1995	62.3	38.6	25.8	35.2	13.3	15.3	36.1	20.4	5.4	4.0	2.9	2.5
1996	68.0	42.5	22.2	36.0	9.5	15.7	38.8	17.2	5.0	5.3	4.8	3.8
1997	70.9	45.2	17.3	30.4	10.5	17.3	41.8	13.4	3.9	5.2	4.4	3.5
1998	73.4	48.2	11.9	24.5	12.6	18.0	44.8	8.9	3.0	5.1	4.2	3.4
1999	74.8	49.8	8.6	19.9	14.1	19.1	46.9	6.5	2.1	4.6	3.9	2.9
All	67.0	42.7	20.5	32.1	12.0	16.3	39.7	16.3	4.2	4.8	3.8	3.0

[a]FT, full-time work; Welf., welfare; FS, food stamps; NW, no work; PT, part-time work. Numbers in choice distribution may not sum to 100 percent due to rounding error.

of workers with integer wages. Table V reports the predicted choice distribution by year. The model predicts the fraction of workers most accurately, followed by the fraction of full-time workers. It underpredicts the levels of welfare and food stamp participation rates, but the changes in levels are more accurately predicted. Within the choice distribution, the model tends to overpredict the fraction of disconnected individuals and underpredict the fraction of nonworking welfare recipients between 1992 and 1995. Table VI compares the actual and predicted participation rates by time limit and work requirement sanction policies. Note that the results should not be interpreted as causal, as policy implementation is highly correlated with time. The predictions in the subcategories are generally consistent with the overall pattern with a few exceptions; for instance, the fraction of workers is underpredicted among individuals who are subject to sanctions but not time limits. However, this group is quite small, constituting 5.2 percent of the sample.

6.1. *Counterfactual Analysis*

Table VII reports the within-sample effects of increasing the baseline wage offer and job offer arrival probability by 10 percent for each individual in each wave of the sample. Individuals are assumed to perceive these changes as permanent. The elasticities are derived from the means of simulated responses in outcomes.[42] The wage elasticity of employment is only 0.09, as labor supply at the extensive margin is primarily determined by job offer availability. The

[42]Note that the elasticity estimates depend on the shape of the budget constraint in the sample. These estimates will be different if the baseline budget constraint is different.

TABLE VI

SAMPLE AND PREDICTED PARTICIPATION RATES BY POLICIES[a]

	No Time Limit		Time Limit		
	No WR	WR	No WR	WR	All
Data					
Work	59.4	73.7	68.0	76.3	66.1
Full-time work	37.8	39.9	39.6	51.0	41.9
Welfare	31.5	24.2	23.0	8.5	23.4
Food stamps	44.3	34.5	35.0	25.7	37.2
Predicted by model					
Work	61.0	68.4	69.2	76.7	67.0
Full-time work	37.8	41.8	44.6	51.0	42.7
Welfare	28.2	21.0	18.9	7.0	20.5
Food stamps	38.9	33.1	29.9	20.3	32.1
Percent of sample	52.8	5.2	13.5	28.5	100.0

[a]WR, subject to intermediate or stringent sanction for failure to meet work requirements. All numbers are in percent. Sample size = 20,437.

intensive margin is larger: the wage elasticity of full-time employment is 0.23. The labor supply elasticities with respect to job offer arrival probability are much larger at around 1.4. Similarly, program participation is inelastic to wage but elastic to job offer arrival probability. Since behavior is more sensitive to the job offer probability than the wage, it provides some rationale for policy interventions that directly affect the job offer arrival probability.

6.1.1. *Relative Role of Policy and the Economy*

Table VIII reports the contributions of various factors in explaining the changes in outcomes during the sample period. Results from three time frames are reported: 1992–1995; 1992–1997; 1992–1999. The contribution of a factor is defined as the difference in the predicted outcome between the baseline sce-

TABLE VII

WAGE AND JOB OFFER PROBABILITY ELASTICITIES

Participation Rate (%)	Baseline	Wage Increases by 10%	Job Offer Probability Increases by 10%[a]	Wage Elasticity	Job Offer Probability Elasticity
Work	67.0	67.6	76.1	0.09	1.36
Full-time work	42.7	43.6	49.2	0.23	1.55
Welfare	20.5	19.7	17.4	−0.39	−1.51
Food stamps	32.1	31.1	28.3	−0.29	−1.19

[a]Truncated from above by 1.

TABLE VIII

CONTRIBUTION OF FACTORS IN EXPLAINING CHANGES IN OUTCOMES[a]

	Change in Level (pct point)				Percent of Total Change (%)			
	Work	FT	Welfare	FS	Work	FT	Welfare	FS
Total change, 1992–1999	15.2	13.1	−21.4	−21.6	100.0	100.0	100.0	100.0
Time limit	0.9	1.3	−3.4	−2.5	5.8	9.5	16.0	11.7
Work requirement sanction	0.1	0.1	−1.0	−0.7	0.3	0.8	4.5	3.1
Welfare earnings disregards	0.0	−0.2	0.2	0.2	−0.3	−1.3	−0.9	−0.8
EITC	0.7	0.5	−0.7	−0.9	4.5	3.8	3.4	4.3
Minimum wage	0.0	0.1	−0.1	−0.1	0.3	0.7	0.3	0.4
Local unemployment rate	7.6	5.5	−2.8	−3.3	49.9	41.6	13.0	15.2
Other economic conditions	0.3	0.5	−0.3	−0.4	1.7	4.1	1.4	2.0
Demographics	0.8	1.2	−0.6	−2.8	5.5	9.1	2.9	12.9
Other factors	−0.2	−0.1	0.1	0.9	−1.1	−0.8	−0.6	−4.0
All of the above	11.7	9.4	−10.6	−10.5	77.1	71.9	49.4	48.5
All policies above[b]	2.5	2.3	−5.4	−4.3	16.2	17.3	25.0	20.1
All economic factors above[b]	8.0	6.1	−3.2	−3.9	52.6	46.7	14.9	18.1
Total change, 1992–1997	11.3	8.6	−12.7	−11.2	100.0	100.0	100.0	100.0
Time limit	0.1	0.3	−1.0	−0.6	1.3	3.0	7.6	5.1
Work requirement sanction	0.2	0.1	−0.9	−0.4	1.7	1.5	6.7	3.9
Welfare earnings disregards	0.0	−0.1	0.3	0.2	0.2	−1.6	−2.0	−1.4
EITC	1.0	0.5	−0.8	−0.7	8.5	6.3	6.5	6.5
Minimum wage	0.0	0.1	−0.1	−0.1	0.4	1.2	0.5	0.6
Local unemployment rate	3.5	2.2	−1.9	−1.8	31.2	25.9	14.9	16.1
Other economic conditions	0.2	0.3	−0.3	−0.4	1.9	3.5	2.7	3.4
Demographics	0.2	0.3	−0.3	−1.1	2.1	3.7	2.6	9.5
Other factors	0.0	0.0	0.0	0.6	−0.2	0.5	−0.2	−5.0
All of the above	5.3	3.8	−5.1	−4.1	47.3	43.8	40.0	36.6
All policies above[b]	1.4	0.8	−2.3	−1.5	12.3	9.8	18.3	13.7
All economic factors above[b]	3.7	2.5	−2.2	−2.1	32.9	29.4	17.0	19.1
Total change, 1992–1995	2.7	2.0	−4.2	−6.4	100.0	100.0	100.0	100.0
Time limit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Work requirement sanction	0.1	0.0	−0.1	0.0	1.9	0.5	2.1	0.6
Welfare earnings disregards	0.0	−0.1	0.2	0.2	1.1	−6.1	−5.0	−2.7
EITC	0.3	0.0	−0.2	−0.2	12.4	0.0	4.5	2.5
Minimum wage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Local unemployment rate	4.5	2.6	−2.0	−1.9	167.0	130.8	47.4	29.2
Other economic conditions	0.1	0.2	−0.1	−0.1	2.2	8.1	2.1	1.7
Demographics	0.7	0.8	−1.8	−2.8	25.8	39.4	42.0	43.0
Other factors	0.0	0.1	0.0	0.1	1.1	6.1	0.0	−1.7
All of the above	5.7	3.5	−4.1	−4.9	212.4	177.8	96.5	76.7
All policies above[b]	0.4	−0.1	−0.1	−0.1	13.9	−7.6	1.9	0.9
All economic factors above[b]	4.4	2.7	−2.0	−1.9	164.8	134.3	47.9	30.2

[a] FT, full-time work; FS, food stamps. "Total change" denotes the model's predicted change in outcome under the baseline scenario.

[b] Exclude "Other factors."

nario and the counterfactual scenario where the factor is kept fixed as in May 1992.[43] In order of importance, the key policies between 1992 and 1999 are time limits, EITC, and work requirement sanctions. They explain 5.8, 4.5, and 0.3 percent of the increase in employment, and 16.0, 3.4, and 4.5 percent of the decline in welfare participation during the period.[44] The expanded welfare earnings disregards reduce full-time work and increase program participation, but the magnitudes are very small. The minimum wage increases have minimal effects. All the policies above explain one-sixth of the increase in labor supply and one-quarter of the decline in program participation between 1992 and 1999. The policies tend to reinforce one another; for instance, assuming no interactions, policy can only explain 10.6 percent of the increase in employment. Economic factors explain one-half of the increase in labor supply and one-sixth of the decline in program participation. Demographics have relatively small effects. All the observable factors together explain three-quarters of the increase in labor supply and one-half of the decline in program participation between 1992 and 1999.

Between 1992 and 1997, EITC explains 8.5 percent of the increase in employment and 6.5 percent of the decline in welfare participation. By contrast, the effects of time limits are much smaller. During this period, policy and the economy explain one-tenth and one-third of the increase in labor supply, respectively, and each contribute to one-sixth of the decline in program participation. Between 1992 and 1995, all policies including EITC have small effects in absolute terms. The economy plays a particularly important role during this period. It explains more than 100 percent of the increase in labor supply, which implies that in the absence of the economic boom, labor supply would have decreased instead. The economy contributes to almost one-half of the decline in program participation during this period. Demographics are also a key factor, explaining roughly one-third of the increase in labor supply and almost one-half of the decline in program participation during this period.

The above estimates are roughly in line with existing reduced-form work, but there are some differences. In a recent survey, Blank (2009) noted a common finding from many existing studies that TANF as a whole causes a 20 percent decline in the welfare case load. Ziliak et al. (2000) found that the economy

[43]For instance, between 1992 and 1999, the contribution is defined as $(\bar{y}_{\text{base},99} - \bar{y}_{\text{base},92}) - (\bar{y}_{\text{cf},99} - \bar{y}_{\text{cf},92}) \approx \bar{y}_{\text{base},99} - \bar{y}_{\text{cf},99}$ where base denotes the baseline, cf denotes the counterfactual, and $\bar{y}$ denotes the mean outcome of interest of the scenario in a given year. $\bar{y}_{\text{base},92}$ and $\bar{y}_{\text{cf},92}$ are almost identical, so they cancel out.

[44]There are two reasons why sanctions have relatively small effects during this period. First, sanctions are targeted toward nonworking welfare recipients and only some of them are subject to severe sanctions. Second, sanctions were not very common until 1997. Assuming an intermediate sanction policy began in all states in 1996, between 1992 and 1999 the policy would have changed employment, full-time work, welfare participation, and food stamp participation by 0.35, 0.46, −2.14, and −1.49 percentage points, respectively.

explains two-thirds of the decline in welfare case load between 1993 and 1996, and welfare waivers have very small effects. Using March CPS data, Grogger (2003) found that time limits, "other reforms" (which include work requirements and welfare disregards), EITC, and unemployment rates explain 7, 6, 34, and 21 percent of the increase in employment, and 12, 2, 16, and 10 percent of the decline in welfare participation between 1993 and 1999. Fang and Keane (2004) estimated a model with a much richer set of specifications on March CPS data from 1993 to 2002. Their results are similar to Grogger (2003), with the exception that work requirements explain 17 percent of the increase in employment and 57 percent of the decline in welfare participation between 1993 and 2002. Mazzolari (2007) found that the behavioral effects of time limits account for 5 percent of the decline in welfare participation between 1996 and 2003. Exploring differences between female heads of family and single women, Meyer and Rosenbaum (2001) found that EITC and other tax changes account for 35 percent of the increase in employment between 1992 and 1996. In general, when compared with existing studies, I find larger effects of time limits, smaller effects of EITC, and larger effects of the economy. My estimates on the effects of work requirements are close to Grogger (2003), but smaller than Fang and Keane (2004).

6.1.2. *Evaluating Alternative Policies*

Table IX reports the within-sample effects of 10 counterfactual policies that involve changing basic welfare, food stamp, EITC, and tax policy rules. The changes are perceived as permanent and they are chosen such that their effects on the government expenditure are comparable. The effects are reported as simple differences in mean outcomes between the baseline and the counterfactual. The efficiency factor (EF) is also computed for each policy change:

$$\mathrm{EF} \equiv \frac{(\bar{U}_{\mathrm{cf}} - \bar{U}_{\mathrm{base}}) - (\bar{C}_{\mathrm{cf}} - \bar{C}_{\mathrm{base}})}{|\bar{C}_{\mathrm{cf}} - \bar{C}_{\mathrm{base}}|}.$$

The baseline scenario is denoted base, the counterfactual is denoted cf, the mean utility level is denoted $\bar{U}$, and $\bar{C} \equiv \bar{\tilde{B}}_{\mathrm{A}} + \bar{B}_{\mathrm{F}} + \bar{B}_{\mathrm{E}} - \bar{T}$ is defined as the mean net government expenditure on the programs. The efficiency factor is analogous to Liebman's (2002) "cost per dollar's worth of utility gain" (CU) as a measure of the efficiency gain or loss due to a policy change.[45] The EF is

[45] Liebman (2002) investigated the efficiency of EITC using a calibrated static model. A similar approach also was pursued by Immervoll, Kleven, Kreiner, and Saez (2007) and Eissa, Kleven, and Kreiner (2008). Under linear utility, $\mathrm{CU} \equiv \frac{\bar{C}_{\mathrm{cf}} - \bar{C}_{\mathrm{base}}}{\bar{U}_{\mathrm{cf}} - \bar{U}_{\mathrm{base}}}$. Note that $\mathrm{CU} > 1$ does not always imply an efficiency loss, as it depends on the sign of $\Delta\bar{C}$. In contrast, EF is robust to the direction of expenditure change. If $\Delta\bar{C} > 0$, then $\mathrm{EF} = \frac{\Delta\bar{U}}{\Delta\bar{C}} - 1 = \frac{1}{\mathrm{CU}} - 1$. If $\Delta\bar{C} < 0$, then $\mathrm{EF} = 1 - \frac{1}{\mathrm{CU}}$.

TABLE IX

WITHIN-SAMPLE EFFECTS OF SELECTED POLICY CHANGES (SIMPLE DIFFERENCE FROM BASELINE)[a]

Outcome	Baseline (1)	Welfare (2)	Welfare (3)	Food Stamps (4)	Food Stamps (5)	EITC (6)	EITC (7)	EITC (8)	Tax (9)	Tax (10)	Tax (11)
Work (%)	67.0	−0.3	0.1	−0.2	0.0	0.3	0.4	0.0	0.3	0.1	0.1
Full-time work (%)	42.7	−0.6	−0.8	−0.6	−0.6	0.4	−0.1	1.3	0.6	0.4	0.3
Welfare (%)	20.5	2.2	1.6	1.2	1.4	−0.3	−0.2	−0.3	−0.3	−0.1	−0.1
Food stamps (%)	32.1	1.3	1.1	1.9	2.0	−0.3	−0.2	−0.5	−0.3	−0.1	−0.1
Earnings ($)	785.4	−4.7	−3.6	−4.4	−3.7	3.5	0.5	9.2	5.1	3.1	2.6
Benefit amount ($):											
Welfare	77.6	28.2	16.0	3.2	5.1	−1.0	−0.9	−0.5	−0.8	−0.2	−0.1
Food stamps	73.6	−3.6	−1.9	20.6	20.5	−0.8	−0.6	−0.9	−0.7	−0.2	−0.2
Federal EITC	88.4	−0.7	0.0	−0.4	0.0	28.5	26.4	29.9	0.3	−0.2	−0.1
Federal & state tax[b]	−104.2	0.5	0.5	0.5	0.5	0.0	0.5	−1.1	26.5	11.3	11.1
Net gov. expenditure ($)	135.4	24.4	14.5	23.9	26.0	26.7	25.3	27.4	25.3	10.7	10.7
Utility	1499.4	7.7	2.5	10.7	9.9	22.9	21.0	22.0	22.1	9.3	9.0
Efficiency factor (%)[c]	–	−68.6	−82.6	−55.0	−62.0	−14.4	−17.1	−19.8	−12.8	−13.4	−15.9
Adjusted expenditure ($)	132.8	25.6	17.2	24.6	28.2	26.6	25.2	27.7	25.6	10.8	10.8
Adjusted utility	1607.9	9.8	3.8	11.4	12.1	29.9	26.4	33.5	29.3	12.7	12.5
Adjusted EF (%)[c]	–	−61.7	−77.6	−53.8	−57.1	12.2	4.8	21.0	14.6	17.1	15.6

[a]Outcomes are expressed on a monthly basis. Scenarios are described as follows: (1) baseline sample; (2) increase the welfare maximum benefit level and eligibility threshold by $100; (3) increase the welfare benefit percent disregard to 100% and eligibility threshold by $100; (4) increase the food stamp maximum benefit level and eligibility thresholds by $50; (5) reduce the food stamp benefit reduction rate on net income from 30% to 10%; (6) increase the federal EITC phase-in rate and maximum benefit level by 20%, and decrease the phase-out rate by 20%; (7) increase the federal EITC phase-in rate and maximum benefit level by 40%, and reduce the threshold of EITC bracket 2 to that of bracket 1; (8) decrease the federal EITC phase-in rate by 20%, increase the threshold of EITC bracket 1 by 50%, increase the maximum benefit level by 20%, and decrease the phase-out rate by 30%; (9) decrease the payroll tax rate by 45%; (10) increase the total amount of federal income tax deductions and exemptions by 28%; (11) remove all state income tax.

[b]Includes state EITC.

[c]Results may be subject to rounding error.

positive whenever the policy change causes a larger net utility gain than the increase in net expenditure, that is, a positive EF implies an efficiency gain; otherwise there is an efficiency loss. For instance, if the counterfactual increases government expenditure, then an EF of -5% implies that each additional dollar of transfer results in a mean utility increase of 0.95 units, which is equivalent to 0.95 dollars for an individual with no income. In addition to labor supply disincentives, disutilities from program participation also contribute to efficiency loss.[46] Due to the concavity of utility, an income transfer at a high-income level is less valued than the same transfer at a low-income level.[47] To allow for an equal valuation of transfers, the table also reports the adjusted expenditure, utility, and EF estimates by assuming linear utility ex post, that is, $\phi_0 = 0$ in the simulation of both the baseline and counterfactual scenarios.

In the baseline scenario, the mean monthly earnings and net government expenditure are 785 and 135 dollars, respectively. The mean monthly welfare and food stamp benefits are around 75 dollars, the mean federal EITC benefit is 88 dollars, and the mean tax burden is 104 dollars. In all scenarios, the two sets of expenditure estimates are very similar, as setting the quadratic term of income to zero results in small changes in behavior. Increasing the welfare maximum benefit level by 100 dollars (column 2) results in a small reduction in labor supply and a moderate increase in program participation. Interestingly, lowering the welfare benefit reduction rate to zero percent (column 3) attracts few individuals to employment, but substantially reduces full-time work and increases program participation. Given these results, it is not surprising that further expanding welfare leads to a large efficiency loss (70–80 percent). Both policies create a crowd-out effect on food stamp participants by reducing the fraction of individuals who receive food stamps only.

The findings are similar for an expansion in food stamps. Since the program covers a wider income range, smaller adjustments in the policy rule, for example, increasing the maximum benefit level by 50 dollars (column 4) or lowering the benefit reduction rate by 20 percentage points (column 5), are sufficient to

[46]If an individual participates in a program, the disutility from program participation is subtracted from the amount of program benefit received, so 1 dollar of program benefit translates to less than 1 dollar's worth of utility increase. Most existing empirical research on efficiency loss focuses on labor supply disincentives, but does not consider disutilities from program participation (e.g., King (1983) on a tax reform). Since labor supply and program participation are joint choices, both types of efficiency loss are not separable, but are jointly reflected in the EF measure. There is additional deadweight loss when revenue is raised via distortionary taxation on other parts of the economy so as to fund the transfers to female heads of family. In the literature, a reasonable estimate of the "marginal excess burden" (e.g., Ballard, Fullerton, Shoven, and Whalley (1985)) of this type of deadweight loss is between 0.3 and 0.5. Therefore, if this deadweight loss is included, the extra cost will be 0.3 to 0.5 dollars per dollar of transfer benefit given out to recipients.

[47]Note that in a dynamic setting with income uncertainty, transfers at a low-income level can lead to a larger increase in expected utility as it fares better in terms of insuring individuals against income shocks.

generate effects of a magnitude similar to the welfare expansion. The efficiency loss of expanding food stamps is around 60 percent.

Columns 6–8 report results from three types of EITC expansions: (i) balanced (1.2× phase-in rate, 0.8× phase-out rate); (ii) low-income range (1.4× phase-in rate, set bracket threshold $b_{\text{E}2it}$ to be equal to $b_{\text{E}1it}$); (iii) high-income range (0.8× phase-in rate, $1.5\times b_{\text{E}1it}$, 0.7× phase-out rate). In scenario (i), both employment and full-time employment increase by a similar amount. In scenario (ii), employment increases, but full-time employment reduces slightly. In scenario (iii), the effect is minimal on employment, but full-time employment increases by more than three times that in the first scenario. All scenarios result in a small decline in program participation. The unadjusted EFs are negative, as EITC transfers are made at a relatively high-income level and lead to a smaller increase in utility. However, the adjusted EFs are positive at 12.2, 4.8, and 21.0 percent, respectively, suggesting that an EITC expansion can effectively offset the disincentives created by other programs (e.g., Liebman (2002), Saez (2002)). In particular, scenario (iii) is more effective in terms of reducing disincentives given the large positive impact on full-time employment and the large adjusted EF.

The last three columns involve lowering the tax burden: reduce the payroll tax rate by 45 percent (column 9); increase the total amount of federal income tax deductions and exemptions by 28 percent (column 10); remove all state income tax (column 11). All three scenarios lead to qualitatively similar results in terms of their effects and efficiency implications. Similar to EITC, the unadjusted EFs are negative, but the adjusted EFs are positive (around 15 percent).

Table X reports the dynamic effects of time limits, work requirement sanction, EITC, and other changes in policy and the economy. All changes are perceived as permanent. The baseline scenario (column 1) assumes all covariates and policy rules are set fixed as in May 1992. Three scenarios involving time limits are simulated: a 5-year lifetime limit (column 2); a 5-year lifetime limit, but individuals are assumed to be uninformed of the policy before they hit the limit (column 3); a 4-year periodic limit with 4 years of ineligibility (column 4). An intermediate work requirement sanction (column 5) and a federal EITC with policy rule as in 1999 (column 7) are simulated. Three other policies are simulated: a 30-percent reduction in welfare benefits among welfare recipients (i.e., 0.7× $B_{\text{A}ikt}$) (column 6); a subsidy for workers (column 8) (see below); a "reform package" that consists of a 5-year lifetime limit, an intermediate work requirement sanction, and federal EITC as in 1999 (column 10). To examine the effect of an economic expansion, a 1-percentage point reduction in the local unemployment rate is also simulated (column 9).

Simulation results in the first decision period, at the end of year 5 (period 15), and at the end of year 10 (period 30) are reported. The effects in each of the decision periods are reported as differences in mean outcomes between

TABLE X

DYNAMIC EFFECTS OF SELECTED POLICY AND ECONOMIC CHANGES (SIMPLE DIFFERENCE FROM BASELINE)[a]

Outcome	Baseline (1)	5yrTL (2)	5yrTL (Uninformed) (3)	4-4TL (4)	WR (5)	Benefit Cut (6)	EITC (7)	Work Subsidy (8)	Economy (9)	Reform (10)
First decision period										
Work (%)	60.7	0.1	0.0	0.1	0.3	0.2	0.6	0.3	0.6	1.0
Full-time work (%)	37.6	0.1	0.0	0.2	0.2	0.2	0.4	−0.5	0.3	0.7
Welfare (%)	29.8	−0.8	0.0	−1.3	−1.8	−1.3	−0.4	0.0	−0.4	−2.8
Food stamps (%)	42.0	−0.2	0.0	−0.3	−0.6	−0.4	−0.3	0.0	−0.2	−1.0
Earnings ($)	667.7	1.0	0.0	1.4	2.4	1.8	3.6	−2.5	5.9	6.2
Net gov. expenditure ($)	180.4	−3.4	0.0	−5.2	−37.8	−30.5	69.6	51.3	−2.7	30.7
Utility	1297.1	16.3	0.0	22.6	0.0	0.2	62.4	39.7	17.8	69.8
Efficiency factor (%)[b]	–	571.0	–	533.7	99.9	100.8	−10.3	−22.6	769.8	127.9
Adjusted EF (%)[b]	–	486.0	–	492.4	97.1	98.3	12.1	−6.9	786.3	184.8
End of year 5										
Work (%)	60.1	2.2	0.0	2.8	1.9	1.7	2.4	0.8	2.8	5.1
Full-time work (%)	37.4	2.5	0.0	3.2	1.7	1.7	2.2	−0.3	1.8	4.9
Welfare (%)	27.3	−10.4	0.0	−15.0	−7.2	−5.8	−2.5	−0.3	−2.1	−15.4
Food stamps (%)	41.6	−4.2	0.0	−6.7	−4.2	−3.4	−2.3	−0.2	−2.0	−8.9
AP earnings ($)	649.3	9.2	0.0	13.4	11.2	9.4	13.6	−1.0	24.2	28.5
AP net gov. expenditure ($)	199.2	−23.8	0.0	−37.1	−52.3	−46.1	68.2	57.0	−11.9	8.7
AP utility	1277.4	4.9	0.0	0.8	−19.6	−17.2	64.5	46.7	33.9	49.3
Efficiency factor (%)[b]	–	120.6	–	102.3	62.6	62.6	−5.4	−18.1	385.2	466.4
Adjusted EF (%)[b]	–	117.3	–	99.0	56.9	56.1	20.4	0.5	397.6	762.8

(*Continues*)

TABLE X—*Continued*

Outcome	Baseline (1)	5yrTL (2)	5yrTL (Uninformed) (3)	4-4TL (4)	WR (5)	Benefit Cut (6)	EITC (7)	Work Subsidy (8)	Economy (9)	Reform (10)
End of year 10										
Work (%)	58.1	2.9	2.6	3.1	1.8	1.7	2.4	1.0	3.1	5.2
Full-time work (%)	35.5	3.2	3.4	3.3	1.5	1.3	2.1	−0.2	1.8	5.2
Welfare (%)	27.6	−16.3	−16.9	−16.9	−7.1	−5.9	−2.6	−0.2	−2.1	−18.5
Food stamps (%)	44.5	−7.0	−11.2	−7.6	−3.7	−3.0	−2.2	−0.2	−2.2	−10.3
AP earnings ($)	607.8	17.7	7.2	22.6	13.9	11.8	16.3	−0.1	27.3	38.7
AP net gov. expenditure ($)	231.5	−49.0	−28.2	−63.3	−58.8	−52.9	64.8	57.7	−14.3	−12.1
AP utility	1246.7	−12.4	−20.3	−19.6	−25.9	−23.2	62.0	47.4	34.6	32.4
Efficiency factor (%)[b]	–	74.8	28.1	69.0	55.9	56.2	−4.4	−17.8	342.3	367.8
Adjusted EF (%)[b]	–	71.4	24.0	65.2	50.3	50.3	23.6	1.4	347.2	413.8
End of year 5										
Cum. effective yrs of work	2.25	0.05	0.00	0.07	0.06	0.05	0.08	0.00	0.08	0.16
Cum. yrs on welfare	1.41	−0.26	0.00	−0.40	−0.28	−0.22	−0.10	−0.01	−0.08	−0.51
Cum. yrs on food stamps	2.06	−0.10	0.00	−0.16	−0.14	−0.11	−0.08	0.00	−0.07	−0.27
End of year 10										
Cum. effective yrs of work	4.44	0.23	0.12	0.28	0.16	0.14	0.21	0.02	0.20	0.47
Cum. yrs on welfare	3.12	−1.15	−0.74	−1.45	−0.70	−0.57	−0.26	−0.03	−0.20	−1.58
Cum. yrs on food stamps	4.69	−0.47	−0.41	−0.61	−0.34	−0.28	−0.21	−0.02	−0.18	−0.83
Having hit time limit (%)	–	7.5	29.3	6.0	–	–	–	–	–	4.3
Disconnected (%)	11.5	3.9	6.8	4.1	2.0	1.5	−0.2	−0.2	−0.5	4.3
Never on welfare (%)	22.8	1.3	0.0	2.4	6.0	3.6	1.5	0.0	1.8	8.6

[a] AP, amortizing payment. Scenarios are described as follows: (1) baseline, environment as in May 1992; (2) 5-year lifetime limit; (3) 5-year lifetime limit, assuming individuals are uninformed of the limit; (4) 4-year periodic limit with 4 years of ineligibility; (5) intermediate work requirement sanction; (6) 30-percent reduction of welfare benefit among welfare recipients; (7) federal EITC as of 1999; (8) work subsidy; (9) 1-percentage-point reduction in the unemployment rate; (10) 5-year lifetime limit, intermediate work requirement sanction, and federal EITC as of 1999.

[b] Results may be subject to rounding error.

the baseline and the counterfactual.[48] In periods 15 and 30, cumulative years of "effective full-time work" and program participation are also reported. One year of effective full-time work is defined as 1 year (i.e., three periods) of full-time work or 2 years of part-time work. In addition, in periods 15 and 30, the net present values (NPV) of the discounted streams of earnings, net government expenditure, and utility starting from the first period are calculated and converted to amortizing payments (AP) per decision period.[49] In both periods, the efficiency factor is derived from the amortizing payments of net government expenditure and utility. Therefore, the efficiency factor in period 15 (or 30) can be interpreted as the overall efficiency gain or loss of a policy change over the entire timeline from period 1 to period 15 (or 30).

A work subsidy in the spirit of Keane (1995) is defined as

$$B_{\text{ws}}(E_{ikt}, H_{ikt}, \mathbf{Z}_{\text{ws}}) = \max\{\mathbf{1}\{H_{ikt} \geq \bar{H}_{\text{ws}}\}(G_{\text{ws}} - r_{\text{ws}}E_{ikt}), 0\},$$

where E_{ikt} is gross earnings, H_{ikt} is work hours, $\mathbf{Z}_{\text{ws}} \equiv (\bar{H}_{\text{ws}}, G_{\text{ws}}, r_{\text{ws}})$ is the policy rule, $\bar{H}_{\text{ws}}$ is the threshold work hour for eligibility, G_{ws} is the maximum benefit level, and r_{ws} is the benefit reduction rate. The benefit is zero if the work hour does not exceed the threshold. Unlike EITC, a work subsidy does not have a phase-in range, and the benefit function jumps at the earnings level where the work hour equals the threshold. In addition, the benefit is a function of both earnings and the wage rate (or work hours). Keeping earnings constant, as the wage rate increases, the threshold earnings increase and the benefit level at the threshold earnings decreases. Therefore, given the same earnings, a work subsidy is less generous toward high-wage workers. A policy rule similar to Keane (1995) is chosen: $\bar{H}_{\text{ws}} = 80$ (i.e., an individual is eligible if she works at least part-time), $G_{\text{ws}} = 100$ for families with one child, $G_{\text{ws}} = 200$ for families with more than one child, and $r_{\text{ws}} = 0.07$.

In the first period of the baseline scenario, 61, 38, 30, and 42 percent of the sample are workers, full-time workers, welfare participants, and food stamp participants, respectively. At the end of year 10, an individual has on average participated in 4.4 years of effective full-time work, 3.1 years of welfare, and 4.7 years of food stamps; the AP earnings and net government expenditure are 608 and 232 dollars, respectively. A 5-year lifetime limit causes a very small instant change in behavior. At the end of year 5, just before any individuals hit the time limit, the policy causes employment to increase by 2.2 percentage points

[48]If an individual reaches her planning horizon in period t, she is excluded from the sample in all periods after t, that is, she is given a weight of zero after period t. As a sensitivity test, the same simulations are conducted using only a subsample of female heads whose planning horizons exceed 10 years. The results are qualitatively similar.

[49]The AP is computed according to the formula $A = \text{NPV}\frac{r(1+r)^n}{(1+r)^n-1}$, where r is the discount rate per decision period (i.e., $r = 1 - (0.86)^{1/3} = 0.049$) and n is the total number of payable decision periods (15 and 30, respectively). Thus $A = 0.0957\text{NPV}$ in period 15, and $A = 0.0643\text{NPV}$ in period 30.

(4 percent) and welfare participation to decrease by 10.4 percentage points (38 percent). At the end of year 10, the effects enlarge to 2.9 and 16.3 percentage points (5 and 59 percent), respectively, but only 7.5 percent of the sample have hit the limit. From year 1 to year 10, the policy causes the cumulative time on welfare to reduce by 37 percent (1.15 years). This is smaller than Swann's (2005) estimate of 60 percent. Less than one-fourth of the effects on cumulative labor supply and program participation occur during the first 5 years.[50] Food stamps act as an important buffer for individuals who leave welfare. For instance, from year 1 to year 10, the time limit causes the cumulative time on food stamps only to *increase* by 0.68 years (1.15 minus 0.47 years), which is over half of the magnitude of the policy's effect on cumulative time on welfare.

The 5-year lifetime limit results in an efficiency gain of 74.8 percent between year 1 and year 10. Throughout this period, the policy causes AP net government expenditure to decrease by 49 dollars (21 percent) and AP utility to decrease by 12.4 units. The efficiency gain is highest in the first period and erodes as individuals approach or hit the time limit. During the first 5 years, the policy reduces AP government expenditure by 23.8 dollars (12 percent) but increases AP utility by 4.9 units. While time-inconsistency is needed for time limits to generate an increase in lifetime utility (e.g., Fang and Silverman (2004)), the above result suggests that short-term increases in utility can occur in a time-consistent framework.[51]

When individuals are uninformed of the time limit, the policy generates a mechanical effect only. Since individuals fail to optimize their behavior in response to the policy, this represents the worst case that can occur under a time limit. In this case, the efficiency gain between year 1 and year 10 is only 28.1 percent. At the end of year 10, 29.3 percent of the sample have hit the limit and the fraction of disconnected individuals is substantially larger than the baseline.[52]

Although the 4×4 periodic limit results in more reduction in AP government expenditure (63.3 dollars or 27 percent) than the 5-year lifetime limit, the overall efficiency gain is very similar (69 percent). At the end of year 10, its effects on cumulative labor supply and program participation are roughly one-fourth larger than the lifetime limit. The dynamics are somewhat different: beginning in year 8, some individuals who have hit the limit become eligible

[50] For instance, 22 percent (0.05/0.23 years) of the effect on cumulative labor supply occur between years 1 and 5.

[51] Note that this result can only occur in a model with state dependence. Without state dependence, individuals will act as if they are myopic in the absence of a time limit. Since a time limit will make individuals behave differently from the myopic solution, it must reduce utility in every decision period.

[52] In terms of cumulative labor supply and welfare participation, the mechanical effects as a percentage of the total effects in the fully informed case are 52 percent (0.12/0.23 years) and 64 percent (0.74/1.15 years), respectively. Although the estimates are not directly comparable, Mazzolari (2007) estimated that as high as 80 percent of the effects of time limits are mechanical.

for welfare again; at the end of year 10, only 6 percent of the sample have hit the limit.[53]

Between year 1 and year 10, the intermediate work requirement sanction results in more reduction in AP government expenditure (58.8 dollars or 25 percent) than the lifetime limit, but the efficiency gain is smaller (55.9 percent). One reason for the relative inefficiency is that the policy entails sizable incentives for people to work part-time while on welfare. By contrast, under a time limit, there is no such incentive because the benefit amount for part-time workers is small. For instance, at the end of year 10, the lifetime limit *reduces* the fraction of part-time workers by 0.3 percentage points, while the work requirement increases it by 0.3 percentage points. Unlike time limits, the work requirement reduces utility in almost all periods. The efficiency factor is highest initially (99.9 percent) and converges to a lower level after year 5. The work requirement initially has larger effects than a time limit, but its effects are smaller than a time limit in years 5 and 10. At the end of year 10, the policy causes employment to increase by 1.8 percentage points (3 percent) and welfare participation to decrease by 7.1 percentage points (26 percent). The policy causes 6 percent of the sample to be "diverted" from welfare, that is, these individuals receive some welfare in the baseline, but they never receive any welfare in the counterfactual scenario.

A 30-percent reduction in welfare benefits generates similar effects to the intermediate work requirement sanction, except that there is disproportionately less reduction in program participation. Moreover, less individuals are diverted from welfare (3.6 percentage points).

The EITC expansion increases AP government expenditure by 64.8 dollars (28 percent) between year 1 and year 10. The unadjusted efficiency factor is almost zero, but the adjusted measure is positive at 23.6 percent. Unlike the above policies, the efficiency factor remains stable over time. The policy increases employment instantly by 0.6 percentage points (1 percent); in years 5 and 10, its effect becomes 2.4 percentage points (4 percent). It causes a small balanced decline in program participation and a slight decline in the fraction of disconnected individuals.

Interestingly, the effects of the EITC expansion are very similar to a 1-percentage point reduction in the local unemployment rate. Relative to EITC, the economic expansion generates larger positive effects on employment and earnings, and a slightly smaller positive effect on full-time work. However, in both year 5 and year 10, their effects on cumulative labor supply and program participation are almost identical.

The work subsidy increases AP government expenditure by 57.7 dollars (25 percent) between year 1 and year 10, but the adjusted efficiency factor is almost zero. The policy results in a small increase in employment and a marginal

[53]The fraction of individuals who have hit the limit rises from 4.5 percent in year 5 to 9.3 percent in year 8, but then drops to around 6 percent in years 9 and 10.

decline in full-time work and program participation. There are two reasons why its effects are much smaller than EITC. First, keeping earnings constant, the generosity of EITC benefits is wage-neutral, but a work subsidy is biased against high-wage workers. This generates a dynamic labor supply disincentive in which the future returns to working (via future wage increases) are discounted. Second, the benefit of a work subsidy is always largest for part-time workers, while low-wage earners can potentially receive more EITC benefits by working full-time. This suggests that the work subsidy generates a larger labor supply disincentive at the intensive margin.

The reform package leads to both a reduction in the government expenditure and an improvement in utility. Between year 1 and year 10, the reform reduces AP government expenditure by 12.1 dollars (5 percent), increases AP utility by 32.4 units, and increases AP earnings by 38.7 dollars (6 percent). There is both an efficiency gain and utility improvement in all periods. The initial effects of the reform are primarily caused by the work requirement and EITC. The reform instantly increases employment by 1 percentage point (2 percent) and reduces welfare participation by 2.8 percentage points (9 percent). At the end of year 5, the effects enlarge to 5.1 and 15.4 percentage points, respectively (8.5 and 56 percent). After year 5, the time limit becomes the primary factor in further driving down program participation and government expenditure. At the end of year 10, the reform reduces welfare participation by 18.5 percentage points (67 percent). Only 4.3 percent of the sample have hit the limit, and 8.6 percent of the sample are diverted from welfare.

Distributional Effects. Table XI reports the distributional effects of the above counterfactual scenarios at the end of year 10. Individuals are categorized into three equally sized groups ranked by the expected log wage offer assuming no work last period.[54] This categorization is slightly more general than Keane and Wolpin (2010), who reported results by unobserved type only. The results extend Bitler, Gelbach, and Hoynes (2006), who analyzed distributional effects on earnings, welfare benefits, and income in a welfare waiver program (Connecticut Jobs First).

At the end of year 10, the average individual in the low-wage group has participated in 3.9 years of effective full-time work, 4.1 years of welfare, and 6.5 years of food stamps. In the high-wage group, the numbers are 5.1, 2.2, and 2.6 years, respectively. The differences in earnings and government expenditure between both groups are pronounced: AP earnings are 357.6 and 960.8 dollars respectively, and AP government expenditures are 357.2 and 72.9 dollars, respectively. Therefore, earnings constitute 50 percent of total income in the low-wage group and more than 90 percent in the high-wage group.

[54]Each individual is categorized according to the value of $\mathbf{X}_{wi}\boldsymbol{\beta}_w + \mu_{wi}$, where covariates $\mathbf{X}_{wi}$ are set fixed as in May 1992 and μ_{wi} is drawn from the type probability distribution. The 33rd and 66th percentiles are 6.14 and 6.39, respectively, which translate to hourly wages of 5.80 ($e^{6.14}/80$) and 7.45 dollars, respectively.

TABLE XI

DISTRIBUTIONAL EFFECTS OF SELECTED POLICY AND ECONOMIC CHANGES (SIMPLE DIFFERENCE FROM BASELINE), YEAR 10[a]

Outcome	Baseline (1)	5yrTL (2)	5yrTL (Uninformed) (3)	4-4 TL (4)	WR (5)	Benefit Cut (6)	EITC (7)	Work Subsidy (8)	Economy (9)	Reform (10)
Low expected wage										
Cum. effective yrs of work	3.87	0.57	0.30	0.71	0.43	0.36	0.58	0.13	0.04	1.27
Cum. yrs on welfare	4.10	−1.78	−1.16	−2.16	−1.04	−0.92	−0.68	−0.08	−0.08	−2.43
Cum. yrs on food stamps	6.47	−0.61	−0.57	−0.77	−0.44	−0.39	−0.53	−0.06	−0.02	−1.26
Having hit time limit (%)	–	9.0	41.6	6.3	–	–	–	–	–	4.0
AP earnings ($)	357.6	43.0	17.5	54.9	35.8	29.8	50.0	10.5	3.3	105.5
AP net gov. expenditure ($)	357.2	−70.9	−42.0	−88.5	−73.9	−71.5	36.1	63.2	−3.7	−48.7
AP utility	1163.4	−15.6	−29.0	−23.5	−28.6	−27.6	61.6	56.7	14.6	31.3
Efficiency factor (%)[b]	–	78.0	30.9	73.4	61.4	61.3	70.4	−10.2	492.5	164.3
Adjusted EF (%)[b]	–	76.2	27.9	71.1	56.9	57.4	128.6	10.2	509.8	195.8
Medium expected wage										
Cum. effective yrs of work	4.51	0.04	0.03	0.06	0.02	0.02	0.03	−0.04	0.28	0.08
Cum. yrs on welfare	2.88	−0.93	−0.59	−1.20	−0.56	−0.40	−0.04	0.02	−0.26	−1.27
Cum. yrs on food stamps	4.55	−0.29	−0.31	−0.40	−0.21	−0.16	−0.05	0.03	−0.26	−0.48
Having hit time limit (%)	–	7.3	25.6	7.1	–	–	–	–	–	4.8
AP earnings ($)	580.0	4.8	2.0	6.0	2.3	2.8	2.7	−4.7	33.0	8.1
AP net gov. expenditure ($)	231.9	−37.2	−22.2	−49.4	−51.8	−43.2	80.9	61.4	−18.2	8.7
AP utility	1285.5	−11.9	−17.6	−19.9	−26.7	−21.9	65.6	48.8	41.6	33.8
Efficiency factor (%)[b]	–	68.0	20.6	59.7	48.4	49.2	−19.0	−20.6	329.3	286.2
Adjusted EF (%)[b]	–	62.2	15.7	55.1	42.5	41.6	2.4	−3.6	326.9	722.0

(*Continues*)

TABLE XI—*Continued*

Outcome	Baseline (1)	5yrTL (2)	5yrTL (Uninformed) (3)	4-4 TL (4)	WR (5)	Benefit Cut (6)	EITC (7)	Work Subsidy (8)	Economy (9)	Reform (10)
High expected wage										
Cum. effective yrs of work	5.08	0.02	0.01	0.03	0.01	0.01	−0.04	−0.04	0.29	−0.01
Cum. yrs on welfare	2.20	−0.66	−0.40	−0.87	−0.45	−0.34	−0.01	−0.01	−0.26	−0.93
Cum. yrs on food stamps	2.63	−0.53	−0.33	−0.69	−0.39	−0.28	0.00	0.00	−0.26	−0.77
Having hit time limit (%)	–	6.0	18.9	4.3	–	–	–	–	–	3.9
AP earnings ($)	960.8	3.8	1.4	4.8	2.4	1.8	−7.6	−7.2	49.8	−3.2
AP net gov. expenditure ($)	72.9	−37.6	−19.1	−50.8	−49.6	−42.9	78.6	45.7	−22.3	5.2
AP utility	1298.0	−8.9	−12.9	−14.4	−21.6	−19.3	57.6	33.9	50.2	32.0
Efficiency factor (%)[b]	–	76.4	32.6	71.7	56.4	55.1	−26.8	−25.9	325.5	514.8
Adjusted EF (%)[b]	–	73.1	27.5	66.2	49.6	47.5	−3.0	−5.2	338.7	6176.8

[a] AP, amortizing payment. Scenarios are described as follows: (1) baseline, environment as in May 1992; (2) 5-year lifetime limit; (3) 5-year lifetime limit, assuming individuals are uninformed of the limit; (4) 4-year periodic limit with 4 years of ineligibility; (5) intermediate work requirement sanction; (6) 30-percent reduction of welfare benefit among welfare recipients; (7) federal EITC as of 1999; (8) work subsidy; (9) 1-percentage-point reduction in the unemployment rate; (10) 5-year lifetime limit, intermediate work requirement sanction, and federal EITC as of 1999.

[b] Results may be subject to rounding error.

The effects of various policies are much larger in the low-wage group, a finding that is consistent with Keane and Wolpin (2010).[55] In particular, the effects on labor supply and earnings are almost exclusively concentrated in the low-wage group, while the effects on program participation and government expenditure are spread more evenly across groups. For instance, in the low-wage group, the 5-year lifetime limit increases cumulative effective full-time work by 0.57 years (15 percent) and AP earnings by 43 dollars (12 percent); it reduces cumulative welfare and food stamp participation by 1.78 and 0.61 years, respectively (43 percent and 9 percent); AP government expenditure reduces by 70.9 dollars (20 percent).[56] In the high-wage group, the effects on labor supply and earnings are almost zero, and the effects on welfare participation, food stamp participation and government expenditure are 0.66 years (30 percent), 0.53 years (20 percent), and 37.6 dollars (52 percent), respectively. The efficiency factors are similar across all groups. The fraction of individuals having hit the limit is also similar across groups; however, if individuals are uninformed of the limit, the fraction becomes substantially larger in the low-wage group (41.6 percent).

The distributional effects of the 4-4 periodic limit, work requirement sanction, and benefit cut are qualitatively similar to the 5-year lifetime limit. The effects of the EITC expansion are different in several ways. In the low-wage group, the EITC expansion increases cumulative effective full-time work by 0.58 years (15 percent) and AP earnings by 50 dollars (14 percent), and results in substantial efficiency gain (unadjusted EF is 70.4 percent; adjusted EF is 128.6 percent). It has almost no effects on behavior in the medium- and high-wage groups. However, the amounts of transfer in both groups are much larger ($\approx$ 80 dollars) than in the low-wage group (36 dollars), while the adjusted efficiency factors are almost zero.

Unlike EITC, the effects of the work subsidy are similar across groups. Although the overall effects of an improvement in the economy are similar to the EITC expansion, their distributional effects are opposite to each other. The economy has negligible effects in the low wage group, while both the medium- and high-wage groups experience significant changes in labor supply, earnings, and program participation.

The reform package generates very large effects in the low-wage group and moderate effects in the medium- and high-wage groups. In the low-wage group,

[55]The behavior of the low-wage group resembles "type-6" women in Keane and Wolpin (2010), the unobserved type with the lowest unobserved skill endowment. This group constitutes one-fourth of their sample. Given the sample proportions of being white (48.5 percent), black (25.0 percent), and hispanic (26.5 percent), it can be calculated from Table 3 in their paper that the average type-6 woman possesses 2.8 years of work experience and has received 4.4 years of welfare by age 30.

[56]In Keane and Wolpin (2010), the 5-year lifetime limit causes the welfare participation rate of type-6 women aged 26–29 to drop from 45 to 15 percent.

the reform increases cumulative effective full-time work by 1.27 years (33 percent) and reduces cumulative welfare and food stamp participation by 2.43 and 1.26 years, respectively (59 percent and 19 percent). AP earnings increase by 105.5 dollars (30 percent) and AP government expenditure reduces by 48.7 dollars (14 percent). As a result, AP income increases by 56.8 dollars and the share of earnings in total income increases to 60 percent. In the high-wage group, the reform has minimal effects on labor supply, earnings, and government expenditure. It reduces cumulative welfare and food stamp participation by 0.93 and 0.77 years, respectively (42 and 29 percent). As a whole, the reform results in both an efficiency gain and utility improvement in all groups. Moreover, it reduces government expenditure in the low-wage group and is almost revenue-neutral in the medium- and high-wage groups.

6.2. *Model Validation and Sensitivity Analysis*

External Validation

The policy environments before and after 1996 are quite different. Between 1992 and 1995, changes in welfare rules were relatively minor, while EITC expanded substantially. Starting from 1996, states changed their welfare rules radically, but EITC remained stable. The economy improved substantially throughout the whole period. The above changes provide a natural setting in which the external predictive performance of the model can be evaluated.[57] Data from the 1996 panel are used to validate the model estimated on the 1992 and 1993 panels, and the 1992 and 1993 panels are used to validate the model estimated on the 1996 panel. The validation data are applied to the model estimates to simulate outcomes of individuals.[58]

Table XII reports the chi-squared goodness-of-fit statistics of the above two models.[59] The model estimated on the 1992 and 1993 panels does not suffer from a deterioration in the fit on choices when it is validated against the 1996 panel. However, there is some deterioration in the fit on wage: its chi-squared statistic increases from 299.3 to 452.8. The model estimated on the 1996 panel exhibits the opposite pattern. When it is validated against the 1992 and 1993 panels, the chi-squared statistic on the choice–year distribution becomes much larger (1160.2 versus 241.3).

[57] Keane and Wolpin (2010) used NLSY97 data to validate the model estimated on NLSY79 data. They did not attempt to capture the full policy environment faced by the NLSY97 cohorts, but instead simulated a simplified version of the environment. Keane and Wolpin (2007) used Texas as a holdout sample to validate the same model.

[58] All relevant time dummy variables are included in estimation, but their values are set to zero during simulation.

[59] As a benchmark, the chi-squared statistics of the full model on the choice–year and log wage distributions are 489.7 and 276.7, respectively. These numbers are different from Table IV because the time dummy variables are set to zero in simulation.

TABLE XII

EXTERNAL MODEL VALIDATION: GOODNESS OF FIT

	1992, 1993 Panel Model[a]		1996 Panel Model[b]	
Panel(s) used for validation	—	1996	—	1992, 1993
χ^2 choice–year (df = 31)	193.5	166.6	241.3	1160.2
χ^2 log wage (df = 12)	299.3	452.8	245.9	276.5

[a]Sample size = 9472; number of parameters = 68.

[b]Sample size = 10,965; number of parameters = 74.

Figure 4 plots the actual rates of employment, full-time work, welfare participation, and participation in food stamp only along with predictions from the full model and the two models above. The results are reported by panel (1992 and 1993 panels combined; 1996 panel) and wave. The models generate reasonably accurate predictions on the fractions of full-time workers and individuals receiving food stamps only. The predictions on the fraction of workers are generally accurate, except that the model estimated on the 1996 panel overpredicts employment in the 1992 and 1993 panels. In terms of welfare par-

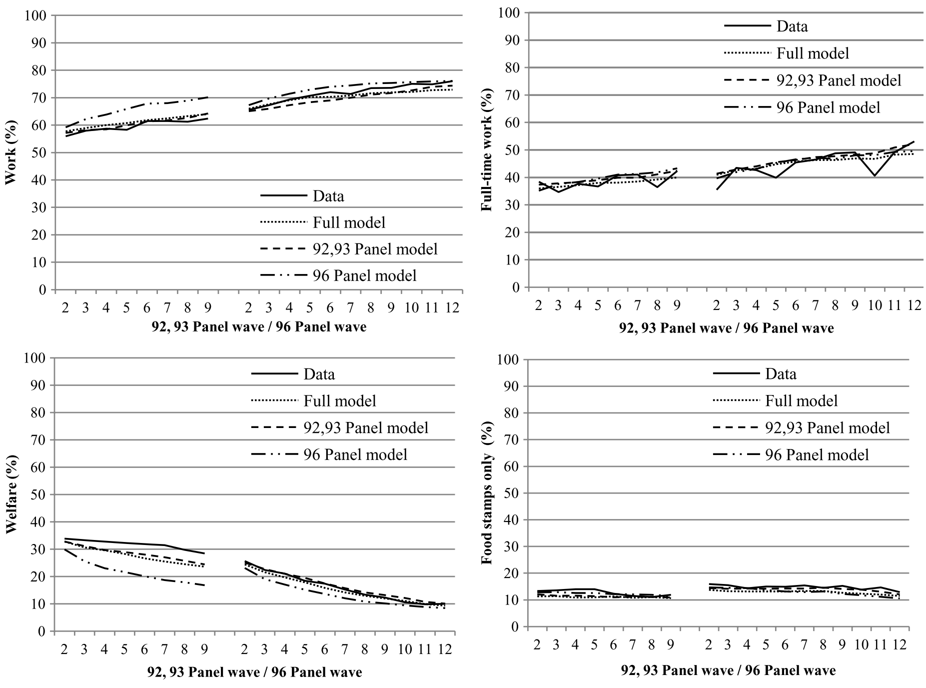


FIGURE 4.—External model validation.

TABLE XIII

COMPARISON OF CROSS-SECTIONAL MODELS[a]

	1992, 1993 Panel Wave 1 Model (With Job Offer Eq.)		1992, 1993 Panel Wave 1 Model (No Job Offer Eq.)[b]	Keane and Moffitt (1998)
Number of parameters	46		40	50
Log likelihood	−2128		−2138	−1826
χ^2, choice–year (df)	6.83 (15)		7.55 (15)	28.1 (11)***
χ^2, log wage (df = 12)	22.19**		99.99***	N/A
Elasticity	Wage	Job Offer Probability	Wage	Wage
Work	0.18	0.98	0.68	0.62
Full-time work	0.39	0.94	0.85	0.80
Welfare	−0.29	−0.94	−0.78	−0.82
Food stamps	−0.29	−0.73	−0.66	−0.70

[a]Sample size for the 1992, 1993 panel wave 1 models = 1184. Sample size for Keane and Moffitt model = 968. Elasticities from Keane and Moffitt model are computed from Table 7, rows 1 (baseline) and 4 (wage increase of 1 dollar) in their paper. **, Significant at the 5 percent level; ***, significant at the 1 percent level.

[b]The concurrent, 3- and 6-month lagged unemployment rates are included in the work preference equation.

ticipation, the predictions of all the models match the 1996 panel relatively well, but they underpredict welfare participation in the 1992 and 1993 panels to varying degrees.

Alternative Model Specifications

Table XIII reports results from two cross-sectional models estimated on wave 1 data in the 1992 and 1993 panels. Both models assume no state dependence and unobserved heterogeneity. The second model excludes the job offer equation as well.[60] These results are compared with the Keane and Moffitt (1998) model, which uses wave 4 of the 1984 SIPP panel for estimation and does not have a job offer equation.

In the first model, the null hypothesis is not rejected in the chi-squared test on the choice–year distribution, but it is rejected at the 5-percent level in the test on the log wage distribution.[61] In this model, around 90 percent of the job offers are accepted. The wage elasticities of labor supply are slightly larger (0.18 and 0.39) than the full model and the job offer probability elasticities are roughly one-third smaller. The second model has a worse fit on wage, as the chi-squared statistic on the log wage distribution is more than four times

[60]Time dummies, exclusion restrictions in the program preference equations, and work requirement sanction variables are also excluded. In the second model, the variables on unemployment rates are included in the work preference equation instead (e.g., Keane and Moffitt (1998)).

[61]The choice–year distribution has 8 choices × 2 years = 16 cells. Note that the chi-squared statistic in the Keane and Moffitt model must be larger because the alternative-specific constant is absent for some choices in their model.

as large (99.99 versus 22.19). Interestingly, when the job offer equation is not included, the wage elasticities become substantially larger. Their magnitudes are also surprisingly similar to the Keane and Moffitt model, which uses data from almost 10 years earlier.

Table XIV presents results from two simpler versions of the full model. The first model is estimated assuming no state dependence in work and program participation. When compared to the full model, it has worse fit on the choice–year distribution and the elasticity estimates are smaller. In order of importance, the largest contributors of changes in outcomes between 1992 and 1999 are demographics, economy, and policy. Although the overall effects of policies from year 1 to year 10 are qualitatively similar to the full model, their magnitudes are typically much smaller.

The second model is estimated assuming that individuals are myopic, that is, the discount factor is zero. To capture the effect of the time limit, the time limit policy dummy variable is interacted with the planning horizon as defined in Grogger and Michalopoulos (2003). The interaction variable is included in the welfare preference equation.[62] Relative to the full model, there is an improvement in the fit on the choice–year distribution, but the fit on wage becomes worse. The wage elasticities of labor supply are slightly larger (0.20 and 0.31), but the job offer probability elasticities are less than one-third as large. The contributions of factors between 1992 and 1999 are more similar to reduced-form studies: higher shares are attributed to EITC and work requirement sanctions, and a lower share is attributed to the economy. From year 1 to year 10, the overall effects of policies on labor supply and earnings are generally larger than the full model. The efficiency factors are smaller, which is not surprising given that individuals do not care about the consequences of their choices on future utility.

Table XV presents results of the full model estimated on four alternative data specifications: there are no work requirement sanctions; the cutoff value for full-time work is 30 instead of 35 hours per week; "effective" welfare benefit reduction rates are used; New York state does not have a time limit. In general, the overall effects of policies from year 1 to year 10 are insensitive to the above changes, but there are slight changes in the contributions of some factors between 1992 and 1999. The first specification is equivalent to a model in which all three coefficients of the work requirement sanction variables are restricted to zero. The log likelihood is −27,170, and the likelihood ratio test rejects the null hypothesis (coefficients are zero) at the 5-percent level. Due to the omission of work requirements, the observable factors together explain less of the changes in outcomes between 1992 and 1999. In the second specification, the results are very similar to the full model, with the exception that the

[62]The variable is defined formally as $\mathrm{TL}_{it} \times \max\{\mathcal{T}_{it} - \bar{M}_i, 0\}$, where TL_{it} is the time limit dummy, $\mathcal{T}_{it}$ is the planning horizon, and $\bar{M}_i$ is the time limit length. A time limit dummy and a benefit-reduction limit dummy are also included in the welfare preference equation.

TABLE XIV

SUMMARY OF RESULTS FROM ALTERNATIVE MODELS[a]

	No State Dependence[b]				Myopic (Discount Factor = 0)[c]			
Log likelihood	−37,017				−27,060			
χ^2, choice-year (df = 31)	752.6				424.1			
χ^2, log wage (df = 12)	111.7				142.5			
Elasticity	Wage		Job Offer Probability		Wage		Job Offer Probability	
Work	0.06		0.63		0.20		0.41	
Full-time work	0.18		0.60		0.31		0.41	
Welfare	−0.13		−0.19		−0.30		−0.28	
Food stamps	−0.14		−0.14		−0.27		−0.21	
Contribution of Factors, 1992–1999 (in Percent)	Work	FT	Welfare	FS	Work	FT	Welfare	FS
Total change (in percentage points)	11.2	9.7	−16.0	−17.4	16.1	13.4	−21.6	−20.8
Time limit	0.7	4.8	17.1	6.5	7.7	12.1	16.2	12.5
Work requirement sanction	−0.3	−0.2	4.4	1.8	10.3	8.2	12.2	10.0
Welfare earnings disregards	0.4	−1.0	−1.4	−0.7	0.6	−1.0	−0.8	−0.9
EITC	4.8	−3.4	1.0	1.5	19.0	10.6	3.1	6.6
Minimum wage	0.5	1.8	0.4	0.6	3.9	4.1	0.6	1.7
Local unemployment rate	36.9	24.4	2.4	2.5	26.2	20.7	4.1	5.7
Other economic conditions	2.0	6.2	1.3	2.1	6.4	7.1	1.3	2.4
Demographics	19.2	30.2	26.8	45.3	9.0	15.0	10.9	28.7
Other factors	−0.1	5.8	2.3	0.3	−7.2	−9.3	−16.1	−19.3
All of the above	71.7	76.0	70.0	67.4	79.6	70.4	37.2	50.0
All policies above[d]	6.8	2.1	24.7	11.0	46.2	35.4	39.2	34.6
All economic factors above[d]	38.7	30.4	3.6	4.4	33.3	28.2	5.6	8.4

(*Continues*)

TABLE XIV—*Continued*

	Effects of Policy Changes, End of Year 10 (Simple Difference From Baseline)									
	Baseline	5yrTL	WR	EITC	Reform	Baseline	5yrTL	WR	EITC	Reform[f]
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
Cum. effective yrs of work	4.45	0.07	0.05	0.15	0.24	4.23	0.30	0.41	0.38	0.78
Cum. yrs on welfare	3.12	−1.09	−0.30	−0.06	−1.24	3.56	−1.03	−0.79	−0.26	−0.99
Cum. yrs on food stamps	4.78	−0.31	−0.13	−0.07	−0.43	5.06	−0.60	−0.54	−0.28	−0.79
Having hit time limit (%)	–	15.3	–	–	11.7	–	34.4	–	–	–
AP earnings ($)	621.2	6.0	5.6	13.3	22.8	585.0	–	44.6	39.1	83.2
AP net gov. expenditure ($)	217.3	−39.2	−49.3	73.9	3.9	257.4	–	−89.0	58.6	−16.8
AP utility	1029.9	−29.8	−30.9	53.6	1.9	1470.5	–	−94.4	52.7	−28.8
Efficiency factor (%)[e]	–	24.0	37.4	−27.4	−52.1	–	–	−6.0	−10.0	−71.6
Adjusted EF (%)[e]	–	17.2	27.9	6.7	669.4	–	–	−7.4	32.7	99.0

[a]FT, full-time work; FS, food stamps; AP, amortizing payment. "Total change" denotes the model's predicted change in outcome under the baseline scenario. Policy scenarios are described as follows: (1) baseline, environment as in May 1992; (2) 5-year lifetime limit; (3) intermediate work requirement sanction; (4) federal EITC as of 1999; (5) 5-year lifetime limit, intermediate work requirement sanction, and federal EITC as of 1999.

[b]Sample size = 22,647, number of parameters = 79.

[c]Sample size = 20,437, number of parameters = 87.

[d]Exclude "Other factors."

[e]Results may be subject to rounding error.

[f]Intermediate work requirement sanction and federal EITC only.

TABLE XV

SUMMARY OF FULL MODELS ESTIMATED WITH ALTERNATIVE DATA DEFINITIONS[a]

	No Work Requirement[b]				Broaden Full-Time Work Definition				Use "Effective" Welfare Tax Rate				New York State No Time Limit			
Log likelihood	−27,170				−25,352				−27,164				−27,166			
χ^2, Choice–Year (df = 31)	575.54				601.72				587.45				569.28			
χ^2, Log Wage (df = 12)	96.91				95.24				96.98				96.93			
	Contribution of Factors, 1992–1999 (in Percent)															
	Work	FT	Welfare	FS	Work	FT	Welfare	FS	Work	FT	Welfare	FS	Work	FT	Welfare	FS
Total change (pct point)	15.4	13.2	−20.7	−21.3	14.6	15.4	−21.3	−22.0	15.3	13.2	−21.5	−21.8	15.2	13.1	−21.0	−21.5
Time limit	6.1	9.6	15.4	11.5	6.2	9.8	15.2	11.7	6.6	9.9	15.4	11.5	5.1	8.5	13.7	10.6
Work requirement sanction	–	–	–	–	1.3	1.2	3.6	2.7	1.2	1.6	4.5	3.2	0.5	1.1	4.2	3.0
Welfare earnings disregards	−0.1	−1.3	−1.0	−1.2	−0.1	−1.2	−1.6	−1.0	1.0	1.9	2.1	1.6	−0.6	−1.1	−1.2	−0.9
EITC	5.5	4.7	4.4	5.0	7.5	6.0	3.4	5.1	5.8	4.8	3.9	4.9	4.3	4.0	3.1	4.1
Minimum wage	0.8	1.2	0.6	0.8	1.2	1.1	0.2	0.5	1.3	1.7	0.7	1.0	0.5	0.9	0.1	0.5
Local unemployment rate	51.3	43.2	15.5	17.3	50.2	40.3	12.4	14.8	50.5	42.2	13.1	15.4	50.1	42.3	13.4	15.4
All of the above[c]	76.5	71.6	45.7	46.0	76.9	69.7	48.5	46.4	75.8	74.1	53.1	50.5	76.1	71.1	47.9	47.6
All policies above	14.7	16.2	20.3	17.0	16.8	18.3	23.7	19.2	16.1	20.7	29.3	22.8	14.8	16.8	22.9	19.3
All economic factors above[d]	53.4	47.6	16.9	19.4	52.0	42.8	13.7	16.6	53.3	46.2	14.1	17.4	53.0	46.9	15.1	17.9

(*Continues*)

TABLE XV—*Continued*

	Effects of policy changes, end of year 10 (simple difference from baseline)															
	5yrTL	WR	EITC	Reform[f]	5yrTL	WR	EITC	Reform	5yrTL	WR	EITC	Reform	5yrTL	WR	EITC	Reform
Cum. effective yrs of work	0.22	–	0.21	0.39	0.23	0.15	0.22	0.48	0.24	0.16	0.21	0.48	0.22	0.16	0.21	0.47
Cum. yrs on welfare	−1.12	–	−0.24	−1.22	−1.15	−0.65	−0.25	−1.55	−1.24	−0.68	−0.26	−1.66	−1.13	−0.69	−0.24	−1.56
Cum. yrs on food stamps	−0.45	–	−0.20	−0.62	−0.46	−0.31	−0.20	−0.80	−0.52	−0.34	−0.22	−0.87	−0.46	−0.34	−0.21	−0.83
Having hit time limit (%)	7.2	–	–	6.4	7.6	–	–	4.6	7.9	–	–	4.6	7.5	–	–	4.2
AP earnings ($)	17.1	–	16.4	31.2	18.7	13.7	17.9	40.5	19.7	13.8	17.0	40.1	17.4	13.8	16.4	38.2
AP net gov. expenditure ($)	−47.6	–	64.9	24.5	−49.0	−55.4	66.9	−8.2	−57.1	−59.9	62.7	−20.5	−48.4	−58.6	64.7	−12.0
AP utility ($)	−10.8	–	62.2	52.3	−11.9	−23.5	57.5	29.7	−14.0	−26.6	59.9	29.4	−11.5	−25.3	62.1	32.7
Efficiency factor (%)[e]	77.2	–	−4.3	113.6	75.7	57.6	−14.0	461.4	75.4	55.6	−4.5	243.5	76.3	56.9	−4.0	373.3

[a] FT, full-time work; FS, food stamps; AP, amortizing payment. "Total change" denotes the model's predicted change in outcome under the baseline scenario. Policy scenarios are described as follows: 5yrTL, 5-year lifetime limit; WR, intermediate work requirement sanction; EITC, federal EITC as of 1999; reform, 5-year lifetime limit, intermediate work requirement sanction, and federal EITC as of 1999.

[b] Number of parameters = 81.

[c] Includes local economic conditions, demographics, and other factors (all not reported in table).

[d] Includes local economic conditions.

[e] Results may differ due to rounding error.

[f] 5-year lifetime limit and EITC only.

EITC contributes to slightly more of the increase in labor supply between 1992 and 1999. In the third specification, the welfare benefit reduction rate (before dollar disregards are applied) is set to be half of the level in the full model to reflect findings that the "effective" rates are lower than the statutory rates (e.g., Fraker, Moffitt, and Wolf (1985), Ziliak (2007)).[63] Policies contribute to slightly more of the increase in outcomes between 1992 and 1999. In addition, welfare disregards increase labor supply and reduce program participation during the sample period. In the last specification, New York state is assumed to have no time limits. New York state implemented a 5-year lifetime limit, but families that reached the limit could continue to receive benefits through the Safety Net Assistance Program (e.g., Fang and Keane (2004)). The results remain largely unchanged, except that time limits contribute to slightly less of the changes in outcomes between 1992 and 1999.

7. CONCLUSION

The welfare system in the United States experienced unprecedented changes in the 1990s. Earnings disregards became more generous, more stringent work requirements were implemented, and time limits were introduced. The EITC program expanded substantially, and the country was undergoing strong economic growth. During this period, female heads of family experienced a substantial increase in labor supply and an even more dramatic decline in welfare and food stamp participation.

The following findings are established. As a whole, the policy components in the model play a relatively limited role in explaining the changes in labor supply and program participation during the sample period. By contrast, half of the increase in labor supply during the period can be attributed to the economic expansion. These results do not necessarily imply that the policies generate small effects. In simulations that control for the environment over a longer period, it is shown that the effects of policies become much larger several years after their implementation. In particular, a 5-year lifetime limit can cause the cumulative time on welfare to drop by 37 percent within the first 10 years of implementation. This offers an explanation for the apparent divergence between the existing reduced-form and structural estimates.

The estimation results indicate that nonworking welfare recipients are, on average, subject only to a partial removal of welfare benefits for failure to comply with work requirements. Even in this case, the effects of work requirement sanctions are still notable. It is important to incorporate food stamp participation into the model, as changes in welfare policies often lead to significant changes in the number of individuals who receive food stamps only. The overall effects of the EITC expansion are similar to a 1-percentage point reduction

[63]For instance, if the original welfare percent disregard is 40 percent, the new level is $1 - (1 - 0.4) \times 0.5 = 70$ percent.

in the unemployment rate; in this respect, the finding is discouraging because a business cycle can easily generate effects that are several times larger than an EITC expansion of such a large scale.

Provided that individuals are fully informed, a time limit is found to generate a larger efficiency gain than a work requirement sanction or a direct reduction in welfare benefits. This does not imply an improvement in utility; instead, the result implies that a time limit can achieve a *larger* reduction in the government expenditure for the same amount of reduction in utility as the other two policies. The reform package, which consists of a time limit, a work requirement sanction, and an EITC expansion, is a powerful policy instrument. It generates strong effects on labor supply and program participation, and results in both a reduction in government expenditure and an improvement in utility.

By dividing the sample into subgroups with different levels of expected wage, it is found that the EITC expansion results in a substantial efficiency gain in the most disadvantaged subgroup. By contrast, the economic expansion primarily affects individuals with better labor market opportunities. Contrary to popular belief, the reform package favorably affects the most disadvantaged subgroup. In addition to an improvement in utility, the package also results in a substantial increase in earnings and a moderate reduction in government expenditure, leading to an increase in overall income. Since welfare reform and the economic expansion have qualitatively different distributional effects, a combination of both factors leads to an improvement in all subgroups of the sample during the sample period. This is a fruitful area for further research.

APPENDIX

A.1. *Program Benefit Functions*

The program benefit functions in equation (2) are defined as follows.

Welfare: The individual is eligible if she passes the income eligibility tests:

$$\begin{aligned} &\text{gross income test,} \quad && E_{ikt} + N_{it} < r_{\mathrm{A}git} e_{\mathrm{A}it}, \\ &\text{net income test,} \quad && (E_{ikt} - D_{\mathrm{A}eit})(1 - R_{\mathrm{A}eit}) + N_{it} < r_{\mathrm{A}nit} e_{\mathrm{A}it}. \end{aligned}$$

The variable $e_{\mathrm{A}it}$ is typically called the *need standard*; $r_{\mathrm{A}git}$ and $r_{\mathrm{A}nit}$ are the ratios used for adjusting the standard; $D_{\mathrm{A}eit}$ and $R_{\mathrm{A}eit}$ are the dollar and percent disregards used for the computation of net income. The benefit amount is

$$\begin{aligned} B_{\mathrm{A}ikt} = \max\bigl\{\min\bigl\{&M_{\mathrm{A}it}, \\ &r_{\mathrm{A}it}\bigl[G_{\mathrm{A}it} - (E_{ikt} - D_{\mathrm{A}bit})(1 - R_{\mathrm{A}bit}) - N_{it}\bigr]\bigr\}, 0\bigr\}. \end{aligned}$$

The variable $G_{\mathrm{A}it}$ is typically called the *payment standard*. Some states implement an additional maximum benefit level, which is denoted by $M_{\mathrm{A}it}$. The dollar and percent disregards for benefit computation, $D_{\mathrm{A}bit}$ and $R_{\mathrm{A}bit}$, are sometimes different from the disregards in the income tests. In several states, a ratio $r_{\mathrm{A}it}$ is used for adjusting the benefit. The policy rule $\mathbf{Z}_{\mathrm{A}it}$ consists of

$(e_{\mathrm{A}it}, r_{\mathrm{A}git}, r_{\mathrm{A}nit}, D_{\mathrm{A}eit}, R_{\mathrm{A}eit}, G_{\mathrm{A}it}, M_{\mathrm{A}it}, D_{\mathrm{A}bit}, R_{\mathrm{A}bit}, r_{\mathrm{A}it})$. All elements vary by state, and $e_{\mathrm{A}it}$, $G_{\mathrm{A}it}$, and $M_{\mathrm{A}it}$ also vary by family size.

Food Stamps: The individual is eligible if she passes the income eligibility tests:

gross income test,	$E_{ikt} + N_{it} < 1.3e_{\mathrm{F}it}$,
net income test,	$E_{\mathrm{F}ikt} < e_{\mathrm{F}it}$.

The variable $e_{\mathrm{F}it}$ is typically called the *poverty guideline*. The net income, denoted $E_{\mathrm{F}ikt}$, is defined as

$$E_{\mathrm{F}ikt} = 0.8E_{ikt} + N_{it} + \tilde{B}_{\mathrm{A}ikt} - D_{\mathrm{F}it} - 134.$$

The shelter deduction is denoted $D_{\mathrm{F}it}$, the standard deduction is 134 dollars, and $\tilde{B}_{\mathrm{A}ikt}$ is the amount of welfare benefit received. The benefit amount is

$$B_{\mathrm{F}ikt} = \max\{G_{\mathrm{F}it} - 0.3E_{\mathrm{F}ikt}, 0\}.$$

The maximum benefit level is denoted $G_{\mathrm{F}it}$. The policy rule $\mathbf{Z}_{\mathrm{F}it}$ consists of $(e_{\mathrm{F}it}, D_{\mathrm{F}it}, G_{\mathrm{F}it})$. Both $e_{\mathrm{F}it}$ and $G_{\mathrm{F}it}$ vary by family size, and $D_{\mathrm{F}it}$ varies by census region.

Federal EITC: The benefit function is given in equation (3). The policy rule $\mathbf{Z}_{\mathrm{E}it}$ consists of $(r_{\mathrm{E}1it}, r_{\mathrm{E}2it}, b_{\mathrm{E}1it}, b_{\mathrm{E}2it})$. All elements vary by family size.

Federal and State Income Tax, State EITC, and Payroll Tax: The amount of federal income tax is[64]

$$T_{ikt}^{\mathrm{ftax}} = 0.15\max\{E_{ikt} - D_t^{\mathrm{ftax}} - e_t^{\mathrm{ftax}} f_{it}, 0\}.$$

The standard deduction as head of household is denoted D_t^{ftax}, the personal exemption amount is denoted e_t^{ftax}, and family size is denoted f_{it}. It is assumed that the individual and all her children take exemptions. The amount of state income tax is

$$T_{ikt}^{\mathrm{stax}} = I_{it}^{\mathrm{stax}} \sum_{j=1}^{n_{it}} r_{jit} \mathbf{1}\{E_{ikt}^{\mathrm{stax}} \geq b_{j-1,it}\} \min\{E_{ikt}^{\mathrm{stax}} - b_{j-1,it}, b_{jit} - b_{j-1,it}\},$$

where E_{ikt}^{stax} is the net income, which is defined as

$$E_{ikt}^{\mathrm{stax}} = E_{ikt} - D_{it}^{\mathrm{stax}} - e_{it}^{\mathrm{stax1}} - e_{it}^{\mathrm{stax2}}(f_{it} - 1).$$

The variables D_{it}^{stax}, e_{it}^{stax1}, and e_{it}^{stax2} denote deduction, exemption for the mother, and exemption for the dependent, respectively. The binary variable

[64]The marginal tax rate is 15 percent. The higher tax brackets are not used since they are never reached by most of the sample.

I_{it}^{stax} indicates whether the state has an income tax. The number of state income tax brackets is n_{it}.[65] For the jth bracket, the bracket level is denoted b_{jit}, and $0 = b_{0it} < \cdots < b_{n_{it}-1,it} < b_{n_{it},it} = \infty$; the marginal tax rate is denoted r_{jit}, where the progressive tax structure implies $r_{1it} < \cdots < r_{n_{it}-1,it} < r_{n_{it},it}$. The operator $\mathbf{1}\{\cdot\}$ equals 1 if the expression in the curly bracket is true and equals 0 otherwise. The amount of state EITC is

$$B_{ikt}^{\text{seitc}} = I_{it}^{\text{seitc}}\left[I_{it}^{\text{seitcr}} B_{\text{E}ikt} r_{it}^{\text{seitc}} + \left(1 - I_{it}^{\text{seitcr}}\right)\min\left\{B_{\text{E}ikt} r_{it}^{\text{seitc}}, T_{ikt}^{\text{stax}}\right\}\right].$$

The binary variable I_{it}^{seitc} indicates whether the state has EITC, and the binary variable I_{it}^{seitcr} indicates whether the state has a *refundable* EITC, that is, the amount of state EITC benefit can exceed the state income tax. The raw amount of state EITC benefit, $B_{\text{E}ikt} r_{it}^{\text{seitc}}$, is a fraction of the federal EITC benefit. The total tax amount is

$$T_{ikt} = T_{ikt}^{\text{ftax}} + T_{ikt}^{\text{stax}} - B_{ikt}^{\text{seitc}} + 0.0765 E_{ikt},$$

where the payroll tax rate imposed on employees is 7.65 percent.[66] The policy rule $\mathbf{Z}_{Tit}$ consists of $(D_t^{\text{ftax}}, e_t^{\text{ftax}}, I_{it}^{\text{stax}}, D_{it}^{\text{stax}}, e_{it}^{\text{stax1}}, e_{it}^{\text{stax2}}, n_{it}, r_{1it}, \dots, r_{6it}, b_{1it}, \dots, b_{6it}, I_{it}^{\text{seitc}}, I_{it}^{\text{seitcr}}, r_{it}^{\text{seitc}})$. All elements vary by state except for the federal deduction and exemption amounts. Moreover, r_{it}^{seitc} can vary by family size.

A.2. *Computation of the Expected Value Function*

The expectation of the value function in equation (5) is computed as follows. Conditional on job offer availability, wage, and type, the expected value function is computed by integrating over the distribution of the choice shocks. Since the choice shocks are i.i.d. extreme value distributed, the conditional expectation has a close form (e.g., Rust (1987))

$$\begin{aligned} &E_{t-1} V_{it}(\mathbf{S}_{it}, \boldsymbol{\mathcal{E}}_{it} | I_{\text{J}it}, w_{it}, q) \\ &\quad = \sigma_c \ln\left(\text{eu} + \sum_{j \in D'(I_{\text{J}it}, \mathbf{S}_{it})} \exp\left(\bar{V}_{ijt}(w_{it}, \mathbf{S}_{it}, q)/\sigma_c\right)\right), \end{aligned}$$

where eu is Euler's constant, $\bar{V}_{ijt}(\cdot)$ is the choice-specific value defined in equation (8), and $D'(I_{\text{J}it}, \mathbf{S}_{it})$ is an index representation of the choice set. Note that when the individual does not have a job offer, the wage does not influence the conditional expectation. The job offer availability and wage distributions are

[65] In states with more than six brackets, only the most important six brackets are chosen.

[66] The payroll tax is the sum of Old-Age, Survivors, and Disability Insurance (OASDI) and Medicare. During the sample period, the statutory tax rates on employees are 6.2 and 1.45 percent, respectively.

then integrated out:

$$E_{t-1}V_{it}(\mathbf{S}_{it}, \boldsymbol{\mathcal{E}}_{it}|q) = \theta_{it}(\mathbf{S}_{it}, q) \int E_{t-1}V_{it}(\mathbf{S}_{it}, \boldsymbol{\mathcal{E}}_{it}|1, w, q) f(w|\mathbf{S}_{it}, q)\, dw + \big(1 - \theta_{it}(\mathbf{S}_{it}, q)\big) E_{t-1}V_{it}(\mathbf{S}_{it}, \boldsymbol{\mathcal{E}}_{it}|0, 0, q).$$

The integration over the wage distribution is computed by Gaussian–Hermite quadrature with three points.

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UTS Business School, Economics Discipline Group, University of Technology, Sydney, P.O. Box 123, Broadway, NSW 2007, Australia; marc.chan@uts.edu.au.

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