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Welfare Dependence and Self-Control: An Empirical Analysis

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Abstract

We use data from Florida Transition Program, a welfare reform experiment in the 1990s, to estimate a discrete choice dynamic programming model of labor supply and welfare participation with potentially time-inconsistent individuals. The time preference parameters are identified through exclusion restrictions generated by welfare time limits. Around one-fourth of the individuals can be regarded as present-biased, and they exhibit a low degree of naivety. Time-inconsistency reduces income by 15 percent and the net tax contribution by almost half. Present-biased individuals are generally more responsive to policy changes than time-consistent individuals. By aggravating the commitment problem, an increase in welfare benefits reduces utility from a time-consistent perspective. An expansion of Earned Income Tax Credit (EITC) can be revenue-neutral due to cross-subsidization between present-biased and time-consistent individuals. A "prowork time limit" is proposed as a more incentivizing policy than standard time limits. A dynamic nonwork tax that is triggered by past employment can generate strong commitment-related incentives and increase utility from a time-consistent perspective. The nonwork tax can be implemented as a targeting intervention, as an estimated 70 percent of present-biased individuals will adopt the policy as a commitment device.

JEL CLASSIFICATION: I3, C3, J2

Keywords: Welfare dependence, hyperbolic discounting, time limits, female labor supply, welfare reform, policy experiment, discrete choice dynamic programming

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1 Introduction

It is widely documented that social welfare programs carry perverse incentives that can induce dependence on the programs. The nature of dependence is, however, often subject to interpretation by researchers and policymakers. Welfare programs can generate labor supply disincentives, inducing individuals to receive less earnings and rely on welfare benefits as the main source of income. Moreover, if the labor supply disincentive is strong, income can drop, creating a "poverty trap" that is considered undesirable by policymakers. Plant (1984) sees welfare dependence as a phenomenon that is related to the dynamics of welfare program participation. He defines the welfare trap as one in which previous participation in the program increases the probability of current participation, ceteris paribus. He remarks that such forms of state dependence can interact with the structure of the welfare program and affect the optimal design of policy. While he sees addiction to welfare as a potential cause of the welfare trap, the nature and implications of the addiction are not further investigated.[1]

In this study, we examine the issue of welfare dependence from a unified perspective, with an emphasis on the narcotic nature of welfare programs. In recent years, models of (quasi-)hyperbolic discounting have become popular as a convenient tool for studying problems of addiction and self-control (e.g. Laibson (1997), O'Donoghue and Rabin (1999b)).[2] These models assume that agents exhibit present-biased preferences, and the intertemporal optimization problem can be viewed to consist of many autonomous selves, one in each period, with each self having a disproportionate tendency of immediate gratification. The misalignment between short-run and long-run goals gives rise to problems of commitment and self-control, and creates room for the design of policy instruments for their rectification. From a "long-run," time-consistent perspective, the behavior of a present-biased individual is suboptimal, as she overemphasizes the immediate reward of receiving welfare, and overlooks the future reward of human capital accumulation (Fang and Silverman (2004, 2009)). While present-bias induces addictive behavior, the structure of the welfare program can also magnify the effect of the present-bias and exacerbate problems of commitment and self-control. With time-inconsistency, the normative implications are strikingly different, as policies may be available to correct for "internalities" that the individual inflicts upon herself (e.g., Gruber

[1] Plant also argues that welfare dependence can be a result of fixed costs, for instance, fixed costs of initial welfare receipt. However, the various causes of welfare dependence are not empirically distinguished in his paper. For related discussions on welfare dependence, see for instance Bane and Ellwood (1983) and Gottschalk and Moffitt (1994).

[2] Early research in this area can be traced back to Strotz (1956), Phelps and Pollak (1968), and Pollak (1968). Recent applications include consumption decisions (e.g., Harris and Laibson (2002)), as well as retirement and savings (e.g., Diamond and Koszegi (2003), Gustman and Steinmeier (2012)).

and Koszegi (2001)).[3]

We use a panel data set from Florida Transition Program (FTP), a welfare reform experiment that operated in the 1990s, to estimate a discrete choice dynamic programming model of labor supply and welfare participation with potentially present-biased agents. We exploit a unique policy feature in FTP to identify the time preference parameters in the hyperbolic discounting model. The FTP treatment group was subject to a time limit, which restricted the total months of eligibility that individuals can receive welfare. By imposing extra intertemporal budget constraints, the time limit forms exclusion restrictions in the intertemporal optimization problem, which affect the transition of states over time, but not the per-period utility function. The exclusion restrictions allow the discount factor and hyperbolic discounting parameters to be identified in a similar spirit to Magnac and Thesmar (2002) and Fang and Wang (2013). This strategy is in line with Mahajan and Tarozzi (2011) and Fang and Wang (2013) which, to our knowledge, are the only empirical studies that use exclusion restrictions for the identification of models with hyperbolic discounting.[4] Our approach is distinct from their work, as we use an exogenous policy variation as a source of exclusion restrictions.

This study adds to the growing literature of the estimation and validation of dynamic structural models using data from policy experiments (e.g., Lise et al. (2005), Todd and Wolpin (2006), Attanasio et al. (2011), Ferrall (2012)). It contributes to the literature of dynamic structural models of welfare reform in the United States and Europe (e.g., Swann (2005), Keane and Wolpin (2010), Chan (2013), Blundell et al. (2013)). It is associated with reduced-form studies that use data from welfare reform experiments in the United States (e.g., Grogger and Michalopoulos (2003), Bitler et al. (2006)). Our work is closely related to Fang and Silverman (2009), who use data from NLSY79 to estimate a similar class of model with present-biased agents. We extend their work in three major dimensions. First, our identification strategy allows for a richer empirical specification of time preference parameters. We estimate not only the discount factor and present-bias factor but also the naivety factor, which determines how well individuals foresee their self-control problems in the future and, most importantly, their behavioral response to a commitment

[3]There are no internalities when preference is time-consistent. The individual chooses a time-consistent plan that maximizes her utility over time. Therefore, a policy intervention that attempts to remove Plant's welfare trap is likely to be distortionary by nature.

[4]Fang and Wang (2013) use certain demographic characteristics as exclusion variables in a model of mammography decisions. Mahajan and Tarozzi (2011) estimate a model of insecticide treated net adoption, using elicited beliefs on time preferences as exclusion restrictions. Earlier studies that use structural models, such as Paserman (2008) and Fang and Silverman (2009), do not explicitly use exclusion restrictions for identification.

device.[5] In addition, all the time preference parameters are heterogeneous, which allows for a mixture of time-consistent and present-biased (with varying degrees of naivety) individuals in the model.[6] We are then able to examine the differential impacts of policies on both types of individuals, and consider policies that can result in cross-subsidization between them. Second, we provide further evidence that the commitment problem is an important consideration in the design of policy. Fang and Silverman (2009) find that time limits can generate large effects on employment, but they are too crude as a commitment device to increase the long-run utility of a present-biased individual.[7] We identify policies that unambiguously reduce the generosity of the welfare system but alleviate the commitment problem substantially, such that they increase the long-run utility of a present-biased individual. This opens up a practical possibility of targeting intervention, in which such policies are voluntarily adopted by present-biased individuals, but never adopted by time-consistent individuals. Third, we expand the model specification in Fang and Silverman (2009) to put it in line with other dynamic structural models in the literature and the policy environment in the 1990s. For instance, work preference and the wage equation are separately distinguished; the budget constraint includes not only welfare but also Earned Income Tax Credit (EITC) and income tax; welfare recipients are allowed to work. Working welfare recipients are an important group during welfare reform, and they represent more than one-third of all welfare recipients in the analysis sample. They are closely related to certain policy elements of welfare reform, such as earnings disregards. We show that the modeling of this group is particularly useful for understanding the commitment problem associated with the transition between welfare and work.

The main findings are summarized as follows. Our model estimates suggest that around one-fourth of the individuals in the analysis sample can be regarded as present-biased, and three-fourths of the individuals can be regarded as time-consistent. The present-biased individuals exhibit a low degree of naivety, which implies that they are aware of their commitment problems. Neglecting time-

[5]A commitment device is broadly defined as an arrangement entered into by an agent that restricts her future choices (or budget sets), with the aim of satisfying goals that are otherwise difficult due to intra-personal conflict (e.g., Bryan et al. (2010)). Naivety captures the current self's perception error of the present-bias of her future selves. In particular, a totally naive present-biased individual erroneously perceives that her future selves are time-consistent, therefore she will not adopt a commitment device. For more details, see Section 3.1.2.

[6]We adopt a more general specification of time preference parameters than Mahajan and Tarozzi (2011) and Fang and Wang (2013). See Section 6.1 for a discussion of their specifications.

[7]The long-run utility is the utility based on discounting from the perspective of a time-consistent individual (e.g., O'Donoghue and Rabin (1999a)). See sections 6.2 for more details. Fang and Silverman (2009) also simulate the effects of workfare (i.e., work requirements for welfare recipients). However, unlike time limits, which unambiguously reduce the generosity of the welfare program, the workfare scenarios that they examine involve a subsidy that compensates for lost home production.

inconsistency will cause state dependence in the preferences for work and welfare (i.e., "habits") to be overestimated by 10 to 15 percent. Simulation over a decade-long horizon shows that under the existing welfare system, being present-biased has the effect of reducing income by 15 percent and the net tax contribution (i.e., tax minus benefits) by almost half; the effects are doubled if the individual is present-biased and totally naive. Present-biased individuals are generally more responsive to policy changes due to the presence of commitment-related incentives. For instance, an increase of the maximum welfare benefit amount by 20 percent leads to a 20-percent reduction in income among present-biased individuals; for time-consistent individuals, the reduction is less than 5 percent.

We find that an increase in the generosity of welfare benefits can result in a significant deterioration of the commitment problem. It is detrimental to employment-related outcomes among present-biased individuals, and leads to a *reduction* in their long-run utility. By contrast, an EITC expansion can alleviate the commitment problem and induce strong earnings growth among present-biased individuals. An EITC expansion can be revenue-neutral because the additional net tax contribution from present-biased individuals can be used to subsidize the increase in net government expenditure on time-consistent individuals.

We analyze a variety of dynamic policy interventions, with an emphasis on decoupling commitment-related incentives from static incentives and effects from state-dependent preferences. A "prowork time limit," in which welfare participation does not count toward the time limit if the welfare recipient is working, is proposed as a more incentivizing policy than standard time limits. By not penalizing working welfare recipients, a prowork time limit is more popular as a commitment device – one-fourth of present-biased individuals prefer a 1-year prowork time limit to no time limits. We analyze several types of dynamic work subsidies and nonwork taxes that are triggered by past employment behavior. We show that such policies can lead to a rich variety of outcomes, as they generate dynamic work incentives (or disincentives) by changing the degree of state dependence in preferences, and induce commitment-related incentives that reinforce or dampen policy effects. In particular, we show that a dynamic nonwork tax that is triggered by past employment can give rise to strong commitment-related work incentives and *increase* the long-run utility of present-biased individuals. Around 70 percent of present-biased individuals will adopt the above nonwork tax as a commitment device. Therefore, the policy can be implemented as a targeting intervention that draws in present-biased individuals who are willing to bind themselves, and leaves time-consistent individuals unaffected.

This paper proceeds as follows. Section 2 provides a brief summary of welfare reform and Family Transition Program. Section 3 describes the model. Section 4 discusses the estimation procedure and model identification. Section 5 describes the basic features of the data. Section 6 presents results from model estimation and counterfactual policy simulations. The last section gives concluding remarks. Additional tables are provided in Supplemental Material (Chan (2014)).

2 Welfare Reform and Family Transition Program

In the late 1990s, the United States implemented a reform that resulted in sweeping changes in its welfare program for female-headed families. The Aid to Families with Dependent Children (AFDC) program, a federal cash assistance program that had existed for six decades, was replaced by the Temporary Assistance for Needy Families (TANF) program. The main goals of the reform were to reduce dependence on the welfare system, and to help families achieve self-subsistence via promoting work. Just prior to the reform, a number of pilot initiatives were conducted in various states as "waiver programs," which allowed states to deviate from federal AFDC rules. While the initiatives differed widely in policy content and research methodology, they provided valuable information on the effects of various policy elements that anticipated the TANF program.

Family Transition Program (FTP) was the first welfare reform initiative in which some families reached their time limit and had their benefits canceled.[8] FTP was a policy experiment that operated from 1994 to 1999 in Escambia, a mid-sized county in western Florida. From May 1994 through October 1996, welfare applicants were randomly assigned to the control or treatment group. The control group (AFDC group) was subject to the rules of the AFDC program, which had no welfare time limits. The treatment group (FTP group) was subject to a time limit which, by default, restricted families to 24 months of welfare receipt within any 60-month period.[9] As in most other reform initiatives, the treatment group faced policies that were different from AFDC in other aspects. The treatment group was subject to more generous financial incentives that encouraged work. The first 200 dollars of earnings were disregarded in the calculation of welfare benefits, and a benefit reduction rate of 50 percent applied to all earnings in excess of 200 dollars.[10] The treatment

[8] Although TANF had a federal 5-year lifetime limit, there were few waiver programs that implemented a time limit policy. Iowa implemented a time limit on an individual basis in 1993. Connecticut implemented a 21-month limit in the Jobs First waiver program in 1996.

[9] Treatment group members are well informed by staff members regarding the dynamic mechanism of the time limit (Bloom and et al. (2000)). For families that were "particularly disadvantaged," they were limited to 36 months of welfare receipt in any 72-month period. Please refer to the data section for more details.

[10] The Appendix contains formal definitions of the program benefit formulas.

group also received enhanced employment and training services, while the control group received conventional AFDC services.

A number of reduced-form studies have focused on the effects of various policy elements in welfare reform initiatives. For instance, using data from Connecticut's Jobs First waiver program, Bitler et al. (2006) find that earnings disregards can generate heterogeneous effects on earnings, transfers, and income that are consistent with the predictions of static labor supply theory. Grogger and Michalopoulos (2003) find that the FTP time limit caused a larger reduction in welfare use among families with young children, a phenomenon that is consistent with the behavior of liquidity constrained, forward-looking individuals who face earnings uncertainty and a time limit.[11] They estimate that the FTP time limit caused welfare use to drop by 16 percent, and the FTP earnings disregard and enhanced services together caused welfare use to increase by 6 percentage points.

3 Economic Model

A discrete choice dynamic programming model is described below. In decision period t, individual i chooses her level of labor supply (h_{it}) and whether to participate in welfare (d_{ait}). The individual chooses one of the following elements of the choice set: (i) no work, no welfare ($h_{it} = 0, d_{ait} = 0$); (ii) part-time work, no welfare ($h_{it} = 1, d_{ait} = 0$); (iii) full-time work, no welfare ($h_{it} = 2, d_{ait} = 0$); (iv) no work, welfare ($h_{it} = 0, d_{ait} = 1$); (v) part-time work, welfare ($h_{it} = 1, d_{ait} = 1$). A full-time worker is assumed to work twice as many hours as a part-time worker.[12] Given the data structure, it is assumed that a decision is made every quarter (three months). However, variables are expressed in monthly units unless otherwise stated. To facilitate the discussion, a dummy variable for employment is defined as follows: d_{hit} is equal to one if the individual works ($h_{it} > 0$), and is zero otherwise. The "deterministic" part of the utility function has a rather stylized form:

$$\begin{aligned} \bar{u}_{it} = {} & y_{it}(h_{it}, d_{ait}) + \alpha_y [y_{it}(h_{it}, d_{ait})]^2 + \alpha_{hi} h_{it} + \alpha_{ai} d_{ait} + \alpha_{hai} d_{hit} d_{ait} \\ & + \gamma_h d_{hit} d_{hi,t-1} + \gamma_a d_{ait} d_{ai,t-1} + \gamma_{ha} d_{hit} d_{ait} d_{hi,t-1} d_{ai,t-1}. \end{aligned} \tag{1}$$

The individual's income (y_{it}) is determined by her choice of labor supply and welfare partic-

[11] As the authors argue, families with young children should have a stronger incentive to conserve their welfare benefits for future use. Their estimates suggest that there is a large difference in incentive between families with the youngest child aged under 10 and those with the youngest child aged over 10. However, the difference in incentive within the former group is small. Our analysis sample mainly consists of the former group (see Table I).

[12] A full-time worker is assumed to work 160 hours per month, which is normalized as $h_{it} = 2$. Receiving welfare and working full-time is not considered as a choice in the model, as full-time workers are usually ineligible for welfare (e.g. Chan (2013)).

ipation, as well as the shape of her budget constraint. The coefficient of the quadratic term of income is α_y. Preferences for work and welfare participation are determined by parameters α_{hi}, α_{ai}, and α_{hai}. There is state dependence in the preferences for work and welfare participation, which is given by parameters γ_h, γ_a, and γ_{ha}. The choice of being a working welfare recipient (choice (v)) is an important component of the model. The interaction coefficients α_{hai} and γ_{ha} allow the preferences for work and welfare participation, as well as their state dependence, to be nonadditive. The preference parameters vary in the population as follows:

$$\begin{aligned} \alpha_{hi} &= \boldsymbol{X}_i \boldsymbol{\psi}_h + \lambda_h e_i + \mu_{hi}, \\ \alpha_{ai} &= \boldsymbol{X}_i \boldsymbol{\psi}_a + \lambda_a e_i + \mu_{ai}, \\ \alpha_{hai} &= \boldsymbol{X}_i \boldsymbol{\psi}_{ha} + \lambda_{ha} e_i + \mu_{hai}. \end{aligned} \tag{2}$$

The vector of covariates $\boldsymbol{X}_i$ includes the unit constant and demographic characteristics such as the number of children, race, and the level of education. It affects preferences via coefficients $\boldsymbol{\psi}_h$, $\boldsymbol{\psi}_a$, and $\boldsymbol{\psi}_{ha}$. Although individuals are randomly assigned into the control and treatment groups, the model allows preferences to be different by treatment status via the treatment group dummy variable e_i and coefficients λ_h, λ_a, and λ_{ha}. These "shifters" serve to capture the effects of FTP that are not explicitly modeled in the budget constraint (i.e., enhanced services). The parameters μ_{hi}, μ_{ai}, and μ_{hai} represent unobserved permanent components, which will be discussed in more detail below. Income is determined by a piecewise-linear budget constraint:[13]

$$y_{it} = E_{it} + B_A(E_{it}, e_i, \boldsymbol{Z}_{Ai}) d_{ait} + B_E(E_{it}, \boldsymbol{Z}_{Ei}) - T(E_{it}, \boldsymbol{Z}_{Ti}); \qquad E_{it} = w_{it} h_{it}. \tag{3}$$

Income is equal to gross earnings E_{it} plus transfer benefits minus tax. Gross earnings is the product of the wage rate w_{it} and labor supply h_{it}. The program benefit formulas for welfare and EITC are denoted by $B_A(.)$ and $B_E(.)$, respectively. In particular, the welfare benefit varies by treatment status due to FTP earnings disregards. The tax formula $T(.)$ consists of income and payroll tax. The formulas are parameterized by "program rules" $\boldsymbol{Z}_{Ai}$, $\boldsymbol{Z}_{Ei}$, and $\boldsymbol{Z}_{Ti}$, which vary by family size. The appendix contains formal definitions of the formulas. The wage follows a

[13] The individual is assumed to consume all her income each period. See Blundell et al. (2013) for an exception among similar structural models. 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)).

log-normal distribution:

$$lnw_{it} = \gamma_{wh} d_{hi,t-1} + \gamma_{wa} d_{ai,t-1} + \gamma_{wha} d_{hi,t-1} d_{ai,t-1} + \tag{4}$$

$$\omega_0 \mathcal{E}_{it} + \omega_1 X_{wi}^{ed} \mathcal{E}_{it} + \omega_2 \mathcal{E}_{it}^2 + \boldsymbol{X}_{wi} \boldsymbol{\psi}_w + \lambda_w e_i + \mu_{wi} + \epsilon_{wit}. \tag{5}$$

Employment and welfare use last period affect the current wage rate via state dependence parameters γ_{wh}, γ_{wa}, and γ_{wha}. The wage rate is also affected by the level of work experience, which is denoted by $\mathcal{E}_{it}$. The marginal return of work experience depends on the individual's level of education (X_{wi}^{ed}). The remainder of the wage equation consists of a vector of covariates $\boldsymbol{X}_{wi}$ which includes the unit constant, race, and education, a treatment group dummy variable e_i, and an unobserved permanent component μ_{wi} which will be discussed below. The logarithm of the wage rate is subject to a normally distributed shock ϵ_{wit}, which has zero mean and standard deviation σ_w, and is independent of other shocks in the model.

Denote the index representation of the choice set by $k \in \{1, 2, 3, 4, 5\}$. The utility of alternative k is the sum of the "deterministic" part $\bar{u}_{it}(k)$ (equation (1)) and a choice-specific preference shock ϵ_{cikt}:

$$u_{ikt} = \bar{u}_{it}(k) + \epsilon_{cikt}. \tag{6}$$

Following Swann (2005), the vector of choice-specific shocks, denoted $\boldsymbol{\epsilon}_{cit}$, is assumed to follow an i.i.d. extreme value distribution with means at Euler's constant $eu \approx 0.5772$ and standard deviations at $\frac{\pi}{\sqrt{6}}\sigma_c$, where $\frac{\pi}{\sqrt{6}} \approx 1.2825$ is a normalization constant.

3.1 Intertemporal Optimization Problem

The individual is assumed to have (β,δ)-preference, or quasi-hyperbolic preference, which is potentially time-inconsistent (e.g., Phelps and Pollak (1968), Laibson (1997), O'Donoghue and Rabin (1999b)). The parameter δ is the (standard) discount factor, and β is called the present-bias factor, which captures the individual's short-term impatience. In this model, utility is discounted by a factor of $1 - \beta\delta$ next period, then by a factor of $1 - \delta$ in each subsequent period. For instance, for an individual in period τ, the discounted stream of utility from period τ to τ' is

$$u_{ik_\tau \tau} + \beta_i \sum_{t=\tau+1}^{\tau'} \delta_i^{t-\tau} u_{ik_t t}, \tag{7}$$

where k_t denotes the individual's choice in period t, and u_{ik_tt} is the utility in period t (given realizations of shocks) when the individual's choice is k_t. When the present-bias factor is equal to one, the model reduces to the standard model with exponential discounting, in which the individual exhibits time-consistent preference. When the present-bias factor is strictly less than one, the individual exhibits present-biased preference, which is time-inconsistent. The rate of discounting is disproportionately larger next period than in subsequent periods, reflecting a tendency of immediate gratification. Since the rate of discounting is no longer independent of the delay period, the individual has imperfect ability to commit to a certain action. The intertemporal optimization problem can be viewed to consist of many autonomous selves, one in each period, that act in their own interests. When the current self makes decisions, she potentially takes into account of the strategic relationship between the current self and future selves. Therefore, the current self's perception of her future selves also matters in the decision-making process.

To illustrate the state space, the intertemporal optimization problem of an exponential discounting model is described first. Then, we describe the intertemporal optimization problem of the quasi-hyperbolic discounting model, which is the baseline model of our analysis.

3.1.1 Time-Consistent Preference

The maximization problem can be written in the following recursive form:

$$V_{it}(\boldsymbol{S}_{it}, \boldsymbol{\epsilon}_{it}) \equiv \max_{\boldsymbol{d}_{it} \in D} \sum_{k=1}^{5} d_{ikt} \left(u_{ikt} + \delta_i E_t V_{i,t+1}(\boldsymbol{S}_{ik,t+1}, \boldsymbol{\epsilon}_{i,t+1}) \right). \tag{8}$$

The value function $V(.)$ has two sets of state variables. The error space $\boldsymbol{\epsilon}_{it} \equiv (\boldsymbol{\epsilon}_{cit}, \epsilon_{wit})$ consists of preference and wage shocks that are integrated out by the expectation operator in each period of the backward recursion procedure.[14] The deterministic part of the state space $\boldsymbol{S}_{it}$ is carried around explicitly as an argument in the expected value function, and evolves according to the intertemporal budget constraint. For control group members, $\boldsymbol{S}_{it} = (d_{hi,t-1}, d_{ai,t-1}, \mathcal{E}_{it})$. Given the state variables, the individual chooses the best alternative in the choice set D. For control group members, the choice set is $D_0 \equiv \{\boldsymbol{d_{it}} | \sum_{k=1}^{5} d_{ikt} = 1\}$, where $\boldsymbol{d_{it}}$ is a five-dimensional vector with $d_{ikt} \in \{0, 1\}$ as the kth element.

For treatment group members, the dynamic programming problem is more complicated due to the presence of welfare time limits. The individual becomes ineligible for welfare when the cumula-

[14]The integration procedure is described in detail in the Appendix. When the individual solves the dynamic programming problem, she perceives the variables outside $\boldsymbol{S}_{it}$ and $\boldsymbol{\epsilon}_{it}$ to remain unchanged over time.

tive number of periods of welfare participation since random assignment (M_{it}) reaches the limit $\bar{M}$. The choice set is D_0 if the individual has not reached the limit, and it is $D_1 \equiv \{\boldsymbol{d_{it}} | \sum_{k=1}^{3} d_{ikt} = 1\}$ otherwise. The time limit introduces an intertemporal budget constraint:

$$M_{i,t+1} = M_{it} + d_{ait}, \qquad \text{and} \quad M_{i1} = 0. \tag{9}$$

When the individual reaches the time limit and becomes ineligible for welfare, she becomes eligible again after $\bar{m}$ periods of ineligibility, and M_{it} is then reset to zero.[15] The intertemporal budget constraints are:

$$m_{i,t+1} = \begin{cases} m_{it} + 1 & \text{if } M_{it} = \bar{M}, \\ 0 & \text{if } M_{it} < \bar{M}, \end{cases} \tag{10}$$

$$m_{i1} = 0; \qquad M_{i,t+1} = 0 \quad \text{and} \quad m_{i,t+1} = 0 \qquad \text{if } m_{it} = \bar{m}. \tag{11}$$

Therefore, for treatment group members, $\boldsymbol{S}_{it} = (d_{hi,t-1}, d_{ai,t-1}, \mathcal{E}_{it}, M_{it}, m_{it})$.

3.1.2 Present-Biased Preference

The backward recursion procedure of the intertemporal optimization problem for individuals with (β,δ)-preference is carried out in a similar spirit to Fang and Silverman (2009). The intertemporal optimization problem can be thought of as having multiple autonomous selves, with one self in each period. Each self optimizes her behavior and is potentially aware that her future selves may act in their own interests. The solution of the intertemporal optimization problem is the equilibrium of an intrapersonal game that can be solved by backward recursion. As in Fang and Silverman (2009), the analysis is restricted to Markov strategies. Denote a Markov strategy as a mapping $\kappa_{it} : \mathcal{X}_i \mapsto D$, where $\mathcal{X}$ is the state space and D is the choice set. The continuation strategy profile in period t is defined as the set of strategies from period t to the end of the time horizon $\mathcal{T}$, and is denoted by $\kappa_{it}^{+} \equiv \{\kappa_{ia}\}_{a=t}^{\mathcal{T}}$. The continuation long-run utility given continuation strategy profile

[15] We adopt the approach of Chan (2013) in modeling the periodic nature of the FTP time limit. The length of ineligibility is set at 12 periods to mimic FTP policy. The time horizon, defined as the number of periods remaining (measured in period 1) until the individual's youngest child reaches 18 years of age, is set at 54 periods, which is close to the median in the analysis sample. Robustness check shows that the length of the time limit $\bar{M}$ is much more important than $\bar{m}$ or the time horizon in determining behavior.

κ_{it}^{+} is defined as

$$v_{it}(\boldsymbol{S}_{it}, \boldsymbol{\epsilon}_{it}; \kappa_{it}^{+}) = u_{ik_\kappa t} + \delta_i E_t v_{i,t+1}(\boldsymbol{S}_{ik_\kappa,t+1}, \boldsymbol{\epsilon}_{i,t+1}; \kappa_{i,t+1}^{+}), \tag{12}$$

where k_κ is the individual's choice based on the strategy in period t. Note that the present-bias factor does not enter into the continuation long-run utility directly.

A distinction between *sophisticated* and *naive* present-biased agents is made (e.g., Strotz (1956), Pollak (1968), O'Donoghue and Rabin (1999b), Fang and Silverman (2004, 2009)). The current self bases her decisions not only on her present-bias factor β, but also on her perception of the present-bias of her future selves. The perception captures the individual's awareness of her self-control problem in the future. The perceived present-bias factor, or the "naivety factor," is denoted by $\tilde{\beta}$. An individual is said to be sophisticated if her perceived present-bias factor is correct, that is, $\tilde{\beta} = \beta$. She is said to be naive if she erroneously believes that her future selves are time-consistent, that is, $\tilde{\beta} = 1$.

The behaviors of sophisticated and naive agents can be very different (e.g., O'Donoghue and Rabin (1999b), Fang and Silverman (2004)). A naive agent is unaware of her commitment problem, and she does not adjust her behavior in response to her inability to commit. By contrast, the behavior of a sophisticated agent takes into account of the extra incentives generated by the commitment problem. A sophisticated agent may adopt a commitment device that constrains the budget sets of her future selves, but a naive agent never adopts a commitment device. In practice, an individual can be neither sophisticated nor naive. For instance, O'Donoghue and Rabin (2001) examine the implications of *partial* naivety, in which $\beta < \tilde{\beta} < 1$.

The backward recursion procedure of the intertemporal optimization problem for a present-biased individual with naivety factor $\tilde{\beta}$ is formally described as follows. The procedure involves recursively solving for the continuation long-run utility that is defined upon the *perceived continuation strategy profile*. A perceived continuation strategy profile $\tilde{\kappa}_{it}^{+} \equiv \{\tilde{\kappa}_{ia}\}_{a=t}^{\mathcal{T}}$ is defined as a continuation strategy profile such that the strategy in each period a, where $a \in \{t, t+1, ..., \mathcal{T}\}$, is

$$\tilde{\kappa}_{ia}(\boldsymbol{S}_{ia}, \boldsymbol{\epsilon}_{ia}) \equiv argmax_{\boldsymbol{d}_{ia} \in D} \sum_{k=1}^{5} d_{ika} \left(u_{ika} + \tilde{\beta}_i \delta_i E_a v_{i,a+1}(\boldsymbol{S}_{ik,a+1}, \boldsymbol{\epsilon}_{i,a+1}; \tilde{\kappa}_{i,a+1}^{+}) \right). \tag{13}$$

Note that the perceived continuation strategy profile is influenced by the naivety factor, hence the name.

Given the perceived continuation strategy profile and its corresponding continuation long-run utility in period $t+1$, the perceived continuation strategy profile in period t can be solved recursively via equation (13). Then, applying equation (12), the corresponding continuation long-run utility in period t is

$$v_{it}(\boldsymbol{S}_{it}, \boldsymbol{\epsilon}_{it}; \tilde{\kappa}_{it}^{+}) = u_{ik_{\tilde{\kappa}}t} + \delta_i E_t v_{i,t+1}(\boldsymbol{S}_{ik_{\tilde{\kappa}},t+1}, \boldsymbol{\epsilon}_{i,t+1}; \tilde{\kappa}_{i,t+1}^{+}). \tag{14}$$

This completes the recursion procedure.

When the current self makes decisions, she believes that her future selves will follow the perceived continuation strategy profile $\tilde{\kappa}_{i,t+1}^{+}$. The current self's optimal strategy is

$$\kappa_{it}^{*}(\boldsymbol{S}_{it}, \boldsymbol{\epsilon}_{it}) \equiv argmax_{\boldsymbol{d}_{it} \in D} \sum_{k=1}^{5} d_{ikt} \left(u_{ikt} + \beta_i \delta_i E_t v_{i,t+1}(\boldsymbol{S}_{ik,t+1}, \boldsymbol{\epsilon}_{i,t+1}; \tilde{\kappa}_{i,t+1}^{+}) \right). \tag{15}$$

Note that the current self's optimal strategy is influenced by the present-bias factor. Although the current self's optimal strategy is not used for recursion in earlier periods, it is directly observed by the researcher in the data and is therefore used for the construction of the likelihood function.[16]

3.1.3 Heterogeneity

The time preference parameters vary in the population as follows:

$$\begin{aligned} \delta_i &= \boldsymbol{X}_i \boldsymbol{\psi}_\delta + \mu_{\delta i}, \\ \beta_i &= \boldsymbol{X}_i \boldsymbol{\psi}_\beta + \mu_{\beta i}, \\ \tilde{\beta}_i &= \boldsymbol{X}_i \boldsymbol{\psi}_{\tilde{\beta}} + \mu_{\tilde{\beta} i}. \end{aligned} \tag{16}$$

The discount factor, present-bias factor, and naivety factor are functions of the vector of covariates $\boldsymbol{X}_i$ and unobserved permanent components $\mu_{\delta i}$, $\mu_{\beta i}$, and $\mu_{\tilde{\beta} i}$.

Unobserved heterogeneity enters into the model in the form of discrete types (e.g., Heckman and Singer (1984)). The vector of permanent components $(\mu_{hi}, \mu_{ai}, \mu_{hai}, \mu_{wi}, \mu_{\delta i}, \mu_{\beta i}, \mu_{\tilde{\beta} i})$ follows a discrete probability distribution with three points of support, each of which reflecting the unobserved type of the individual. The probability that an individual is of type q, where $q \in \{1, 2, 3\}$, is denoted by π_q. Denote the unobserved characteristics of a type-q individual by $\boldsymbol{\mu}_q \equiv (\mu_{hq}, \mu_{aq}, \mu_{haq}, \mu_{wq}, \mu_{\delta q}, \mu_{\beta q}, \mu_{\tilde{\beta} q})$. The discrete distribution is normalized with respect to type

[16] For sophisticated agents, the perception of the present-bias factor is correct. Therefore, the perceived continuation strategy profile coincides with the optimal strategy in equation (15) in each period.

1, i.e. $\boldsymbol{\mu}_1 = 0$ and $\pi_1 = 1 - \pi_2 - \pi_3$. Hence the distribution contains 16 parameters, namely, π_2, π_3, $\boldsymbol{\mu}_2$, and $\boldsymbol{\mu}_3$.

4 Estimation Strategy

The model is estimated by the method of maximum likelihood. In each period, the researcher observes the individual's employment status d_{hit}, welfare participation status d_{ait}, demographic characteristics $\boldsymbol{X}_i$, treatment status e_i, program rules $\boldsymbol{Z}_{iA}$, $\boldsymbol{Z}_{iE}$, and $\boldsymbol{Z}_{iT}$, and the vector of state variables $\boldsymbol{S}_{it}$. In a similar spirit to Hoynes (1996) and Keane and Wolpin (2010), observed earnings $\tilde{E}_{it}$ and earnings implied by the model are related through a multiplicative shock:

$$\tilde{E}_{it} = E_{it} e^{\epsilon_{Eit}}, \tag{17}$$

where the stochastic term ϵ_{Eit} follows a normal distribution with mean $-\sigma_E^2/2$ and standard deviation σ_E, and is independent of other shocks. It follows that $e^{\epsilon_{Eit}}$ follows a lognormal distribution with mean 1 and standard deviation $\sqrt{e^{\sigma_E^2} - 1}$.

The parameters to be estimated include state dependence parameters in the utility function (γ_h, γ_a, γ_{ha}) and the wage equation (γ_{wh}, γ_{wa}, γ_{wha}), coefficients of demographic characteristics ($\boldsymbol{\psi}_h$, $\boldsymbol{\psi}_a$, $\boldsymbol{\psi}_{ha}$, $\boldsymbol{\psi}_w$, $\boldsymbol{\psi}_\delta$, $\boldsymbol{\psi}_\beta$, $\boldsymbol{\psi}_{\tilde{\beta}}$), treatment status coefficients (λ_h, λ_a, λ_{ha}, λ_w), work experience coefficients in the wage equation (ω_0, ω_1, ω_2), standard deviations of random shocks (σ_c, σ_w, σ_E), and parameters of unobserved heterogeneity (π_2, π_3, $\boldsymbol{\mu}_2$, $\boldsymbol{\mu}_3$).[17]

In each iteration in the parameter space, computation of the likelihood for individual i consists of three nested loops. The inner loop computes the likelihood for each period t given type q and the expected continuation long-run utility obtained from the backward recursion procedure. The middle loop carries out the backward recursion procedure of the dynamic programming problem given type q. In the outer loop, the likelihood is computed as the average of type-specific likelihoods, which are weighted by type probabilities.

The likelihood contribution in the inner loop is derived as follows. Let $\bar{V}_{ikt}$ denote the choice-

[17] Chan (2013) argues that exogenous parallel shifts in the budget constraint, such as an EITC expansion, are very helpful in identifying the curvature of the utility function. Unfortunately, the most significant changes in EITC had ended just before the sample period. Due to similarities in model structure, we set the quadratic coefficient of income based on his estimate of -0.9×10^{-4}.

specific value, *exclusive* of the choice-specific preference shock, for alternative k:[18]

$$\bar{V}_{ikt}(w_{it}, \boldsymbol{S}_{it}, q) \equiv \bar{u}_{it}(k; w_{it}, \boldsymbol{S}_{it}, q) + \beta_i \delta_i E_t v_{i,t+1}(\boldsymbol{S}_{ik,t+1}, \boldsymbol{\epsilon}_{i,t+1}; \tilde{\kappa}^{+}_{i,t+1}; q). \tag{19}$$

The choice-specific value is conditional on wage w, state variables $\boldsymbol{S}$, type q, and the expected continuation long-run utility. The distributional assumption for the choice shock implies that the conditional choice probability in period t has the following form:

$$P_{ikt}(w_{it}, \boldsymbol{S}_{it}, q) \equiv \frac{\exp(\bar{V}_{ikt}(w_{it}, \boldsymbol{S}_{it}, q)/\sigma_c)}{\sum_{j=1}^{5} \exp(\bar{V}_{ijt}(w_{it}, \boldsymbol{S}_{it}, q)/\sigma_c)}. \tag{20}$$

Let $f_i(.)$ and $g_i(.)$ denote the probability density functions of wage and observed earnings, respectively. The likelihood contribution of individual i in period t, denoted L_{it}, is given as follows:

$$L_{it}(d_{hit}, d_{ait}, \tilde{E}_{it}, \boldsymbol{S}_{it}, q) = \begin{cases} \int P_{i1t}(w, \boldsymbol{S}_{it}, q) f_i(w|\boldsymbol{S}_{it}, q) dw & \text{if} \quad d_{hit} = 0, d_{ait} = 0; \\ \int [P_{i2t}(w, \boldsymbol{S}_{it}, q) g_i(\tilde{E}_{it}|w, k=2) & \\ \quad + P_{i3t}(w, \boldsymbol{S}_{it}, q) g_i(\tilde{E}_{it}|w, k=3)] f_i(w|\boldsymbol{S}_{it}, q) dw & \text{if} \quad d_{hit} = 1, d_{ait} = 0; \\ \int P_{i4t}(w, \boldsymbol{S}_{it}, q) f_i(w|\boldsymbol{S}_{it}, q) dw & \text{if} \quad d_{hit} = 0, d_{ait} = 1; \\ \int P_{i5t}(w, \boldsymbol{S}_{it}, q) g_i(\tilde{E}_{it}|w, k=5) f_i(w|\boldsymbol{S}_{it}, q) dw & \text{if} \quad d_{hit} = 1, d_{ait} = 1. \end{cases}$$

The wage is integrated out in the likelihood contribution using Gaussian-Hermite quadrature with five points (e.g. Butler and Moffitt (1982), Swann (2005)). Suppose individual i is observed in the data for T periods and there are N individuals in the sample. The log likelihood function is:[19]

$$LL = \sum_{i=1}^{N} \ln \sum_{q=1}^{3} \pi_q \prod_{t=2}^{T} L_{it}. \tag{21}$$

The standard errors are computed using the BHHH algorithm (Berndt et al. (1974)).

[18]For notational simplicity, other control variables are not shown in the expression. Note that in an exponential discounting model, the choice-specific value is

$$\bar{V}_{ikt}(w_{it}, \boldsymbol{S}_{it}, q) \equiv \bar{u}_{it}(k; w_{it}, \boldsymbol{S}_{it}, q) + \delta_i E_t V_{i,t+1}(\boldsymbol{S}_{ik,t+1}, \boldsymbol{\epsilon}_{i,t+1}; q). \tag{18}$$

[19]The first period is not used directly for likelihood computation, as data prior to period 1 are not utilized in the formulation of state variables (e.g., Chan (2013)). This method of conditional maximum likelihood estimation (CMLE) does not require specifying the distribution of initial conditions, but incurs a cost on statistical efficiency.

4.1 Identification

The identification of parameters in the utility function and wage equation has been discussed studies that use a similar class of models. For instance, Chan (2013) discusses the overidentifying restrictions and relevant policy variations in a related dynamic model under a broader policy environment. In our model, the piecewise-linear nature of the budget constraint and the difference in welfare earnings disregards by treatment status allow the above parameters to be identified in a similar manner.

We focus our attention on time preference parameters. While Rust (1994) shows that the discount factor in discrete choice dynamic programming models is generally underidentified, Magnac and Thesmar (2002) propose that the issue can be resolved if certain exclusion restrictions are used.[20] Fang and Wang (2013) show further that under general conditions, exclusion restrictions can also be used for the identification of the present-bias factor and naivety factor in models with hyperbolic discounting. They focus on a particular type of exclusion restrictions, namely, exclusion variables that affect the transition probabilities of states over time, but do not affect the per-period utility function. Since the transition probabilities are affected by time preference parameters via an intertemporal tradeoff, exogenous variations in such exclusion variables can provide an exogenous source of variation in transition probabilities that reveal how the individual discounts the future.

The welfare time limit forms natural exclusion restrictions that affect state transition probabilities but not the per-period utility function. In the presence of a time limit, the individual faces extra intertemporal budget constraints (9) and (10), which change the mechanism of transitions in work and welfare use status over time. During the sample period, no individuals have reached the time limit, so the per-period utility in equation (1) is not affected by the policy. Cumulative periods of welfare use since random assignment (M_{it}) affect the behavior of treatment group members via the time limit. Assuming individuals are forward-looking, the choice probabilities between control and treatment group members will be uniquely different at *each* value of M_{it}, other things being equal. Since M_{it} can take eight possible values (from zero to seven) during the sample period, there are multiple values of M_{it} at which the researcher can exploit control-treatment behavioral differences to infer about time preferences. If the model is time-consistent, as in Magnac and Thesmar (2002),

[20] In the labor literature, few studies have used exogenous policy variations to form exclusion restrictions that identify the discount factor. In Ferrall (2012), treatment group members in the Self-Sufficiency Project (SSP) will be eligible for a wage subsidy if they can find a full-time job and go off income assistance within one year following random assignment. Differences in behavior between the control and treatment groups within that period allow the discount factor to be recovered. Formally speaking, the exclusion is the time lapsed since random assignment.

the discount factor δ will be overidentified.[21] In the case of present-biased preference, more exclusions are needed for the identification of the discount factor δ, present-bias factor β, and naivety factor $\tilde{\beta}$. With multiple values of M_{it}, there are more than enough exclusions to identify these parameters (Proposition 2, Fang and Wang (2013)). In particular, for treatment group members, the time limit can act as a commitment device. Their behavior under the time limit can thus help reveal the magnitude of present-bias and naivety, as discussed below.

We highlight below the intuitive arguments for identification in the specific context of our data and policy structure.[22] To facilitate the discussion, suppose the treatment group faces a (lifetime) time limit only, and cumulative periods of welfare use since random assignment (M_{it}) is the only state variable in the intertemporal optimization problem of an individual under the time limit. By not receiving welfare now, the individual can preserve one period of eligibility for future use. If the individual is time-consistent, the option value of *not* receiving welfare now is:

$$\delta[E_t V_{t+1}(m;\delta) - E_t V_{t+1}(m+1;\delta)], \tag{22}$$

where $V(.)$ is the value function and m is the current value of M_{it}. The discount factor affects the option value directly through the multiplicative factor and indirectly through the expected value function. The appendix summarizes the regularity conditions for the expected value function. Other things unchanged, a larger option value will lead to a larger effective distaste for welfare, and hence a lower welfare participation rate. In addition, the option value is positive, so the individual will have a lower welfare participation rate than when she faces no time limits.[23]

Let $\bar{y}_t^0(m)$ and $\bar{y}_t^1(m)$ denote the sample welfare participation rates of control and treatment group members with realized value of state variable m in period t, respectively. The following

[21] Note that we do not explicitly invoke nonstationarity of the model to help identify the time preference parameters. The time horizon is significantly longer than the sample period. In practice, we find that the value function (or continuation long-run utility) is similar across time periods during the sample period.

[22] The reader can refer to Fang and Wang (2013) for formal econometric arguments in a more general structure.

[23] The option value has a positive effect on employment by lowering work reservation wage. Moreover, if job search is a choice, then it should also lead to a higher job search intensity, which positively affects employment. Following the related literature on welfare, we do not attempt to distinguish the job search mechanism separately.

moment condition can be formed to estimate the discount factor:[24]

$$Q\left(\hat{\delta}[E_t V_{t+1}(m;\hat{\delta}) - E_t V_{t+1}(m+1;\hat{\delta})]\right) = \bar{y}_t^0(m) - \bar{y}_t^1(m), \tag{23}$$

where $Q(.)$ is strictly increasing and $Q(0) = 0$. In principle, the control-treatment difference in the sample welfare participation rate at one realized value of state variable m allows the discount factor to be recovered.

4.1.1 Present-Biased Preference

It may seem that the present-bias factor is not identified due to its multiplicative relationship with the discount factor in equation (15). However, this is not true because the continuation long-run utility in equation (15) is based on equation (14), which carries out the discounting differently. As an illustration, consider a naive present-biased individual (i.e., $\beta < 1$, $\tilde{\beta} = 1$). Since she never adopts a commitment device, this case is particularly interesting because there is no "smoking gun" (O'Donoghue and Rabin (1999b)) that distinguishes her behavior from a time-consistent individual who has a low discount factor.[25] The option value of not receiving welfare now is:

$$\beta\delta[E_t v_{t+1}(m;\tilde{\kappa}_{t+1}^{+},\delta) - E_t v_{t+1}(m+1;\tilde{\kappa}_{t+1}^{+},\delta)]. \tag{24}$$

By equations (13) and (14), the perceived continuation strategy profile coincides with the optimal strategy profile under time-consistent preference, that is, the current self thinks that her future selves will behave in a time-consistent manner. Therefore, equation (24) can be written as:

$$\beta\delta[E_t V_{t+1}(m;\delta) - E_t V_{t+1}(m+1;\delta)]. \tag{25}$$

[24] Moment conditions are used for the purpose of discussing identification arguments only. In practice, the method of maximum likelihood is used. In this example, a two-step estimation procedure can be applied. The first step uses control group data to estimate other parameters in the model. The moment condition can then be used to estimate the discount factor. Note that the welfare participation rate in the control group does not depend on m given other characteristics. Please refer to the Appendix for a detailed discussion of discrete types.

[25] O'Donoghue and Rabin (1999b) discuss how the behavior of an individual will change if she becomes present-biased, keeping the discount factor constant. Therefore, their discussion is not directly involved with the issue of identification of time preference parameters.

Two moment conditions are needed:

$$\hat{\beta}\hat{\delta}[E_t V_{t+1}(m;\hat{\delta}) - E_t V_{t+1}(m+1;\hat{\delta})] = Q^{-1}\left(\bar{y}_t^0(m) - \bar{y}_t^1(m)\right), \tag{26}$$

$$\hat{\beta}\hat{\delta}[E_t V_{t+1}(m+1;\hat{\delta}) - E_t V_{t+1}(m+2;\hat{\delta})] = Q^{-1}\left(\bar{y}_t^0(m+1) - \bar{y}_t^1(m+1)\right). \tag{27}$$

Dividing both equations, we have

$$\frac{E_t V_{t+1}(m;\hat{\delta}) - E_t V_{t+1}(m+1;\hat{\delta})}{E_t V_{t+1}(m+1;\hat{\delta}) - E_t V_{t+1}(m+2;\hat{\delta})} = \frac{Q^{-1}\left(\bar{y}_t^0(m) - \bar{y}_t^1(m)\right)}{Q^{-1}\left(\bar{y}_t^0(m+1) - \bar{y}_t^1(m+1)\right)}. \tag{28}$$

The discount factor and present-bias factor can be solved sequentially from equations (28) and (26).[26] Note that by equation (28), the discount factor determines the *ratio* of option values and, consequently, the ratio of the effect of the time limit at various values of m. In particular, a lower discount factor implies that the "trajectory" of welfare participation rates along m will drop at a faster rate. By equation (26), the present-bias factor determines the *size* of the option value at different values of m. A naive present-biased individual can therefore be empirically distinguished from a time-consistent individual as follows. For a naive present-biased individual with a high discount factor, the effect of the time limit will be small, and the trajectory of welfare participation rates along m will be relatively flat – she does not reduce welfare use substantially as she approaches the time limit. For a time-consistent individual with a low discount factor, the effect of the time limit will also be small, but she reduces welfare use substantially as she approaches the time limit.

Now consider the general case where the naivety factor $\tilde{\beta}$ is a parameter to be estimated. Moment conditions that are analogous to equations (26) and (27) can be constructed:

$$\begin{aligned}&\hat{\beta}\hat{\delta}[E_t v_{t+1}(m;\tilde{\kappa}_{t+1}^{+}(m;\hat{\tilde{\beta}},\hat{\delta}),\hat{\delta}) - E_t v_{t+1}(m+1;\tilde{\kappa}_{t+1}^{+}(m+1;\hat{\tilde{\beta}},\hat{\delta}),\hat{\delta})]\\ &= Q^{-1}\left(\bar{y}_t^0(m) - \bar{y}_t^1(m)\right),\end{aligned} \tag{29}$$

$$\begin{aligned}&\hat{\beta}\hat{\delta}[E_t v_{t+1}(m+1;\tilde{\kappa}_{t+1}^{+}(m+1;\hat{\tilde{\beta}},\hat{\delta}),\hat{\delta}) - E_t v_{t+1}(m+2;\tilde{\kappa}_{t+1}^{+}(m+2;\hat{\tilde{\beta}},\hat{\delta}),\hat{\delta})]\\ &= Q^{-1}\left(\bar{y}_t^0(m+1) - \bar{y}_t^1(m+1)\right),\end{aligned} \tag{30}$$

where $\tilde{\kappa}_{t+1}^{+}(\tilde{\beta},\delta)$ is the perceived continuation strategy profile constructed from equation (13). The current self perceives that her future selves may be present-biased. In particular, she perceives that her future selves have a tendency to receive welfare immediately and neglect the future

[26] The ratio on the left hand side of equation (28) is strictly increasing in $\hat{\delta}$. With reasonable values of the sample moments, a unique solution for $\hat{\delta}$ can be obtained from the equation. Please refer to the appendix for more details.

benefits of retaining an eligible period under the time limit. Her incentive to participate in welfare will therefore be affected by her perception of the commitment problem, therefore the option value will be a function of the naivety factor. Note that if the discount factor is known, the present-bias factor and naivety factor can be solved sequentially from equations (29) and (30) by constructing a ratio of option values similar to equation (28). Otherwise, an extra moment with $Q^{-1}\left(\bar{y}_t^0(m+2) - \bar{y}_t^1(m+2)\right)$ is needed to solve for the time preference parameters jointly in a system of equations.[27]

It is useful to provide further insight on how the naivety factor affects incentives and option values under a time limit. An interesting observation is that the expected continuation long-run utility is no larger than the expected value:

$$E_t v_{t+1}(m; \tilde{\kappa}_{t+1}^{+}(m; \tilde{\beta}, \delta), \delta) \leq E_t v_{t+1}(m; \tilde{\kappa}_{t+1}^{+}(m; 1, \delta), \delta) \equiv E_t V_{t+1}(m; \delta). \tag{31}$$

When the naivety factor is smaller than one, then by equation (13), $\tilde{\kappa}_{t+1}^{+}(m; \tilde{\beta}, \delta)$ will deviate from the perceived continuation strategy profile under time-consistent preference. Inequality (31) then follows from the definition of $E_t v_{t+1}(.)$ in equation (14). The difference in the above inequality represents the deterioration in expected value due to the (perceived) presence of a commitment problem. Now consider the following inequality:

$$E_t V_{t+1}(m; \delta) - E_t v_{t+1}(m; \tilde{\kappa}_{t+1}^{+}(m; \tilde{\beta}, \delta), \delta) \geq E_t V_{t+1}(m+1; \delta) - E_t v_{t+1}(m+1; \tilde{\kappa}_{t+1}^{+}(m+1; \tilde{\beta}, \delta), \delta). \tag{32}$$

It states that the commitment problem reduces the expected value by a smaller degree among individuals who are closer to reaching the time limit. While the sign and size of the inequality depend on a number of factors such as the state variable, it is worth noting that if the inequality holds, nonnaivety will *reduce* the effect of the time limit on welfare participation. In this case, nonnaivety creates an incentive to receive welfare now because this will alleviate the commitment problem by making the next-period self one period closer to reaching (and more constrained by) the time limit. Therefore, the incentive is analogous to choosing a commitment device. The option value will then be smallest among nonnaive present-biased individuals, larger among naive present-

[27]For a sophisticated present-biased individual (i.e., $\tilde{\beta} = \beta$), the present-bias factor and discount factor can be simultaneously determined from equations (29) and (30) only.

biased individuals, and largest among time-consistent individuals:

$$\begin{aligned}
&\beta\delta[E_t v_{t+1}(m;\tilde{\kappa}^+_{t+1}(m;\tilde{\beta},\delta),\delta) - E_t v_{t+1}(m+1;\tilde{\kappa}^+_{t+1}(m+1;\tilde{\beta},\delta),\delta)] \\
&\leq \beta\delta[E_t v_{t+1}(m;\tilde{\kappa}^+_{t+1}(m;1,\delta),\delta) - E_t v_{t+1}(m+1;\tilde{\kappa}^+_{t+1}(m+1;1,\delta),\delta)] \\
&= \beta\delta[E_t V_{t+1}(m;\delta) - E_t V_{t+1}(m+1;\delta)] \\
&\leq \delta[E_t V_{t+1}(m;\delta) - E_t V_{t+1}(m+1;\delta)]. \qquad (33)
\end{aligned}$$

This result is consistent with O'Donoghue and Rabin (1999b), who show that sophistication can exacerbate preproperation (i.e., do too soon) in immediate-reward activities.[28] In their terminology, the first and last inequality in (33) captures the *sophistication effect* and *present-bias effect*, respectively.[29]

4.1.2 Commitment to Work

In the above discussion, the time limit creates a commitment problem in which the present-biased individual underrates the option value of retaining eligible periods of welfare use. In the general setting, the time limit also influences the *preexisting* work commitment problem in which the individual underrates the benefit of work experience accumulation. The main implications are summarized below, and the reader can refer to the Appendix for a more formal analysis.[30]

When the work commitment problem is present, the time limit generates two extra effects that work against each other in determining the employment and welfare participation rates among nonnaive present-biased individuals. On the one hand, the imposition of a time limit alleviates the work commitment problem, which creates an incentive to work now (Fang and Silverman (2004)). On the other hand, the individual has an incentive to receive welfare now, as this will alleviate the work commitment problem next period by making the next-period self more constrained by the time limit. The competing effects reconcile with seemingly surprising results in Fang and Silverman (2004), who find that the imposition of a time limit will trigger some sophisticated individuals who were working in the absence of time limits to take welfare under a time limit. If

[28] O'Donoghue and Rabin (1999b) consider a model in which the individual does an activity exactly once. Our model is analogous to theirs when $m = \bar{M} - 1$, that is, the individual has one remaining eligible period of welfare use under the time limit. Then, our result is identical to theirs because inequality (32) holds due to the right hand side being zero.

[29] O'Donoghue and Rabin (1999a) and Fang and Silverman (2004) decompose the sophistication effect into *incentive effect* and *pessimism effect*, which work in opposing directions. In fact, both are captured by inequality (32), whose sign determines which effect dominates.

[30] Fang and Silverman (2004) discuss the various implications of the work commitment problem and its relationship with the time limit. The option value is not discussed, partly due to the absence of uncertainty in their model.

a present-biased individual is nonnaive, the presence of both extra effects will disproportionately increase the attractiveness of being a working welfare recipient, and reduce the attractiveness of being idle (i.e., no work and no welfare). In particular, under a time limit, she will experience a smaller reduction (or even an increase) in the probability of being a working welfare recipient, and a smaller increase (or a larger reduction) in the probability of being idle. Therefore, data on both choices can provide useful additional information on the magnitude of naivety and other time preference parameters.

5 Data

The data set used for estimation is drawn from the public-use data file provided by Manpower Demonstration Research Corporation (MDRC). The file contains information on individuals who were randomly assigned to the control or treatment group between May 1994 and February 1995. It includes individuals' demographic characteristics at the time of random assignment, and administrative records on welfare participation (by month) and earnings (by calendar quarter). Both welfare and earnings data are realigned as quarterly variables that are defined with respect to the month of random assignment.[31] The analysis sample is restricted to female heads of family who are under 30 years of age, whose youngest child is under 12 years of age, and whose characteristics would make them subject to the default time limit if they were assigned to the treatment group.[32] The panel data set is formed by taking the first eight quarters of data following random assignment, with the first quarter defined as the quarter in which random assignment occurred. The analysis sample contains 202 control group members and 185 treatment group members, with a total of 387 individuals and 3096 observations.

Summary statistics of the analysis sample are reported in Table I. The control and treatment groups are similar in demographic characteristics and pre-random-assignment behavior. During the first two years following random assignment, the employment rate is around 5 percentage points higher in the treatment group, and the welfare participation rate is lower by around 5

[31] Data on welfare participation is aggregated to the quarterly level as follows. Let x_t be the cumulative months on welfare from the month of random assignment to the last month of quarter t. The recoded welfare participation variable in quarter t equals $int(x_t/3) - int(x_{t-1}/3)$, where $int(x_t)$ is the largest integer smaller than or equal to x_t.

[32] Individuals in the treatment group were "assigned a 24-month limit unless they (1) had received AFDC for at least 36 of the 60 months prior to enrollment; or (2) were under age 24 and had no high school diploma and little or no recent work history."(Farrell et al. (2008)). The assignment criteria are well documented by several variables in the public-use file. Around 55 percent of the treatment group members were subject to the 24-month time limit. Individuals who never received welfare during the first eight quarters were excluded, as they had little or no contact with the welfare program (Bloom and et al. (2000)). A small number of individuals with missing demographic information and extreme measures of long-term welfare exposure were excluded from the sample.

percentage points. What is more interesting is the differences in the breakdown of workers and welfare participants. For instance, in the treatment group, the majority of welfare recipients are employed. Relative to the control group, the proportion of working welfare recipients is higher by 3 percentage points, while the proportion of nonworking welfare recipients is lower by 8 percentage points. Workers in the treatment group receive higher earnings than workers in the control group. Between year 1 and year 2, the employment rate in the treatment group increases by 3 percentage points, and the employment rate in the control group decreases slightly. The small changes in the employment rate are due to a considerable reduction in the proportion of working welfare recipients, which offset the increase in the proportion of workers who do not receive welfare. Both groups experience a sharp decline in welfare participation during the sample period. The decline is larger in the treatment group, which is due to a larger decline in the proportion of nonworking welfare recipients. Earnings in both groups increase substantially during the sample period.

Table II reports the one-period transition rates of choice outcomes in the sample. In both the control and treatment groups, observations are categorized by the choice made in the previous period. Then, for each category, the distribution of the choice outcomes made in the current period is reported. The results indicate that the treatment group exhibits stronger persistence in employment and weaker persistence in welfare participation than the control group. For instance, among individuals who worked last period, the employment rate this period is around 90 percent in the treatment group, which is around 5 percentage points higher than the control group. The differences in transition rates are particularly large among individuals who were welfare recipients last period. Relative to the control group, a treatment group individual who was a *nonworking* welfare recipient last period is much less likely to stay in the same state, and she is more likely to become idle (i.e., no work and no welfare) this period. By contrast, if she was a *working* welfare recipient last period, she will be more likely to stay in the same state, and less likely to become a nonworking welfare recipient this period.

Table III reports the distribution of choice outcomes by different levels of cumulative periods (i.e., quarters) of welfare use since random assignment. In both the control and treatment groups, observations are classified into three categories of cumulative welfare use: 0 or 1 period; 2 or 3 periods; 4 or more periods. Although individual characteristics may differ across categories, in each category the behavioral difference between the control and treatment groups can provide evidence for the effects of FTP, in particular the time limit. Among individuals who have received at most one period of welfare since random assignment, the choice distribution is similar by treatment status. However, the difference widens among individuals with more cumulative periods of welfare use. For instance, among individuals who have received at least four periods of welfare since random assignment, the employment and welfare participation rates in the control group are 45.4 and 60.1 percent, respectively, and the corresponding rates in the treatment group are 65.7 and 48.7 percent, respectively. The lower welfare participation rate in the treatment group is a result of two changes in opposite directions. Relative to the control group, treatment group members who are close to reaching the time limit are much less likely to be a nonworking welfare recipient, but are more likely to be a working welfare recipient.[33]

6 Results

6.1 Interpretation of Estimates from the Baseline Model

Table IV reports parameter estimates of the baseline model. A base group individual is defined as a type-1 mother who is white, has one child, has less than grade 12 education, and is in the control group. The first two preference equations (ϕ_H and ϕ_A) suggest that individuals generally have a strong distaste for work and a weaker distaste for welfare. For instance, a base group individual has a distaste for work of 1043 dollars, while her distaste for welfare is only 356 dollars.[34] Relative to the base group, the distaste for welfare is larger among individuals who have more than one child, and slightly larger among individuals who are nonwhite. The third preference equation (ϕ_{HA}) suggests that distastes for work and welfare are largely additive in the base group. However, among individuals with more than one child, the distastes are not additive, as they have a disproportionate taste for being a working welfare recipient. There is substantial state dependence in preferences. The distaste for work becomes smaller by 382 dollars if the individual worked last period, and the distaste for welfare becomes smaller by 348 dollars if she was on welfare last period. State dependence in work and welfare preferences are roughly additive, as indicated by the small interaction coefficient between lagged work and welfare status.

The log wage equation suggests that the wage will be lower by 12 percent and higher by 34 percent if the individual is nonwhite and has an education of at least grade 12, respectively.

[33]As a robustness check, summary statistics on welfare use in Table III are constructed using monthly data. Although data on employment is not available at the monthly level, the fraction of working welfare recipients can be imputed from monthly data on the amount of welfare benefit received. The results are qualitatively similar to Table III. In particular, relative to the control group, treatment group members indeed become more likely to be a working welfare recipient when they are close to reaching the time limit.

[34]Zero income is used as the reference point in all discussions of utility where dollar amounts are used.

Lagged employment has a strong positive effect on current wage, while lagged welfare use has a modest negative effect on current wage. For individuals with less than grade 12 education, the wage increases by 11 percent for every half-year increase in cumulative employment since random assignment. The wage growth is 4 percent among individuals with more education.[35]

The model contains a treatment status indicator in all preference equations and the wage equation. Since earnings disregards and the time limit are modeled in the budget constraints, the dummy variable serves to capture the remainder effects of FTP (i.e., enhanced service). The estimates suggest that enhanced service increases the wage by 13 percent and the distaste for work by 68 dollars. This implies that individuals tend to receive better wage offers, but they also become more selective in accepting wage offers. The distaste for welfare becomes lower, but the effect is statistically insignificant.

A base group individual has an annualized discount factor of 0.965, a present-bias factor of 0.854, and a naivety factor of 0.574. While the point estimates imply that these individuals are present-biased and not naive, the standard errors of the present-bias factor and naivety factor are noticeably larger than the standard error of the discount factor. Nevertheless, for the base group, the Wald test rejects the null hypothesis of total naivety (i.e., the naivety factor equals one) at the 10 percent significance level. The time preference parameters differ by observable characteristics, with some coefficients being statistically significant at a level close to 10 percent. For instance, relative to the base group, individuals with more than one child tend to exhibit time-consistent preference. The present-bias and naivety factors are close to one, and the annualized discount factor is slightly lower at 0.906.[36]

Around 30 percent of the individuals belong to each of type-1 and type-2, and the remaining 40 percent belong to type-3. Type-2 individuals receive better wage offers than type-1 individuals, but they have a larger distaste for work. They are more present-biased than type-1 individuals. Type-3 individuals receive worse wage offers than type-1 individuals. However, they have a smaller distaste for work, and have a disproportionate taste for being a working welfare recipient. Type-3 individuals tend to exhibit time-consistent preference.

[35] In our time-consistent model, the difference in wage growth by education is statistically insignificant (see Appendix Table AII). Thus, the evidence is not conclusive. Recent studies such as Blundell et al. (2013) find a higher return to labor market experience among women with more than basic formal education. It is worth noting that our sample period starts from the time of random assignment instead of the start of the life cycle. Moreover, the macroeconomic expansion during the sample period was accompanied by strong earnings growth among low-education individuals.

[36] The time preference parameters are estimated with a logistic function specification. The time preference coefficients reported in Table IV are obtained by transformations of the logistic function, and the standard errors are obtained by the delta method. Therefore, the non-intercept coefficients can only be interpreted as differences from the base group. They are nonadditive by nature.

The log likelihood of the baseline model is -4418.117. For comparison, two nested models are estimated. The first model assumes that all individuals are sophisticated, that is, $\tilde{\beta}_i = \beta_i$ for all i. This model has 53 parameters, and the log likelihood is -4424.109. The second model assumes that all individuals have time-consistent preference, that is, $\tilde{\beta}_i = \beta_i = 1$ for all i. The model has 47 parameters, and the log likelihood is -4426.993.[37] As can be seen above, the likelihood worsens by a larger degree when the sophistication assumption is imposed. In fact, the likelihood-ratio test rejects the null hypothesis of sophisticated agents at the 10 percent significance level.[38] In the likelihood-ratio test that compares the baseline model with the time-consistent model, the null hypothesis of time-consistency is rejected at a significance level close to 10 percent.[39]

Table V reports the one-period transition rates predicted by the baseline model. The model is able to capture the differences in sample transition rates between the control and treatment groups, but the magnitudes are generally smaller. For instance, the model correctly predicts that the treatment group exhibits stronger persistence in employment and weaker persistence in welfare participation than the control group. Among individuals who were welfare recipients last period, there is a notable difference in predicted transition rates by treatment status, and the signs of the predicted differences are consistent with the data. On the other hand, the model has a tendency to underpredict the persistence of certain states. The persistence of being idle (i.e., no work and no welfare) is underpredicted in both groups.

Table VI reports the predicted choice outcomes by different levels of cumulative periods of welfare use since random assignment. The predictions are consistent with the main patterns observed in the data. For instance, behavior is similar by treatment status among individuals who have had few periods of welfare use. Relative to the control group, treatment group members who are close to reaching the time limit have a higher tendency to be employed and a lower tendency to receive welfare. In addition, they are less likely to be a nonworking welfare recipient and more likely to be a working welfare recipient.

By applying the estimated coefficients to equation (16), the time preference parameters for each individual can be computed. Table VII reports the predicted distribution of the time preference

[37] Estimates from both models are available upon request. Note that both models allow individuals to have heterogeneous discount factors.

[38] The chi-squared statistic is $2 \times (4424.109 - 4418.117) = 11.984$. The p-value is 0.062 at six degrees of freedom.

[39] The chi-squared statistic is $2 \times (4426.9 - 4418.117) = 17.752$, yielding a p-value of 0.123 at 12 degrees of freedom. However, the effective degree of freedom can be lower than 12. Certain subgroups have present-bias and naivety factors that are very close to one. The corresponding coefficients in the baseline model can be set as given so that the degree of freedom is lower than 12, with the likelihood being almost identical. For instance, at 10 degrees of freedom, the same chi-squared statistic will yield a p-value of 0.059.

parameters in the sample.[40] Around three-fourths of the sample have present-bias and naivety factors that are both larger than 0.9. Since the present-bias is small, we regard these individuals as roughly time-consistent. Among these individuals, the discount factor is quite heterogeneous, with roughly half of them having an annualized discount factor that is lower than 0.8. Among one-fourth of the sample who are regarded as present-biased (i.e., $\beta_i \leq 0.9$), only one-third of them have a present-bias factor that is lower than 0.8. In addition, all present-biased individuals have an annualized discount factor that is higher than 0.8. In general, a small present-bias factor tends to be accompanied by a small naivety factor. This suggests that most present-biased individuals exhibit a considerable degree of sophistication.

The above results share some similarities with Mahajan and Tarozzi (2011), who estimate the fractions of time-consistent, naive present-biased, and sophisticated present-biased agents in their sample. They find that around 10 percent of the individuals are sophisticated (with a present-bias factor of 0.55), half are naive (with a present-bias factor of 0.97), and 40 percent are time-consistent (with a discount factor of 0.79).[41] Since the present-bias of naive agents is very small, most individuals in their sample can be regarded as roughly time-consistent. Fang and Wang (2013) estimate not only the discount factor and present-bias factor but also the naivety factor. They find that individuals are considerably present-biased (with a present-bias factor of 0.70) and are totally naive.[42] In a structural model with time-consistent agents, Ferrall (2012) exploits particular policy features in the Self-Sufficiency Project (SSP) to estimate the discount factor. He finds substantial heterogeneity in the discount factor.[43] In Fang and Silverman (2009), the baseline model with sophisticated present-biased agents yields estimates of the present-bias factor and discount factor at 0.34 and 0.88, respectively. They noted that the estimate of the present-bias factor is lower than some of the existing estimates in the literature. They also estimate a model with naive present-biased agents, which produces similar estimation and simulation results.

[40] The predictions are based on 20 type simulations per individual in the sample. There are a number of categories with zero frequency. This can be resolved by, for instance, including interaction terms in the estimation of equation (16).

[41] The discount factor is assumed to be identical across all three types of agents, and the naivety factor is not estimated. In total, five time preference parameters are estimated, including two parameters that involve type proportions. The point estimate of the discount factor should be taken with caution, as it is associated with a very wide confidence interval.

[42] The time preference parameters are assumed to be identical across all individuals. The estimated discount factor and naivety factor are 0.71 and 1.00, respectively.

[43] There are four types of individuals, and each type of individual has a specific mixture proportion in geographical location and family size. The discount factor is different by type. It can be verified that 37 percent of the sample are of type 1, 18 percent are of type 2, 37 percent are of type 3, and 8 percent are of type 4. Therefore, around 37 percent of the sample have an annualized discount factor of close to one, 18 percent have a discount factor of 0.44, and the rest are almost myopic.

6.2 Modifying Time Preference Parameters

Table VIII reports counterfactuals that involve changing the hyperbolic discounting parameters of control group members who are regarded as present-biased (i.e., $\beta_i \leq 0.9$). As discussed above, these individuals constitute around one-fourth of the sample. In each scenario, simulation is conducted over the full time horizon under the control group policy environment.[44] Column 1 represents the baseline scenario, in which the estimates of the time preference parameters are applied. In column 2, individuals are assumed to be totally naive (i.e., $\tilde{\beta}_i = 1$). In column 3, individuals are assumed to be sophisticated, that is, for each individual, the naivety factor is set to be the same as the estimate of the present-bias factor (i.e., $\tilde{\beta}_i = \beta_i$). In column 4, individuals are assumed to be time-consistent (i.e., $\tilde{\beta}_i = \beta_i = 1$).

In the baseline scenario, the average employment and welfare participation rates are 71 and 31 percent, respectively. A sizable proportion of welfare recipients works. These individuals constitute around 40 percent of all welfare recipients, or 12 percent of the whole subsample. Net present values (NPV) of discounted streams of earnings, net government expenditure, and utility over the time horizon are computed. Net government expenditure is defined as the sum of welfare and EITC benefits, minus tax. The NPVs are computed using the long-run criterion (e.g., O'Donoghue and Rabin (1999b), Fang and Silverman (2009)), which discounts all future flows using the standard discount factor only. The NPV is therefore based on the perspective of a fictitious time-consistent self just prior to the decision-making sequence from period 1.[45] All NPVs are normalized as amortizing payments (AP) per decision period, which are used in all subsequent discussions.[46] In the baseline scenario, the average (amortizing payment of) earnings for the time horizon is 1063 dollars. The average net government expenditure is -66.8 dollars, implying that individuals pay more taxes than receiving benefits. The average "long-run" utility is 252 units.[47]

Results in columns 2 and 3 indicate that the size of the naivety factor has important implications on behavior, government budget, and the long-run utility of individuals. When individuals are totally naive (column 2), they work much less frequently and are more dependent on welfare. The

[44] The time horizon consists of 54 periods. Twenty paths are simulated for each individual.

[45] An alternative criterion is called the Pareto criterion (e.g., Goldman (1979)), which requires that all period selves to be better off. O'Donoghue and Rabin (1999b) remark that this criterion is often too restrictive for policy analysis.

[46] The amortizing payment of the NPV of a stream of flows from period 1 to period t (denoted by NPV_{it}) is computed according to the formula $A_{it} = NPV_{it}\frac{r_i(1+r_i)^t}{(1+r_i)^t-1}$, where $r_i = 1 - \delta_i$ is individual i's discount rate per decision period. For more details, see Chan (2013). The amortizing payment is roughly invariant of the level of the discount rate, as NPV_{it} and $\frac{r_i(1+r_i)^t}{(1+r_i)^t-1}$ tend to offset each other as the discount rate changes. As a robustness check, we also compute the amortizing payments using a uniform discount rate. The results, in particular the effects of the counterfactuals, are similar.

[47] This represents an equivalent of 252 dollars at a reference point of zero income.

average employment and welfare participation rates are 56 and 41 percent, respectively, and only 25 percent of the welfare recipients are working. In addition, naivety aggravates the "poverty trap" by reducing income further even though more government benefits are given. Relative to the baseline, earnings are lower by 268 dollars (at 795 dollars), and net government expenditure is higher by 65 dollars (at -1.3 dollars). As a result, income is lower by 200 dollars, which represent a 20-percent reduction from the baseline. From a time-consistent perspective, the individual is also worse off, with a reduction in long-run utility by 25 units (at 227 units). Being unaware of her present-bias in the future, the naive individual is overly optimistic about her ability of self-control. That leads to higher dependence on welfare, as well as lower income and long-run utility.

When individuals are assumed to be sophisticated (column 3), the outcomes change in the same direction as the case of total naivety, but at a much smaller magnitude. There is a decrease in employment and an increase in welfare use. Interestingly, despite the sophistication, the long-run utility becomes lower at 241 units. The above results suggest that being sophisticated, or having no perception error in the present-bias factor, does not necessarily minimize the negative impact of the commitment problem. From a time-consistent perspective, it is possible that the individual may be better off by slightly overestimating the present-bias of her future selves.[48]

Individuals have no commitment problem when they are time-consistent (column 4). The employment and welfare participation rates become 84 and 28 percent, respectively. Time-consistency results in an improvement in work incentive among welfare recipients. The relatively small reduction in welfare use is due to the large increase in the number of working welfare recipients, who now constitute 16.3 percent of the whole subsample. Relative to the baseline, earnings are higher by 210 dollars (at 1272.7 dollars), and net government expenditure is lower by 46 dollars (at -112.7 dollars). The poverty trap becomes less severe, with income being higher by 164 dollars. The improvement in long-run utility is 18 units, which is relatively modest when compared to the increase in income. The small change in long-run utility relative to other outcomes is consistent with the finding of Fang and Silverman (2009).

To examine how time-inconsistency affects behavior dynamically, Table VIII also reports outcomes in three different periods: period 1, end of year 2, and end of year 5. Relative to later periods, the outcomes in period 1 are similar across scenarios. In period 1, the employment rate ranges from

[48] In the baseline model, the naivety factor can lie between zero and one. Therefore, sophisticated individuals in column 3 can be more "naive" than individuals in the baseline scenario. Due to the parametric restriction on the naivety factor, the model with sophisticated agents must have a lower likelihood than the baseline model. However, it does not necessarily imply that the long-run utility must also be lower.

44 percent in the naive case to 60 percent in the time-consistent case. In all scenarios, the initial welfare participation rate is around 50 percent, and earnings and net government expenditure are around 400 and 110 dollars, respectively. Although the welfare participation rates are very similar, in the time-consistent scenario the fraction of working welfare recipients is substantially higher, which leads to lower welfare benefits. However, this is largely offset by a larger amount of EITC benefits, so the net government expenditure is almost identical to other scenarios.[49] In addition, in the time-consistent scenario, the initial long-run utility is much lower due to a stronger incentive to invest in human capital in early periods.

As time progresses, the outcomes become diverge substantially across scenarios. Time-inconsistency weakens the incentive to invest in human capital, which results in lower earnings growth over time. In particular, naive individuals fail to escape from the trajectory of low earnings, low income, and high government benefits. For instance, during the first five years, earnings and income are 558.6 and 624.3 dollars, respectively, and net government expenditure remains relatively large at 65.7 dollars. In other scenarios, there is a considerable increase in employment, earnings, and income over time, as well as a substantial reduction in net government expenditure. For instance, during the first five years in the baseline scenario, earnings is 829 dollars, and the net government expenditure is almost zero. The latter result implies that the cumulative tax payment has become roughly equal to the cumulative receipt of government benefits by the end of year 5. Despite the large reduction in net government expenditure, income has increased by around 300 dollars to 831.8 dollars.

6.3 Expansion of Welfare and EITC

Table IX reports the outcomes of control group members when welfare and EITC programs are expanded at various scales. Results are reported separately for present-biased and time-consistent individuals in the control group.[50] The following counterfactual policies are analyzed: increase the maximum welfare benefit level by 10, 20, and 50 percent, respectively (columns 2 to 4); increase the EITC phase-in rate and maximum benefit level by 20, 50, and 100 percent, respectively (columns 5 to 7).[51]

[49] Welfare benefits are lower because working welfare recipients usually receive partial welfare benefits only. In addition, working welfare recipients hold low-paying jobs because otherwise their income will be too high to be eligible for welfare. These jobs tend to be accompanied by large EITC benefits.

[50] As discussed earlier, an individual is regarded as present-biased if her present-bias factor is lower than 0.9. These individuals constitute around one-fourth of the control group sample. The rest are regarded as time-consistent.

[51] Results from a subgroup analysis by income level are provided in the Appendix.

Results for present-biased individuals are reported in Panel A of the table. The expansion of welfare has a detrimental effect on employment, earnings, and income among present-biased individuals. For instance, when the maximum welfare benefit level is increased by 50 percent (column 4), the employment rate drops from 71.3 percent to 26.1 percent, the welfare participation rate increases from 31 percent to 67.3 percent, and earnings drop from 1063 dollars to 456.6 dollars. Although net government expenditure increases from -66.8 dollars to 119.7 dollars, the increase is too small to offset the huge reduction in earnings. As a result, income reduces from 996.1 dollars to 576.4 dollars. This implies that for each extra dollar of government expenditure, income drops by 2.25 dollars. Therefore, the poverty trap becomes more severe, that is, a more generous welfare program leads to increased poverty. Furthermore, despite the increased generosity of the welfare program, the individual is worse off from a time-consistent perspective; long-run utility decreases from 252 units to 231.4 units due to a deterioration of the commitment problem. Interestingly, a similar reduction in long-run utility is attained when individuals are assumed to be totally naive (Table VIII, column 2). However, under total naivety, individuals have better employment-related outcomes.

An EITC expansion improves employment-related outcomes substantially among present-biased individuals. For instance, when the EITC phase-in rate and maximum benefit level are doubled (column 7), the employment rate increases to 83.4 percent, the welfare participation rate decreases to 22.9 percent, and earnings increase to 1224.1 dollars. Surprisingly, the EITC expansion causes net government expenditure to *reduce* by 26 dollars to -93 dollars. Due to the induced earnings growth, the increase in EITC benefits is more than offset by a reduction in welfare benefits and an increase in tax revenue in later periods. Income increases by around 135 dollars to 1131.1 dollars, and long-run utility increases to 267.6 units. It is less straightforward to assess to what extent the EITC expansion alleviates the commitment problem. The increase in long-run utility could be a result of an increase in the generosity of EITC. However, there are two pieces of supportive evidence. First, similar effects are attained when individuals are assumed to be time-consistent (Table VIII, column 4). Second, the reduction in net government expenditure is indicative of strong earnings growth, which is likely a result of improved commitment. As shown below, there is no such reversal in government expenditure among time-consistent individuals.

Results for time-consistent individuals are reported in Panel B of the table. In the baseline, the employment and welfare participation rates are similar to those of present-biased individuals; however, more individuals are idle or are working welfare recipients, and earnings and income are lower. The expansion of welfare results in much smaller changes in outcomes among time-consistent individuals. For instance, when the maximum welfare benefit level is increased by 50 percent (column 4), the employment rate drops from 66.1 percent to 42.7 percent, the welfare participation rate increases from 29.5 percent to 58.0 percent, and earnings drop from 458.4 dollars to 259.0 dollars. Net government expenditure increases from 53.8 dollars to 190.2 dollars, and income drops from 512.2 dollars to 449.2 dollars. This implies that for each extra dollar of government expenditure, income merely drops by 0.46 dollars. Since these individuals are time-consistent, it is not surprising that they are better off; long-run utility increases from 105.5 units to 124.1 units. The effects of an EITC expansion also tend to be smaller among time-consistent individuals. In particular, the EITC expansion results in an increase in net government expenditure among time-consistent individuals. In other words, the reduction in welfare benefits and increase in tax revenue are not enough to offset the increase in EITC expenditure.

In summary, when time-inconsistency is present, there are several extra features that make an EITC expansion a more favorable policy option than a welfare expansion. While a welfare expansion is detrimental to employment-related outcomes, an EITC expansion is effective in alleviating the commitment problem among present-biased individuals. The induced strong earnings growth provides a basis for cross-subsidization between EITC and other programs – the increase of EITC expenditure in earlier periods is offset by an increase of tax revenue, as well as a reduction of welfare benefits, in later periods. In a broader perspective, due to stronger behavioral responses among present-biased individuals, an EITC expansion can be revenue neutral as a result of cross-subsidization between present-biased and time-consistent individuals. For instance, when the EITC phase-in rate and maximum benefit level are doubled (Table IX, column 7), net government expenditure reduces by 26.2 dollars among present-biased individuals, but it increases by 8.1 dollars among time-consistent individuals. Since present-biased individuals constitute around one-fourth of the sample, the overall change in net government expenditure is close to zero.[52]

6.4 Prowork Time Limits

Table X reports the outcomes of control group members when different time limits are implemented. Results are reported separately for present-biased and time-consistent individuals. Column 1 represents the baseline scenario (i.e., no time limits). In columns 2 to 4, three different lengths of the

[52] The overall change in net government expenditure is $-26.2 \times 0.25 + 8.1 \times (1-0.25) = -0.475$ dollars.

lifetime limit are implemented (4-year, 2-year, and 1-year, respectively).[53] These counterfactual scenarios are similar to Fang and Silverman (2009).

Under the standard type of time limit, any participation of welfare, regardless of the benefit amount received, counts as one period toward the time limit. This has the effect of discouraging both workers and nonworkers from receiving welfare. However, a main goal of welfare reform is to help welfare recipients achieve self-subsistence via work. The standard time limit contradicts with the above goal by discouraging welfare recipients from working. As a variant of the standard time limit, a "prowork time limit" is proposed and analyzed. Under a prowork time limit, welfare participation does not count toward the time limit if the welfare recipient is working. The intertemporal budget constraint in equation (9) becomes:[54]

$$M_{ik,t+1} = M_{it} + d_{ait}(1 - d_{hit}), \qquad \text{and} \quad M_{i1} = 0. \tag{34}$$

Once the prowork time limit is reached, the individual becomes ineligible for welfare for the rest of the time horizon. In columns 5 to 7 of Table X, three different lengths of the prowork time limit are implemented (4-year, 2-year, and 1-year, respectively).

Panel A of the table reports outcomes for present-biased individuals. Both the standard and prowork time limits improve employment, earnings, and income by a similar degree. Although the prowork limit results in a smaller reduction in the welfare participation rate, many individuals remain as working welfare recipients. Since working welfare recipients accumulate human capital and they often receive partial welfare benefits, the prowork time limit has a similar effect on net government expenditure as the standard time limit. A main advantage of the prowork time limit is that it has minimal effects on long-run utility even when a very short limit is imposed. For instance, under a 1-year prowork time limit, the long-run utility drops by 2.3 units only; by contrast, a standard time limit of the same length reduces long-run utility by 12 units.

Our analysis confirms the finding of Fang and Silverman (2009) that the standard time limit is not strong enough as a commitment device to increase long-run utility. Note that their model does not allow welfare recipients to work, which is a main feature in prowork time limits. As part

[53] Under a lifetime limit, the individual is ineligible for welfare for the rest of the time horizon after she reaches the limit.

[54] More generally, a period of welfare participation that involve working can be counted as a *fraction* of a period toward the time limit. For instance, the fraction can be the actual welfare benefit received divided by the maximum benefit amount. Usually the fraction is considerably lower than one because working welfare recipients often receive partial welfare benefits. In this general case, the prowork time limit is analogous to a "welfare account," in which an individual is eligible for fixed *dollar* sum of welfare benefits throughout the time horizon. See Laroque (2009) for a discussion of history-dependent tax and benefit schemes.

of a further investigation, we compute the fraction of present-biased individuals who strictly prefer a time limit to no time limits just prior to the decision-making sequence from period 1.[55] Unlike time-consistent individuals, a present-biased individual may choose to adopt a time limit if she thinks that the policy can sufficiently alleviate the commitment problem. Somewhat surprisingly, almost half of the present-biased individuals prefer a 4-year standard time limit to no time limits. However, no individuals choose to adopt a shorter standard time limit. By contrast, still one-fourth of the present-biased individuals prefer a 1-year prowork time limit to no time limits. By not penalizing working welfare recipients, prowork time limits are more popular as a commitment device.

Panel B of the table reports outcomes for time-consistent individuals. There are some differences when compared to the case of present-biased individuals. First, the policy effects are much less dramatic. Second, the standard time limit results in a slight *reduction* in the employment rate. Instead of becoming employed, many individuals have become idle. By contrast, the prowork time limit is still effective in improving employment. Third, a shorter prowork time limit results in a larger reduction in long-run utility, as expected, since there is no commitment problem among these individuals.

6.5 Dynamic Work Subsidy

From a long-run, time-consistent perspective, a present-biased individual fails to allocate resources efficiently between time periods. In particular, she tends to underestimate the future value of human capital accumulation, which leads to low employment.[56] A natural policy that can specifically target toward this issue would, for instance, involve a *relative* increase in the expected future value of working versus the expected future value of not working. Note that traditional policy instruments such as EITC primarily affects decisions by changing the static budget constraint. These policies involve a relative increase in the current utility of working versus not working, but they do not necessarily involve a relative increase in the expected future value of working versus not working.

An easy point of departure would be to consider several fixed work subsidies, which are defined as follows. An *static* fixed work subsidy is defined as a policy that provides a fixed amount of

[55] The comparison is based on continuation long-run utilities in period 1. The individual will prefer to be subject to the time limit throughout the time horizon if its continuation long-run utility is larger than when there are no time limits.

[56] As discussed previously and in the Appendix, there are two effects: present-bias effect and sophistication effect. When both effects work in opposite directions, the former usually dominates; indeed, in all the scenarios investigated by Fang and Silverman (2004), employment never decreases when a time-consistent individual becomes present-biased (naive or sophisticated).

benefit if the individual works. The benefit formula is given by $b_H d_{hit}$, where b_H is a constant that represents the subsidy amount, and d_{hit} is an indicator variable of employment in period t.[57] Similar to EITC, the subsidy increases the relative current utility of working versus not working. By contrast, the following two types of *dynamic* fixed work subsidies affect incentives in a different manner:

1. A fixed work subsidy triggered by employment last period (type-1 subsidy): the benefit formula is given by $b_H d_{hit} d_{hi,t-1}$. The individual can only receive the subsidy if she works both in the current period and the last period. The subsidy amount is zero if she did not work last period.

2. A fixed work subsidy triggered by nonemployment last period (type-2 subsidy): the benefit formula is given by $b_H d_{hit}(1 - d_{hi,t-1})$. The individual can only receive the subsidy if she works in the current period and did not work in the last period. The subsidy amount is zero if she worked last period.

The properties of type-1, type-2, and static work subsidies are summarized in the upper part of Appendix Table AI. The type-1 subsidy generates a static work incentive among individuals who were employed last period. For these individuals, there is a relative increase in the current utility of working versus not working. However, if the individual was not employed last period, the static budget constraint remains unaffected. The subsidy also generates a dynamic work incentive for both types of individuals. If the individual works now, she may be able to receive the subsidy next period. If she does not work now, the subsidy will be unavailable to her next period. Therefore, the policy results in a relative increase in the expected future value of working versus not working. It can readily be shown that the type-1 subsidy increases state dependence in the preference for work.

The properties of a type-2 subsidy are a mirror image of the type-1 subsidy. The type-2 subsidy generates a static work incentive among individuals who were *not* employed last period. It also generates a dynamic work *disincentive* among all individuals. If an individual works now, the subsidy will be unavailable to her next period; therefore, the policy results in a relative decrease in the expected future value of working versus not working. The type-2 subsidy reduces state dependence in the preference for work.

Table XI reports the effects of fixed work subsidies on present-biased and time-consistent control group members in the sample. For each of the three types of subsidies, amounts of 25, 50, and 100 dollars are considered. A type-1 work subsidy (columns 2 to 4) improves employment-related out-

[57] The formula of the fixed work subsidy is simpler than the work subsidy proposed by Keane (1995). However, he does not consider dynamic work subsidies.

comes substantially for both present-biased and time-consistent individuals. For instance, among present-biased individuals, a 50-dollar type-1 subsidy (column 3) increases the employment rate from 71.3 percent to 82.8 percent, earnings from 1063 dollars to 1215.1 dollars, and income from 996.2 dollars to 1255.3 dollars. Long-run utility increases substantially from 252 units to 281.8 units. While the effects are similar to an EITC expansion, there are two important differences. First, the 50-dollar subsidy is only revenue neutral among present-biased individuals. The induced earnings growth is not strong enough to support a cross-subsidy from present-biased to time-consistent individuals.[58] Second, among time-consistent individuals, the increase in net government expenditure exceeds the increase in utility. Therefore, when there is no commitment problem, a type-1 work subsidy, which increases state dependence in the preference for work, is potentially distortionary.

The effects of the remaining two types of work subsidies are somewhat surprising. A type-2 work subsidy (columns 5 to 7) has almost no effects on employment, earnings, income, and long-run utility. This suggests that the dynamic work disincentive generated by the policy is as large as its static work incentive. A static work subsidy (columns 8 to 10) generates similar effects to a type-1 work subsidy. Although there is no clear dynamic work incentive, the work subsidy creates a static work incentive among all individuals and not just individuals who were employed last period.

6.6 Dynamic Nonwork Tax

The type-1 work subsidy has been shown to improve employment-related outcomes substantially. However, it is costly to the government, especially if individuals are time-consistent. The discussion of work subsidies forms a basis for the fixed "nonwork tax," which is proposed and analyzed below. Although a nonwork tax is formulated as a mirror image of a work subsidy, it can generate effects that are qualitatively different from a work subsidy.

A static fixed nonwork tax is a defined as a policy that charges a fixed amount of tax if the individual does not work.[59] The benefit formula is given by $-b_H(1 - d_{hit})$, where b_H is a positive constant. The nonwork tax increases the relative current utility of working by reducing the attractiveness of nonwork alternatives. Similar to work subsidies, two types of dynamic fixed nonwork taxes are defined:

1. A fixed nonwork tax triggered by employment last period (type-1 tax): the benefit formula

[58] Similar to an EITC expansion, the increase in work subsidy expenditure is offset by an increase in tax revenue and reduction in welfare benefits in later periods. In fact, a 25-dollar subsidy (column 2) can slightly reduce net government expenditure among present-biased individuals.

[59] In practice, it may not be straightforward to implement a pure nonwork tax. However, similar policies exist, e.g., a welfare sanction policy reduces a welfare recipient's benefits if she does not work.

is given by $-b_H(1-d_{hit})d_{hi,t-1}$. The individual will only be charged a tax if she worked last period and chooses not to work this period. The tax amount is zero if she did not work last period. For individuals who worked last period, the policy generates a static work incentive. The type-1 tax also creates a dynamic work *discincentive* among all individuals – if an individual chooses not working now, she can avoid the tax altogether next period. The type-1 tax reduces state dependence in the preference for work.

2. A fixed nonwork tax triggered by nonemployment last period (type-2 tax): the benefit formula is given by $-b_H(1-d_{hit})(1-d_{hi,t-1})$. The individual will only be charged a tax if she does not work both in the current period and the last period. The tax amount is zero if she worked last period. For individuals who did not work last period, the policy generates a static work incentive. The type-2 tax also creates a dynamic work incentive among all individuals – if an individual works now, she can avoid the tax altogether next period. The type-2 tax increases state dependence in the preference for work.

The properties of the above nonwork taxes are summarized in the lower part of Appendix Table AI. In terms of incentives generated, the dynamic nonwork taxes are mirror images of dynamic work subsidies. In particular, we should expect the effects of the type-1 nonwork tax to be similar to the type-2 work subsidy, and the effects of the type-2 nonwork tax to be similar to the type-1 work subsidy.

Table XII reports the effects of nonwork taxes on present-biased and time-consistent control group members in the sample. For each of the three types of nonwork tax, amounts of 50, 100, and 200 dollars are considered. Surprisingly, despite the dynamic work disincentive, the type-1 nonwork tax (columns 2 to 4) generates a substantial increase in employment, earnings, and income. For instance, among present-biased individuals, a 200-dollar nonwork tax (column 4) increases the employment rate from 71.3 percent to 86 percent, and earnings from 1063 dollars to 1270.4 dollars. The policy causes a large reduction in net government expenditure from -66.8 dollars to -120.5 dollars. Income increases from 996.2 dollars to 1149.9 dollars.

The most striking result is that the 200-dollar tax *increases* long-run utility from 252 units to 258.5 units among present-biased individuals. Moreover, a heavier nonwork tax results in a larger increase in long-run utility. Although the size of the increase is relatively small, this is accompanied by a large reduction in government expenditure. The above results suggest that the type-1 nonwork tax carries features of a commitment device that can alleviate the commitment problem. In each decision period of the baseline scenario, the next-period self is tempted to choose not to work because she is present-biased. Without a commitment device, the current self faces difficulty in committing her future selves to work, which results in suboptimal employment from a time-consistent perspective. Under a type-1 nonwork tax, the next-period self faces a higher cost of not working whenever the current self chooses to work. Therefore, the next-period self will be less tempted to choose not to work if the current self works. The policy generates a work incentive that counteracts the inability to commit. This, together with the static work incentive, outweigh the dynamic work disincentive generated by the policy. In fact, the effects of the 200-dollar nonwork tax are similar to assuming the individuals to be time-consistent (Table VIII, column 4).

The type-1 nonwork tax is less desirable as a policy option when there is no commitment problem. Among time-consistent individuals, the type-1 nonwork tax generates a much smaller effect on employment, earnings, income, and net government expenditure. The tax causes a reduction in utility.

The type-1 nonwork tax improves the long-run utility of present-biased individuals, but it makes time-consistent individuals worse off. Instead of implementing the tax universally, the government can offer individuals a choice of whether to enrol in a "tax plan" just prior to the decision-making sequence from period 1. If an individual enrols in the tax plan, she will face a tax schedule with a type-1 nonwork tax throughout the time horizon. Time-consistent individuals will never enrol because the new tax schedule will make them worse off. Those who enrol are present-biased individuals who value the nonwork tax as a strong commitment device.[60] By offering such a choice, the government can avoid implementing the tax on time-consistent individuals and making them worse off. An estimated 69.9 percent of present-biased individuals will choose to adopt the type-1 nonwork tax. Those who do not adopt are predominantly individuals who have small present-bias or are relatively naive. Interestingly, the enrolment rate does not depend on the amount of the nonwork tax.

As a whole, it is difficult to judge whether an EITC expansion or a type-1 nonwork tax plan is a more desirable policy option. The revenue neutrality of the EITC expansion depends on cross-subsidization between present-biased and time-consistent individuals. The enrolment of the tax plan depends on the degree of present-bias and naivety of individuals. Both policies have their drawbacks.

[60] The individual will choose to enrol if the continuation long-run utility under the new tax schedule is larger than the continuation long-run utility under the tax schedule without the nonwork tax. Note that naive present-biased individuals will never enrol because they are not aware of their commitment problem. Therefore, the enrolment rate depends on the naivety of individuals in the population.

The effects of a type-2 nonwork tax are reported in columns 5 to 7 of Table XII. Since the tax generates both a static and dynamic work incentive, it has strong positive effects on employment, earnings, and income among present-biased and time-consistent individuals. However, the type-2 nonwork tax fails to increase long-run utility among present-biased individuals. In particular, it is not popular as a commitment device – no present-biased individuals will enrol in the tax plan, if the type-2 nonwork tax is made available as a choice. Under a type-2 nonwork tax, the next-period self will face a higher cost of not working only when the current self does not work. In other words, the current self can commit the next-period self to work only when she does not work. This is clearly different from the commitment incentive under the type-1 nonwork tax.

The effects of a static nonwork tax are reported in columns 8 to 10 of Table XII. The policy generates an even stronger effect on employment, earnings, and income than both the type-1 and type-2 nonwork tax. Despite the increase in long-run utility among present-biased individuals, the static nonwork tax is less popular as a commitment device than the type-1 nonwork tax. For instance, although a 50-dollar static nonwork tax (column 8) has a similar effect on net government expenditure to a 200-dollar type-1 nonwork tax, only 19.9 percent of present-biased individuals will enrol in a related tax plan. Interestingly, unlike time limits, the enrolment rate is higher under a heavier tax. However, even with a 200-dollar static nonwork tax (column 10), the enrolment rate is only 45.7 percent, which is still lower than 69.9 percent under the 200-dollar type-1 nonwork tax.

6.7 Conditional Choice Probabilities and Commitment Device

In previous sections, it was shown that time limits and nonwork taxes can be appealing to present-biased individuals. In this section, we provide further evidence that these policies can create behavioral incentives that are qualitatively different between present-biased and time-consistent individuals.[61]

Table XIII reports the predicted conditional choice probabilities when a control group member is subject to the FTP time limit. The probabilities are computed separately for present-biased and time-consistent individuals. They are made conditional on cumulative periods of welfare use under the time limit, as well as the choice made in the previous period.[62] When an individual is closer to reaching the time limit, she tends to be more likely to work and less likely to be on welfare. However,

[61] Gustman and Steinmeier (2012) compare policy effects in exponential and hyperbolic discounting models of consumption and retirement. The time preference parameters are chosen such that the individual yields approximately the same level of assets at age 62. The results are mixed – while it is frequently difficult to distinguish behavior between both models, there are policy simulations in which the effects are non-trivially different.

[62] All other factors are kept fixed; for instance, other state variables are kept fixed as in wave 1.

among present-biased individuals, there is an *increase* in the probability of being a working welfare recipient, while the opposite is true among time-consistent individuals. This heavily influences the magnitude of change in employment and welfare participation probabilities between both types of individuals. For instance, consider an individual who was a working welfare recipient last period. If she is present-biased, the probability of being a working welfare recipient this period will be 35.6 percent if she has been on welfare for one period under the time limit (i.e., seven periods left), and 43.1 percent if she has been on welfare for seven cumulative periods under the time limit (i.e., one period left). For a time-consistent individual, the corresponding probabilities are 48.9 and 35.9 percent, respectively.

The above discrepancy is related to the commitment problem faced by present-biased individuals. The identification section discussed several commitment-related incentives that are generated by the time limit. The time limit creates a work incentive by alleviating the work commitment problem. There is also an incentive to receive welfare, as the next-period self will then be less tempted to choose not to work because she is one period closer to reaching the time limit.[63] Both incentives make it more attractive for the current self to combine work with welfare, and the effect is stronger when the individual is close to reaching the time limit. Among time-consistent individuals, there are no commitment-related incentives. Both workers and nonworkers are discouraged from using welfare, especially when they are close to reaching the time limit.

Table XIV reports the predicted conditional choice probabilities when a control group member is subject to a type-1 nonwork tax of 100 dollars. The probabilities are computed separately for present-biased and time-consistent individuals, and they are made conditional on the choice made in the previous period. For comparison, choice probabilities under the baseline scenario (i.e., no nonwork tax) are also reported. As discussed previously, under a type-1 nonwork tax, individuals who did not work last period are subject to a dynamic work disincentive, but their static budget constraint remains unaffected. Without commitment-related incentives, the policy should reduce the employment probability among these individuals. This is indeed the case for time-consistent individuals; for instance, if the individual was idle last period, the type-1 nonwork tax will reduce her current employment probability from 17.6 percent to 16.2 percent. The opposite is true for present-biased individuals; if the individual was idle last period, the nonwork tax will *increase*

[63] The incentive shares some similarities with the dynamic nonwork tax. By receiving welfare now, the "effective cost" of being a nonworker, in particular, a nonworking welfare recipient, will become higher next period. An extreme case is when there is only one period of eligibility left – if the individual receives welfare, the option of being a nonworking welfare recipient will become unavailable to her in the future.

her current employment probability from 26.4 percent to 29.4 percent. This suggests that the alleviation of the commitment problem plays a significant role in generating work incentives under the type-1 nonwork tax.

6.8 Sensitivity Analysis

6.8.1 Results from a Time-Consistent Model

In the baseline model, the discrepancy in policy effects between present-biased and time-consistent individuals could be due to differences in other dimensions. To examine this issue and to facilitate comparison with other existing structural models, a time-consistent model with a uniform discount factor is estimated.[64] The model estimates are reported in Appendix Table AII. The point estimate of the annualized discount factor is 0.941, with a standard deviation of 0.056. It is larger than estimates from a similar class of models (i.e., labor supply and welfare) that use survey data, for instance, Swann (2005) (0.81), Chan (2013) (0.84), and the time-consistent version of the model in Fang and Silverman (2009) (0.41).[65] Interestingly, the time-consistent model tends to overestimate state dependence in preferences; the addictive effects of the present-bias are subsumed into state dependence parameters. The estimates of state dependence in the preferences for work and welfare participation are 443 and 388 dollars, respectively. These are larger than the estimates in the baseline model by 13.4 and 11.5 percent, respectively.

Using the model estimates, behavior is simulated for the same groups of present-biased and time-consistent individuals who were previously defined in the *baseline* model. The simulation results will then reflect the bias in policy effects when time-inconsistency is assumed away *ex-ante*. The results are reported in Tables XV to XVII.

Tables XV and XVI report the predicted conditional choice probabilities of a control group member under the FTP time limit and type-1 nonwork tax, respectively. In Panel A of both tables, the choice probabilities are computed for individuals who are regarded as present-biased in the baseline model. Results in Panel B are for individuals who are regarded as time-consistent in the baseline model. Note that both groups are, by definition, time-consistent in the new model. As expected, when commitment incentives are absent, the pattern of choice probabilities in Panel A becomes qualitatively similar to Panel B. In particular, an individual in Panel A becomes less

[64] As a robustness check, we also look at a time-consistent model with heterogeneous discount factors. The results are qualitatively similar.

[65] The above studies use PSID, SIPP, and NLSY79 for estimation, respectively. Chan (2013) obtained the estimate from a simplified version of his baseline model. Other studies calibrate the discount factor (e.g., Keane and Wolpin (2010) (0.93)).

likely to be a working welfare recipient when she is close to reaching the time limit. The type-1 nonwork tax will cause a reduction in the current employment probability, if she did not work in the previous period.

Table XVII reports the effects of several policies on control group members who are regarded as present-biased in the baseline model. The results confirm the finding in previous sections that the commitment problem tends to magnify behavioral responses to various policies. A time-consistent model will therefore understate behavioral responses of present-biased individuals. For instance, the effects of increasing the maximum welfare benefit by 20 percent are roughly three-fourths of the effects predicted by the baseline model. The prowork policies result in a significantly smaller increase in employment, earnings, and income, as well as a smaller reduction (or a larger increase) in net government expenditure.

6.8.2 Estimation using Pre-Random-Assignment Data and Model Validation

The time preference parameters are identified by the difference in time limit policy between the control and treatment groups. As a robustness check and a "placebo," the time-consistent model is estimated using the last eight quarters of data prior to random assignment.[66] Since both the control and treatment groups face identical policies (i.e., AFDC) prior to random assignment, it will be difficult to estimate the discount factor if the exogenous policy variation is the primary source of identification. The full set of model estimates is reported in Appendix Table AIII. The coefficients of the treatment group indicator in the preference and wage equations are all statistically insignificant, which confirms that both the control and treatment groups are similar prior to random assignment. The point estimate of the discount factor is smaller at 0.426, but the standard error is much larger at 0.439. This is consistent with Ferrall (2012), who finds that the standard error of the discount factor becomes very large if only the data moments within the control group are used.[67] However, unlike Ferrall (2012), the standard errors of other coefficients in the model do not increase substantially.

In principle, a structural model estimated on pre-random-assignment data can be used to forecast the effects of various policies even before the experimental data is collected. This provides policymakers a relatively inexpensive but valuable piece of information for the implementation,

[66] For each individual in the sample, data is available for up to two years prior to random assignment.

[67] Ferrall (2012)'s approach is slightly different. The model is first estimated using moments from both the control and treatment groups. Then, based on the model estimates, standard errors are re-computed using moments from one of the groups only.

monitoring, and evaluation of experiments. We first estimate two structural models using pre-random-assignment data: 1. a time-consistent model with the discount factor pre-fixed at 0.985 per period (or 0.941 per annum); 2. a present-biased model with the discount factor, present-bias factor, and naivety factor pre-fixed at 0.951, 0.918, and 0.843, respectively, which reflect the estimated means in the baseline model.[68] Both models are used to forecast outcomes of control group members in the first eight quarters following random assignment. The effects of the FTP earnings disregard and FTP time limit are then simulated from each model. To evaluate the predictive performance of both models, the effects are compared with the benchmark policy effects that are generated from the baseline model.

The above approach shares some similarities with Lise et al. (2005) and Todd and Wolpin (2006), in which the treatment group is used as a validation sample for a structural model that is estimated on the control group sample. It is also related to Attanasio et al. (2011) and Ferrall (2012), who assess the importance of control-treatment policy variations to the predictive performance of structural models. Keane and Wolpin (2007) use Texas as a holdout sample to validate the structural model in Keane and Wolpin (2010).

Table XVIII reports the forecast of control group behavior in the first eight quarters following random assignment, the policy effects predicted by the pre-random-assignment models, and the benchmark policy effects. Both pre-random-assignment models predict the behavior of control group members in the post-random-assignment period remarkably well. The accuracy of the predicted policy effects depends on the policy involved. On the one hand, in both pre-random-assignment models, the predicted effects of the FTP earnings disregard are very close to the benchmark effects. On the other hand, the predictions are less accurate for a more complicated policy such as the FTP time limit. Although the present-biased model generates a more accurate prediction than the time-consistent model, both models overpredict the reduction of working welfare recipients and the increase of idle individuals by more than 5 percentage points. As a result, both models predict that the time limit will cause a minor *reduction* in employment and a large reduction in welfare participation.

Two additional model validation exercises are carried out using models that are estimated on *post-random-assignment* data.[69] In the first exercise, FTP policies are simulated using a model that is estimated on the control group sample only, and the effects of *removing* FTP policies are

[68]Estimation results are available upon request.

[69]For more details, please refer to Supplemental Material (Chan (2014)).

simulated using a model that is estimated on the treatment group sample only.[70] In both cases, the predicted effects are reasonably close to the benchmark policy effects obtained from the baseline model. The predictions appear to be more accurate in the model that is estimated on the treatment group sample. In addition, the effect of imposing a policy is generally different from the effect of removing it, as the effect depends heavily on what other policies are in place.

In the second exercise, data from the third year following random assignment are used to evaluate the predictive performance of the baseline model. The results should be treated with caution, as individuals in later periods were indirectly exposed to a broad policy change in Florida. Florida started to implement a TANF program at the end of 1996. Although it did not affect the policy environment of the control and treatment groups, there is a possibility of behavioral change due to contamination.[71] Nevertheless, as of the end of year 3, the model accurately predicts the proportion of individuals who have reached the time limit (or have had eight or more cumulative quarters of welfare use). For instance, in quarter 12, the model predicts that 19.4 percent of control group members have had eight or more cumulative quarters of welfare use, while the actual figure is 20.3 percent. The proportion of treatment group members who have reached the time limit is predicted to be 11.2 percent, which is less than 1 percent above the actual figure (10.3 percent).

7 Conclusion

In this paper, we used welfare time limits to help identify and estimate a dynamic structural model of labor supply and welfare participation with potentially time-inconsistent individuals. The model has three major building blocks that together determine welfare dependence: 1. Static labor supply disincentives generated by a piecewise-linear budget constraint; 2. State dependence in preferences for work and welfare participation; 3. Time-inconsistent preference, which makes individuals unable to fully commit to their plans, and makes welfare programs addictive by nature. We found that a significant proportion of individuals is time-inconsistent, and these individuals are generally aware of their commitment problem. Time-inconsistency plays an important role in worsening dependence on the welfare system. It also creates commitment-related incentives that tend to magnify behavioral responses to policies. A time-consistent model may thus understate the effects of policies on present-biased individuals. The distinct behavioral mechanism calls for a

[70] Both models are assumed to be time-consistent with the discount factor pre-fixed. There are no treatment group indicators in the preference and wage equations.

[71] The control group experienced an unusually large decline in welfare participation during the last two years of the policy experiment. For more details, see Bloom and et al. (2000).

reassessment of policy interventions on welfare and Earned Income Tax Credit (EITC) programs. In particular, we found that an unscrutinized expansion of the welfare system, such as a direct increase in welfare benefits, can make individuals worse off (from a time-consistent perspective) by worsening their commitment problem. By contrast, an EITC expansion alleviates the commitment problem and induces strong earnings growth among time-inconsistent individuals. In general, policy effects between time-consistent and present-biased individuals differ not only in magnitude but also in qualitative patterns of choice probabilities. A robust policy analysis would thus require a thorough understanding how the policy affects both types of individuals in the population.

Time-inconsistency also opens up an array of dynamic policy interventions for consideration. These interventions are important because they directly affect how individuals make intertemporal decisions. We found two hypothetical policies to be particularly interesting. The first is the "prowork time limit," which does not count working welfare recipients toward the limit. The second is the dynamic (type-1) nonwork tax, which imposes a tax on nonwork alternatives if the individual was employed in the previous period. Both policies unambiguously reduce the generosity of the welfare system. However, they are considered desirable by a significant portion of time-inconsistent individuals because they can significantly alleviate the commitment problem. In principle, such policies can be implemented as a targeting intervention, in which only time-inconsistent individuals may adopt the policies voluntarily. In practice, these policies may be combined with other policies to achieve a more balanced objective.

A number of research directions are proposed below. We estimated the discount factor and hyperbolic discounting parameters from a policy experiment. It will be useful to collect further evidence in a broader setting, using other policy variations as a source of identification. Wherever possible, estimates from observational data and data on elicited beliefs should be validated against each other. The ideas of prowork time limit and dynamic nonwork tax are intriguing, but their theoretical properties should be further confirmed by actual behavior (ideally in another policy experiment) before large-scale implementation. The revenue-neutrality of certain policies such as EITC expansion depends heavily on increases in tax revenue in the long run. However, the government may exhibit time-inconsistent preference as well, which enriches the budget analysis. These are potentially fruitful areas for future research.

8 Appendix

8.1 Program Benefit and Tax Formulas

The program benefit and tax formulas in the budget constraint (equation (3)) are defined as follows. The net income for the determination of welfare benefits is

$$N_{it} = \max\{(E_{it} - b_{A2i})(1 - r_{Ai}), 0\}, \tag{35}$$

and the welfare benefit amount is

$$B_{Ait} = \max\{b_{A1i} - N_{it}, 0\}. \tag{36}$$

The program rule $\boldsymbol{Z}_{Ai}$ consists of the maximum benefit amount b_{A1i}, dollar earnings disregard b_{A2i}, and percent earnings disregard r_{Ai}. The maximum benefit amount varies by family size, and earnings disregards vary by treatment status.[72]

The EITC benefit amount is

$$B_{Eit} = \begin{cases} r_{E1i}E_{it}, & \text{if} \quad E_{it} < b_{E1i}, \\ r_{E1i}b_{E1i}, & \text{if} \quad b_{E1i} \leq E_{it} < b_{E2i}, \\ \max\{r_{E1i}b_{E1i} - r_{E2i}(E_{it} - b_{E2i}), 0\}, & \text{if} \quad E_{it} \geq b_{E2i}. \end{cases} \tag{37}$$

The program rule $\boldsymbol{Z}_{Ei}$ consists of the subsidy phase-in rate r_{E1i}, phase-out rate r_{E2i}, lower bracket threshold b_{E1i}, and upper bracket threshold b_{E2i}. The rates and the bracket thresholds all vary by family size.[73]

The tax formula is

$$T_{it} = r_{T1} \max\{E_{it} - b_{T1} - b_{T2i}, 0\} + r_{T2}E_{it}. \tag{38}$$

The program rule $\boldsymbol{Z}_{Ti}$ consists of federal income tax rate $r_{T1} = 0.15$, payroll tax rate $r_{T2} = 0.0765$ (half of the tax incidence), standard deduction as head of household b_{T1}, and personal exemption amount b_{T2i}. The exemption amount varies by family size. Florida has no state income tax during the sample period.

8.2 Backward Recursion of the Dynamic Programming Problem

Time-Consistent Preference. The following procedure is used in the time-consistent model. The expectation of the value function in equation (8) is computed as follows. The first step involves integrating over the distribution of the choice-specific preference shocks. The distributional assumption implies that the integral has a closed form solution (e.g. Rust (1987)),

$$E_{t-1}V_{it}(\boldsymbol{S}_{it}, \boldsymbol{\epsilon}_{it}|w_{it}, q) = \sigma_c \ln\left(eu + \sum_{k=1}^{5} \exp(\bar{V}_{ikt}(w_{it}, \boldsymbol{S}_{it}, q)/\sigma_c)\right), \tag{39}$$

[72] The maximum benefit amount is 241, 303, and 364 dollars for families with one child, two children, and three children, respectively. The control group has a 120-dollar and 33-percent disregard for the first four months of work, and a 90-dollar disregard subsequently. The treatment group has a 200-dollar and 50-percent disregard.

[73] For instance, in Fiscal Year 1995, $\boldsymbol{Z}_{Ei} = \{0.34, 0.1598, 6160, 11290\}$ for families with one child (dollar amounts in annual figures, same below), and $\boldsymbol{Z}_{Ei} = \{0.36, 0.2022, 8640, 11290\}$ for families with two or more children.

where eu is Euler's constant and $\bar{V}_{ikt}(.)$ is the choice-specific value defined in equation (18). The wage is then integrated out:

$$E_{t-1}V_{it}(\boldsymbol{S}_{it}, \boldsymbol{\epsilon}_{it}|q) = \int E_{t-1}V_{it}(\boldsymbol{S}_{it}, \boldsymbol{\epsilon}_{it}|w, q) f_i(w|\boldsymbol{S}_{it}, q) dw. \tag{40}$$

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

Present-Biased Preference. The expectation of the continuation long-run utility in equation (14) is computed as follows. First, in a similar manner to equation (19), define the *perceived* choice-specific value $\tilde{\bar{V}}_{ikt}$ as

$$\tilde{\bar{V}}_{ikt}(w_{it}, \boldsymbol{S}_{it}, q) \equiv \bar{u}_{it}(k; w_{it}, \boldsymbol{S}_{it}, q) + \tilde{\beta}_i \delta_i E_t v_{i,t+1}(\boldsymbol{S}_{ik,t+1}, \boldsymbol{\epsilon}_{i,t+1}; \tilde{\kappa}^{+}_{i,t+1}, q). \tag{41}$$

Then, given wage w_{it} and type q, the expectation of the maximum value of the maximization problem in equation (13) has the following solution:

$$\sigma_c \ln \left(eu + \sum_{k=1}^{5} \exp(\tilde{\bar{V}}_{ikt}(w_{it}, \boldsymbol{S}_{it}, q)/\sigma_c) \right). \tag{42}$$

To obtain the expectation of the continuation long-run utility, the above expression is adjusted upward using a weighted sum of expected continuation long-run utilities in period $t+1$:

$$\begin{aligned} E_{t-1}v_{it}(\boldsymbol{S}_{it}, \boldsymbol{\epsilon}_{it}; \tilde{\kappa}^{+}_{it}|w_{it}, q) = \sigma_c \ln \left(eu + \sum_{k=1}^{5} \exp(\tilde{\bar{V}}_{ikt}(w_{it}, \boldsymbol{S}_{it}, q)/\sigma_c) \right) \\ + (1 - \tilde{\beta}_i)\delta_i \sum_{k=1}^{5} \tilde{P}_{ikt}(w_{it}, \boldsymbol{S}_{it}, q) E_t v_{i,t+1}(\boldsymbol{S}_{ik,t+1}, \boldsymbol{\epsilon}_{i,t+1}; \tilde{\kappa}^{+}_{i,t+1}, q), \end{aligned} \tag{43}$$

where the weights $\tilde{P}_{ikt}(.)$ are choice probabilities obtained from the following closed form solution:

$$\tilde{P}_{ikt}(w_{it}, \boldsymbol{S}_{it}, q) \equiv \frac{\exp(\tilde{\bar{V}}_{ikt}(w_{it}, \boldsymbol{S}_{it}, q)/\sigma_c)}{\sum_{j=1}^{5} \exp(\tilde{\bar{V}}_{ijt}(w_{it}, \boldsymbol{S}_{it}, q)/\sigma_c)}. \tag{44}$$

The wage is then integrated out:

$$E_{t-1}v_{it}(\boldsymbol{S}_{it}, \boldsymbol{\epsilon}_{it}; \tilde{\kappa}^{+}_{it}|q) = \int E_{t-1}v_{it}(\boldsymbol{S}_{it}, \boldsymbol{\epsilon}_{it}; \tilde{\kappa}^{+}_{it}|w, q) f_i(w|\boldsymbol{S}_{it}, q) dw. \tag{45}$$

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

8.3 Further Notes on Identification

Regularity Conditions. Suppose $0 < \delta < 1$ and the time limit is a binding constraint, that is, the remaining length of the time horizon exceeds the remaining periods of welfare eligibility ($\mathcal{T} - t + 1 > \bar{M}$). The expected value function satisfies the following properties:
(i) $EV(m; \delta) > 0$ for $m = 0, 1, ..., \bar{M}$;
(ii) $\frac{dEV(m;\delta)}{d\delta} > 0$ for $m = 0, 1, ..., \bar{M}$;

(iii) $EV(m;\delta) > EV(m+1;\delta)$ for $m = 0, 1, ..., \bar{M}-1$;
(iv) $\frac{d[EV(m;\delta)-EV(m+1;\delta)]}{d\delta} > 0$ for $m = 0, 1, ..., \bar{M}-1$;
(v) $EV(m;\delta) - EV(m+1;\delta) < EV(m+1;\delta) - EV(m+2;\delta)$ for $m = 0, 1, ..., \bar{M}-2$;
(vi) $\frac{d[EV(m;\delta)-EV(m+1;\delta)]}{d\delta} > \frac{d[EV(m+1;\delta)-EV(m+2;\delta)]}{d\delta}$ for $m = 0, 1, ..., \bar{M}-2$.

Conditions (i) to (iii) are trivial; they state that the expected value function is positive, is an increasing function of the discount factor, and is a decreasing function of m. Condition (iv) implies that the option value is an increasing function of the discount factor. Condition (v) states that the expected function is strictly concave in m. This implies that the option value will become larger as the individual approaches the time limit. Condition (vi) states that the expected value function will become less concave in m when the discount factor increases.

Further Discussion of Equation (28). The ratio on the left hand side of equation (28) is strictly increasing in $\hat{\delta}$. To simplify the notation, denote $E_tV_{t+1}(m;\hat{\delta}) - E_tV_{t+1}(m+1;\hat{\delta})$ as $\Delta E_tV_{t+1}(m;\hat{\delta})$. Taking derivative of the ratio with respect to $\hat{\delta}$, we have

$$[\Delta E_tV_{t+1}(m+1;\hat{\delta})]^{-2}\left(\Delta E_tV_{t+1}(m+1;\hat{\delta})\frac{d\Delta E_tV_{t+1}(m;\hat{\delta})}{d\hat{\delta}} - \Delta E_tV_{t+1}(m;\hat{\delta})\frac{d\Delta E_tV_{t+1}(m+1;\hat{\delta})}{d\hat{\delta}}\right). \tag{46}$$

It is straightforward to show that the expression is positive due to regularity conditions (iii) to (vi). If $\bar{y}^0_t(m) - \bar{y}^1_t(m)$ is sufficiently smaller than $\bar{y}^0_t(m+1) - \bar{y}^1_t(m+1)$, the right hand side of equation (28) will be sufficiently smaller than one, and a unique solution can be found for $\hat{\delta}$.

Discrete Types. As an illustration, we will discuss the case of two unobserved types of individuals (i.e., $q = 1, 2$). The moment condition in equation (23) can be rewritten as:

$$\begin{aligned}
&E(y^0_t(m)) - E(y^1_t(m)) \\
&= \sum_{q=1}^{2} E(y^0_t|m,q)Pr^0_t(q|m) - \sum_{q=1}^{2} E(y^1_t|m,q;\delta)Pr^1_t(q|m;\delta) \\
&= \sum_{q=1}^{2} E(y^0_t|m,q)Pr^0_t(q|m) - E(y^1_t|m,q=1;\delta)(Pr^0_t(q=1|m) + \Delta Pr_t) - \\
&\quad E(y^1_t|m,q=2;\delta)(Pr^0_t(q=2|m) - \Delta Pr_t) \\
&= \sum_{q=1}^{2} \left(E(y^0_t|m,q) - E(y^1_t|m,q;\delta)\right) Pr^0_t(q|m) + (E(y^1_t|m,q=2;\delta) - E(y^1_t|m,q=1;\delta))\Delta Pr_t \\
&= \sum_{q=1}^{2} Q(\delta\Delta E_tV_{t+1}(m;q,\delta);q)Pr^0_t(q|m) + (E(y^1_t|m,q=2;\delta) - E(y^1_t|m,q=1;\delta))\Delta Pr_t,
\end{aligned} \tag{47}$$

where $\Delta Pr_t \equiv Pr^1_t(q=1|m;\delta) - Pr^0_t(q=1|m)$. The summation term represents the weighted average of the type-specific effect of the time limit, with weights given by posterior type probabilities when the time limit is absent. The summation term is strictly increasing in δ. The second term is an adjustment that takes into account that the posterior type probabilities may be different with and without the time limit. The posterior probabilities can be computed via Bayes' rule:

$$Pr_t^k(q|m;\delta) = \frac{Pr_t^k(m|q;\delta)Pr(q)}{\sum_{q=1}^{2} Pr_t^k(m|q;\delta)Pr(q)}, \qquad k = 0, 1. \tag{48}$$

Note that in the initial period $t = 0$, all individuals will have $m = 0$, hence $Pr_0^1(q|m = 0;\delta) = Pr_0^0(q|m = 0) = Pr(q)$, and the second term on the right hand side of equation (47) disappears. In later periods, depending on the model's dynamic selection of types into different values of m, the moment condition may in principle have more than one root. In that case, moment conditions with different values of m can be used as overidentifying restrictions.[74]

Commitment to Work. Let work experience ($\mathcal{E}_{it}$) be a state variable in the individual's intertemporal optimization problem. Suppose wage is strictly increasing in work experience. To facilitate the discussion, suppose there are only four choices: (i) no work, no welfare; (ii) work, no welfare; (iii) no work, welfare; (iv) work, welfare. Denote the 3-dimensional vector $\boldsymbol{dev}_t \equiv (dev_{2t}, dev_{3t}, dev_{4t})$ as the differences in the expected value (or continuation long-run utility) between choice 1 and the other three choices. First, consider time-consistent and naive present-biased individuals. In the control group, the vector is

$$\boldsymbol{dev}_t = (\beta\delta[E_tV_{t+1}(e+1;\delta) - E_tV_{t+1}(e;\delta)], 0, \beta\delta[E_tV_{t+1}(e+1;\delta) - E_tV_{t+1}(e;\delta)]), \tag{49}$$

where e is the current value of $\mathcal{E}_{it}$. Therefore, in the control group, we have $dev_{2t} = dev_{4t} > dev_{3t} = 0$, where dev_{t2} (or dev_{t4}) represent the future benefit of work experience accumulation. In the treatment group, the vector is

$$\begin{aligned}\boldsymbol{dev}_t = (&\beta\delta[E_tV_{t+1}(m, e+1;\delta) - E_tV_{t+1}(m, e;\delta)], \beta\delta[E_tV_{t+1}(m+1, e;\delta) - E_tV_{t+1}(m, e;\delta)], \\ &\beta\delta[E_tV_{t+1}(m+1, e+1;\delta) - E_tV_{t+1}(m, e;\delta)]).\end{aligned} \tag{50}$$

The per-period utilities and $\boldsymbol{dev}_t$ together determine the choice probabilities in the control and treatment groups. The following inequality is assumed to hold:

$$E_tV_{t+1}(m, e;\delta) - E_tV_{t+1}(m+1, e;\delta) \geq E_tV_{t+1}(m, e+1;\delta) - E_tV_{t+1}(m+1, e+1;\delta). \tag{51}$$

It states that the option value of not receiving welfare is smaller among individuals with high work experience. In the extreme case, an individual with substantial work experience rarely participates in welfare, so the time limit is largely irrelevant to her. Note that the above inequality implies

$$\begin{aligned}&E_tV_{t+1}(e+1;\delta) - E_tV_{t+1}(e;\delta) \\ \leq\ &E_tV_{t+1}(m, e+1;\delta) - E_tV_{t+1}(m, e;\delta) \\ \leq\ &E_tV_{t+1}(m+1, e+1;\delta) - E_tV_{t+1}(m+1, e;\delta).\end{aligned} \tag{52}$$

The future benefit of work experience accumulation is larger among individuals who are close to reaching the time limit. The following proposition has interesting implications on the behavior of treatment group members.

Proposition 1. *Suppose the individual is time-consistent or naive present-biased. Then, in the*

[74] Alternatively, other types of moment conditions can be constructed. For instance, consider $E(y_t^1|m, y_{t-1}^1 = 1) - E(y_t^1|m, y_{t-1}^1 = 0)$. When there is no unobserved heterogeneity, the above term is zero because m is the only relevant state variable. Otherwise, lagged welfare participation will contain information about the dynamic selection of types. The term will be a function of δ, whose size determines the dynamic selection process.

treatment group, $dev_{3t} < dev_{2t} + dev_{3t} \leq dev_{4t} < dev_{2t}$*, where* $dev_{2t} > 0$ *and* $dev_{3t} < 0$*.*

Proof. The first inequality holds because dev_{2t} is positive. A decomposition in dev_{4t} gives

$$\begin{aligned}
&\beta\delta[E_tV_{t+1}(m+1,e+1;\delta) - E_tV_{t+1}(m,e;\delta)] \\
&= \beta\delta[E_tV_{t+1}(m,e+1;\delta) - E_tV_{t+1}(m,e;\delta)] + \beta\delta[E_tV_{t+1}(m+1,e+1;\delta) - E_tV_{t+1}(m,e+1;\delta)] \\
&= \beta\delta[E_tV_{t+1}(m,e+1;\delta) - E_tV_{t+1}(m,e;\delta)] + \beta\delta[E_tV_{t+1}(m+1,e;\delta) - E_tV_{t+1}(m,e;\delta)] \\
&\quad + \beta\delta[E_tV_{t+1}(m+1,e+1;\delta) - E_tV_{t+1}(m,e+1;\delta)] - \beta\delta[E_tV_{t+1}(m+1,e;\delta) - E_tV_{t+1}(m,e;\delta)] \\
&= dev_{2t} + dev_{3t} + \Delta. \qquad (53)
\end{aligned}$$

By (51), $\Delta \geq 0$, therefore the second inequality holds. The last inequality comes from the following relationship:

$$\begin{aligned}
&\beta\delta[E_tV_{t+1}(m+1,e+1;\delta) - E_tV_{t+1}(m,e;\delta)] \\
&= \beta\delta[E_tV_{t+1}(m,e+1;\delta) - E_tV_{t+1}(m,e;\delta)] + \beta\delta[E_tV_{t+1}(m+1,e+1;\delta) - E_tV_{t+1}(m,e+1;\delta)] \\
&< \beta\delta[E_tV_{t+1}(m,e+1;\delta) - E_tV_{t+1}(m,e;\delta)] = dev_{2t}. \qquad (54)
\end{aligned}$$

□

If the individual chooses to be a working welfare recipient, she will gain one period of work experience but lose one period of welfare eligibility. Therefore, the net future benefit of being a working welfare recipient (dev_{4t}) is smaller than a worker who does not receive welfare (dev_{2t}), but larger than a nonworking welfare recipient (dev_{3t}). Now define a ratio as follows:

$$R_t(m,e;\delta) \equiv \frac{dev_{4t} - dev_{3t}}{dev_{2t} - dev_{4t}}. \qquad (55)$$

The ratio determines the relative future benefit of a working welfare recipient to other choices. In particular, a large R_t implies that a working welfare recipient generates similar future benefits to a worker who does not receive welfare. The following propositions summarize how the present-bias factor and discount factor affect the vector $\boldsymbol{dev}_t$.

Proposition 2. *The present-bias factor* β *plays no role in influencing* R_t*.*

Proposition 3. *A larger discount factor* δ *will result in an increase in* dev_{2t} *and a reduction in* dev_{3t} *in the treatment group. Its effect on* R_t *is ambiguous.*

Proof. A larger discount factor will increase both the future benefit of work experience accumulation and the option value of not receiving welfare. The definition of R_t gives

$$R_t(m,e;\delta) = \frac{E_tV_{t+1}(m+1,e+1;\delta) - E_tV_{t+1}(m+1,e;\delta)}{E_tV_{t+1}(m,e+1;\delta) - E_tV_{t+1}(m+1,e+1;\delta)}. \qquad (56)$$

Both the numerator and the denominator increase in δ, therefore the effect on R_t is ambiguous. □

Now consider nonnaive present-biased individuals. There are two channels by which the time limit affects the preexisting work commitment problem among these individuals. First, it creates a work incentive by alleviating the work commitment problem:

$$\begin{aligned}
&E_tv_{t+1}(m,e+1;\tilde{\kappa}^+_{t+1}(m,e+1;\tilde{\beta},\delta),\delta) - E_tv_{t+1}(m,e;\tilde{\kappa}^+_{t+1}(m,e;\tilde{\beta},\delta),\delta) \\
&\geq E_tV_{t+1}(m,e+1;\delta) - E_tV_{t+1}(m,e;\delta). \qquad (57)
\end{aligned}$$

This is consistent with O'Donoghue and Rabin (1999b), who show that sophistication can mitigate procrastination in immediate-cost activities. Second, the time limit creates an incentive to participate in welfare now because it can help alleviate the work commitment problem next period:

$$\begin{aligned} & E_t v_{t+1}(m+1, e; \tilde{\kappa}^{+}_{t+1}(m+1, e; \tilde{\beta}, \delta), \delta) - E_t v_{t+1}(m, e; \tilde{\kappa}^{+}_{t+1}(m, e; \tilde{\beta}, \delta), \delta) \\ \geq\ & E_t V_{t+1}(m+1, e; \delta) - E_t V_{t+1}(m, e; \delta). \end{aligned} \tag{58}$$

Note that the above inequality is similar to (32), but the underlying incentives are different. Non-naivety increases the relative future benefit of a working welfare recipient to other choices:

Proposition 4. *$R_t(m, e; \tilde{\beta}, \delta) \geq R_t(m, e; \delta)$ for any $0 < \tilde{\beta} < 1$.*

Proof. The definition of $R_t(m, e; \delta)$ gives

$$\begin{aligned} R_t(m, e; , \delta) &= \frac{E_t V_{t+1}(m+1, e+1; \delta) - E_t V_{t+1}(m+1, e; \delta)}{E_t V_{t+1}(m, e+1; \delta) - E_t V_{t+1}(m+1, e+1; \delta)} \\ &\leq \frac{E_t v_{t+1}(m, e+1; \tilde{\kappa}^{+}_{t+1}(m, e+1; \tilde{\beta}, \delta), \delta) - E_t v_{t+1}(m, e; \tilde{\kappa}^{+}_{t+1}(m, e; \tilde{\beta}, \delta), \delta)}{E_t V_{t+1}(m, e+1; \delta) - E_t V_{t+1}(m+1, e+1; \delta)} \\ &\leq \frac{E_t v_{t+1}(m, e+1; \tilde{\kappa}^{+}_{t+1}(m, e+1; \tilde{\beta}, \delta), \delta) - E_t v_{t+1}(m, e; \tilde{\kappa}^{+}_{t+1}(m, e; \tilde{\beta}, \delta), \delta)}{E_t v_{t+1}(m+1, e; \tilde{\kappa}^{+}_{t+1}(m+1, e; \tilde{\beta}, \delta), \delta) - E_t v_{t+1}(m, e; \tilde{\kappa}^{+}_{t+1}(m, e; \tilde{\beta}, \delta), \delta)} \\ &= R_t(m, e; \tilde{\beta}, \delta), \end{aligned} \tag{59}$$

where the first inequality follows from (58) and the second inequality follows from (57). □

8.4 Subgroup Analysis

This section briefly discusses results of subgroup analysis on the effects of welfare and EITC expansions in Table IX, and time limits in Table X. Individuals are partitioned into three equally-sized subgroups according to their income in the baseline scenario. The analysis is conducted separately for present-biased and time-consistent individuals. All related tables are provided in Supplemental Material (Chan (2014)).

Among present-biased individuals, the expansion of welfare creates large labor supply disincentives and causes income to reduce substantially in all income subgroups. While net government expenditure increases in all subgroups, long-run utility increases modestly in the low-income subgroup and reduces substantially in the other two subgroups. The reason for this divergence is that in the medium and high-income subgroups, individuals attain high earnings by investing heavily in human capital. Both subgroups are severely affected, as the expansion of welfare causes an under-investment of human capital by aggravating the commitment problem. This results in a trajectory of low earnings growth, as well as an increased dependence on welfare and lower long-run utility. While the EITC expansion has qualitatively similar effects in all income subgroups, its effects are the strongest in the low-income subgroup. In particular, only the low income subgroup experiences a large decline in net government expenditure.

Among time-consistent individuals, the expansion of welfare causes the employment rate to increase in the low-income subgroup, as individuals become working welfare recipients instead of staying idle. Moreover, in the low-income subgroup, the poverty trap becomes less severe, as each extra dollar of government expenditure translates into an increase of income by 1.15 dollars. As expected, the welfare expansion still generates sizable labor supply disincentives in the medium and high-income subgroups. Under an EITC expansion, net government expenditure increases in the low-income subgroup, but it remains relatively unchanged in the medium and high-income subgroups.

For both types of individuals, the effects of standard and prowork time limits are strongest in the low-income subgroup. Both types of time limits cause a decline in long-run utility in all income subgroups; however, the prowork time limit generates minimal effect on long-run utility.

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TABLE I
SUMMARY STATISTICS OF SELECTED VARIABLES

Variable	Control Group Mean	Control Group Std. dev.	Treatment Group Mean	Treatment Group Std. dev.
Highest grade completed	11.2	1.3	11.4	1.5
Race (white=1, %)	60.4	49.0	55.7	49.8
Number of children under 18	1.7	0.8	1.7	0.9
Age of youngest child (years)	3.2	2.3	3.3	2.3
Last two years before random assignment:				
Total months of welfare receipt	8.4	7.5	8.2	8.0
Total quarters of employment	2.8	2.6	2.6	2.6
Total earnings ($)	3990.3	5733.2	3900.8	6290.2
First two years following random assignment:				
Work (%)	53.4	49.9	58.9	49.2
Welfare (%)	46.2	49.9	40.9	49.2
No work, no welfare (%)	20.4	40.3	23.4	42.3
Work, no welfare (%)	33.4	47.2	35.7	47.9
No work, welfare (%)	26.2	44.0	17.8	38.2
Work, welfare (%)	20.0	40.0	23.1	42.2
Earnings (workers only, $)	419.3	354.0	533.0	412.5
Quarters 1 to 4 following random assignment:				
Work (%)	53.8	49.9	57.3	49.5
Welfare (%)	57.3	49.5	54.3	49.8
No work, no welfare (%)	14.6	35.3	16.8	37.4
Work, no welfare (%)	28.1	45.0	28.9	45.4
No work, welfare (%)	31.6	46.5	25.9	43.9
Work, welfare (%)	25.7	43.7	28.4	45.1
Earnings (workers only, $)	356.0	309.0	442.6	367.1
Quarters 5 to 8 following random assignment:				
Work (%)	53.0	49.9	60.4	48.9
Welfare (%)	35.1	47.8	27.4	44.6
No work, no welfare (%)	26.2	44.0	30.0	45.9
Work, no welfare (%)	38.6	48.7	42.6	49.5
No work, welfare (%)	20.8	40.6	9.6	29.5
Work, welfare (%)	14.4	35.1	17.8	38.3
Earnings (workers only, $)	483.6	384.3	618.7	434.8

TABLE II

SAMPLE ONE-PERIOD TRANSITION RATES BY LAGGED CHOICE[a]

	Outcome in the Current Period						
Outcome in the Previous Period	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)	Number of Observations
Control group:							
No work, no welfare	12.7	20.1	71.6	8.2	15.7	4.5	268
Work, no welfare	87.3	19.7	9.2	71.2	3.5	16.2	458
No work, welfare	19.7	82.6	12.0	5.4	68.3	14.3	391
Work, welfare	83.2	61.3	3.0	35.7	13.8	47.5	297
Treatment group:							
No work, no welfare	10.8	16.7	75.3	8.0	13.9	2.8	288
Work, no welfare	91.9	19.4	4.7	75.8	3.4	16.0	443
No work, welfare	20.7	71.1	23.6	5.3	55.7	15.4	246
Work, welfare	88.1	64.2	3.5	32.4	8.5	55.7	318

a Numbers in the choice distribution may be subject to rounding error. One period is defined as one quarter.

TABLE III

SAMPLE OUTCOMES BY CUMULATIVE PERIODS OF WELFARE USE SINCE RANDOM ASSIGNMENT[a]

Cumulative Periods of Welfare Use since Random Assignment	Outcome in the Current Period: Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)	Number of Observations
Control group:							
0 to 1	57.1	40.3	23.6	36.1	19.3	21.0	606
2 to 3	54.4	44.0	20.1	35.9	25.5	18.5	502
4 to 7	45.4	60.1	15.0	24.8	39.5	20.6	306
Treatment group:							
0 to 1	58.7	37.5	23.0	39.4	18.3	19.2	578
2 to 3	57.2	37.6	26.6	35.8	16.2	21.4	481
4 to 7	65.7	48.7	19.5	31.8	14.8	33.9	236

a Numbers in the choice distribution may be subject to rounding error. One period is defined as one quarter.

TABLE IV

BASELINE MODEL SPECIFICATION, ESTIMATION RESULTS[a]

	Work (ϕ_H)			Welfare (ϕ_A)			Work&Welfare (ϕ_{HA})			Log Wage		
Intercept	-1043.58	(134.13)	***	-356.75	(60.53)	***	-22.85	(67.86)		4.44	(0.12)	***
Work (t-1)	382.06	(61.10)	***							1.18	(0.10)	***
Welfare (t-1)				348.93	(48.24)	***				-0.20	(0.11)	*
Work (t-1) * Welfare (t-1)							-55.92	(26.59)	**	0.08	(0.11)	
More than one child	-6.76	(42.29)		-131.28	(24.62)	***	94.49	(29.68)	***			
Race (nonwhite=1)	-10.05	(44.86)		-49.37	(23.89)	**	45.91	(32.43)		-0.12	(0.03)	***
Grade 12 or above	45.59	(62.23)		-25.89	(25.87)		47.68	(33.70)		0.34	(0.06)	***
Treatment group	-68.73	(21.60)	***	41.24	(29.46)		-23.56	(23.56)		0.13	(0.03)	***
Type 2 intercept	-343.43	(108.23)	***	-67.46	(58.61)		96.98	(65.94)		0.72	(0.04)	***
Type 3 intercept	304.22	(76.89)	***	-240.46	(40.09)	***	141.21	(52.61)	***	-1.14	(0.05)	***
Experience[b]										0.11	(0.05)	**
Experience* Grade 12 or above[b]										-0.07	(0.03)	**
Experience squared[b]										0.01	(0.01)	

	Discount Factor (Annualized)[c]			Present-Bias Factor[c]			Naivety Factor[c]	
Intercept	0.965	(0.035)	***	0.854	(0.187)	***	0.574	(0.225) ***
More than one child	-0.059	(0.037)		0.120	(0.077)		0.388	(0.353)
Race (nonwhite=1)	-0.023	(0.025)		0.144	-[d]		0.419	-[d]
Grade 12 or above	-0.061	(0.038)		0.035	(0.099)		-0.185	(0.218)
Type 2 intercept	0.034	-[d]		-0.470	(0.285)	*	-0.309	(0.212)
Type 3 intercept	-0.030	(0.041)		0.125	-[d]		0.413	-[d]

Standard deviation of shocks:				Type Probabilities:			
Choice	196.37	(23.56)	***	Type 2	0.29	(0.04)	***
Wage	0.83	(0.02)	***	Type 3	0.40	(0.04)	***
Observed earnings	0.44	(0.01)	***				

a Number of observations = 2709, log-likelihood = 4418.117. Standard errors are given in parentheses. *, Significant at the 10 percent level; **, significant at the 5 percent level; ***, significant at the 1 percent level.

b Cumulative periods of employment since random assignment, expressed in half-year intervals.

c Coefficients are obtained by transformations from the logistic function. Standard errors are obtained by delta method.

d The standard error is not reported, as the sum of the coefficient and the intercept is close to one.

TABLE V

PREDICTED ONE-PERIOD TRANSITION RATES[a]

	Outcome in the Current Period					
Outcome in the Previous Period	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)
Control group:						
No work, no welfare	20.6	29.8	55.4	14.8	24.0	5.8
Work, no welfare	86.8	20.1	10.2	69.7	3.0	17.1
No work, welfare	17.9	76.0	19.6	4.5	62.5	13.5
Work, welfare	81.4	63.3	4.9	31.7	13.7	49.7
Treatment group:						
No work, no welfare	23.8	27.7	55.2	17.0	21.0	6.8
Work, no welfare	86.5	21.2	11.0	67.8	2.4	18.7
No work, welfare	21.6	71.5	23.2	5.3	55.2	16.4
Work, welfare	85.0	62.5	5.3	32.2	9.7	52.7

a Predictions are made from the baseline model. Numbers in the choice distribution may be subject to rounding error. One period is defined as one quarter.

TABLE VI

PREDICTED OUTCOMES BY CUMULATIVE PERIODS OF WELFARE USE SINCE RANDOM ASSIGNMENT[a]

	Outcome in the Current Period					
Cumulative Periods of Welfare Use since Random Assignment	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)
Control group:						
0 to 1	60.8	32.9	23.5	43.7	15.7	17.2
2 to 3	55.2	48.8	18.8	32.4	26.0	22.8
4 to 7	45.8	59.9	17.2	22.9	37.0	22.9
Treatment group:						
0 to 1	62.2	32.6	24.2	43.3	13.7	18.9
2 to 3	57.6	44.9	21.6	33.5	20.8	24.1
4 to 7	63.8	50.0	17.0	33.0	19.2	30.8

a Predictions are made from the baseline model. Numbers in the choice distribution may be subject to rounding error. One period is defined as one quarter.

TABLE VII

PREDICTED DISTRIBUTION OF TIME PREFERENCE PARAMETERS[a]

Present-Bias Factor	Panel A: Discount Factor (Annualized)					Panel B: Naivety Factor				
	<0.7	0.7-0.8	0.8-0.9	0.9-0.95	>0.95	<0.7	0.7-0.8	0.8-0.9	>0.9	All
<0.8	0.0	0.0	0.0	0.0	9.3	9.3	0.0	0.0	0.0	9.3
0.8-0.9	0.0	0.0	6.9	3.2	7.5	10.0	4.1	3.5	0.0	17.6
>0.9	17.2	19.0	16.5	7.9	12.6	0.0	0.0	0.0	73.2	73.2
All	17.2	19.0	23.4	11.1	29.4	19.3	4.1	3.5	73.2	100.0

a Predictions are made from the baseline model with twenty type simulations per individual. All numbers are in percent. Numbers in the choice distribution may be subject to rounding error.

TABLE VIII

EFFECTS OF MODIFYING HYPERBOLIC DISCOUNTING PARAMETERS, PRESENT-BIASED INDIVIDUALS[a]

	Baseline (1)	Becoming Naïve (2)	Becoming Sophisticated (3)	Becoming Time-Consistent (4)
All periods: [b]				
Work (%)	71.3	55.8	63.7	84.1
Welfare (%)	31.0	40.5	36.3	27.7
No work, no welfare (%)	9.7	14.5	12.0	4.5
Work, no welfare (%)	59.3	45.0	51.7	67.8
No work, welfare (%)	19.0	29.7	24.3	11.4
Work, welfare (%)	12.0	10.8	12.0	16.3
AP Earnings ($)	1063.0	794.6	930.2	1272.7
AP Net gov. expenditure ($)	-66.8	-1.3	-33.8	-112.7
AP Income ($)	996.2	793.3	896.4	1160.0
AP Long-run utility	252.0	227.3	240.8	269.9
Period 1:				
Work (%)	53.4	43.9	48.1	59.8
Welfare (%)	47.8	52.4	51.1	53.2
No work, no welfare (%)	13.2	16.5	14.8	8.9
Work, no welfare (%)	39.0	31.1	34.0	37.9
No work, welfare (%)	33.4	39.6	37.0	31.3
Work, welfare (%)	14.4	12.8	14.1	21.9
Earnings ($)	411.2	377.1	393.0	425.9
Net gov. expenditure ($)	105.2	112.3	110.0	113.6
Income ($)	516.4	489.4	503.0	539.5
Long-run utility	13.5	73.2	52.9	-36.5
End of year 2: [c]				
Work (%)	68.9	45.4	54.2	77.7
Welfare (%)	37.4	51.6	46.9	40.9
No work, no welfare (%)	8.5	16.0	13.5	4.0
Work, no welfare (%)	54.2	32.4	39.6	55.1
No work, welfare (%)	22.6	38.6	32.2	18.3
Work, welfare (%)	14.8	13.0	14.7	22.6
AP Earnings ($)	563.1	398.9	460.8	639.1
AP Net gov. expenditure ($)	73.8	106.6	94.5	69.5
AP Income ($)	636.9	505.5	555.3	708.6
AP Long-run utility	40.4	91.5	76.3	14.4
End of year 5: [c]				
Work (%)	78.3	57.6	66.8	90.8
Welfare (%)	29.2	41.9	37.1	25.6
No work, no welfare (%)	6.4	12.8	9.7	1.1
Work, no welfare (%)	64.4	45.3	53.2	73.2
No work, welfare (%)	15.4	29.6	23.5	8.0
Work, welfare (%)	13.9	12.3	13.6	17.6
AP Earnings ($)	829.0	558.6	667.5	984.2
AP Net gov. expenditure ($)	2.8	65.7	41.1	-25.0
AP Income ($)	831.8	624.3	708.6	959.2
AP Long-run utility	138.9	146.6	143.4	142.4

a Results are based on control group members who have a present-bias factor of lower than 0.9 in the baseline model. AP, amortizing payment.

b From period 1 to the end of the time horizon.

c Amortizing payments start from period 1 to the period considered.

TABLE IX

EFFECTS OF EXPANDING WELFARE AND EARNED INCOME TAX CREDIT[a]

		Expand Welfare[b]			Expand EITC[c]		
	Baseline	1.1x	1.2x	1.5x	1.2x	1.5x	2.0x
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A (present-biased individuals):							
Work (%)	71.3	58.3	47.4	26.1	76.3	80.4	83.4
Welfare (%)	31.0	41.4	50.1	67.3	27.5	24.7	22.9
No work, no welfare (%)	9.7	10.2	10.6	11.7	9.2	8.5	7.7
Work, no welfare (%)	59.3	48.4	39.2	21.0	63.3	66.9	69.4
No work, welfare (%)	19.0	31.5	42.0	62.2	14.6	11.2	8.9
Work, welfare (%)	12.0	9.9	8.1	5.1	12.9	13.5	14.0
AP Earnings ($)	1063.0	921.9	794.4	456.6	1118.9	1176.9	1224.1
AP Net gov. expenditure ($)	-66.8	-24.8	13.9	119.7	-79.4	-89.9	-93.0
AP Income ($)	996.1	897.1	808.3	576.4	1039.5	1087.0	1131.1
AP Long-run utility	252.0	251.9	249.8	231.4	254.3	259.7	267.6
Panel B (time-consistent individuals):							
Work (%)	66.1	62.9	58.4	42.7	71.3	77.1	83.1
Welfare (%)	29.5	34.6	41.0	58.0	28.4	27.3	26.3
No work, no welfare (%)	22.3	21.3	19.9	17.9	19.3	15.8	11.9
Work, no welfare (%)	48.3	44.1	39.1	24.1	52.3	56.9	61.8
No work, welfare (%)	11.6	15.8	21.7	39.5	9.4	7.1	5.0
Work, welfare (%)	17.8	18.8	19.3	18.5	19.0	20.2	21.2
AP Earnings ($)	458.4	426.3	383.7	259.0	486.9	519.2	553.9
AP Net gov. expenditure ($)	53.8	77.3	105.9	190.2	53.2	55.0	61.9
AP Income ($)	512.2	503.6	489.7	449.2	540.1	574.2	615.9
AP Long-run utility	105.5	108.4	112.8	124.1	106.8	109.0	113.4

a Results in Panel A are based on control group members who have a present-bias factor of lower than 0.9 in the baseline model. Results in Panel B are based on control group members who have a present-bias factor of at least 0.9 in the baseline model. Simulations are conducted from period 1 to the end of the time horizon. AP, amortizing payment.

b Increase the maximum welfare benefit level by 10, 20, and 50 percent, respectively.

c Increase the EITC phase-in rate and maximum benefit level by 20, 50, and 100 percent, respectively.

TABLE X

EFFECTS OF TIME LIMITS[a]

	Baseline	Standard Time Limit			Prowork Time Limit		
		4-Year	2-Year	1-Year	4-Year	2-Year	1-Year
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A (present-biased individuals):							
Work (%)	71.3	79.3	83.7	85.9	77.5	81.8	85.1
Welfare (%)	31.0	21.2	12.2	6.0	25.2	20.8	16.9
No work, no welfare (%)	9.7	10.6	11.5	12.0	10.1	10.4	10.8
Work, no welfare (%)	59.3	68.2	76.4	81.9	64.6	68.9	72.3
No work, welfare (%)	19.0	10.1	4.9	2.1	12.4	7.8	4.1
Work, welfare (%)	12.0	11.1	7.3	4.0	12.8	13.0	12.8
AP Earnings ($)	1063.0	1158.7	1235.4	1276.7	1132.4	1204.5	1257.6
AP Net gov. expenditure ($)	-66.8	-97.3	-122.6	-137.7	-88.2	-109.1	-125.2
AP Income ($)	996.1	1061.4	1112.8	1139.0	1044.2	1095.4	1132.4
AP Long-run utility	252.0	248.5	246.0	240.0	249.4	250.5	249.7
Fraction that prefers policy (%)[b]	-	46.8	0.0	0.0	53.8	43.1	26.0
Panel B (time-consistent individuals):							
Work (%)	66.1	67.6	67.2	65.0	67.5	70.2	73.3
Welfare (%)	29.5	22.8	12.5	6.0	28.2	25.7	21.9
No work, no welfare (%)	22.3	24.0	28.4	32.8	22.3	22.4	22.7
Work, no welfare (%)	48.3	53.2	59.1	61.1	49.5	51.9	55.4
No work, welfare (%)	11.6	8.3	4.4	2.1	10.2	7.5	4.0
Work, welfare (%)	17.8	14.5	8.1	3.9	18.0	18.2	17.9
AP Earnings ($)	458.4	477.2	503.4	517.9	466.7	489.1	520.3
AP Net gov. expenditure ($)	53.8	42.8	19.2	-2.3	51.0	43.3	30.7
AP Income ($)	512.2	520.0	522.6	515.6	517.7	532.4	551.0
AP Long-run utility	105.5	104.2	100.2	93.7	105.2	103.8	100.1

a Results in Panel A are based on control group members who have a present-bias factor of lower than 0.9 in the baseline model. Results in Panel B are based on control group members who have a present-bias factor of at least 0.9 in the baseline model. Simulations are conducted from period 1 to the end of the time horizon. AP, amortizing payment.

b The fraction of individuals that strictly prefer having the time limit to no time limits throughout the time horizon.

TABLE XI

EFFECTS OF FIXED WORK SUBSIDIES[a]

	Baseline	Dynamic Type-1 Subsidy			Dynamic Type-2 Subsidy			Static Subsidy		
		$25	$50	$100	$25	$50	$100	$25	$50	$100
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A (present-biased individuals):										
Work (%)	71.3	78.7	82.8	87.7	70.8	70.7	69.5	78.3	82.1	86.6
Welfare (%)	31.0	26.0	23.4	21.0	31.4	31.4	32.2	26.2	23.9	21.6
No work, no welfare (%)	9.7	8.5	7.5	5.8	9.8	10.0	10.5	8.6	7.7	6.2
Work, no welfare (%)	59.3	65.5	69.1	73.2	58.8	58.6	57.3	65.2	68.3	72.2
No work, welfare (%)	19.0	12.9	9.7	6.5	19.4	19.3	19.9	13.0	10.2	7.2
Work, welfare (%)	12.0	13.2	13.7	14.5	12.0	12.1	12.2	13.2	13.7	14.4
AP Earnings ($)	1063.0	1153.6	1215.1	1294.2	1055.1	1051.9	1028.0	1148.1	1203.0	1275.5
AP Net gov. expenditure ($)	-66.8	-71.5	-65.9	-38.9	-63.6	-61.6	-52.7	-69.2	-61.6	-32.8
AP Income ($)	996.2	1082.1	1149.2	1255.3	991.5	990.3	975.3	1078.9	1141.4	1242.7
AP Long-run utility	252.0	265.7	281.8	315.4	252.6	253.3	252.6	266.4	283.2	316.9
Panel B (time-consistent individuals):										
Work (%)	66.1	75.7	82.1	89.5	65.9	65.8	65.4	75.3	81.6	88.2
Welfare (%)	29.5	28.4	27.6	26.5	29.7	30.0	30.6	28.6	27.8	26.8
No work, no welfare (%)	22.3	16.1	11.8	7.1	22.2	22.1	22.0	16.3	12.2	7.8
Work, no welfare (%)	48.3	55.5	60.6	66.4	48.0	47.8	47.4	55.1	60.0	65.4
No work, welfare (%)	11.6	8.2	6.0	3.4	11.9	12.1	12.6	8.5	6.3	4.0
Work, welfare (%)	17.8	20.1	21.6	23.1	17.9	17.9	18.0	20.1	21.5	22.8
AP Earnings ($)	458.4	502.5	535.1	576.9	454.0	448.8	440.3	497.6	529.2	567.8
AP Net gov. expenditure ($)	53.8	67.1	85.3	127.9	56.5	59.9	66.5	69.6	88.1	131.6
AP Income ($)	512.2	569.6	620.4	704.8	510.5	508.7	506.8	567.2	617.3	699.4
AP Long-run utility	105.5	116.0	129.0	159.1	106.8	107.8	110.8	117.0	131.4	162.9

a Results in Panel A are based on control group members who have a present-bias factor of lower than 0.9 in the baseline model. Results in Panel B are based on control group members who have a present-bias factor of at least 0.9 in the baseline model. Simulations are conducted from period 1 to the end of the time horizon. AP, amortizing payment.

TABLE XII

EFFECTS OF FIXED NONWORK TAXES[a]

	Baseline	Dynamic Type-1 Tax			Dynamic Type-2 Tax			Static Tax		
		$50	$100	$200	$50	$100	$200	$50	$100	$200
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A (present-biased individuals):										
Work (%)	71.3	75.2	78.9	86.0	81.6	85.3	89.0	84.2	89.1	94.3
Welfare (%)	31.0	28.9	26.8	23.1	23.9	21.7	19.8	22.8	20.4	18.3
No work, no welfare (%)	9.7	8.6	7.6	5.4	8.0	6.9	5.7	6.9	5.2	2.9
Work, no welfare (%)	59.3	62.4	65.5	71.4	68.2	71.4	74.6	70.3	74.5	78.8
No work, welfare (%)	19.0	16.2	13.5	8.6	10.4	7.8	5.3	8.9	5.7	2.8
Work, welfare (%)	12.0	12.8	13.4	14.5	13.5	13.9	14.4	13.9	14.7	15.5
AP Earnings ($)	1063.0	1115.4	1167.4	1270.4	1199.4	1259.0	1320.3	1240.5	1321.9	1406.4
AP Net gov. expenditure ($)	-66.8	-81.3	-95.3	-120.5	-108.8	-126.0	-142.8	-118.7	-140.1	-158.5
AP Income ($)	996.2	1034.1	1072.1	1149.9	1090.6	1133.0	1177.5	1121.8	1181.8	1247.9
AP Long-run utility	252.0	252.4	253.2	258.5	249.8	250.1	250.0	252.1	254.6	259.1
Fraction that prefers policy (%)[b]	-	69.9	69.9	69.9	0.0	0.0	0.0	19.9	29.2	45.7
Panel B (time-consistent individuals):										
Work (%)	66.1	68.7	71.0	76.5	80.5	86.0	90.2	82.8	89.5	94.8
Welfare (%)	29.5	28.8	28.3	27.5	28.1	27.4	26.9	27.7	26.9	26.1
No work, no welfare (%)	22.3	20.8	19.4	15.8	12.9	9.4	6.7	11.4	7.0	3.5
Work, no welfare (%)	48.3	50.4	52.2	56.6	59.1	63.2	66.4	60.9	66.1	70.4
No work, welfare (%)	11.6	10.5	9.6	7.7	6.6	4.6	3.1	5.8	3.5	1.7
Work, welfare (%)	17.8	18.3	18.7	19.8	21.5	22.8	23.8	21.9	23.4	24.4
AP Earnings ($)	458.4	475.6	489.4	516.9	526.2	559.8	590.3	539.6	579.9	616.8
AP Net gov. expenditure ($)	53.8	48.6	45.2	40.9	44.1	41.4	41.7	41.0	38.2	38.5
AP Income ($)	512.2	524.2	534.6	557.8	570.3	601.2	632.0	580.6	618.1	655.3
AP Long-run utility	105.5	103.0	100.8	97.4	93.7	87.2	81.7	91.3	83.6	78.9

a Results in Panel A are based on control group members who have a present-bias factor of lower than 0.9 in the baseline model. Results in Panel B are based on control group members who have a present-bias factor of at least 0.9 in the baseline model. Simulations are conducted from period 1 to the end of the time horizon. AP, amortizing payment.

b The fraction of individuals that strictly prefer the nonwork tax to no nonwork tax throughout the time horizon.

TABLE XIII

PREDICTED CHOICE PROBABILITIES UNDER FTP TIME LIMIT, BASELINE MODEL[a]

Cumulative Periods of Welfare Use Under Time Limit	Panel A: Present-Biased Individuals						Panel B: Time-Consistent Individuals					
	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)
No work, no welfare last period:												
1	32.2	28.7	44.1	27.2	23.7	4.9	18.3	23.2	63.2	13.6	18.5	4.7
3	32.7	28.0	44.2	27.8	23.1	4.9	18.8	21.4	64.7	13.8	16.4	5.0
5	35.7	25.8	44.2	30.1	20.1	5.7	19.2	18.2	67.3	14.5	13.5	4.7
7	43.1	18.6	46.3	35.1	10.6	8.0	20.8	10.1	72.4	17.5	6.8	3.3
Work, no welfare last period:												
1	92.0	12.2	5.1	82.7	2.8	9.3	79.0	21.0	17.4	61.6	3.6	17.4
3	92.2	11.5	5.2	83.3	2.6	8.9	78.9	19.3	17.7	63.1	3.4	15.8
5	92.6	11.9	4.9	83.1	2.5	9.4	78.8	16.6	18.8	64.7	2.5	14.1
7	95.3	11.5	4.3	84.2	0.4	11.1	78.1	10.3	20.4	69.2	1.5	8.9
No work, welfare last period:												
1	24.7	74.2	15.1	10.6	60.1	14.1	19.8	68.9	26.5	4.6	53.7	15.3
3	25.7	73.8	15.4	10.8	58.9	14.8	19.8	67.0	28.6	4.5	51.6	15.3
5	29.2	73.1	15.7	11.3	55.1	18.0	21.4	62.3	32.2	5.5	46.4	15.9
7	42.8	66.7	19.5	13.7	37.7	29.1	23.6	49.3	43.3	7.4	33.0	16.3
Work, welfare last period:												
1	86.0	47.2	2.4	50.4	11.6	35.6	77.4	64.1	7.3	28.6	15.2	48.9
3	86.8	46.0	2.5	51.5	10.7	35.3	78.3	61.3	7.9	30.8	13.7	47.6
5	88.5	46.6	2.3	51.1	9.2	37.4	79.3	56.5	9.6	33.9	11.1	45.4
7	93.5	47.5	2.1	50.4	4.4	43.1	79.5	43.7	12.8	43.6	7.7	35.9

a Results in Panel A are based on control group members who have a present-bias factor of lower than 0.9 in the baseline model. Results in Panel B are based on control group members who have a present-bias factor of at least 0.9 in the baseline model. All other conditioning state variables are kept fixed as in quarter 1 following random assignment. Numbers in the choice distribution may be subject to rounding error. One period is defined as one quarter.

TABLE XIV

PREDICTED CHOICE PROBABILITIES UNDER DYNAMIC NONWORK TAX, BASELINE MODEL[a]

	Panel A: Present-Biased Individuals						Panel B: Time-Consistent Individuals					
	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)
No work, no welfare last period:												
No nonwork tax	26.4	37.1	41.2	21.7	32.4	4.7	17.6	28.1	59.5	12.4	22.9	5.3
Type-1 nonwork tax ($100)	29.4	35.8	40.1	24.1	30.5	5.3	16.2	28.0	60.6	11.4	23.2	4.8
Work, no welfare last period:												
No nonwork tax	89.8	15.9	5.6	78.5	4.6	11.4	78.0	25.5	16.3	58.1	5.7	19.8
Type-1 nonwork tax ($100)	94.8	15.4	2.7	81.9	2.6	12.8	84.7	26.0	11.6	62.3	3.6	22.4
No work, welfare last period:												
No nonwork tax	20.8	78.9	12.5	8.6	66.7	12.2	18.8	73.8	22.7	3.5	58.6	15.2
Type-1 nonwork tax ($100)	23.4	79.0	12.2	8.8	64.4	14.6	17.3	73.4	23.3	3.3	59.3	14.1
Work, welfare last period:												
No nonwork tax	80.6	53.3	2.1	44.6	17.3	35.9	76.7	69.0	6.4	24.6	17.0	52.1
Type-1 nonwork tax ($100)	88.7	51.2	1.3	47.5	10.0	41.2	83.6	69.2	4.8	26.0	11.6	57.6

a Results in Panel A are based on control group members who have a present-bias factor of lower than 0.9 in the baseline model. Results in Panel B are based on control group members who have a present-bias factor of at least 0.9 in the baseline model. All other conditioning state variables are kept fixed as in quarter 1 following random assignment. Numbers in the choice distribution may be subject to rounding error. One period is defined as one quarter.

TABLE XV

PREDICTED CHOICE PROBABILITIES UNDER FTP TIME LIMIT, TIME-CONSISTENT MODEL[a]

Cumulative Periods of Welfare Use Under Time Limit	Panel A: Present-Biased Individuals in the Baseline Model						Panel B: Time-Consistent Individuals in the Baseline Model					
	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)
No work, no welfare last period:												
1	35.0	31.3	39.4	29.3	25.6	5.7	18.4	20.1	65.9	14.0	15.7	4.4
3	35.1	29.3	41.1	29.6	23.8	5.5	18.8	18.7	66.9	14.4	14.3	4.4
5	36.1	26.5	42.8	30.7	21.1	5.4	19.7	16.5	68.1	15.4	12.2	4.3
7	41.8	15.6	48.1	36.3	10.1	5.5	20.6	11.0	71.9	17.2	7.6	3.4
Work, no welfare last period:												
1	93.7	12.5	4.1	83.4	2.2	10.3	81.0	18.5	16.9	64.6	2.2	16.4
3	93.8	12.0	4.1	83.9	2.1	9.9	80.6	17.9	17.2	64.9	2.2	15.7
5	94.0	11.0	4.1	84.9	1.8	9.2	81.1	15.8	17.4	66.8	1.5	14.3
7	95.4	7.6	4.0	88.4	0.5	7.1	80.4	12.2	18.2	69.6	1.4	10.8
No work, welfare last period:												
1	23.3	79.4	11.5	9.1	65.2	14.2	18.8	66.4	29.3	4.3	51.9	14.5
3	23.9	78.2	12.4	9.4	63.7	14.5	19.5	64.5	30.7	4.8	49.8	14.6
5	26.9	75.1	14.1	10.8	59.0	16.0	20.4	61.3	33.3	5.3	46.3	15.1
7	37.7	63.2	21.8	15.0	40.5	22.6	23.8	53.4	39.5	7.1	36.7	16.7
Work, welfare last period:												
1	85.7	49.6	1.9	48.5	12.4	37.2	80.3	60.4	7.7	31.9	12.0	48.4
3	87.3	46.9	2.0	51.1	10.7	36.2	80.3	58.9	8.3	32.9	11.5	47.4
5	88.9	45.0	2.0	53.0	9.1	35.9	80.8	55.5	9.1	35.4	10.0	45.4
7	93.0	38.9	2.4	58.8	4.6	34.3	80.6	48.1	10.4	41.4	9.0	39.2

a The model assumes that all individuals are time-consistent. Estimation results are provided in Appendix Table AII. Results in Panel A are based on control group members who have a present-bias factor of lower than 0.9 in the baseline model. Results in Panel B are based on control group members who have a present-bias factor of at least 0.9 in the baseline model. All other conditioning state variables are kept fixed as in quarter 1 following random assignment. Numbers in the choice distribution may be subject to rounding error. One period is defined as one quarter.

TABLE XVI

PREDICTED CHOICE PROBABILITIES UNDER DYNAMIC NONWORK TAX, TIME-CONSISTENT MODEL[a]

	Panel A: Present-Biased Individuals in the Baseline Model						Panel B: Time-Consistent Individuals in the Baseline Model					
	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)
No work, no welfare last period:												
No nonwork tax	33.2	37.4	35.4	27.2	31.4	6.0	17.7	26.7	61.0	12.4	21.3	5.3
Type-1 nonwork tax ($100)	32.8	37.4	35.6	27.0	31.6	5.8	16.7	26.0	62.2	11.8	21.1	4.9
Work, no welfare last period:												
No nonwork tax	92.0	15.6	4.3	80.1	3.7	11.9	80.8	25.2	15.0	59.7	4.2	21.1
Type-1 nonwork tax ($100)	95.1	14.6	2.7	82.7	2.2	12.4	85.9	25.6	11.3	63.0	2.8	22.9
No work, welfare last period:												
No nonwork tax	21.7	82.8	9.2	8.1	69.1	13.7	19.1	74.8	21.6	3.6	59.2	15.6
Type-1 nonwork tax ($100)	21.4	82.8	9.2	8.1	69.4	13.4	16.5	74.3	22.7	3.0	60.8	13.5
Work, welfare last period:												
No nonwork tax	83.2	54.2	1.6	44.2	15.1	39.0	79.0	68.8	5.8	25.4	15.2	53.6
Type-1 nonwork tax ($100)	88.3	52.5	1.0	46.5	10.7	41.8	83.8	68.6	4.6	26.8	11.6	57.0

a The model assumes that all individuals are time-consistent. Estimation results are provided in Appendix Table AII. Results in Panel A are based on control group members who have a present-bias factor of lower than 0.9 in the baseline model. Results in Panel B are based on control group members who have a present-bias factor of at least 0.9 in the baseline model. All other conditioning state variables are kept fixed as in quarter 1 following random assignment. Numbers in the choice distribution may be subject to rounding error. One period is defined as one quarter.

TABLE XVII

EFFECTS OF VARIOUS POLICIES, TIME-CONSISTENT MODEL[a]

Outcomes of Present-Biased Individuals in the Baseline Model	Baseline (1)	Expand Welfare (1.2x) (2)	Expand EITC (1.5x) (3)	Standard Time Limit (2-year) (4)	Prowork Time Limit (2-year) (5)	Type-1 Work Subsidy ($50) (6)	Type-1 Nonwork Tax ($100) (7)
Work (%)	81.4	64.3	87.2	89.6	87.4	88.1	84.4
Welfare (%)	24.5	39.3	20.2	11.4	18.8	19.7	22.6
No work, no welfare (%)	5.6	6.1	4.8	6.3	5.7	4.3	4.5
Work, no welfare (%)	69.9	54.6	75.0	82.2	75.5	76.0	72.8
No work, welfare (%)	13.0	29.5	8.0	4.1	6.8	7.5	11.1
Work, welfare (%)	11.5	9.7	12.1	7.3	11.9	12.1	11.6
AP Earnings ($)	1223.2	1018.4	1300.9	1334.2	1295.7	1310.6	1266.4
AP Net gov. expenditure ($)	-101.0	-37.2	-113.6	-137.0	-122.2	-80.3	-113.3
AP Income ($)	1122.2	981.2	1187.3	1197.2	1173.5	1230.3	1153.1
AP Long-run utility	251.3	252.4	258.5	246.5	248.7	278.6	250.4

a The model assumes that all individuals are time-consistent. Estimation results are provided in Appendix Table AII. Results are based on control group members who have a present-bias factor of lower than 0.9 in the baseline model. Simulations are conducted from period 1 to the end of the time horizon. AP, amortizing payment.

TABLE XVIII

PREDICTED POST-RANDOM-ASSIGNMENT OUTCOMES AND POLICY EFFECTS, MODELS ESTIMATED ON PRE-RANDOM-ASSIGNMENT DATA[a]

	Work (%)	Welfare (%)	No Work, no Welfare (%)	Work, no Welfare (%)	No Work, Welfare (%)	Work, Welfare (%)
Predicted outcomes in the control group (first eight quarters following random assignment):						
Baseline model[b]	52.2	43.8	23.1	33.2	24.7	19.1
Present-biased pre-RA model[c]	52.4	43.6	24.5	31.9	23.1	20.5
Time-consistent pre-RA model[d]	52.4	43.4	24.5	32.1	23.1	20.3
Predicted effects of FTP earnings disregard:[a]						
Baseline model[b]	+4.1	+5.0	-2.6	-2.5	-1.5	+6.5
Present-biased pre-RA model[c]	+2.1	+3.9	-1.5	-2.4	-0.6	+4.5
Time-consistent pre-RA model[d]	+2.5	+4.0	-1.7	-2.3	-0.8	+4.8
Predicted effects of FTP time limit:[a]						
Baseline model[b]	+5.1	-9.1	+2.3	+6.7	-7.4	-1.7
Present-biased pre-RA model[c]	-0.6	-14.4	+8.2	+6.2	-7.6	-6.9
Time-consistent pre-RA model[d]	-1.4	-18.2	+10.8	+7.4	-9.4	-8.8

a The validation sample consists of control group data from the first eight quarters following random assignment. All predicted policy effects are computed as the average percentage-point difference in outcomes between the actual control group environment and the counterfactual policy scenario. RA, random assignment.

b See Table IV for estimation results from the baseline model.

c The model is estimated with pre-RA specification and data, with the discount factor, present-bias factor, and naivety factor pre-fixed at 0.951, 0.918, and 0.843, respectively.

d The model is estimated with pre-RA specification and data, with the discount factor pre-fixed at 0.985.

APPENDIX TABLE AI

WORK INCENTIVES OF FIXED WORK SUBSIDIES AND NONWORK TAXES

	Type of Work Incentive			
	For Individuals who Worked Last Period		For Individuals who did not Work Last Period	
	Static[a]	Dynamic[b]	Static[a]	Dynamic[b]
Work subsidy:				
Dynamic Type-1	positive	positive	no effect	positive
Dynamic Type-2	no effect	negative	positive	negative
Static	positive	ambiguous	positive	ambiguous
Nonwork Tax:				
Dynamic Type-1	positive	negative	no effect	negative
Dynamic Type-2	no effect	positive	positive	positive
Static	positive	ambiguous	positive	ambiguous

a The current reward of working versus not working as given by the static budget constraint.

b The expected future reward of working versus not working under time-consistent preference.

APPENDIX TABLE AII

TIME-CONSISTENT MODEL, ESTIMATION RESULTS[a]

	Work (ϕ_H)			Welfare (ϕ_A)			Work&Welfare (ϕ_{HA})			Log Wage		
Intercept	-1125.70	(99.34)	***	-436.70	(59.58)	***	-3.15	(60.87)		4.52	(0.12)	***
Work (t-1)	443.41	(68.23)	***							1.16	(0.10)	***
Welfare (t-1)				388.17	(53.43)	***				-0.25	(0.11)	**
Work (t-1) * Welfare (t-1)							-68.79	(28.64)	**	0.12	(0.11)	
More than one child	-67.44	(13.26)	***	-132.45	(17.77)	***	116.22	(27.57)	***			
Race (nonwhite=1)	23.00	(18.27)		-56.53	(19.53)	***	85.78	(30.28)	***	-0.15	(0.03)	***
Grade 12 or above	-38.85	(38.05)		-10.59	(20.71)		23.98	(31.35)		0.33	(0.06)	***
Treatment group	-67.28	(19.53)	***	52.09	(26.04)	**	-6.51	(21.70)		0.12	(0.03)	***
Type 2 intercept	-227.85	(65.76)	***	16.44	(62.87)		-5.15	(74.33)		0.70	(0.03)	***
Type 3 intercept	326.74	(40.58)	***	-217.73	(36.51)	***	140.01	(52.92)	***	-1.16	(0.04)	***
Experience[b]										0.09	(0.04)	**
Experience* Grade 12 or above[b]										-0.04	(0.03)	
Experience squared[b]										0.01	(0.01)	
<u>Discount Factor (Annualized):</u>[c]												
Intercept	0.941	(0.056)	***									
<u>Standard deviation of shocks:</u>				<u>Type Probabilities:</u>								
Choice	217.02	(26.04)	***	Type 2			0.27	(0.04)	***			
Wage	0.84	(0.02)	***	Type 3			0.40	(0.04)	***			
Observed earnings	0.44	(0.01)	***									

a Number of observations = 2709, log-likelihood = 4431.428. Standard errors are given in parentheses. *, Significant at the 10 percent level; **, significant at the 5 percent level; ***, significant at the 1 percent level.

b Cumulative periods of employment since random assignment, expressed in half-year intervals.

c Coefficients are obtained by transformations from the logistic function. Standard errors are obtained by delta method.

APPENDIX TABLE AIII

MODEL ESTIMATED ON PRE-RANDOM-ASSIGNMENT DATA, ESTIMATION RESULTS[a]

	Work (ϕ_H)			Welfare (ϕ_A)			Work&Welfare (ϕ_{HA})			Log Wage		
Intercept	-1297.59	(435.62)	***	-1167.38	(433.96)	***	305.83	(130.13)	***	5.07	(0.12)	***
Work (t-1)	904.80	(407.91)	**							0.88	(0.11)	***
Welfare (t-1)				1038.14	(428.35)	**				-0.11	(0.11)	
Work (t-1) * Welfare (t-1)							-197.6	(115.88)	*	-0.11	(0.13)	
More than one child	-40.01	(26.90)		-108.59	(25.01)	***	48.31	(39.41)				
Race (nonwhite=1)	12.86	(27.76)		-35.76	(24.78)		93.78	(56.73)	*	-0.11	(0.05)	**
Grade 12 or above	-3.47	(45.29)		52.77	(31.39)	*	-35.87	(60.83)		0.48	(0.09)	***
Treatment group	-21.68	(36.14)		-18.07	(28.91)		0.10	(32.53)		0.00	(0.05)	
Type 2 intercept	210.67	(97.03)	**	-50.50	(42.43)		-60.24	(91.99)		-1.35	(0.05)	***
Experience[b]										0.17	(0.09)	*
Experience* Grade 12 or above[b]										-0.09	(0.04)	**
Experience squared[b]										-0.02	(0.02)	
Discount Factor (Annualized):[c]												
Intercept	0.424	(0.439)										
Standard deviation of shocks:				Type Probabilities:								
Choice	361.41	(144.56)	**	Type 2			0.54	(0.04)	***			
Wage	0.63	(0.05)	***									
Observed earnings	0.63	(0.04)	***									

a Number of observations = 2709, log-likelihood = 3731.285. Standard errors are given in parentheses. *, Significant at the 10 percent level; **, significant at the 5 percent level; ***, significant at the 1 percent level.

b Cumulative periods of employment since random assignment, expressed in half-year intervals.

c Coefficients are obtained by transformations from the logistic function. Standard errors are obtained by delta method.