Marriage, Labor Supply and the Social Safety Net *

Hamish Low[†] Costas Meghir[‡] Luigi Pistaferri[§] Alessandra Voena[¶]

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Abstract

This paper develops a dynamic model of marriage, labor supply, welfare participation, savings and divorce under limited commitment and uses it to understand the impact of welfare reforms, particularly the time-limited eligibility, as in the TANF program. In the model, welfare programs can affect whether marriage and divorce take place, the extent to which people work as single or as married individuals, as well as the allocation of resources within marriage. The model thus provides a framework for estimating not only the short-term effects of welfare reforms on labor supply, but also the extent to which welfare benefits affect family formation and the way that transfers are allocated within the family. This is particularly important because many of these benefits are ultimately designed to support the well-being of mothers and children. The limited commitment framework in our model allows us to capture the effects on existing marriages as well as marriages that will form after the reform has taken place, offering a better understanding of transitional impacts as well as longer run effects. Using variation provided by the introduction of time limits in welfare benefits eligibility following the Personal Responsibility and Work Opportunity Act of 1996 (welfare reform) and data from the Survey of Income and Program Participation between 1985 and 2011, we provide reduced form evidence of the importance of these reforms on a number of outcomes relevant to our model. We then estimate the parameters of the model using the pre-reform data, and show that such a model can replicate the main reduced form estimates. We use the model to perform welfare and counterfactual exercises.

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[†]University of Cambridge.

[‡]Yale University, NBER and IFS.

[§]Stanford University, NBER, CEPR and SIEPR.

[¶]The University of Chicago, CEPR and NBER (email: avoena@uchicago.edu).

Welfare programs constitute an important source of insurance for low-income households, particularly in an incomplete markets world in which people have little protection against income and employment shocks. If carefully targeted and designed to minimize work disincentives, social insurance programs can increase overall welfare. However, if the potential disincentives are not taken into account they can distort family formation, saving and work decisions with far reaching consequences. These issues have been the source of continuous debate and underlie the major US welfare reform of 1996. The key innovation of the Personal Responsibility and Work Opportunity Act of 1996 (PRWORA) was to introduce lifecycle time limits on receipt of welfare benefits as well as reduce or remove marital disincentives implicitly built into the preceding program, the Aid for Families with Dependent Children (AFDC), while increasing the relative importance of in-work benefits through the Earned Income Tax Credit (EITC). Understanding the tradeoff between incentives and insurance for such programs and their broader effects both in the short run and the long run is a central motivation of this paper.

The PRWORA of 1996 gave the states greater latitude in setting their own parameters for welfare. However, the length of period over which federal government funds (in the form of block grants) could be used to provide assistance to needy families was limited to sixty months. About one-third of states adopted shorter time limits. States could also set longer limits but would have to cover the financial obligations with their own funds. In Table we show how time limits differ across states in 2000. The result of the flexibility brought about by PRWORA was that the new program varied widely from state to state, with the number of years that it would be available for any one individual being set in a decentralized way. Indeed Arizona just moved to a new limit of just one year[1], while some states have imposed no limits (at least initially). [2] In addition, the new program removed the requirement of being single to be eligible for benefits, as was the case in most states under AFDC, thus seeking to reduce the disincentives to marry.

Our aim is to understand how this set of reforms affected women over their life cycles. We recognize that the immediate effects may differ from those in the long run because people

[1]New York Times May 20, 2016.

[2]This is the case of Michigan, who started with no formal time limits but moved to imposing a 4 year time limit in 2008.

Table 1: Time Limits in the year 2000

Type of limit	Duration	State
No limit	n.a.	Michigan, Vermont, Maine
Benefit reduction	60	California, Maryland, Rhode Island
Benefit reduction	24	Indiana
Periodic	24/48	Nebraska
Periodic	24/84	Oregon
Periodic	24/60	Arizona, Massachussets
Periodic	36/60	Ohio
Lifetime	60	Alabama, Alaska, Colorado, D.C., Hawaii, Illinois, Iowa, Kansas, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Montana, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, Washington, West Virginia, Wisconsin, Wyoming
Lifetime	48	Georgia, Florida
Lifetime	36	Delaware, Utah
Lifetime	24	Montana, Idaho, Arkansas
Lifetime	21	Connecticut

Notes: Source: Welfare Rules Database (http://wrd.urban.org).

who know the new institutional framework is in place at the start of their careers before they make work and family choices, can plan their life in a different way than those who are surprised by the changes, having made a number of prior decisions consistent with the previous institutional framework. We thus start by estimating the immediate impact of the reform on welfare participation, employment, asset accumulation and marital status. This serves the dual purpose of documenting the direct effects and showing that indeed the margins we are considering do respond to changes in the institutional setting, a premise that underlies our model. To estimate the immediate effects we use a difference-in-differences framework exploiting the fact that the new welfare rules varied by state and affected different demographic groups differently. For example, women whose youngest child is close enough to 18 years old (when benefit eligibility terminates anyway) would have remained unaffected by the time limits, while women with younger kids may be affected, depending on the actions taken by their state of residence. Based on this approach we show that welfare utilization declined quite dramatically and persistently, employment of women increased, while the flow of *both* marriages and divorces declined, with no detectable effects on fertility.

The reduced form analysis can reliably document the impacts that occurred but cannot reveal the longer-run dynamics of nor the rich underlying mechanisms through which policy changes take place. For this purpose we need to develop a model of female marital and labor supply choices, which can be used both for understanding the dynamics and the mediating factors and for counterfactual analysis, leading us to a better understanding of the tradeoffs involved in designing and reforming welfare programs.

In the model we specify, marriage, divorce, welfare program participation, labor supply and savings are endogenous choices. In an attempt to understand better how welfare reform can affect intrahousehold inequality both in the longer run and the short run we characterize intrahousehold allocations within a limited commitment framework in which the outside options of hasband and wife are key determinants of both the willingness to marry and the way resources are allocated within the household. Depending on the circumstances, the Pareto weights and hence the allocation of resources changes to ensure that the marriage can continue (if at all possible).

A key element of our approach is the budget constraint and how this is shaped by the welfare system. We account for the structure of the welfare system that low-income households are likely to face, including TANF, Food Stamps, and the Earned Income Tax credit (EITC). The full structure, including the budget constraint, allows us to understand the dynamics implied by the time limits and more generally to evaluate how the structure of welfare affects marriage, labor supply and the allocation of resources within the household. This latter point is important because it allows us to address the issue of inequality and how this is affected by policy.

We estimate our model using the SIPP data for the 1990-2011 period using the method of simulated moments (McFadden, 1989; Pakes and Pollard, 1989). We restrict our sample to women between the ages of 18 and 60 who are not college graduates and for whom the policy changes are directly pertinent.

Our paper builds on existing work relating both welfare reform and lifecycle behavior. The literature on the effects of welfare reform is large and contentious and would take too long to list here. Excellent overviews are featured in Blank (2002) and Grogger and Karoly (2005). Experimental studies have highlighted that time limits encourage households to limit benefit utilization to "bank" their future eligibility (Grogger and Michalopoulos, 2003) and more generally are associated with reduced welfare participation (Swann, 2005; Mazzolari and Ragusa, 2012).

The literature on employment effects of welfare reform has primarily focused on the sample of single women (see, for instance, Keane and Wolpin (2010)). This is not surprising, given that both institutionally and in practice single women with children are the main recipients and targets of welfare programs such as AFDC or TANF. Recently, Chan (2013) indicates that time limits associated with welfare reform are an important driver of the increase of labor supply in this group. Kline and Tartari (forthcoming) examine both intensive and extensive margin labor supply responses in the context of the Connecticut Jobs First program, which imposed rather stringent time limits. Limited evidence on the overall effect of welfare reform on household formation and dissolution suggests that the reform was associated with a small decline in both marriages and divorces, although the estimated effects tend to be rather noisy (Bitler et al., 2004).

Our paper draws from the literature on dynamic career models such as Keane and Wolpin (1997) and subsequent models that allow for savings and labor supply in a family context such as Blundell et al. (2016). We build on this literature by endogenizing both marriage and divorce and allowing intra-household allocations to evolve depending on changes in the economic environment and preferences. The theoretical underpinnings draw from Chiappori (1988, 1992) and Blundell, Chiappori and Meghir (2005) and its dynamic extension by Mazzocco (2007*b*). We apply the risk sharing framework with limited commitment of Ligon, Thomas and Worrall (2000) and Ligon, Thomas and Worrall (2002*b*) as extended to the lifecycle marriage model by Voena (2015).[3] Thus we specify a framework that allows us to analyze the way that policy can affect key lifecycle decisions, including marriage, divorce,

[3]Our paper also relates to the life cycle analyses of female labor supply and marital status (Attanasio, Low and Sanchez-Marcos, 2008; Fernández and Wong, 2014; Blundell et al., 2016) and contributes to existing work on taxes and welfare in a static context including Heckman (1974), Burtless and Hausman (1978), Keane and Moffitt (1998), Eissa and Liebman (1995) for the US as well as Blundell, Duncan and Meghir (1998) for the UK and many others.

savings and labor supply.[4]

To summarize, our paper offers a number of innovations. First, this is the first model to endogenize marriage and divorce and to model intrahousehold allocations in a limited commitment framework, allowing for savings and subject to search frictions in the marriage market, where people meet patterns drawn from the empirical distribution of singles. Second, we do this while taking into account the detailed structure of welfare benefits. Third, we use the short run effects of the reform to validate our model. Finally, we are able to use our model to estimate the welfare effects of the program and to perform counterfactual analysis.

In what follows we present first the data and the reduced form analysis of the effects of the time limits component of the PRWORA. We then discuss our model, followed by estimation, analysis of the implications and counterfactual policy simulations. We end with some concluding remarks.

1 The Data and Empirical Evidence on the Effects of Time Limits

We use eight panels of the Survey of Income and Program Participation (SIPP) spanning the 1990-2011 period.[5] The SIPP is a representative survey of the US population collecting detailed information on participation in welfare and social insurance programs in the US. In each panel, people are interviewed every four months for a certain number of times (waves).[6] We restrict the sample to individuals between 18 and 60, with at least one child under age 19, and who are not college graduates. We focus on low-skilled individuals because they are the typical recipients of welfare programs. Due to the well-known "seam effect" (Young, 1989), we keep only the 4th monthly observations for each individual. Table 12 in the Appendix describes the sample selection in detail: our main regression sample comprises of 75,938 women, contributing 455,514 quarterly observations. Of these women, 64,739 are heads or spouses of the head of their household, leading to a total of 406,370 quarterly observations.

[4] See Persson (2014) for an example of how social policy can directly influence household formation.

[5] We use the 1990, 1991, 1992, 1993, 1996, 2001, 2004 and 2008 panels.

[6] The number of waves differ by panels. For example, the 1990 panel covers eight waves, while the 1993 panel was conducted for nine waves.

Table 2: Summary statistics

Variable	Obs	Mean	Std. Dev.
Welfare participation	406,370	0.067	0.250
Welfare participation (married)	286,425	0.024	0.152
Welfare participation (unmarried)	119,945	0.170	0.375
Employed	455,514	0.636	0.481
Employed (married)	287,528	0.636	0.481
Employed (unmarried)	167,986	0.636	0.481
Divorced or separated	455,514	0.158	0.364
Gets divorced or separated	455,514	0.032	0.175
Married	455,514	0.631	0.482
Gets married	455,514	0.102	0.302
Age	455,514	35.260	9.366
$Exposed * Post$	455,514	0.397	0.489
Age of youngest child	455,514	7.692	5.591
Number of children	455,514	1.981	1.085
Age	455,514	35.260	9.366
White	455,514	0.783	0.413
Disabled	455,514	0.113	0.316

Notes: Data from the 1990-2008 SIPP panels. Sample of households in which the head is not a college graduate and which have children below the age of 19.

Table 2 summarizes the data. Women in our sample are on average 35 years old. The program participation rate (AFDC/TANF), which is overall 7% in this population, is only 2.4% for married heads of household and jumps to 17% for unmarried heads. There is a 1% annual divorce rate and 2% annual marriage rate. The employment rate for married and unmarried women is about the same at 63%. Table 2 in the Appendix shows how these socio-demographic characteristics vary in the pre-reform period. In particular, welfare participation rates are higher and employment rates lower.

Below, we describe a simple strategy to examine the relationship between the introduction of time limits through welfare reform and our outcome variables of interest: welfare benefit utilization, female employment, marital status, and fertility.

1.1 Empirical strategy

The basic idea behind our descriptive empirical strategy is to compare households that, based on their demographic characteristics and state of residence, could have been affected by time limits with households that were not affected, before and after time limits were introduced. This strategy extends prior work about time limits and benefits utilization (Grogger and Michalopoulos, 2003) to cross-state variation.

We define a variable $Treat$ which takes value 0 if the household's expected benefits have *not* changed as a result of the reform, assuming the household has never used benefits before.[7] $Treat$ takes value 1 if a household's benefits (in terms of eligibility or amounts) have been affected in any way by the reform. Hence, $Treat$ is a function of the demographic characteristics of a household and the rules of the state the household resides (which may change over time - something we allow for in estimation - both because states differ with regards to the date where the time limit clock starts to tick and because some states change their statutory time limits during the sample period).

For example, if a households's youngest child is aged 13 or above in year t and the state's lifetime limit is 60 months, the variable $Treat$ takes value 0, while if a households's youngest child is aged 12 or below in year t and the state's lifetime limit is 60 months, the variable $Treat$ takes value 1.

As well, if a households's youngest child is aged 13 in year t and the state has an intermittent limit of 24 months every 60, the variable $Treat$ takes value 1. Lastly, if a households's youngest child is aged 16 in year t and the state's time limit is an intermittent limit of 24 months every 60 months, the variable $Treat$ takes value 0, because the household would be eligible for at most 24 months both pre- and post-reform.

The estimation equation for household i with demographics d (age of the youngest child)

[7]The relationship between our exposure variable and the effect of time limits becomes increasingly attenuated as time goes by, since we cannot observe the actual history of welfare utilization. Moreover, in most states the reform also imposed stricter work requirements, so that a level effect on employment may be expected across both treated and control states. However, unless work requirements interact with age of children in a complex way, our strategy still identifies the differential effect of time limits. Finally, most states reduce child's age eligibility to 17 if the child is not in school - a complication we ignore.

in state s at time t takes the form:

$$y_{idst} = \alpha Treat_{dst} * Post_{st} + \mathbf{X}_{idst}\boldsymbol{\beta} + fe_{st} + fe_{ds} + fe_{s} + fe_{t} + fe_{d} + \epsilon_{idst}$$

where $Post_{st}$ equals 1 if state s has enacted the reform at time t and 0 otherwise. We include state, year and demographic (age of the youngest child) fixed effects, as well as state by time fixed effects to account for differential trends and state by demographic fixed effects to allow for heterogeneity across states in the way demographic groups behave. Hence, this exercise can be seen as a difference-in-differences one that compares demographic groups before and after the welfare reform.

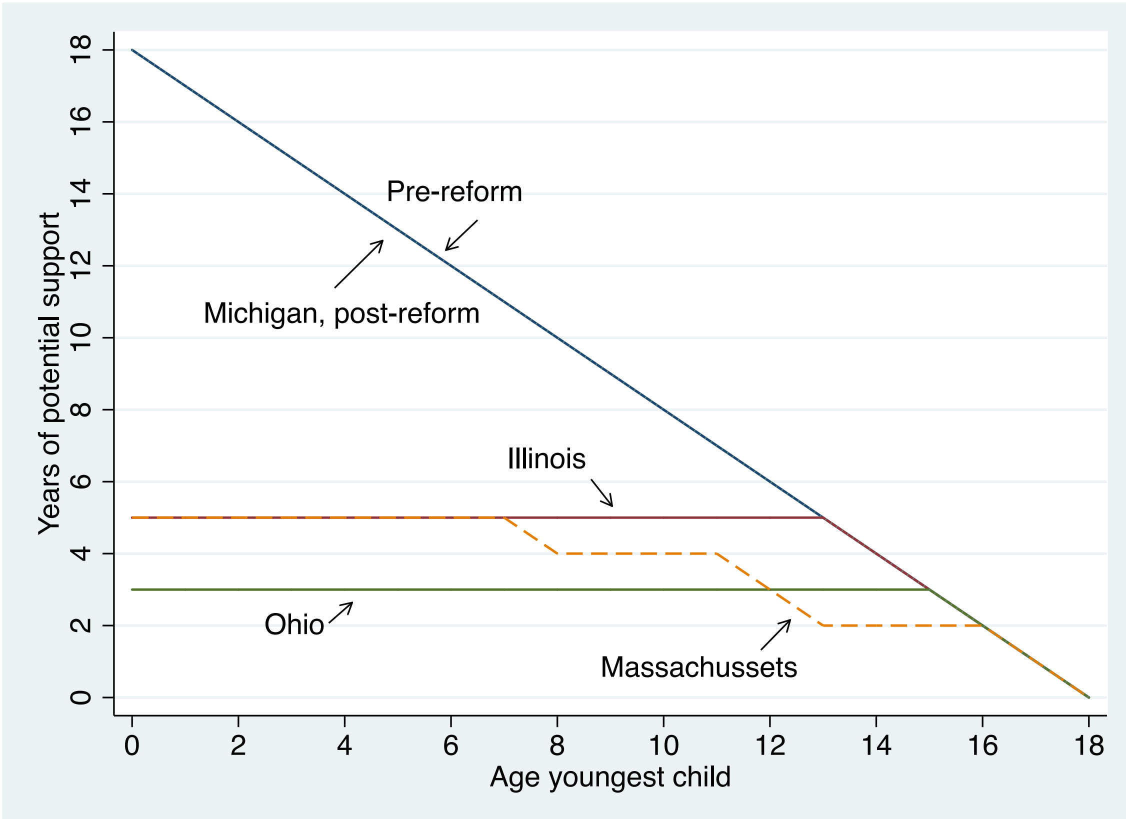
Figure 1 illustrates the definition of the variable $Treat$. The horizontal axis represents the age of the youngest child in the household. The vertical axis represents the number of years of potential benefits the household can claim. The blue solid line (Pre-reform) indicates that before the reform the household could claim benefits for as many years as the difference between 18 and the age of the youngest child. Post-reform, Michigan maintain a similar regime. The variable $Treat$ is equal to 0 whenever the line representing the regime the household is exposed to equals the pre-reform line, and 1 otherwise.

The variable $Post_{st}$ is constructed based on the timing of the introduction of time limits reported in Mazzolari and Ragusa (2012).

To study the relationship between time limits and outcome variables over time, we allow the variable $Treat_{ds}$ to interact differently with each calendar year between the reform and 2011. Moreover, we estimate pre-reform interactions with year dummies to rule out pre-reform trends across demographic groups.

$$y_{idst} = \sum_{\tau=1992}^{2011} \alpha_{\tau} Treat_{dst} * \mathbf{1}\{t = \tau\}_{t} + \mathbf{X}_{idst}\boldsymbol{\beta} + fe_{st} + fe_{ds} + fe_{s} + fe_{t} + fe_{d} + \epsilon_{idst}.$$

Figure 1: Time limits and the definition of treatment



1.2 Empirical Results

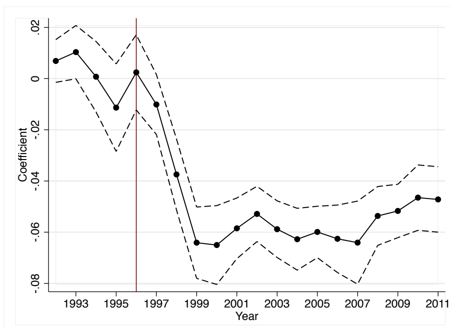
1.2.1 Benefits utilization

We start by examining changes in the utilization of AFDC and of TANF. On average, in our sample, 7% of households are claiming benefits (Table 2); among households headed by an unmarried person, the rate is close to 17%.

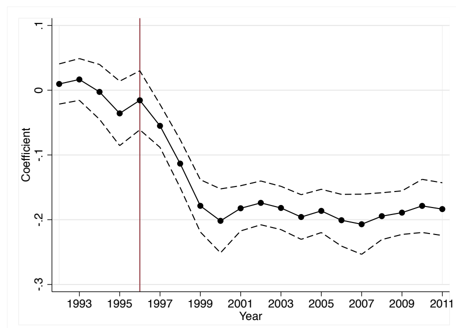
Households that are likely to be affected by the welfare reform based on the age of their youngest child have a 5 percentage points lower probability of claiming benefits after the introduction of time limits (Table 3, columns 1 and 2). Treated households headed by an unmarried person have 15 percentage points lower probability of claiming welfare benefits after welfare reform, while those headed by a married head have 2 percentage points lower probability of claiming such benefits.

Examining how treatment interacts with year dummies, we notice that the utilization rate among treated households begins to significantly decline in 1998, down to a persistent drop of 6 percentage points by 1999 (figure 2, panel A). It hence appears that households reduce their benefits utilization *before* anyone is likely to have run out of benefits eligibility. Similar time patterns are observed among the marital status subgroups and are particularly strong for single mothers.

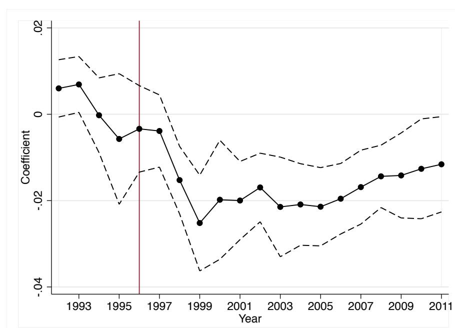
Figure 2: Program participation dynamics



(a) Everyone



(b) Unmarried head

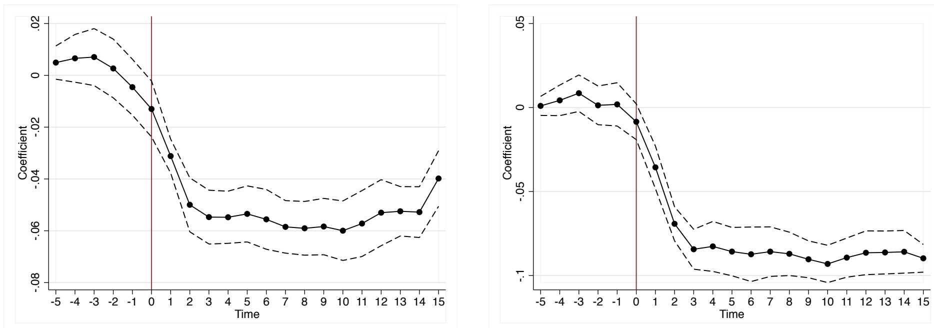


(c) Married head

Notes: Data from the 1990-2008 SIPP panels. Sample of households in which the head is not a college graduate with at least a child below age 19. The full set of controls includes age dummies, education dummies, number of children dummies, year-by-month fixed effects, state fixed effects, demographics fixed effects, state-by-demographics fixed effects, state-by-year fixed effects, race and disability status.

To verify this intuition, we re-define the annual treatment dummies as $Treated_{dst}\mathbf{1}\{\tau\, years\, since\, TL\}_{st}$, hence counting the number of years since the official introduction of time limits in each state. We perform this exercise on the overall sample and on the sample that excludes states with shorter time limits (less or equal to 24 months). The goal is to verify whether the decline in welfare utilization takes place before households may have reasonably exhausted their eligibility. As shown in figure 3, the fraction of household claiming benefits begins to decline immediately after the introduction of time limits, suggesting that foresight (in the form of "banking" of benefits) is a key driver of the reduction in welfare utilization.

Figure 3: Program participation dynamics relative to the introduction of time limits



(a) Everyone (b) States with limit above 24 months

Notes: Data from the 1990-2008 SIPP panels. Sample of households in which the head is not a college graduate with at least a child below age 19. The full set of controls includes age dummies, education dummies, number of children dummies, year-by-month fixed effects, state fixed effects, demographics fixed effects, state-by-demographics fixed effects, state-by-year fixed effects, race and disability status.

1.2.2 Employment

The introduction of time limits is associated with a 3 percentage points (pp) increase in the employment probability of women, while the sample average employment rate is 63%. The result is mostly driven by an 8 pp point increase in the employment of unmarried women. (table 4). The increase in employment is likely a direct consequence of the decline in welfare utilization. However, there is not a one-to-one match, implying that some of the welfare leavers do not move back into work - some may have moved onto more intense utilization of alternative social insurance programs (such as Food Stamps, SSI, etc.), or different residential arrangements (such as return to parental home).

1.2.3 Household formation and dissolution

A central motivation (and indeed a statutory goal) of the 1996 welfare reform was to encourage "the formation and maintenance of two-parent families". In studying this relationship, we first consider the impact of welfare reform on the probability of being divorced or separated for women. We find that treated women are 3 percentage points less likely to be divorced after the introduction of time limits (table 5, columns 1 and 2).

As shown in the last two columns of Table 5, the decline in divorce was not associated with an increase in the fraction of women who are married. On the contrary, there was 1.6 percentage points decline in the proportion married.

Thus there seem to be more people staying together but at the same time fewer are getting married as a result of the reform. In theory, as discussed by (Bitler et al., 2004), the effects of the welfare reform on household formulation and household dissolution are not obvious. The welfare reform, by curtailing the extent of public insurance available to low-income women, may have induced those who were already married to attach a higher value to marriage as a valuable risk sharing tool (through male labor supply, for example). For single women, this channel may have been counteracted by the overall decline in the attractiveness of a new marriage in the absence of the safety net that the imposition of time limits generated.

1.2.4 Fertility

Because our empirical strategy, in this section of the paper, relies on the age of the youngest child as a source of predetermined variation, it is not suited to examine contemporary changes in fertility outcomes, which directly affect the age of the youngest child. Hence, to examine whether time limits influenced fertility outcomes, we focus on the probability that a household will have a newborn (a child below age 1) in the following year, with the specification:

$$newborn_{idst+1} = \alpha Treat_{dst} * Post_{st} + \mathbf{X}_{idst}\boldsymbol{\beta} + fe_{st} + fe_{ds} + fe_s + fe_t + fe_d + \epsilon_{idst}$$

Appendix table 13 reports the results of estimating this regression on the whole sample and on subsamples that depend on marital status. In no specification do we find that exposure to time limits influences the probability of future births, irrespective of marital status.

Table 3: Benefits utilization

VARIABLES	(1) AFDC/ TANF	(2) AFDC/ TANF	(3) AFDC/ TANF married	(4) AFDC/ TANF married	(5) AFDC/ TANF unmarried	(6) AFDC/ TANF unmarried
$Treat_{dst}Post_{st}$	-0.0504***	-0.0502***	-0.0180***	-0.0177***	-0.157***	-0.154***
	(0.00284)	(0.00275)	(0.00243)	(0.00234)	(0.0102)	(0.00935)
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Race	No	Yes	No	Yes	No	Yes
Disability status	No	Yes	No	Yes	No	Yes
Unemp. rate*Demog.	No	Yes	No	Yes	No	Yes
Observations	406,370	406,370	286,425	286,425	119,945	119,945
R-squared	0.070	0.108	0.043	0.058	0.172	0.196

Standard errors in parentheses clustered at the state level
*** p<0.01, ** p<0.05, * p<0.1

Notes: Data from the 1990-2008 SIPP panels. Sample of households in which the head is not a college graduate with at least a child below age 19. The full set of controls includes age dummies, education dummies, number of children dummies, year-by-month fixed effects, state fixed effects, demographics fixed effects, state-by-demographics fixed effects, state-by-year fixed effects. Standard errors in parentheses, clustered at the state level.

Table 4: Employment status - Women

VARIABLES	(1) employed	(2) employed	(3) employed married	(4) employed married	(5) employed unmarried	(6) employed unmarried
$Treat_{dst}Post_{st}$	0.0328***	0.0294***	0.00318	0.00187	0.0800***	0.0716***
	(0.00596)	(0.00531)	(0.00717)	(0.00652)	(0.00855)	(0.00788)
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Race	No	Yes	No	Yes	No	Yes
Disability status	No	Yes	No	Yes	No	Yes
Unemp. rate*Demog.	No	Yes	No	Yes	No	Yes
Observations	455,514	455,514	287,528	287,528	167,986	167,986
R-squared	0.058	0.104	0.055	0.084	0.080	0.168

Standard errors in parentheses clustered at the state level
*** p<0.01, ** p<0.05, * p<0.1

Notes: Data from the 1990-2008 SIPP panels. Sample of non-college graduates with at least a child below age 19. The full set of controls includes age dummies, education dummies, number of children dummies, year-by-month fixed effects, state fixed effects, demographics fixed effects, state-by-demographics fixed effects, state-by-year fixed effects. Standard errors in parentheses, clustered at the state level.

Table 5: Divorce and marriage

VARIABLES	(1) divorced/ separated	(2) divorced/ separated	(3) married	(4) married
$Exposed_{dst}Post_{st}$	-0.0271*** (0.00601)	-0.0260*** (0.00573)	-0.0132* (0.00173)	-0.0160** (0.00176)
Basic controls	Yes	Yes	Yes	Yes
Race	No	Yes	No	Yes
Disability status	No	Yes	No	Yes
Unemp. rate*Demog.	No	Yes	No	Yes
Observations	455,514	455,514	455,514	455,514
R-squared	0.023	0.030	0.152	0.208

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Data from the 1990-2008 SIPP panels. Sample of non-college graduate women with at least a child below age 19. The full set of controls includes age dummies, education dummies, number of children dummies, year-by-month fixed effects, state fixed effects, demographics fixed effects, state-by-demographics fixed effects, state-by-year fixed effects. Robust standard errors in parentheses.

1.3 Robustness checks

1.3.1 Attrition in the SIPP sample

To address concerns regarding the high rate of attrition in the SIPP (Zabel, 1998), we limit our analysis to the first two waves of each SIPP panel. In Appendix table 14 we show that this adjustment leaves the results unaffected.

1.3.2 Exclude mothers of young children

A potential concern is that our results are driven by changes in the behavior of households with small children after welfare reform as a result of the childcare provisions in the PRWORA.[8] However, Appendix table 15 shows that the results are robust to excluding households in which the youngest child is below the age of 6.

2 The model

The empirical result provide support for the hypothesis that low-income households had an incentive to "bank" their benefits in response to the introduction of time limits. We also found that women changed their marital decisions in response to the reform. This forward-looking behavior is important for justifying the model we present in this section. The model, while taking into account the entire family structure, focuses primarily on the behavior of mothers, who can be single or married. Marriage and divorce are endogenous and take place at the start of the period. We begin by describing labor supply, savings and welfare participation choices that take place after the marital status decision. We then describe how marital status choices are made, and clarify the timing of each shock realization and decision.

[8]The welfare reform eliminated federal child care entitlements and replaced them with a childcare block grant to the states. Under these changes, states became more flexible in designing their childcare assistance programs. In practice, the total amount available for state-level childcare programs could increase or decrease depending on the state's own level of investment.

2.1 Problem of the single woman

We start by describing the problem of a single woman who has completed her schooling choices.[9] In each period, she decides whether to work, whether to claim welfare and how much to save.

The vector of choice variables $\boldsymbol{q}_t = \{c_t^W, P_t^W, B_t\}$ includes consumption (c_t^W), employment (P_t^W), and welfare participations ($B_t \in \{0,1\}$, which leads to benefits b_t). In addition, she makes a choice to marry, which will depend on meeting a man and whether he will agree. The decision to marry takes place at the start of the period, before any consumption, welfare participation, or work plan is implemented: the latter will be conditional on the marriage decision.

If she remains single, her budget constraint is given by

$$\begin{aligned} \frac{A_{t+1}^W}{1+r} &= A_t^W - \frac{c_t^W}{e(k_t^a)} + (w_t^W - CC_t^a)P_t^W + B_t b_t + FS_t + EITC_t \qquad (1) \\ A_{t+1}^W &\geq 0 \end{aligned}$$

where A are assets, $e(k_t^a)$ is an equivalence scale due to the presence of children k_t^a, and CC_t^a is the financial cost of childcare paid if the woman works. Her wage w_t is drawn from a distribution that depends on her age and the previous period wage (detailed below). We model three social insurance programs: food stamps, EITC and AFDC (or TANF). Benefits received from the first two programs are denoted by FS_t and $EITC_t$ respectively, while AFDC/TANF benefits are denoted by b_t. We assume that the latter are subject to time limits.

The state space for a single woman is $\boldsymbol{\Omega}_t^{Ws} = \{A_t, w_t, k_t^a, TB_t\}$, where TB_t is the number of time periods the woman has claimed the time-limited benefits. The within-period preferences for a single woman are denoted by $u^{Ws}(c_t^W, P_t^W, B_t)$. Food stamps and EITC are functions of the vector $\{k_t^a, w_t^W P_t^W\}$, while AFDC/TANF is a function of the vector $\{k_t^a, w_t^W P_t^W, TB_t\}$.

[9] Our main focus in on low-education women, because we are interested in the impacts of means-tested welfare benefits, such as TANF. An important question is how education choice is itself affected by the presence of such benefits (Blundell et al., 2016). We leave this question for further research. Bronson (2014) studies women's education decisions in a dynamic collective model of the household with limited commitment.

We discuss the parametrization of the various benefits programs, which interact in a complex way with one another, in the structural estimation section.

With probability λ_t, at the begining of the period the woman meets a man with characteristics $\{A^m, y_t^m\}$ (assets and exogenous earning) and together they draw an initial match quality s_t^0. In the case a meeting occurs, the two individuals decide whether to get married, as described below. Denote the distribution of available men in period t as $G(A, y|t)$. We restrict encounters to be between a man and a woman of the same age group.[10]

We denote by $V_t^{Ws}(\mathbf{\Omega}_t^{Ws})$ the value function for a single woman at age t and $V_t^{Wm}(\mathbf{\Omega}_t^{Wm})$ the value function for a married woman at age t, which we will define below.

A single woman has the following value functions:

$$V_t^{Ws}(\mathbf{\Omega}_t^{Ws}) = max_{\boldsymbol{q}_t} \ \{ \ u^{Ws}(c_t^W, P_t^W, B_t)$$
$$+\beta E_t \left[\lambda_{t+1}[(1 - M_{t+1}(\mathbf{\Omega}_{t+1}))V_{t+1}^{Ws}(\mathbf{\Omega}_{t+1}^{Ws}) + M_{t+1}(\mathbf{\Omega}_{t+1})V_{t+1}^{Wm}(\mathbf{\Omega}_{t+1}^{M})] + (1 - \lambda_{t+1})V_{t+1}^{Ws}(\mathbf{\Omega}_{t+1}^{Ws}) \right] \}$$

subject to the two constraints in (1), and where M_{t+1} represents a dummy for marrying in period $t + 1$.

2.2 Problem of the single man

Men solve an analogous problem without welfare benefits and without a labor supply choice. Men's earnings follow a stochastic process described by the distribution $f^M(y_t^M|y_{t-1}^M, age)$. Children affect the man's problem only when he is married to their mother.

These assumptions determine $V^{Ms}(\mathbf{\Omega}_t^{Ms})$, the man's value function when he is single. $V_t^{Mm}(\mathbf{\Omega}_t^M)$ the value accruing to a married man. In all cases $\mathbf{\Omega}_t^j$ is the relevant state space.

[10] In principle, this distribution is endogenous and as economic conditions change, the associated marriage market will change, with this "offer" distribution changing. In this paper we take this distribution as given and do not solve for it endogenously. This mainly affects counterfactual simulations. Note that solving for the equilibrium distribution in two dimensions is likely to be very complicated computationally.

His budget constraint is given by[11]

$$\frac{A^M_{t+1}}{1+r} = A^M_t - c^M_t + y^M_t + FS_t \tag{2}$$
$$A^M_{t+1} \geq 0.$$

The problem for the single male is thus defined by

$$V^{Ms}_t(\mathbf{\Omega}^{Ms}_t) = max_{c^M_t} \ \Big\{ \ u^{Ms}(c^M_t) + \beta E_t[\lambda_{t+1}[(1 - M_{t+1}(\mathbf{\Omega}_{t+1}))V^{Ms}_{t+1}(\mathbf{\Omega}^{Ms}_{t+1})$$
$$+ M_{t+1}(\mathbf{\Omega}_{t+1})V^{Mm}_{t+1}(\mathbf{\Omega}^{M}_{t+1})] + (1 - \lambda_{t+1})V^{Ms}_{t+1}(\mathbf{\Omega}^{Ms}_{t+1})]\Big\} \, .$$

This problem is more complex than the simple consumption smoothing and precautionary savings problem because assets affect the probability of marriage as well as the share of consumption when married.

2.3 Problem of the couple

The state variables, represented by $\mathbf{\Omega}^m_t$, are: assets, spouses' productivity, number of periods of welfare benefits utilization, age of the child (if present) (k^a_t), the weight on each spouse's utility θ^H_t, θ^W_t (Mazzocco, 2007*a*; Voena, 2015). Given the decision to continue being married the couple solves:

$$V^m_t(\mathbf{\Omega}^m_t) = max_{\boldsymbol{q}_t} \ \left\{ \theta^W_t \ u^{Wm}(c^W_t, P^W_t, B_t) + \theta^M_t \ u^{Mm}(c^M_t) + s_t \right.$$
$$+ \beta E_t \left[(1 - D_{t+1}(\mathbf{\Omega}_{t+1}))V^m_{t+1}(\mathbf{\Omega}^m_{t+1}) + D_{t+1}(\mathbf{\Omega}_{t+1}) \left(\theta^W_t V^{Ws}_{t+1}(\mathbf{\Omega}^{Ws}_{t+1}) + \theta^M_t V^{Ms}_{t+1}(\mathbf{\Omega}^{Ms}_{t+1}) \right) \right] \Big\}$$
$$\text{s.t.} \qquad \tfrac{A_{t+1}}{1+r} = A_t - x(c^W_t, c^M_t, k^a_t) + (w^W_t - CC^a_t)P^W_t + y^M_t + B_t b_t + FS_t + EITC_t$$
$$A_{t+1} \geq 0$$
$$V^{Wm}_{t+1}(\mathbf{\Omega}^m_{t+1}) \geq V^{Ws}_{t+1}(\mathbf{\Omega}^{Ws}_{t+1})$$
$$V^{Mm}_{t+1}(\mathbf{\Omega}^m_{t+1}) \geq V^{Ms}_{t+1}(\mathbf{\Omega}^{Ms}_{t+1})$$

[11] We do not consider EITC for men because the value of the program for an individual without a qualifying child is modest (for example, in 2017 the maximum annual credit for an individual without a qualifying child was \$510, as opposed to \$3,400 for those with a qualifying child).

where $\theta_t^W = \theta_{t-1}^W + \mu_t^W$ and $\theta_t^M = \theta_{t-1}^M + \mu_t^M$, with μ_t^j (for $j = W, H$) representing the Lagrange multiplier on each spouse's sequential participation constraint (the last two equations in the program above). Here D_{t+1} is a dummy for divorce in period $t+1$, and we assume that the match quality evolves according to a random walk process:

$$s_t = s_{t-1} + \xi_t$$

where ξ_t can be interpred as a "love shock". Finally, $V_{t+1}^{Mm}(\mathbf{\Omega}_{t+1}^m), V_{t+1}^{Wm}(\mathbf{\Omega}_{t+1}^m)$ are defined recursively as each spouses' value from being married in period $t+1$:

$$\begin{aligned}
&V_{t+1}^{Jm}(\mathbf{\Omega}_{t+1}^m) = u^{Jm}(c_{t+1}^{J*}, P_{t+1}^{J*}, B_{t+1}^{J*}) \\
&+ \beta E\left[(1 - D_{t+1}(\mathbf{\Omega}_{t+2}))V_{t+2}^{Jm}(\mathbf{\Omega}_{t+1}^m) + D_{t+2}(\mathbf{\Omega}_{t+2})V_{t+2}^{Js}(\mathbf{\Omega}_{t+2}^{Js})\right]
\end{aligned}$$

for $J = W, M$.

Hence, the Pareto weights θ_t^M and θ_t^W are set to ensure that both spouses want to remain married at each point in time as long as there are transfers that can support that.

To capture economies of scale in marriage the individual consumptions c_t^W and c_t^M and the equivalence scale $e(k^a)$ imply an aggregate household expenditure of $x_t = \frac{((c_t^W)^\rho + (c_t^M)^\rho)^{\frac{1}{\rho}}}{e(k^a)}$. The extent of economies of scale is controlled by ρ and $e(k^a)$.

When married the Pareto weights remain unchanged so long as the participation constraint for each partner is satisfied. If one partner's participation constraint is not satisfied the Pareto weight moves the minimal amount needed to satisfy it. This is consistent with the dynamic contracting literature with limited commitment, such as Kocherlakota (1996) and Ligon, Thomas and Worrall (2002*a*). If it is not feasible to satisfy both spouses' participation constraints and the intertemporal budget constraint for any allocation of resources, then divorce follows.

In our context, marriage is not a pure risk sharing contract. Marriage takes place because of complementarities (i.e., economies of scale in consumption), love (ξ), and possibly also because features of the welfare system promote it. And indeed, marriage can break down efficiently if the surplus becomes negative for all Pareto weights. However, when marriage is better than the single state, overall transfers will take place that will *de facto* lead to risk sharing, exactly because this is a way to ensure that the participation constraint is satisfied for both partners, when surplus is present. Suppose, for instance, the female wage drops relative to the male one; the husband may end up transferring resources because single life may have become relatively more attractive to the wife, say because of government transfers to single mothers.

2.4 Marital status transitions

Having described how men and women compute their value across marital states, we now describe how men and women jointly choose their marital status.

2.4.1 Marriage decision

Define $\mathbf{\Omega}_t = \{\mathbf{\Omega}_t^{Ws}, \mathbf{\Omega}_t^{Ms}, \mathbf{\Omega}_t^{M}\}$, i.e., the relevant state space for a couple who have met (with probability λ_t). Whether this match results in a marriage depends on the existence of a feasible allocation such that:

$$M_t(\mathbf{\Omega}_t) = 1\{V_t^{Wm}(\mathbf{\Omega}_t^M) > V_t^{Ws}(\mathbf{\Omega}_t^{Ws}) \text{ and } V_t^{Mm}(\mathbf{\Omega}_t^M) > V_t^{Ms}(\mathbf{\Omega}_t^{Ms})\}$$

Married couples share resources in an *ex post* efficient way solving an intertemporal Pareto problem subject to participation constraints. Following the existing literature, the Pareto weights at the time of marriage (θ_1^M for the husband, θ_1^W for the wife) is chosen as the solutions to a symmetric Nash bargaining game between spouses.

Upon divorce, assets are divided equally upon separation - hence, there is no need to keep track of individual assets during marriage. Thus once married, spouses' assets merge into one value:

$$A_t = A_t^W + A_t^M.$$

We denote by $\mathbf{\Omega}_t^M$ the state space for a married couple.

2.4.2 Divorce decision

At the start of the period, the couple decides whether to continue being married or whether to divorce. Divorce can take place unilaterally and is efficient, in the sense that if there is a positive surplus from remaining married, the appropriate transfers will take place. Thus divorce ($D_t = 1$) takes place if (and only if) the marital surplus is negative. Here, this is equivalent to saying that there exists no feasible allocation and corresponding Pareto weights θ_t such that:

$$V_t^{Mm}(\boldsymbol{\Omega}_t^m(\boldsymbol{\theta}_t)) \geq V_t^{Ms}(\boldsymbol{\Omega}_t^{Ms}) \text{ and } V_t^{Wm}(\boldsymbol{\Omega}_t^m(\boldsymbol{\theta}_t)) \geq V_t^{Ws}(\boldsymbol{\Omega}_t^{Ws})$$

where $\boldsymbol{\theta}_t$ is a vector of the two Pareto weights in period t discussed below. The value functions for being single are defined above and evaluated at the level of assets implied by the equal division of assets as defined in divorce law. Denote the value of marriage $V_t^m(\boldsymbol{\Omega}_t^m)$. The vector of choice variables for those remaining married, is $\boldsymbol{q}_t = \{c_t^W, c_t^M, P_t^W, B_t\}$. It includes: how much spouses consume (c_t^W and c_t^M), whether the wife works (P_t^W), whether the woman claims welfare benefits amounting to b_t ($B_t \in \{0, 1\}$).

2.5 Exogenous processes

2.5.1 Fertility

Children arrive exogenously, given marital status. The conditional probability of having a child is taken to be $Pr(k_t^1|M_t, t)$. The maximum number of children is 1. The probability depends on whether a male partner is present ($M = 1$), and hence to some extent fertility is endogenous through the marital decision.

2.5.2 Female wages and male earnings

We estimate an hourly wage process for the woman and an earnings process for the men. Since we take female employment as endogenous we also need to control for selection. However, we simplify the overall estimation problem by estimating the income processes separately and outside the model. The woman's average hourly earnings is obtained by dividing total earnings by total hours.[12]

The earnings process for men and the wage process for women take the form

$$\log(y_{it}^{M}) = a_0^M + a_1^M age_t^M + a_2^M (age_t^M)^2 + f_i^M + z_{it}^M + \epsilon_{it}^M$$

$$\log(w_{it}^{W}) = a_0^W + a_1^W age_t^W + a_2^W (age_t^W)^2 + f_i^W + z_{it}^W + \epsilon_{it}^W$$

$$z_{it}^M = z_{i,t-1}^M + \zeta_{it}^M$$

$$z_{it}^W = z_{i,t-1}^W + \zeta_{it}^W.$$

for $j = H, M$, z_{it}^j is permanent income, which evolves as a random walk following innovation ζ_{it}^j, and ϵ_{it}^j is i.i.d. measurement error.[13]

2.6 Timing

At the beginning of each period, uncertainty is realized. People observe their productivity realization y_t^j and childless women learn whether they have a child. If single, people may meet a partner drawn from the distribution of singles and observe both the partner's characteristics and an initial match quality s_t^0. If they are married, they observe the realization of the match quality shock ξ_t^τ.

Based on these state variables, marital status and the sharing rule are jointly decided. Conditional on a marital status and on a sharing rule for couples, consumption, labor supply and program participation choices are made, which determine the state variables in the following period.

[12] We take the sum of earnings and hours worked to construct the average hourly earning. For the rest of the variables, we consider the last observation within a year.

[13] One interesting issue is the extent to which the reform affected the labor market and in particular human capital prices (Rothstein, 2010). Whether such general equilibrium effects are important or not depends very much on the extent to which the skills of those affected by the welfare reforms are substitutable or otherwise with respect to the rest of the population. With reasonable amounts of substitutability we do not expect important general equilibrium effects.

3 Structural Estimation

3.1 Parametrization

3.1.1 Preferences

A woman's within-period utility function is

$$u(c, P, B) = \frac{\left(c \cdot e^{\psi(M,k^a)\cdot P}\right)^{1-\gamma}}{1-\gamma} - \eta B.$$

In the above, when a person works ($P = 1$) her marginal utility consumption (c) changes, by an amount that depends on the presence of a child. The parameter η represents the stigma cost from claiming AFDC/TANF benefits.[14]

3.1.2 Partner meeting process

Couples meet with probability λ_t. We parametrize λ_t to vary over time according to the following rule:

$$\lambda_t = \frac{e^{\lambda_0+\lambda_1\cdot t+\lambda_2\cdot t^2}}{1+e^{\lambda_0+\lambda_1\cdot t+\lambda_2\cdot t^2}}.$$

When a couple meets, it draws an initial match quality s^0 drawn from a distribution $N(0, \sigma_{s^0})$. If marriage occurs, match quality then evolves as a random walk for married couples as:

$$s_t^\tau = s_{t-1}^{\tau-1} + \xi_t^\tau$$

where τ are the years of marriage and the innovations ξ^τ follow a distribution $N(0, \sigma_\xi)$. Hence, we allow the distribution of the initial match quality draw and the one of the subsequent innovations to differ.

[14] We assume there is no stigma cost from claiming Food Stamps or EITC benefits - this is partly because of the way benefits are received (debit card under SNAP program, and tax refund payments in the case of EITC), which may limit the visibility factor, and partly because these for these two programs we do not endogenize the participation decision.

3.1.3 Children

Children affect consumption, benefits eligibility and the opportunity cost of women's time on the labor market (because of child care costs). We use the OECD equivalence scale to account for the cost of providing for a child.[15] We also account for child care costs in the budget constraint.

3.2 The welfare system

We model the welfare system by considering AFDC/TANF, food stamps and EITC benefits. Eligibility for these benefits is based on a combination of economic and demographic criteria.

AFDC and TANF benefits amounts are established for different household compositions and household income levels by taking an average benefit level across states, weighted by the states' population. In our model, all adult earnings determine income eligibility for AFDC/TANF. Figure 4 shows how AFDC benefits vary by income level and by marital status. A single mother with no sources of income receives approximately \$315 per month in AFDC benefits. Adopting the OECD equivalence scale, the adult equivalent amount is approximately \$210. If she were to marry a man with no income, benefits would increase, but less than what would be needed to keep her adult equivalent amount unchanged.

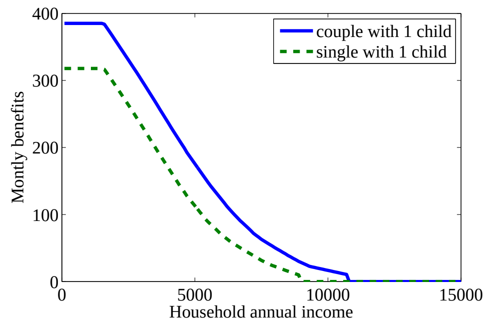
Similarly, we include food stamps by taking an average of food stamps amounts by different household compositions and household income levels (we ignore state variation because food stamps is a federal program). Unlike AFDC or TANF, food stamps are available to all households, irrespectively of the presence and of the age of the children. Eligibility and amount of food stamp benefits are determined by accounting for adult earnings and for AFDC or TANF benefits, which generate household income, as well as household assets.[16]

Finally, we compute EITC benefits based on household earnings and household composition and using the statutory rules of the program.

[15] Available at `http://www.oecd.org/eco/growth/OECD-Note-EquivalenceScales.pdf`, accessed August 7, 2015.

[16] See `http://dhs.dc.gov/page/chapter-4-determining-countable-income`, accessed August 14 2015.

Figure 4: AFDC benefits and household income by marital status



(a) AFDC benefits

Notes:

3.3 Estimation of the wage/earnings processes

We use the SIPP data to estimate the earnings (men) and wage (women) processes and restrict the sample to individuals between 23 and 60 years old, dropping all college graduates and constructing a yearly panel.

We drop individuals whose hourly wage is less than one half the minimum wage in some of the years she reported being working and we drop observations whose percentage growth of average hourly earnings is a missing value, if it is lower than -70% or higher than 400%.

The hourly wage variable we use corresponds to the sum of the reported earnings within a year divided by the sum of hours within that same year. Annual hours are computed as: reported weekly "usual hours of work" $\times$ the number of weeks at the job within the month $\times$ number of months the individual reported positive earnings.

3.3.1 Men's earnings

We compute GMM estimates of the variance of the permanent component of log income (σ^2_ζ) and the variance of the measurement error (σ^2_ε), based on the following moment conditions:

$$E[\Delta u_t^2] = \sigma^2_\zeta + 2\sigma^2_\varepsilon$$
$$E[\Delta u_t \Delta u_{t-1}] = -\sigma^2_\varepsilon$$

where u_t is the residual log earnings obtained after regressing earnings on dummy for age, disability status, and year.

3.3.2 Women's wage

We first estimate the following model. Wages are:

$$\log w_{it} = \mathbf{X}_{it}\boldsymbol{\beta} + \varepsilon_{it}.$$

Wages are observed only when the woman works ($P_{it} = 1$), which happens under the following condition:

$$P_{it} = 1 \quad \text{if} \quad \mathbf{Z}_{it}\boldsymbol{\gamma} + \nu_{it} > 0,$$

where w_{it} is annual earnings. In $\mathbf{X}_{it}$ we include age dummies, disability status, race, state dummies and year dummies. In $\mathbf{Z}_{it}$ we include X_{it} and a vector of simulated welfare benefits, as described in Low and Pistaferri (2015), Appendix C. In particular, we use state, year and demographic variation in simulated AFDC, EITC and food stamps benefits for a single mother with varying number of children who works part-time at the minimum wage. The first stage is reported in table 6.

GMM estimates of the variance of the permanent component of log income (σ^2_ζ) are computed based on the following moment conditions:

$$\begin{aligned}
E[\Delta u_t \mid P_t = 1, P_{t-1} = 1] &= \sigma_{\zeta_W \eta}\left[\frac{\phi(\alpha_t)}{1-\Phi(\alpha_t)}\right] \\
E[\Delta u_t^2 \mid P_t = 1, P_{t-1} = 1] &= \sigma^2_{\zeta W} + \sigma^2_{\zeta_W \eta}\left[\frac{\phi(\alpha_t)}{1-\Phi(\alpha_t)}\alpha_t\right] + 2\sigma^2_{\varepsilon_W} \\
E[\Delta u_t \Delta u_{t-1} \mid P_t = 1, P_{t-1} = 1, P_{t-2} = 1] &= -\sigma^2_{\varepsilon_W}
\end{aligned}$$

where we ignore selection correction for the first order covariance in order to reduce noise.

Table 6: Employment status Probit regressions - Women

VARIABLES	(1) coeff.	(2) marg. eff.
Average AFDC payment ($100)	-0.0674***	-0.0224***
	(0.00715)	(0.00237)
Average food stamps payment ($100)	-0.0276	-0.00917
	(0.1000)	(0.0332)
Average EITC payment ($100)	0.165***	0.0547***
	(0.0561)	(0.0186)
Age dummies	Yes	
State dummies	Yes	
Year dummies	Yes	
Controls	Yes	
Observations	64,696	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Data from the 1990-2008 SIPP panels. Sample of non-college graduates. Annualized data.

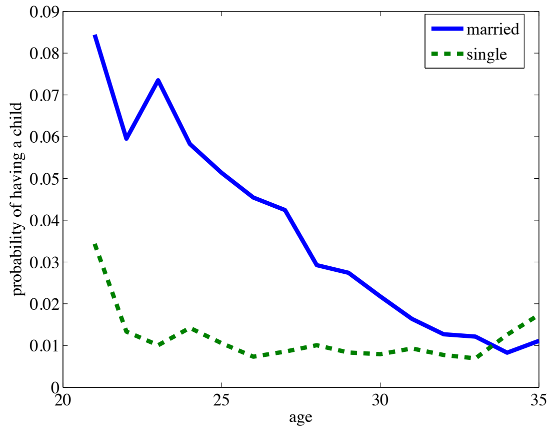
3.4 Estimation of the fertility process

We allow each household to have up to one child, and compute the transition probability from no children to one child using SIPP data. We first estimate the initial condition as the probability of a woman in period 1 (age 20) has a child of age a as $P(k_1^a > 0)$. Then, we compute the Markov process for fertility by examining transition probabilities in the SIPP data as a function of a woman's age and marital status

$$Pr(k_{t+1}^a | k_t^a = 0, M_t, age_t^f).$$

Figure 5 plots the estimated transition probabilities from having no child to having one by a woman's age and marital status in the SIPP.

Figure 5: Probability of having a first child by woman's age and marital status



Source: Data from SIPP panels 1990-2010.

3.5 Estimation of the distributions of the singles' characteristics

Computational constraints prevent us from solving for the equilibrium in the marriage market in the estimation routine. We instead use the empirical distribution of the characteristics of singles in the SIPP data. We model the joint distribution of $\{A_t^j, y_t^j\}$ by assuming that $\{\log(A_t^j), \log(y_t^j)\}$ are distributed as bivariate normals. For men, $\{\log(A_t^M), \log(y_t^M)\} \sim BVN(\boldsymbol{\mu}_t^M, \boldsymbol{\Sigma}_t^M)$ depends on the single man's age, while for women $\{\log(A_t^M), \log(y_t^M)\} \sim BVN(\boldsymbol{\mu}_{ta}^W, \boldsymbol{\Sigma}_{ta}^W)$ also depends on the age of her youngest child.[17] We allow also for additional mass for the cases in which $A_t^j = 0$ or $y_t^j = 0$. We use the same selection correction procedure described above to estimate the distribution of single women's offer wages for those single women who do not work.

3.6 Moments

We estimate the remaining parameters of model by the Method of Simulated Moments (McFadden, 1989):

[17]The bivariate normality assumption is inappropriate for the whole population (due to the long right tail in both assets and income), but less problematic for our low-income/low-assets sample.

$$min_{\mathbf{\Pi}}(\hat{\boldsymbol{\phi}}_{data} - \boldsymbol{\phi}_{sim}(\mathbf{\Pi}))G(\hat{\boldsymbol{\phi}}_{data} - \boldsymbol{\phi}_{sim}(\mathbf{\Pi}))'. \quad (3)$$

The vector $\mathbf{\Pi}$ contains the following parameters: the disutility from working parameters for unmarried women without children (ψ^{00}), married women without children (ψ^{01}), women with a child (ψ^{11}), and unmarried women with a child (ψ^{10}); the variance of match quality at marriage ($\sigma^2_{s^0}$); the variance of innovations to match quality (σ^2_{ξ}); the parameters characterizing the probability of meeting a partner over the life cycle ($\lambda_0, \lambda_1, \lambda_2$); and the stigma cost of being on welfare (η).

We estimate our empirical moments $\boldsymbol{\phi}_{data}$ on the SIPP sample of women without a college degree. We focus on the 1960-69 birth cohort in the pre-reform period (1990-95).[18] These women are between age 21 and 35, ages for which we have a sufficiently large number of observations. We annualize data by considering the marital status, fertility, employment status and welfare participation status that women had for more than half of the calendar year. We use a diagonal matrix with the variances of the empirical moments as weighting matrix G.

We consider three sets of moments, listed in table 7. The first set of moments includes the profile of the probability of being ever married between period 1 (age 21) to period 15 (age 35). These moments pin down the variance of initial match quality, as well as the parameters characterizing the probability of meeting a potential partner. The second sets of moments includes the probability of divorcing between period 6 (age 26) and period 15 (age 35). The reason why we do not consider these moments for earlier ages is related to initial conditions: divorces in these early years are concentrated among people who married *before* age 21, for which we do not know the actual distribution of the match quality realizations, as the marriages occur before the model begins. These moments mostly pin down the variance of innovations to match quality. The third set of moments includes conditional moments for labor supply, i.e., the fraction of women employed by marital and fertility status (which pin down the disutility from work), Finally, we include the proportion of single mothers on

[18] We use pre-reform data for three reasons. First, the model is easier to solve when we do not have to keep track of the time in the past spent on welfare. Second, we can use post-reform data to validate the model. Finally, in the post-reform period it is difficult to separately identify reluctance to participate in welfare due to stigma from "banking" behavior.

welfare (which identifies the stigma cost from welfare participation). Table 7 reports the empirical moments we target and shows the resulting fit.

Table 7: Target moments

Moment	**Data**		**Model**
	moment	**(s.e. in %)**	
% ever married at age 21	31.20%	0.03%	30.66%
% ever married at age 22	46.46%	0.02%	42.25%
% ever married at age 23	53.54%	0.01%	54.08%
% ever married at age 24	63.22%	0.01%	65.46%
% ever married at age 25	67.58%	0.01%	72.43%
% ever married at age 26	72.08%	0.01%	76.90%
% ever married at age 27	74.65%	0.01%	79.30%
% ever married at age 28	78.60%	0.01%	80.72%
% ever married at age 29	81.35%	0.00%	81.57%
% ever married at age 30	82.49%	0.00%	81.99%
% ever married at age 31	85.16%	0.00%	82.28%
% ever married at age 32	85.76%	0.00%	82.43%
% ever married at age 33	86.20%	0.00%	82.48%
% ever married at age 34	85.76%	0.01%	82.55%
% ever married at age 35	87.02%	0.01%	82.56%
% divorced at age 26	11.81%	0.00%	11.63%
% divorced at age 27	13.32%	0.00%	11.54%
% divorced at age 28	14.78%	0.00%	12.03%
% divorced at age 29	15.54%	0.00%	12.41%
% divorced at age 30	15.52%	0.00%	13.24%
% divorced at age 31	16.05%	0.00%	14.08%
% divorced at age 32	17.17%	0.01%	14.90%
% divorced at age 33	16.75%	0.01%	16.06%
% divorced at age 34	17.51%	0.01%	17.23%
% divorced at age 35	18.63%	0.01%	18.23%
% employed (married without children)	85.45%	0.01%	85.69%
% employed (unmarried without children)	87.96%	0.01%	87.64%
% employed (married with children)	60.02%	0.00%	60.88%
% employed (unmarried with children)	55.78%	0.01%	53.55%
% on AFDC (unmarried with children)	37.53%	0.01%	38.22%

Notes: SIPP data 1985-2011. Sample of women born in the 1960s and aged 21-35 without college degrees. Annualized data.

3.7 Life-cycle timing

Table 8 summarizes the lifecycle timeline of the model. Women enter the model at age 21, men at age 23. Marriage takes place between people who are two years apart (the typical age difference at first marriage). Until age 35, a woman can conceive her (one and only) child. That implies that she can have a child below age 18, and hence be potentially eligible for welfare, until she is 53. Age 53 is also the last year in which a woman can get married. After that age, she can divorce but will remain single if she does. In addition, women between the ages of 21 and 60 decide whether or not to work and retire thereafter, living up to age 79.

Table 8: Life cycle timeline

t	woman's age	man's age	benefit elig.	labor supply	fertility	marriage
1-15	21-35	23-37	Yes	Choice	Can conceive child	Can marry and divorce
16-33	36-53	38-55	Yes	Choice	Can have child below 18	Can marry and divorce
34-40	54-60	56-62	No	Choice	No children at home	Can divorce
41-59	61-79	63-81	No	Retired	No children at home	Can divorce

3.8 Parameter estimates

The structural parameters we estimate are separated into three groups: those we set from sources in the literature or (as in the case of child care costs, which are directly computed from the CEX); those estimated by us, but outside the model; and those used to fit the moments we defined in the previous section. The estimates are shown in Table 9. We set the coefficient of reative risk aversion to 1.5 and the discount rate to 0.98, values that are relatively uncontroversial. We impute childcare cost using information from the Consumer Expenditure Survey. We sum spending on babysitting and day care and then compute averages for working women, separately by age and marital status. We set the parameter defining economies of scale in marriage from Voena (2015).

Both male and female earnings are subject to relatively high variance of permanent shocks with male earnings shocks having a standard deviation of 15%, while female have a standard deviation of hourly wages of 20%. Initial heterogeneity is large, with a standard deviation of

Table 9: Parameters of the model

Parameter	Value/source
Panel A - Parameters fixed from other sources	
Relative risk aversion (γ)	1.5
Discount factor (β)	0.98
Childcare costs (CC^a)	CEX
Economies of scale in marriage (ρ)	1.23 (Voena 2015)
Panel B - Parameters estimated outside the model	
Variance of men's unexplained earnings in period 1	0.13
Variance of women's unexplained wages in period 1	0.15
Variance of men's earnings shocks	0.027
Variance of women's wage shocks	0.041
Life cycle profile of log male earnings (a_0^M, a_1^M, a_2^M)	9.76, 0.043, -0.001
Life cycle profile of log female wages (a_0^W, a_1^W, a_2^W)	2.48, 0.013, -0.0001
Panel C - Initial conditions	
% married at age 20	24.35%
% divorced at age 20	3.90%
Panel D - Parameters estimated by MSM	
Cost of working for unmarried women without children (ψ^{00})	-1.2990
Cost of working for married women without children (ψ^{10})	-0.9886
Cost of working for unmarried women with a child (ψ^{01})	-1.2880
Cost of working for married women with a child (ψ^{11})	-1.2646
Variance of match quality at marriage ($\sigma^2_{s^0}$)	0.0019
Variance of innovations to match quality (σ^2_ξ)	0.0020
Probability of meeting partner by age	
λ_0	0.2078
λ_1	-0.2839
λ_2	-0.0157
Cost of being on welfare (η)	0.0066

initial wages for men and women of approximately 36% and 38% respectively, implying large initial dispersion in productivities. Male and female wages have a concave lifecycle profile as expected. We find large disutility costs of working, especially among married women. Since employment rates among unmarried women are low, the model fits this with high disutility costs. In reality, it is possible that this is indicating our inability to control for missing sources of income from the budget constraints (such as parents' support, etc.). Arrival rates of partners decline with age, but at a decreasing rate. The stigma cost of welfare benefits is high, and is identified by the women who are not claiming benefits while eligible given their income. In the pre-reform period, there was no intertemporal tradeoff to claiming benefits, and hence we can attribute not claiming to utility or other costs of claiming. In the counterfactual simulations, for the post reform period, the intertemporal tradeoff will add to this cost, which makes it important to identify the utility cost from the pre-reform period.

3.9 Validation and quantitative implications of the model

To study the quantitative implications of our model, we begin by examining how our model fits patterns in the data that are not explicitly targeted by the estimation.

3.9.1 Income and wages

3.9.2 Difference-in-differences estimates of the impact of welfare reform

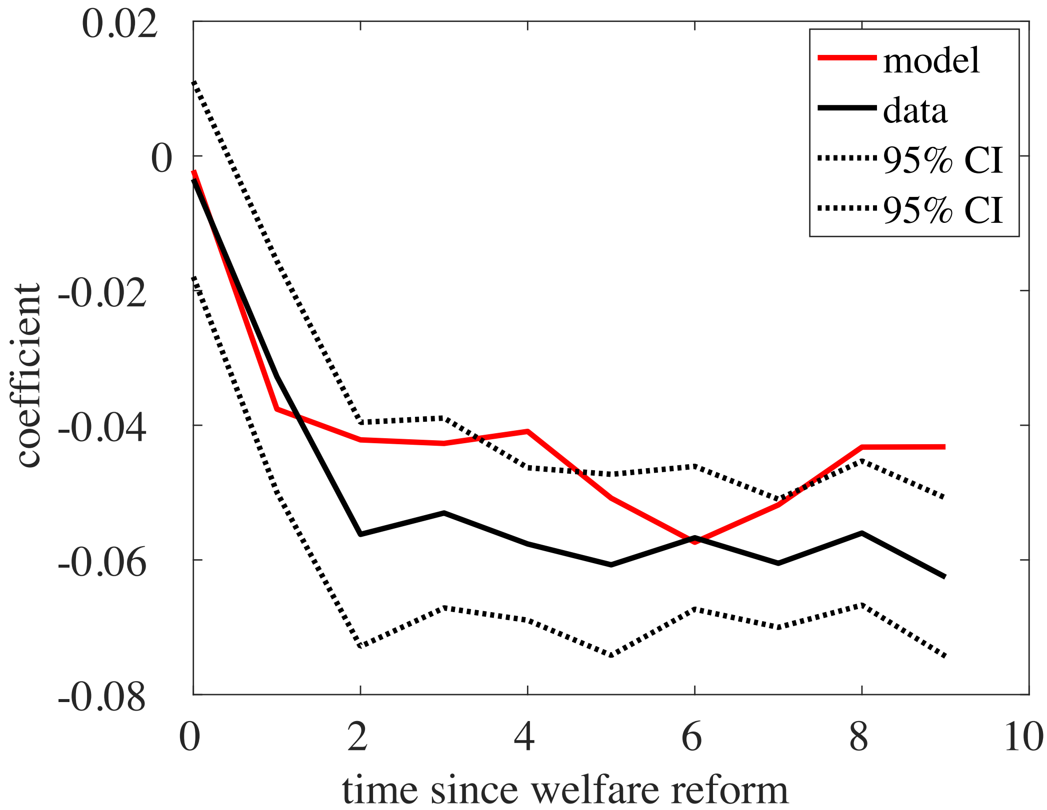
As a validation of our model, we replicate our difference-in-differences analysis by simulating the introduction of TANF for different women at different ages according to the 1996 age distribution of observation in our SIPP dataset. We randomly assign time limits to different subjects and observe their welfare utilization behavior over time, which track the empirical one very closely (figure 6).

Table 10 reports the estimated coefficients on the simulated data and in the SIPP data, focusing on the sample of women aged 21 to 53, which are the ages of eligibility in the model given fertility. Remarkably, the simulated difference-in-differences estimates are qualitatively, and often quantitatively, quite close to the empirical ones.

Table 10: Difference-in-differences estimates in the simulated data and in the SIPP data

Variable	**Coef. Sim.**	**Coef. data**	**95% CI**	**95% CI**
Welfare	-0.043	-0.055	-0.061	-0.049
Welfare (married)	0.001	-0.020	-0.025	-0.015
Welfare (unmarried)	-0.101	-0.157	-0.176	-0.139
Employed	0.017	0.026	0.013	0.040
Employed (married)	-0.0088	-0.001	-0.016	0.015
Employed (unmarried)	0.054	0.085	0.064	0.106
Divorced	-0.007	-0.030	-0.045	-0.015
Married	0.011	-0.009	-0.027	0.010

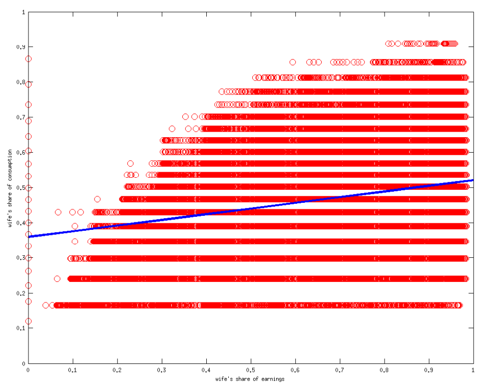
Figure 6: Dynamic response of welfare utilization to time limits in the data and in the model



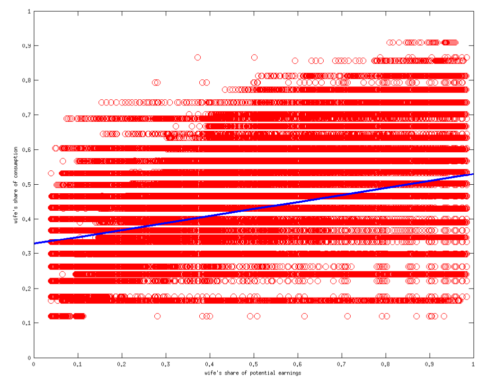
3.9.3 Intra-household allocations

Wefinally study what implications our estimated model has for variables that we cannot observe in the data. We begin by examining the distribution of resources in the household. The mean Pareto weight for women is about one half of the one for men ($\frac{E(\theta^W)}{E(\theta^H)} = \frac{0.35}{0.65} = 0.54$). This number is in line with estimates and calibrations from the literature on collective household models for the Unites States, the United Kingdom, and Japan (Lise and Seitz, 2011; Mazzocco, Yamaguchi and Ruiz, 2013; Voena, 2015; Lise and Yamada, 2014). Below, we plot the relationship between consumption sharing and earnings/wage shares. As expected, the model produces a positive correlation between wages and private consumption. In particular, a 1 percentage points increase in the share of income earned by the wife ($\frac{w_t^W P_t^W}{w_t^W P_t^W + y_t^H}$) raises her share of consumption ($\frac{c_t^W}{c_t^W + c_t^H}$) by 0.17 percentage points (figure 7 panel a), while a 1 percentage points increase in the share of potential income earned by the wife ($\frac{w_t^W}{w_t^W + y_t^H}$) raises her consumption by 0.22 percentage points (panel b). Because of the limited commitment setup, the most important factor affecting the distribution of consumption are potential earnings at the time in marriage: a 1 percentage points increase in the share of potential income earned by the wife *at the time of marriage* ($\frac{w_{t_0}^W}{w_{t_0}^W + y_{t_0}^H}$ where t_0 is the year of marriage) raises her lifetime consumption in marriage by 0.29 percentage points (panel c).

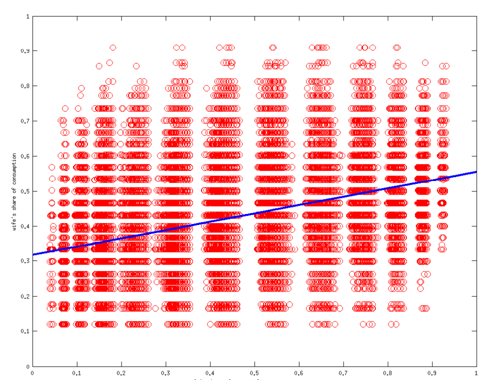
Figure 7: Consumption allocation in the household



(a) Earnings



(b) Offer wages



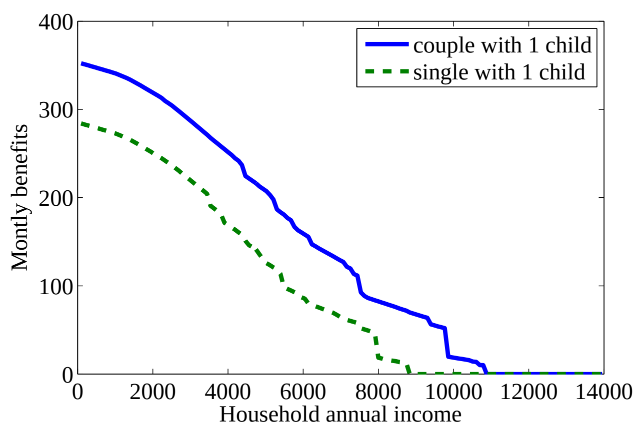
(c) Offer wages at marriage

4 The impact of time limits on household behavior and welfare

4.1 Welfare utilization and time limits

In our main counterfactual exercise, we simulate the introduction of the PRWORA. We do so in two stages: first, we maintain all features of AFDC place, but impose a 5-year time limit. In a second step, we allow for TANF to differ from AFDC not only because of time limits, but also because of the mapping between household income and benefits by marital status (figure 8). In practice, this second element has no real dent because the structure of benefits under TANF was not dramatically different from that under AFDC. The key difference between the two programs is the introduction of time limits.

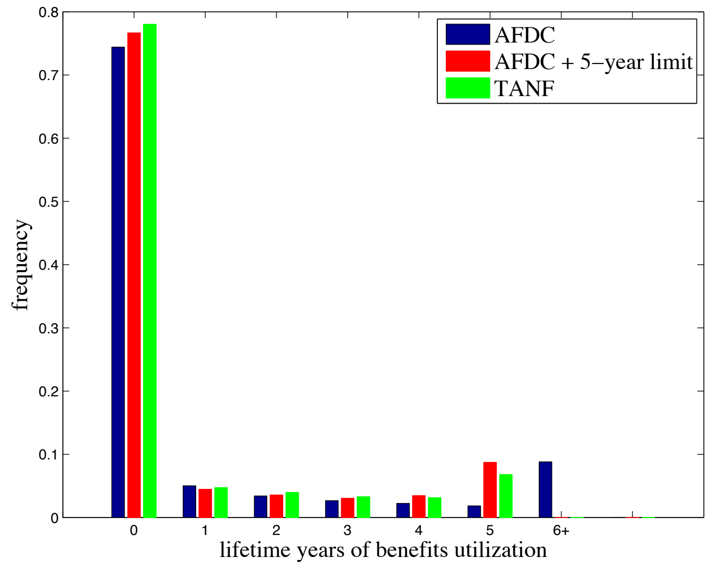
Figure 8: TANF benefits and household income by marital status



Notes: Simulated TANF monthly payments based on population-weighted state averages.

We start by studying how individuals' welfare participation dynamic behavior changes when we introduce time limits. Under AFDC, the average welfare users is on welfare for 6.12 years. Time limits, once introduced, are binding for 11.8% of women under AFDC, and we observe significant bunching at 5 years once the limit is introduced (figure 9). Under a 5-year time limit, the average utilization among welfare users drops to 3.34, and to 3.17 under TANF. There is substantial bunching at 5 years, but also a reduction in overall utilization, due to banking (figure 9).

Figure 9: Lifecycle welfare utilization by program



Notes: Simulation from estimated model.

4.2 Welfare calculations

To define the welfare cost or benefit of reforming TANF, we write the lifetime expected utility of a woman in our model as

$$E_0U(s) = E_0 \sum_{t=1}^{T} \beta^{t-1} \left(\frac{\left(c_t(s) \cdot e^{\psi(M,k^a) \cdot P_t}\right)^{1-\gamma}}{1-\gamma} - \eta B_t + \xi_t^{\tau} M_t \right),$$

where $\{c_t, P_t, B_t, M_t\}$ refer to the implied consumption, labor supply, benefit stream and marital status in the baseline economy ($s = AFDC$) or in an alternative economy with different welfare parameters (e.g. ($s = TANF$)). E_0 represents the expectation at the beginning of working life (before period 1).

When performing the policy experiments ,we use as a baseline a case in which the payroll tax rate on labor is set to 0, and hence we let the government run a deficit $\bar{D}$. When varying parameters from AFDC to TANF (changes in benefits and time limits), we hold the government budget deficit $\bar{D}$ constant. This is achieved by adjusting the proportional payroll tax, τ_w, such that the present discounted value of net revenue flows is constant:

$$\sum_{i=1}^{N}\sum_{t=1}^{T}\frac{1}{(1+r)^{t-1}}\left[FS_{it}+EITC_{it}+b_{it}\right]=\sum_{i=1}^{N}\sum_{t=1}^{T}\frac{1}{(1+r)^{t-1}}\tau_w w_{it}P_{it}+\bar{D}$$

where b captures the payment through AFDC or TANF. This calculation can be carried out using realized payments.[19]

In practice, we first calculate the left hand side in the baseline. This gives the size of $\bar{D}=172$ per capita when $\tau=0$. Second, we change the policy rule into TANF and recalculate the LHS. This gives the new deficit if the tax rate remains at zero ($\bar{D}'=73$ per capita). Third, we iterate on τ so that the deficit under the new policy is equal to $\bar{D}$. As τ adjusts, the choices individuals make will change and so the model needs to be resolved. But, the final iteration gives the behavior of individuals in the new policy regime holding revenue constant, with $\tau_w=-0.69\%$.

The output from the last iteration of the calculation of τ_w should be a sequence for each of the N women of the realizations at each age of consumption, labour supply, marriage and program participation. These sequences do not change in doing the welfare calculation. What we are asking is what proportion of consumption an individual is willing to pay ex-ante to be indifferent between environment $s'=TANF$ and $s=AFDC$. Note that ex-ante, no one knows the resulting sequence and since there are no aggregate shocks, realized discounted lifetime utility averaged across all individuals will be equal to expected utility.

$$E_0U\left(TANF,\tau_w\right)|_{\pi}=\sum_{i=1}^{N}\sum_{t=0}^{T}\beta^t\left(\frac{\left((1-\pi)\,c\left(TANF\right)\cdot e^{\psi(M,k^a)\cdot P}\right)^{1-\gamma}}{1-\gamma}-\eta B_t\right)\tag{4}$$

We solve for π such that

$$E_0U\left(TANF,\tau_w\right)|_{\pi}=E_0U\left(b\right),\tag{5}$$

where π can be interpreted as the consumption cost of going from AFDC to TANF.

[19] Note that the summation is across individuals, i, who are the women. This is because our simulations do not keep track of men unless they are in a relationship. So, benefits are being spent on the women and the extra tax to cover that is being taken from the women. Hence, the amount of taxes raised from the men is held constant and budget balance comes only from women.

Table 11: Long-term effects of time limit

	all	married	unmarried
From AFDC to 5-year time limit			
Welfare utilization	-0.02	-0.00	-0.05
Employed	+0.01	-0.01	+0.02
Divorced	-0.004		
Married	+0.004		
Assets (%)	-0.01	-0.04	+0.01
From AFDC to TANF			
Welfare utilization	-0.03	+0.00	-0.05
Employed	0.01	-0.01	+0.03
Divorced	-0.004		
Married	+0.004		
Assets (%)	+0.02	-0.02	+0.02

The results suggest that women are willing to pay 0.46% of lifetime consumption to be indifferent between the new program (TANF) and the old version of it (AFDC). For single mothers, for whom welfare benefits are more valuable, the willingness to pay is higher (2% of lifetime consumption).

In Table 11 we compute the behavioral changes in the economy that transitions from AFDC to AFDC with time limits (the upper part of the table), before also adopting the benefit schedule of TANF (lower part of the table). Most of the changes are driven, as anticipated, by the introduction of time limits. In the new steady state, there is a 3 p.p. decline in welfare utilization, all coming from single mothers. There is a 1 p.p. increase in employment, with similar distinctive heterogeneity. Marital arrangements are slightly affected - in particular, there seems to be greater marriage stability (a few more marriages, and a few less divorces). Assets, perhaps because of reduced insurance, increase among the single mothers and decline among married women.

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Appendix

Sample selection

Table 12 reports the sample sample selection from the 1990-2008 SIPP panels to the sample used in our empirical analysis.

Table 12: Sample selection for empirical analysis

	individuals	observations
Everyone over 18	481,327	3,306,878
Drop college graduates	303,033	1,996,570
Drop men	163,500	1,097,432
Drop over 60	123,994	784,791
Drop if no children in household	75,938	455,514
Household heads or spouses	64,739	406,370

Definition of variables

Program participation equals 1 if the individual reports to be covered by AFDC program and 0 otherwise. Later, AFDC regressions are run at the household level. We consider a family covered by AFDC if at least one member of the household reports to be covered.

Employed equals 1 if an individual reports having a job at least one week during the past month and 0 otherwise.

Assets equals the sum of total net worth (debt minus unsecured debt), home equity, real state equity, IRA and KEOGH accounts, net equity in vehicles.

Liquid assets total net worth (debt minus unsecured debt).

Married equals 1 if the individual reports being married and 0 otherwise.

Divorced/Separated equals 1 if the individual reports being separated or divorce and 0 otherwise.

Table 13: Fertility

VARIABLES	(1) newborn$_{t+1}$	(2) newborn$_{t+1}$	(3) newborn$_{t+1}$ married	(4) newborn$_{t+1}$ married	(5) newborn$_{t+1}$ unmarried	(6) newborn$_{t+1}$ unmarried
$Treat_{dst}Post_{st}$	-0.000747	-0.000894	-0.000662	-0.000880	0.00317	0.00335
	(0.00125)	(0.00129)	(0.00176)	(0.00178)	(0.00278)	(0.00284)
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Race	No	Yes	No	Yes	No	Yes
Disability status	No	Yes	No	Yes	No	Yes
Unemp. rate*Demog.	No	Yes	No	Yes	No	Yes
Observations	233,944	233,944	167,065	167,065	66,879	66,879
R-squared	0.010	0.010	0.014	0.014	0.021	0.021

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Data from the 1990-2008 SIPP panels. Sample of non-college graduates with at least a child below age 19. The full set of controls includes age dummies, education dummies, number of children dummies, year-by-month fixed effects, state fixed effects, demographics fixed effects, state-by-demographics fixed effects, state-by-year fixed effects. Standard errors in parentheses, clustered at the state level.

Table 14: OLS regressions with first two waves of each SIPP panel

VARIABLES	(1) AFDC/ TANF	(2) AFDC/ TANF unmarried	(3) employed	(4) employed unmarried	(5) divorced/ separated	(6) married
$Treat_{dst}Post_{st}$	-0.0687***	-0.190***	0.0329***	0.0818***	-0.0251***	-0.0239**
	(0.00515)	(0.0125)	(0.00954)	(0.0169)	(0.00836)	(0.00903)
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Race	Yes	Yes	Yes	Yes	Yes	Yes
Disability status	Yes	Yes	Yes	Yes	Yes	Yes
Unemp. rate*Demog.	Yes	Yes	Yes	Yes	Yes	Yes
Observations	57,591	21,112	57,591	21,112	57,591	57,591
R-squared	0.116	0.196	0.105	0.171	0.028	0.200

Standard errors in parentheses clustered at the state level
*** p<0.01, ** p<0.05, * p<0.1

Notes: Data from the 1990-2008 SIPP panels. Sample of households in which the head is not a college graduate with at least a child below age 19. The full set of controls includes age dummies, education dummies, number of children dummies, year-by-month fixed effects, state fixed effects, demographics fixed effects, state-by-demographics fixed effects, state-by-year fixed effects. Standard errors in parentheses, clustered at the state level.

Table 15: Employment status OLS regressions - Women with child above age 5

VARIABLES	(1) employed	(2) employed	(3) employed married	(4) employed married	(5) employed unmarried	(6) employed unmarried
$Treat_{dst}Post_{st}$	0.0173***	0.0124**	-0.000858	-0.00400	0.0469***	0.0370***
	(0.00624)	(0.00591)	(0.00822)	(0.00773)	(0.0111)	(0.0101)
Basic controls	Yes	Yes	Yes	Yes	Yes	Yes
Race	No	Yes	No	Yes	No	Yes
Disability status	No	Yes	No	Yes	No	Yes
Unemp. rate*Demog.	No	Yes	No	Yes	No	Yes
Observations	260,528	260,528	160,388	160,388	100,140	100,140
R-squared	0.063	0.133	0.063	0.113	0.081	0.196

Standard errors in parentheses clustered at the state level
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Notes: Data from the 1990-2008 SIPP panels. Sample of non-college graduates with at least a child below age 19. The full set of controls includes age dummies, education dummies, number of children dummies, year-by-month fixed effects, state fixed effects, demographics fixed effects, state-by-demographics fixed effects, state-by-year fixed effects. Standard errors in parentheses, clustered at the state level.