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Anti-poverty Income Transfers in the U.S.: A Framework for the Evaluation of Policy Reforms

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and

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Abstract

In this paper, we present a dynamic model of labor supply, consumption, savings and marital decisions where we embed the income tax schedule and the four main anti-poverty income transfer programs in the U.S. The model is calibrated to match moments from a sample of non-college-educated workers with children in the 2014 Annual Social and Economic Supplement of the Current Population Survey. We then use the model to assess the effects of three recent proposals to reform the U.S. tax-transfer system, and especially to ameliorate the disincentives introduced by the current EITC schedule to married mothers' labor force participation. The categorical and economic conditions for eligibility and benefits of the transfer programs, along with the income and payroll tax system, yield complex budget constraints and introduce a web of interactions whose effects we aim to understand and quantify. (JEL E21, H24, H31, J12)

Keywords: Anti-poverty income transfers; household decisions; cohabitation and marriage.

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1 Introduction

During the last three decades, income redistribution to low-income households in the U.S. has increasingly shifted toward means-tested programs with work and earnings requirements. For instance, the Earned Income Tax Credit (EITC), which subsidizes earnings for eligible tax filers, was expanded since its creation in 1975 to become one of the largest anti-poverty programs, distributing almost \$70 billion in 2014. The large size of three of its expansions —1986, 1990 and 1993— triggered a vast empirical literature estimating their effects on labor supply and marriage (Nada Eissa and Hilary W. Hoynes 2003, 2004, 2006a, 2006b; Raj Chetty, John N. Friedman and Emmanuel Saez 2013).

In a different strand of the literature, discrete choice dynamic programming models of labor supply and welfare program participation have been developed (Christopher A. Swann 2005; Michael P. Keane and Kenneth I. Wolpin 2010; Marc K. Chan 2013). Dynamic structural models allow for the estimation of the effects of each transfer program and for assessing the interactions among the different programs in shaping the costs and welfare consequences of policy reforms. Some of these models contain a rich set of individual choices, such as labor supply, marriage and fertility, but limit anti-poverty transfers to a single program, hence missing the critical interaction among transfer programs. Other models, on the contrary, are rich in the modeling of the transfer programs but limit individual choices to only labor supply. Other potentially important ingredients such as a consumption/savings decision, borrowing constraints or risk sharing within the household have not been fully explored in this literature.¹

In this paper, we present a dynamic model of labor supply, consumption, savings and marital decisions where we embed the income tax schedule and the four main anti-poverty income transfer programs in the U.S. — the EITC, the Child Tax Credit (CTC), Temporary Assistance for Needy Families (TANF) and the Supplemental Nutrition Assistance Program (SNAP). The model is calibrated to match moments from a sample of non-college-educated workers with children in the 2014 Annual Social and Economic Supplement (ASEC) of the Current Population Survey (CPS). We use the model to assess the effects of three recent proposals to reform the U.S. tax-transfer system, and especially to fix the disincentives introduced by the current EITC schedule to married mothers' labor force participation. The categorical and economic conditions for eligibility and benefits of the four programs above, along with the income and payroll tax system, yield complex budget constraints and introduce a web of interactions whose effects we aim to understand and quantify.

¹For an analysis of the effects of the EITC on the labor supply of single mothers in a model with a consumption/savings decision and borrowing constraints see Kartik Athreya, Devin Reilly and Nicole Simpson (2014).

Our model extends the Bewley-Huggett-Aiyagari framework of uninsurable idiosyncratic risk with borrowing constraints to include one- and two-adult households, and an endogenous choice of the living arrangement between (i) single alone, (ii) unmarried and cohabiting, and (iii) married. In addition to labor productivity shocks, adult females are also subjected to fertility shocks. The presence and number of qualifying children, and the living arrangement, are key determinants of both tax liabilities and transfers. Since our model yields a stationary equilibrium distribution of households across living arrangements, labor productivities, wealth and number of children, we will be able to understand not only the average effects of anti-poverty policy reforms, but also how they affect households conditional on their characteristics.

The labor supply decision in our model includes a participation decision (extensive margin) and an hours worked decision (intensive margin). We model the cost of labor market participation as commuting and child care expenses, and assume that these expenses vary with the number of children and adults in the household. In particular, two-adult households are assumed to have a relative advantage at allocating individual working times to save on child care while working. A second advantage of two-adult households, relative to one-adult households, is their ability to share risks within the household. In particular, once a single female accepts a cohabiting or a marriage proposal, the couple is assumed to pool their resources, share idiosyncratic labor market risks and make joint decisions on consumption, savings and labor supply. This is an important feature of our model, which acknowledges the potential crowding-out effects of anti-poverty income transfers on the labor supply of secondary earners. In particular, the current EITC schedule for married couples is based on household earnings, thus reducing the labor force participation of married mothers whose husbands' earnings fall into the phase-out region of this tax credit.

Single females in our model receive cohabiting and marriage proposals, which they may accept or turn down. Likewise, cohabiting couples may get married as soon as they are better off compared to cohabitation. Taxation and income transfers introduce both incentives and disincentives to marry, depending on the individuals' characteristics. While the marriage penalty/bonus created by income taxation has been extensively documented, the effects of income transfers on marriage are somewhat less understood. For instance, the EITC may increase marriage among single mothers with no earnings if the prospective husband has earnings between \$20,000 and \$40,000. However, a single mother already receiving the EITC may become ineligible if she marries. TANF may also disincentivize single mothers both to marry and cohabit with the father of their children, but it incentivizes cohabitation with a male who is not their biological father. Our model introduces in detail the statutory program requirements for eligibility and benefits for the different living arrangements. Hence, we can analyze the effects of policy reforms on the rate of

new marriages and on the percentage of births outside of marriage.

Our analysis of three policy reforms shows that there is room for improvement in the design of income transfers without increasing their costs, especially concerning the EITC schedule for married couples with children. In particular, we first assess a proposal to reform the EITC presented in the “21st Century Worker Tax Cut Act” to the 113th Congress. This reform plan calls for the introduction of a deduction for married couples of 20 percent of the earnings of the secondary worker. We find that in the long run, this deduction increases the labor force participation of married females by 3.36 percent and the fraction of two-earner married households by 4.67 percent. Hours worked fall slightly, both for married females and males. Also, household wealth goes down because they need less precautionary savings. Overall, the poverty rate among married households goes down by 3.35 percent. Importantly, the effects of this deduction go beyond the ambit of married couples. There is an increase in the marriage acceptance rate of single mothers, explained by the higher value of marriage after the reform. However, in anticipation of marriage, single mothers save less and their poverty rate increases by 0.13 percent. Demographics change following the higher new marriage rate: the fraction of single mother and cohabiting households declines, and there is an increase in the fraction of married households. This reform plan reduces the cost for the government. Indeed, government revenues per household in the steady-state equilibrium under the reform increase to \$1,066 compared to \$1,035 under the current transfer policy.

The second proposal to reform the tax-transfer system considered here is the one contained in the “Tax Reform Act 2014”. Roughly, this is a plan that reduces the EITC to almost all households, but extends the bottom income brackets to \$71,200 to married couples. It also increases the subsidy rate per child in the Child Tax Credit, reduces the personal exemption and increases the standard deduction. We find that this reform plan has positive, sizable effects on the labor supply of married couples, but reduces the labor force participation of single mothers. Accordingly, poverty among married households goes down, but increases for single mothers. Net transfers to single mothers are drastically reduced by 23 percent, contributing to an increase in marriage acceptance rate and hence to a reduction in the fraction of single mother households.

The third reform proposal assessed in our framework consists of the replacement of the current EITC schedule by an EITC based on personal earnings, which depends neither on living arrangement nor on the number of children. We show that while this plan would remove the disincentives to married females to supply labor, raising their labor force participation by 41 percent and the fraction of two-earner married couples by 50 percent, it would be quite costly. The government would lose \$279 in revenues per household per year.

The remainder of the paper is organized as follows. Section 2 describes the income and payroll tax schedules, and the four income transfer programs included in our analysis. Section 3 contains our model, the definition of the steady-state equilibrium and the parameterization of preferences, consumption commitments and work and child care costs. Section 4 describes our data from the sample of households, calibrates the model and then assesses the fit of the model. Section 5 evaluates three EITC policy reforms. Finally, Section 6 presents concluding remarks.

2 Taxes and Means-tested Transfers

In this section we briefly describe the U.S. federal income tax scheme, two tax credits and two transfer programs to assist low-income households with children. These tax and transfer schemes are then embedded into a model of savings, labor supply and living arrangements in the next section.

2.1 Income and Payroll Taxes

There are three main filing statuses with the Internal Revenue Service (IRS): single (s), head of household (\bar{h}) and married filing jointly (x). The filing status affects both taxes paid (tax rates and deductions) as well as eligibility and benefits for tax credits.

A tax filer's income is made up of earnings, e , and capital income, ra , where r is the return on investment and a is the filer's asset level. Income taxes, before credits, owed by a tax filer under status $j = s, \bar{h}, x$ with income $y \equiv e + ra$ and n qualifying children are given by

$$T^j(y, n) = \sum_{i=1}^7 \tau_y^i \max\{\min\{y - d_T^j - \xi_T^{jn}, b^{j,i}\} - b^{j,i-1}, 0\},$$

where $b^{j,i}$ are parameters characterizing the seven income brackets in the U.S. tax code, and $\tau_y^{j,i}$ are the corresponding tax rates. The upper bound for the last bracket, $b^{j,7}$, is set to a very large value such that taxable income for any household is below this limit. The remaining values, $b^{j,i}$, are the break points between the different income brackets. The income tax deduction is denoted by d_T^j and personal exemptions by ξ_T^{jn} .

Finally, payroll taxes (FICA) are $T_p(e) = \tau_p \min\{e, \bar{e}\}$, where $\tau_p = \tau_{p,SS} + \tau_{p,ME}$ is the employee's tax rate (the sum of social security and medicare tax rates), and \bar{e} is the payroll tax cap.

2.2 The Earned Income Tax Credit (EITC)

The earned income tax credit is a refundable credit which cost the government 58 billion dollars in 2013. Eligibility is determined by the following conditions: (i) Investment income, ra , cannot exceed a level, say $\bar{r}a_I$; (ii) Income (earned plus non-earned income) cannot exceed a level, say y_I^{jn} , which depends on the number of children and the filing status. That is, the EITC-eligibility set, $\{a, e, n\}$, of a tax filer with n qualifying children under filing status $j = s, \bar{h}, x$ is

$$\{ra \leq \bar{r}a_I\} \cap \{e + ra \leq y_I^{jn}\}. \quad (1)$$

Provided eligibility, the amount of the credit accruing to a filer with earned income e , n qualifying children and filing under status j is given by

$$I^j(e, n) = \begin{cases} \kappa_1^{jn} e & \text{if } 0 \leq e \leq e_{I_1}^{jn} \\ \kappa_1^{jn} e_{I_1}^{jn} & \text{if } e_{I_1}^{jn} \leq e \leq e_{I_2}^{jn} \\ \max\{\kappa_1^{jn} e_{I_1}^{jn} - \kappa_2^{jn}(e - e_{I_2}^{jn}), 0\} & \text{if } e \geq e_{I_2}^{jn}, \end{cases}$$

where κ_1^{jn} is the earnings subsidy rate in the phase-in region and κ_2^{jn} is the credit phase-out rate. The thresholds, $e_{I_1}^{jn}$ and $e_{I_2}^{jn}$, mark the end of the phase-in region and the beginning of the phase-out region, respectively. In the region between these two thresholds, the credit is constant at its maximum value $\kappa_1^{jn} e_{I_1}^{jn}$. Note that both the credit rates and the earnings thresholds depend on the number of qualifying children and the filing status. However, the maximum level of investment income for program eligibility, $\bar{r}a_I$, does not depend on either of the two. (Figure A1 in the online appendix shows the EITC schedule for the 2013 tax returns.)

2.3 The Child Tax Credit (CTC)

The (non-refundable) child tax credit for a filer under status j , income y and n qualifying children is

$$CTC^j(y, n) = \begin{cases} \theta n & \text{if } y \leq y_{CTC}^j \\ \max\{\theta n - \eta(y - y_{CTC}^j), 0\} & \text{if } y > y_{CTC}^j, \end{cases}$$

where θ is the subsidy per child and y_{CTC}^j is the income level at which the child tax credit starts being phased out. Parameter η characterizes the child tax credit phase-out rate.

If the child tax credit, $CTC^j(y, n)$, is lower than the tax liability, $T^j(y, n)$, then this liability is reduced by the amount of the child tax credit. If the child tax credit is higher than the liability,

then the liability is reduced to zero and the filer can apply for the (refundable) additional child tax credit (ACTC). The additional child tax credit depends on the number of children, in particular on whether it is two or less, or larger than two. The amount of the additional child tax credit is

$$ACTC^j(y, e, n) = \begin{cases} \min \left\{ CTC^j(y, n) - T^j(y, n), \max\{\phi(e - \delta), 0\} \right\} & \text{if } n \leq 2 \\ \min \left\{ CTC^j(y, n) - T^j(y, n), \max\{\phi(e - \delta), T_p(e) - I^j(e, n), 0\} \right\} & \text{if } n > 2, \end{cases}$$

where ϕ and δ are parameters.

2.4 Temporary Assistance for Needy Families (TANF)

Families with children may be eligible for assistance from state-run TANF. The federal TANF block grant contributes 16.5 billion dollars to states each year to assist families in need. States must also contribute with their own funds in order to receive funds from the federal block grant. This program replaced the former Aid to Families with Dependent Children in 1996.

Despite variation across states, many features of the program are common across most states. Eligibility and benefits are determined by categorical and quantitative variables of the assistance unit on a monthly basis. When the children's two parents live together, marital and tax filing statuses become irrelevant for the purpose of TANF. The assistance unit in this case is formed by the two parents and their children. Hence, for the sake of our analysis, we consider two different types of assistance units: one-parent households with children (u), and two-parent households (either cohabiting or married) with children (ν). Financial eligibility requirements include: (i) Family resources (stocks, bonds, bank deposits) cannot exceed a certain limit, say a_B , which is independent of family size. (ii) Gross family income cannot exceed $y_{B_1}^m$, say, where $j = u, \nu$. Gross income includes earned and non-earned income, such as interests and child support income. (iii) Net family income cannot exceed $y_{B_2}^m$. Net income for the purpose of determining TANF eligibility is computed as

$$t_B^j(a, e, n) = (e - d_{B_1} \mathbb{1}_{\{h>0\}} - d_{B_2} \Gamma(n) - d_{B_3}) \sigma_B + ra + \vartheta n, \quad (2)$$

where $\sigma_B < 1$ is a parameter that introduces an earned income disregard; d_{B_1} is a work deduction, $\mathbb{1}_{\{h>0\}}$ is an indicator function which takes value 1 if hours worked are strictly positive; d_{B_2} is a child care deduction, which is set as a fraction of child care costs incurred while working, $\Gamma(n)$, and d_{B_3} is a fixed deduction. Parameter ϑ is child support per child. Notice that the work

deduction applies to every working person in the assistance unit. That is, in households with two working adults the work deduction must be applied twice.

These three financial requirements define the TANF-eligibility set, $\{a, e, n\}$, of an assistance unit of type j as

$$\{a \leq a_B\} \cap \{e + ra + \vartheta n \leq y_{B_1}^m\} \cap \{\iota_B^j(a, e, n) \leq y_{B_2}^m\}. \quad (3)$$

If eligible, the income transfer, $B^j(a, e, n)$, is determined by a standard of need and net family income, with a maximum payment set by a payment standard. That is, an eligible assistance unit of type $j = u, \nu$ is entitled to TANF benefits

$$B^j(a, e, n) = \min \left\{ \bar{B}^m, \max\{[S^m - \iota_B^j(a, e, n)] \times \varsigma, 0\} \right\}, \quad (4)$$

where \bar{B}^m is the maximum transfer for a family of type j with n children; S^m is the standard of need for that family, which is typically set as a percentage of the federal poverty level, $\iota_B^j(a, e, n)$ is net income as defined above, and ς is a parameter that controls when, and the rate at which, transfers are phased out. (Figure A2 in the online appendix shows the 2013 TANF schedule.)

TANF has work requirements and time limits, typically of 60 months, to receive TANF benefits. However, the extent of enforceability of these limits varies widely across states. Besides a number of exemptions from time limits, states are allowed to extend assistance beyond these limits to up to 20% of their caseload.

2.5 Supplemental Nutrition Assistance Program (SNAP)

SNAP is a federal program that provides monthly food assistance to nearly 23 million U.S. households. For SNAP, an assistance unit is an individual or a group of individuals who live together and purchase and prepare meals together. Eligibility is determined by (i) a resource limit, a_F , which is independent of household size; (ii) a gross income limit, $y_{F,1}^m$, which depends on household size. Gross income includes earned and non-earned income, such as investment income, child support and income received from TANF; and (iii) a net income limit, $y_{F,2}^m$. Net income is computed as gross income minus an earned income disregard, a child care deduction when needed for work, d_{F_1} , a standard deduction and an excess shelter deduction. More specifically, net income for the purpose of determining SNAP eligibility and benefits is calculated as follows. First, the earned income disregard and child care and standard deductions are subtracted from gross income to obtain countable income

$$c\iota_F^j(a, e, n) = e\sigma_F + ra + \vartheta n + B^j(a, e, n) - d_{F_1}\Gamma(n) - d_{F_2}. \quad (5)$$

Next, the shelter deduction is calculated by subtracting half of countable income from shelter costs, \hat{c} say. Finally, net income is obtained by subtracting the shelter deduction from countable income, i.e.

$$\iota_F^j(a, e, n) = c\iota_F^j(a, e, n) - \max\{\hat{c} - \frac{1}{2}c\iota_F^j(a, e, n), 0\}. \quad (6)$$

In sum, the SNAP-eligibility set $\{a, e, n\}$ of an assistance unit is

$$\{a \leq a_F\} \cap \{e + ra + \vartheta n + B^j(a, e, n) \leq y_{F_1}^m\} \cap \{\iota_F^j(a, e, n) \leq y_{F_2}^m\}. \quad (7)$$

As an exception, households where *all* its members receive TANF income do not need to pass the income tests, and are immediately entitled to SNAP transfers if they meet the resource test.

SNAP benefits are calculated by subtracting the family's expected contribution towards food, i.e. χ times net income, from a maximum allotment for the family. That is, an eligible assistance unit of type $j = u, \nu$ is entitled to SNAP benefits

$$F^j(a, e, n) = \max \left\{ \bar{F}^m - \chi \iota_F^j(a, e, n), \underline{F}^m \right\}, \quad (8)$$

where \bar{F}^m is the maximum allotment an assistance unit of type j with n children can receive from SNAP, and \underline{F}^m is the minimum benefit an eligible unit can get. (Figure A3 in the online appendix shows the 2013 SNAP schedule.)

3 A Model of Savings, Labor Supply and Living Arrangements

3.1 Demographics

Our model economy is populated by ex-ante identical females, ex-ante identical males and by children. The population of interest for our analysis of the effects of anti-poverty transfers is made up of non-college-educated households with children. This population includes single mothers living alone with their children, unmarried cohabiting couples and married couples. Within the group of unmarried cohabiting couples we distinguish between both-parents-present couples and mother-only-present couples. Our focus on households with children formed by non-college-educated workers is motivated by their higher at-risk-of-poverty rate relative to households where at least one adult is college educated.

Individuals of gender $g \in \{f, m\}$ enter the economy as singles with no children. Females (f) are subjected to fertility shocks and can have up to three children.² We assume that children

²Our modeling of fertility as a process independent of taxes and transfers is supported by empirical evidence showing that fertility does not respond to changes in the EITC (Baughman and Dickert-Conlin 2009).

age stochastically, i.e. every period a fraction of households see their children become adults, in which case the household leaves our target group. Within a household, all children age at the same time. That is, from one period to the next the number of children either stays constant, grows or becomes zero, but it never decreases gradually.

Specifically, the number of children in a household follows a Markov chain with five states: childless ($n = 0$), with one child ($n = 1$), with two children ($n = 2$), with three children ($n = 3$) and, finally, with grown-up children who have already left the nest ($n = \emptyset$). We denote the set of these five states by $N = \{0, 1, 2, 3, \emptyset\}$, where state \emptyset is an absorbing state, as children eventually grow old and leave the household. The transition matrix between these five states is

$$M = \begin{pmatrix} m_{00} & m_{01} & m_{02} & m_{03} & m_{0\emptyset} \\ 0 & m_{11} & m_{12} & m_{13} & m_{1\emptyset} \\ 0 & 0 & m_{22} & m_{23} & m_{2\emptyset} \\ 0 & 0 & 0 & m_{33} & m_{3\emptyset} \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix} \quad (9)$$

where $m_{nn'}$ is the probability of moving from state n to state n' . We make the following two simplifying assumptions. First, we rule out the possibility that a female gives birth to triplets, i.e. $m_{03} = 0$. Second, the probability that a household will move to state \emptyset next period is independent of the number of children, i.e. $m_{1\emptyset} = m_{2\emptyset} = m_{3\emptyset}$. As stated above, our population of interest is made up of households in states 1, 2 and 3. The measure of this population is pinned down by the fertility-aging parameters in matrix M .

3.2 Productivity and Earnings

Adult individuals allocate their time endowment to leisure and work, and the productivity of their working time is subject to idiosyncratic shocks. We denote labor productivity by z and assume that it evolves according to the process

$$\log z' = \rho \log z + \epsilon, \quad \text{with } \epsilon \sim N(0, \sigma_\epsilon^2). \quad (10)$$

For households with two adults we denote the vector of individual labor productivities by $\mathbf{z} \equiv [z_f \ z_m]$ and the vector of log productivities by $\ln \mathbf{z} \equiv [\ln z_f \ \ln z_m]^T$. The vector of productivity shocks is denoted by $\boldsymbol{\epsilon} \equiv [\epsilon_f \ \epsilon_m]^T$ and the shocks variance-covariance matrix by σ_ϵ^2 . Productivity shocks for workers within the same household are allowed to be partially correlated. We write the evolution of the two labor productivities within a household with two adults as $\ln \mathbf{z}' = \boldsymbol{\rho} \ln \mathbf{z} + \boldsymbol{\epsilon}$, where $\boldsymbol{\rho} \equiv [\rho \ \rho]^T$.

Earnings of a worker of gender g are given by $e_g \equiv h_g z_g \omega_g$, which is the product of the number of hours worked, h_g , the worker’s labor productivity, z_g , and her/his wage rate, ω_g , which is assumed to be exogenous. For households with two adults we denote by e the vector of earnings, i.e. $e \equiv [e_f \ e_m]$. Households can save in a risk-free asset subject to a non-borrowing constraint. Household asset holdings are denoted by a .

3.3 Living Arrangements

A female with children can be in one of the following four living arrangements: single living alone with her children (ℓ_s); unmarried and cohabiting with the father of the children (ℓ_{cp}); unmarried and cohabiting with a male who is not the father of her children (ℓ_c); and married and living with her husband and their children (ℓ_m). We denote the living arrangement by $\ell \in L \equiv \{\ell_s, \ell_{cp}, \ell_c, \ell_m\}$. Single males are not modeled explicitly. They are simply assumed to receive “love shocks” and make either cohabitation or marriage proposals to single females living alone or with her children, if any. These females, provided that they have a proposal, decide whether to accept it or not. If they accept, the female and the male form a household, pool resources and solve a joint decision problem. In particular, cohabiting couples make decisions on individual consumptions, hours worked, joint savings and on whether or not to get married. Married couples decide on individual consumptions, hours worked and joint savings. Both cohabiting and married couples have full commitment and do not separate.³

Living arrangements have implications beyond taxation and eligibility/generosity of tax credits and assistance programs. In particular, in our model economy one- and two-adult households differ in terms of: (i) the extent of intra-household risk sharing; (ii) household consumption commitments; and (iii) child care demand while working.

As it should be apparent, intra-household risk sharing is not available to one-adult households. In two-adult households, however, individuals are assumed to share idiosyncratic risks efficiently, in the sense that individual allocations lie on the Pareto frontier.

By consumption commitments we refer to the quasi-non-discretionary, minimum expenses needed to run a household, in particular, shelter and utilities. We assume that these expenses vary with the number of adults and children in the household, but are otherwise fixed. As is well known, the presence of consumption commitments increases individuals’ risk aversion, which in our framework enhances the role played by intra-household risk sharing.

³In light of the empirical finding by Herbst (2011) establishing a lack of relationship between the EITC and divorce rates, our assumption of commitment does not seem to be key for our analysis of EITC reforms.

Finally, regarding child care costs, we assume that two-adult households can allocate their working times in a way that reduces child care costs incurred while working. By contrast, single mothers living alone must necessarily incur child care costs during their entire working time. That is, two-adult households not only have twice as much adult time resources as one-adult households, but they can also allocate individual working times so that they save on child care.

3.4 Bellman Equations

Before laying out the problems solved by the households in our model, we introduce some notation. For the sake of brevity, we merge the non-refundable part of the child tax credit with income and payroll taxes and denote it by $\mathcal{T}^j(a, e, n)$, i.e.

$$\mathcal{T}^j(a, e, n) \equiv T^j(y, n) + T_p(e) - \min\{CTC^j(y, n), T^j(y, n)\}. \quad (11)$$

Likewise, we merge the refundable part of the child tax credit with the earned income tax credit, which is also refundable, and denote it by $\mathcal{I}^j(a, e, n)$, i.e.

$$\mathcal{I}^j(a, e, n) \equiv I^j(y, a, n) + ACTC^j(y, e, n). \quad (12)$$

We denote the net balance with the Internal Revenue Service (tax liabilities after credits) by $IRS(a, e, n)$. As a remark, it should be noted that while taxes and tax credits in the U.S. are based on annual income and earnings, TANF and SNAP are monthly-based programs. We resolve this mixed timing by setting the length of a period in the model equal to one year and by annualizing transfers from TANF and SNAP.

Single mothers living alone with n children

A single female living alone with her $n \geq 0$ children makes decisions on consumption, hours supplied to work, savings and, provided she has a cohabitation or a marriage proposal, on whether she accepts the proposal or remains alone. For a single female with $n > 0$ children, the probabilities of receiving offers from single males are denoted as follows: $\pi_{\ell_{cp}}$ is the probability that she receives a cohabitation proposal from the father of her children; π_{ℓ_c} is the probability that she receives a cohabitation proposal from a single man who is not the father of the children; and π_{ℓ_m} is the probability that she receives a marriage proposal. The probability that she has no proposal is hence $\pi_{\ell_s} = 1 - \pi_{\ell_{cp}} - \pi_{\ell_c} - \pi_{\ell_m}$.

The value function of a female in living arrangement $\ell \in L$ is denoted by v_f^ℓ . Then, the value of a single female living alone who has labor productivity z , asset holdings a and $n > 0$ children

is given by

$$v_f^{\ell_s}(z, a, n) = \max_{c, l, a'} \left\{ U_f(c, l) + \beta \mathbb{E} \left[\pi_{\ell_{cp}} \max\{v_f^{\ell_{cp}}(z', \tilde{a}', n'), v_f^{\ell_s}(z', a', n')\} + \pi_{\ell_c} \max\{v_f^{\ell_c}(z', \tilde{a}', n'), v_f^{\ell_s}(z', a', n')\} + \pi_{\ell_m} \max\{v_f^{\ell_m}(z', \tilde{a}', n'), v_f^{\ell_s}(z', a', n')\} + \pi_{\ell_s} v_f^{\ell_s}(z', a', n') \right] \right\} \quad (13)$$

s.t.

$$c + \hat{c}(n) + \Gamma(h, n) + a' = e_f + (1 + r)a + \vartheta n - IRS(a, e_f, n) + B^u(a, e_f, n) + F^u(a, e_f, n)$$

$$\ln z' = \rho \ln z + \epsilon, \quad \text{with } \epsilon \sim N(0, \sigma_\epsilon^2)$$

$$c \geq 0, \quad 0 \leq l \leq 1 \quad \text{and} \quad a' \in A,$$

where

$$IRS(a, e_f, n) = \mathcal{T}^h(a, e_f, n) - \mathcal{I}^h(a, e_f, n), \quad (14)$$

and where $h = 1 - l$ are hours worked, $e_f \equiv h z \omega_f$ are household earnings, a' are next-period asset holdings of the single mother if she receives no cohabitation/marriage proposal or if she rejects any proposal, and $\tilde{a}' \equiv a' + a'_m$ are household asset holdings if the single mother accept a proposal made by a single male with assets a'_m . The function $\hat{c}(n)$ represents fixed consumption commitments of a single mother with n children. The function $\Gamma(h, n)$ represents work-related expenses (commuting costs, etc.) plus child care costs paid while working. Asset holdings lie in the set $A = [0, \bar{a}]$, where \bar{a} is a non-binding upper bound. The expectation is taken with respect to the realization of her own labor productivity next period, z' , on the labor productivity and the level of assets of the potential suitor, z'_m and a'_m , respectively, and on the number of children, n' . The values when the children leave the household, $v_f^\ell(z, a, \emptyset)$ for $\ell \in L$, in the maximization problem above, are the values associated with remaining childless forever.

The problem of a single female without children ($n = 0$) is similar to the one above, with the exception that the probability that she receives a proposal to cohabit is the sum of $\pi_{\ell_{cp}}$ and π_{ℓ_c} .⁴

Cohabiting couples with n children

We model cohabitation as an unmarried female and an unmarried male living in the same dwelling, pooling wealth and income, sharing the fixed costs of running the household and making joint decisions on individual consumptions, savings and labor supplies. Risk sharing within the

⁴Even though households without children are not in our population of interest, we include single childless females in the model so that single males can propose to them and start cohabiting or married households before they have their first child. Without single childless females, all cohabiting and married couples in the model would have at least one child born to a single mother alone, and we do not want to restrict our sample of U.S. households to this group when we compare outcomes from our model with the data.

household is assumed to be efficient, in the sense that the couple maximizes a weighted sum of the two adults' utility functions. These weights are referred to as Pareto weights, and will be denoted by η_g for $g \in \{f, m\}$. Cohabiting couples file separate tax returns and get married as soon as marriage yields more value to the couple than cohabitation. As will become clear below when we describe the problem of a married couple, we assume no difference between cohabitation and marriage other than the tax and transfer schemes they face, and the fact that cohabitants can get married. The assumption that cohabiting and married couples are ex-ante identical will help us assess the effects of the differential tax-transfer treatment of these two types of couples.

Since taxes, credits and the TANF also vary across cohabiting couples, depending on whether or not the cohabiting male is the father of the children, we present these two cases in turn.

Both-parents-present cohabiting couples

Both-parents-present cohabiting couples face the additional, non-trivial decision of who of the two adults will file as head of household (\bar{h}) and who as single (s). The simultaneous labor supply and filing status decisions are made so that the optimal level of household earnings creates the minimum tax liabilities after credits.⁵ In the instance where only one adult works, then, trivially, she/he claims the children as dependent and files as head of household. Importantly, the parent that does not claim the children as qualifying children cannot take the EITC using the rules for those with no qualifying child. This is one of the key differences with respect to cohabiting households where the male is not the father of the children.

The problem of a both-parents-present cohabiting couple with labor productivities $\mathbf{z} \equiv [z_f z_m]$, assets a and n children involves decisions on savings, individual consumption and hours worked, tax filing statuses and whether to get married or remain as cohabitants. Formally, a cohabiting couple in living arrangement ℓ_{cp} , with Pareto weights on individual utilities η_g , solves

$$V^{\ell_{cp}}(\mathbf{z}, a, n) = \max_{c_f, c_m, l_f, l_m, a'} \left\{ \sum_{g=f, m} \eta_g U_g(c_g, l_g) + \beta \mathbb{E} \left[\max\{V^{\ell_{cp}}(\mathbf{z}', a', n'), V^{\ell_m}(\mathbf{z}', a', n')\} \right] \right\} \quad (15)$$

s.t.

$$c_f + c_m + \hat{c}(n) + \Gamma(h_f, h_m, n) + a' = e + (1+r)a - IRS(a, e, n) + B^\nu(a, e, n) + F^\nu(a, e, n)$$

$$\ln \mathbf{z}' = \rho \ln \mathbf{z} + \boldsymbol{\epsilon}, \quad \text{with } \boldsymbol{\epsilon} \sim N(0, \sigma_\epsilon^2)$$

$$c_f, c_m \geq 0, \quad 0 \leq l_f, l_m \leq 1 \quad \text{and} \quad a' \in A,$$

⁵We do not impose the statutory requirement that the head of household must contribute at least 50 percent to household expenses. Contribution to household expenses is self-declared and hence difficult to verify. Indeed, using CPS data (which we present below) we observe a substantial number of both-parents-present cohabiting couples where the head of household is not the worker with the highest earnings.

where

$$IRS(a, \mathbf{e}, n) = \begin{cases} \mathcal{T}^h(a/2, e_f, n) + \mathcal{T}^s(a/2, e_m, 0) - \mathcal{I}^h(a/2, e_f, n) & \text{if female files as } \bar{h} \\ \mathcal{T}^s(a/2, e_f, 0) + \mathcal{T}^h(a/2, e_m, n) - \mathcal{I}^h(a/2, e_m, n) & \text{if male files as } \bar{h}, \end{cases}$$

and where $h_g = 1 - l_g$ are hours worked, $e \equiv e_f + e_m = h_f z_f \omega_f + h_m z_m \omega_m$ are household earnings. The function $V^{\ell_{cp}}$ denotes the value of the both-parents-present cohabiting couple, and the function V^{ℓ_m} denotes the value of a married couple. The expectation is formed over the two labor productivities and on the number of children. Note that the adult filing taxes as single cannot apply for the EITC. Also note that TANF eligibility and benefits depend on total household wealth, a .

Mother-only-present cohabiting couples

We now write the problem of a mother cohabiting with a man who is not the father of her children. The main differences with respect to both-parents-present cohabiting couples are: First, the male cannot claim the children as dependents, as they fail to satisfy the relationship test. Consequently, he cannot file as head of household, but can apply for the EITC as single without dependents. Note that this is in contrast to the case of both-parents-present cohabiting couples, where the father of the children is not allowed to apply for the EITC as single without dependents. Second, most states do not include the male in the TANF assistance group, and his resources and income are not counted towards eligibility and benefits. This is in contrast to cohabiting couples where the male is the father of the children. For SNAP, the male is in the assistance group regardless his biological relationship with the children, as long as the cohabiting couple shares and prepares food together.

The value of a mother-only-present cohabiting couple is

$$V^{\ell_c}(\mathbf{z}, a, n) = \max_{c_f, c_m, l_f, l_m, a'} \left\{ \sum_{g=f,m} \eta_g U_g(c_g, l_g) + \beta \mathbb{E} \left[\max\{V^{\ell_c}(\mathbf{z}', a', n'), V^{\ell_m}(\mathbf{z}', a', n')\} \right] \right\} \quad (16)$$

s.t.

$$c_f + c_m + \hat{c}(n) + \Gamma(h_f, h_m, n) + a' = e + (1+r)a + \vartheta n - IRS(a, \mathbf{e}, n) + B^u(a/2, e_f, n) + F^\nu(a, e, n)$$

$$\ln \mathbf{z}' = \boldsymbol{\rho} \ln \mathbf{z} + \boldsymbol{\epsilon}, \quad \text{with } \boldsymbol{\epsilon} \sim N(0, \sigma_\epsilon^2)$$

$$c_f, c_m \geq 0, \quad 0 \leq l_f, l_m \leq 1 \quad \text{and } a' \in A,$$

where

$$IRS(a, \mathbf{e}, n) = \mathcal{T}^h(a/2, e_f, n) + \mathcal{T}^s(a/2, e_m, 0) - \mathcal{I}^h(a/2, e_f, n) - \mathcal{I}^s(a/2, e_m, 0),$$

and where $h_g = 1 - l_g$ are hours worked, and $e \equiv e_f + e_m = h_f z_f \omega_f + h_m z_m \omega_m$ are household earnings. Function V^{ℓ_c} is the value of the mother-only-present cohabiting couple and V^{ℓ_m} is the

value of a married couple. Note that TANF eligibility and benefits depend on the female's wealth and earnings (assistance unit $j = u$), while SNAP is based on household-level variables ($j = \nu$).

Married couples with n children

The problem solved by married couples is similar to the one solved by cohabitants, save for the tax-transfer system they face, and for the fact that once married they cannot change marital status. Married couples file with a *married filing jointly* status ($j = x$). Hence, a married couple with labor productivities \mathbf{z} , assets a and n children solves

$$V^{\ell_m}(\mathbf{z}, a, n) = \max_{c_f, c_m, l_f, l_m, a'} \left\{ \sum_{g=f,m} \eta_g U_g(c_g, l_g) + \beta \mathbb{E} V^{\ell_m}(\mathbf{z}', a', n') \right\} \quad (17)$$

s.t.

$$c_f + c_m + \hat{c}(n) + \Gamma(h_f, h_m, n) + a' = e + (1+r)a - IRS(a, e, n) + B^\nu(a, e, n) + F^\nu(a, e, n)$$

$$\ln \mathbf{z}' = \rho \ln \mathbf{z} + \epsilon, \quad \text{with } \epsilon \sim N(0, \sigma_\epsilon^2)$$

$$c_f, c_m \geq 0, \quad 0 \leq l_f, l_m \leq 1 \quad \text{and} \quad a' \in A,$$

where

$$IRS(a, e, n) = \mathcal{T}^x(a, e, n) - \mathcal{I}^x(a, e, n), \quad (18)$$

and where $h_g = 1 - l_g$ are hours worked and $e \equiv e_f + e_m = h_f z_f \omega_f + h_m z_m \omega_m$ are household earnings. Note that the married couples' taxes, tax credits and assistance transfers are based on household income, earnings and wealth.

3.5 The Steady-State Partial Equilibrium

Before providing a definition of the steady-state partial equilibrium in our economy we need to introduce some notation. We denote by \mathcal{B}^s the Borel σ -algebra on the space of labor productivity and asset holdings of single mothers, $Z^f \times A$, where Z^f is the space of labor productivity and A is the space of asset holdings. The projection of $B \in \mathcal{B}^s$ on Z^f is denoted by B_{z_f} . Let \mathcal{B}^c denote the Borel σ -algebra on the space of labor productivities and asset holdings of couples, i.e. $Z^f \times Z^m \times A$.

The probability that a single mother with labor productivity z_f , assets a_f , and n children will have productivity and assets lying in set $B \in \{\mathcal{B}^s \cup \mathcal{B}^c\}$, will have n' children and will move to living arrangement $\ell' \in L$ next period is denoted by $P^s(z_f, a_f, n; B, n', \ell')$.

The probability that a couple with productivities z^f and z^m , assets a , n children and in living arrangement ℓ will transit to productivities and assets lying in set $B \in \mathcal{B}^c$, will have n' children

and will move to living arrangement ℓ' next period is denoted by $P^c(z_f, z_m, a, n, \ell; B, n', \ell')$. (These transition functions are derived in the online appendix.)

The mass of single mothers at each $B \in \mathcal{B}^s$ with n children is denoted by $\psi^s(B, n)$. The mass of couples at each $B \in \mathcal{B}^c$, with n children and in living arrangement $\ell \in \{\ell_{cp}, \ell_c, \ell_m\}$ is denoted by $\psi^c(B, n, \ell)$.

We now define the steady-state partial equilibrium as:

DEFINITION: A steady-state partial equilibrium in our economy is a set of value functions $\{v_f^{\ell_s}, V^{\ell_{cp}}, V^{\ell_c}, V^{\ell_m}\}$; policy functions for consumption, hours worked, savings, single mothers' acceptance/rejection of cohabiting and marriage proposals, cohabiting couples' marriage decisions, and for the filing statuses in both-parents-present cohabiting couples; and time-invariant measures of one-adult households, $\psi^s(B, n)$, and two-adult households, $\psi^c(B, n, \ell)$, such that

1. Given the wage rates and the tax-transfer scheme, the value functions $\{v_f, V^{\ell_{cp}}, V^{\ell_c}, V^{\ell_m}\}$ solve equations (13) – (17) above with the corresponding policy functions.
2. The invariant probability measures: The invariant measure of single mothers living alone is given by

$$\psi^s(B, n') = \sum_{n \in N} \int_{Z^f \times A} P^s(z_f, a, n; B, n', \ell_s) \psi^s(dz_f, da, n), \quad (19)$$

for all $B \in \mathcal{B}^s$ and $n' \in N \setminus \{0, \emptyset\}$. For $n' = 0$

$$\psi^s(B, 0) = \int_{Z^f \times A} P^s(z_f, a, 0; B, 0, \ell_s) \psi^s(dz_f, da, 0) + \mathbb{1}_{\{0 \in B_a\}} \psi_0^s \int_{B_{z_f}} \tilde{f}_{z_f}(dz_f), \quad \text{for all } B \in \mathcal{B}^s, \quad (20)$$

where ψ_0^s is the measure of entering single females (who enter with zero assets), and $\tilde{f}_{z_f}(\cdot)$ is the unconditional density function from where the newborn draw their initial productivity shock. To ensure a stationary measure of households at non-absorbing states, the measure of entering single females must be equal to the number of households that transit to the absorbing state \emptyset each period. Thus,

$$\psi_0^{\ell_s} = \frac{1}{(\mathbf{I}_4 - \tilde{M})^{-1} \cdot \mathbf{1}}, \quad (21)$$

where \mathbf{I}_4 is a (4×4) identity matrix, \tilde{M} is the (4×4) upper-left block of M , and $\mathbf{1}$ is a (4×1) -vector whose entries are all 1.

The invariant probability measures of couples are given by

$$\begin{aligned} \psi^c(B, n', \ell') &= \sum_{n \in N} \sum_{\ell \in L \setminus \ell_s} \int_{Z^f \times Z^m \times A} P^c(z_f, z_m, a, n, \ell; B, n', \ell') \psi^c(dz_f, dz_m, da, n, \ell) + \\ &\quad \sum_{n \in N} \int_{Z^f \times A} P^s(z_f, a, n; B, n', \ell') \psi^s(dz_f, da, n) \end{aligned} \quad (22)$$

for all $B \in \mathcal{B}^c$, $n' \in N \setminus \{\emptyset\}$ and $\ell' \in L \setminus \ell_s$.

3.6 Parameterization

Preferences.—We assume that females and males have identical preferences over consumption and leisure, which are represented by the following per-period utility function

$$U(c, l) = \frac{c^{1-\sigma} - 1}{1-\sigma} + \varphi \frac{l^{1-\zeta} - 1}{1-\zeta}, \quad (23)$$

where σ is the coefficient of relative risk aversion, $\varphi > 0$ is a utility weight on leisure, and $\zeta > 0$ controls the Frisch elasticity of labor supply.

Consumption Commitments.—We specify fixed, non-discretionary expenses for households of type $\ell \in L$ with n children as

$$\hat{c}(n) = \hat{c}_0^\ell + \hat{c}_1^\ell \cdot n, \quad (24)$$

where \hat{c}_0^ℓ and \hat{c}_1^ℓ are parameters.

Work-Related and Child Care Costs.—Households incur direct budgetary costs when adult members choose to supply positive hours to market work. We distinguish two such costs: (i) Work-related costs such as transportation, meals outside of the home, buying clothing, etc, and (ii) Child care paid while working. We parameterize these costs as a function of labor market participation, hours worked and the number of children

$$\begin{aligned} \Gamma(h^f, n) &= \gamma_1 \mathbb{1}_{\{h^f > 0\}} + \gamma_2 \mathbb{1}_{\{h^f > 0\}} n^\alpha && \text{for } \ell = \ell_s, \\ \Gamma(h^f, h^m, n) &= \gamma_1 [\mathbb{1}_{\{h^f > 0\}} + \mathbb{1}_{\{h^m > 0\}}] + \gamma_2 \mathbb{1}_{\{h^f + h^m > 1\}} n^\alpha && \text{for } \ell = \ell_{cp}, \ell_c, \ell_m, \end{aligned} \quad (25)$$

where γ_1 denotes work-related costs and γ_2 denotes child care costs per child. $0 < \alpha \leq 1$ is a parameter that introduces economies of scale in child care (all else equal child care costs decrease with the number of children, examples are multiple children at the same school, sibling discounts at day care center, etc.). The distinction between these two types of costs allows us to embed the possibility for couples of making use of their joint time allocation problem to reduce child care costs. Specifically, γ_1 includes all expenditures that cannot be eluded when an adult in the

household chooses to work. By contrast, γ_2 characterizes expenditures that can be avoided if there are two working adults in the households who split their working hours so that there is always at least one adult at home (e.g. saving on daycare).

4 Data, Calibration and Model Fit

In this section we first describe the sample of households that we use to calculate moments for key variables. Then, we calibrate the parameters of the model. Some of the parameters have a direct empirical counterpart and hence values to these parameters are set outside of the model. Values to the remaining thirteen parameters are set so that the steady-state partial equilibrium of our model matches thirteen moments calculated from our sample of households.

4.1 Data

Personal and household data on labor force participation, annual hours worked, earnings and taxes and transfers are taken from the 2014 Annual Social and Economic Supplement (ASEC) of the Current Population Survey (CPS), which also contains information on marital status, living arrangements, filing status, education and number of children. The ASEC is administered to households in March and surveys information for the previous calendar year.

The sample of households we use to calibrate our model is obtained from the ASEC by removing all households with characteristics that do not match the characteristics of the households in our model economy. More specifically, from the 2014 ASEC we drop: households with more than one family (i.e. where a subfamily is present); households with a member who is not a child, partner, partner's child or spouse of the reference person (i.e. we remove households where a grandparent, uncle, or another non-related individual is present); households formed by cohabiting couples where at least one of the cohabitants has been previously married or is separated; households where the female is not the mother of all the children in the household; households where the male is the father of some of the children but not all; households headed by a male with children and without a wife or cohabitant; households where there is a child with neither parent present; households with at least one adult in the armed forces; households with no children or more than three children; households with at least one member holding a college degree; households with no income; households receiving disability, retirement, survivor or veterans income; and households where there is a member with negative earnings. After completing this pruning of the raw data, we end up with a sample of 14,540 individuals in 3,945 households.

Table 1 below shows the breakdown of our sample into the four living arrangements: Single mothers living alone with their children, both-parents-present cohabiting couples, mother-only-present cohabiting couples and married couples with children. The first two rows of the table show the percentages of individuals and households in each living arrangement, respectively. 17.5 percent of households in our sample are made up by single mothers living alone with their children, 6.8 percent are both-parents-present cohabiting couples, 2 percent are mother-only-present cohabiting couples and 73.5 percent are married couples. For each living arrangement, the distribution of households over the number of children is shown in rows (3) to (5). Nearly half of single mothers and cohabiting couples have only one child, against 35 percent of married couples. By contrast, 16 percent of single mothers and cohabiting couples have three children, against 20.8 percent of married couples.

The distribution of households over the number of workers is shown in rows (6) to (8). Almost 20 percent of single mothers do not work. About 40 percent of both-parents-present cohabiting couples and married couples have only one adult in the labor force, and almost 60 percent have the two adults in the labor force. Among mother-only-present cohabiting couples, 6 percent have no one in the labor force, 26 percent have only one worker and the remaining 67 percent have two workers.

TABLE 1— OUR SAMPLE OF HOUSEHOLDS

	Single mothers	Cohabiting couples		Married couples
		Both parents present (bpp)	Mother only present (mop)	
Individuals (%)	13.07	6.83	2.02	78.09
Households (%)	17.59	6.87	2.08	73.46
Distribution (# children)				
1	45.24	51.66	54.32	35.37
2	38.33	32.10	30.86	43.69
3	16.43	16.24	14.81	20.95
Distribution (# workers)				
0	19.46	1.85	6.10	2.38
1	80.55	39.48	26.90	40.03
2	—	59.04	67.07	57.59

Source: Sample of households from the 2014 Annual Social and Economic Supplement (ASEC).

Average labor supply and average earnings for groups of individuals in this sample of households will be used as targets to calibrate some parameter values in our model (section 5.3 below).

It must be stressed, however, that all the moments used for calibration are from single mothers alone and married couples. We purposely leave aside moments from cohabiting couples. The rationale for this calibration strategy is as follows. By leaving aside information from cohabitants, we can then use our model to assess the extent to which the differential tax-transfer treatment of cohabiting and married couples affects the labor supply decisions of two-adult households. As noted above, cohabiting and married couples in our model are ex-ante identical along all dimensions, except for the taxes and transfers they face. Hence, the model so calibrated can inform us on the existence and extent of a marriage penalty/bonus in the tax-transfer system.

4.2 Parameters calibrated outside of the model

Taxes, tax credits and assistance programs.—Tax rates, income brackets, deductions and personal exemptions are taken from the IRS website for the 2013 tax returns. Parameter values determining eligibility and benefits for the earned income tax credit and the child tax credit in 2013 are also taken from the IRS website. Tables A1 to A5 in the online appendix present all these parameter values. Since there is some variation across U. S. states in the parameter values determining eligibility and benefits of the Temporary Assistance for Needy Families (TANF), we take the values for 2013 from Delaware’s TANF schedule, which does not show large deviations from national mean values.⁶ Parameter values of the 2013 Supplemental Nutrition Assistance Program (SNAP) are taken from the U.S. Department of Agriculture, Food and Nutrition Service.⁷ Tables A6 and A7 in the online appendix present TANF and SNAP parameter values, respectively.

Demographics.—After the assumptions made on the fertility and children-aging processes, the transition matrix M contains seven parameters: m_{00} , m_{01} , m_{02} , m_{10} , m_{12} , m_{13} and m_{23} . We set these probabilities so that the matrix M and its associated stationary distribution match the following seven moment conditions: (1) the average age at first birth among non-college-educated females is 23 years. Since in our model single females enter the economy childless at age 18, we must set values to m_{00} and $m_{0\emptyset}$ so that the expected number of years until a child is born, conditional on having a child, is equal to 5;⁸ (2) the share of households with 1 child in our ASEC sample of households is 36.65 percent; (3) the share of households with 2 children is 42.42 percent; (4) the probability of having twins, conditional on having a conception, is 3.26 percent (National Vital Statistics Reports, 2010). We assume that this conditional probability is the same for childless females and for those who are already mothers of one child, and hence obtain

⁶www.dhss.delaware.gov/dhss/ds/tanf.html.

⁷www.fus.usda.gov/snap.

⁸Note that the expected number of periods for a female before she becomes a mother, conditional on becoming a mother, is $1/(1 - m_{00} - m_{0\emptyset})$.

two moment conditions to match; (5) for households with children, the expected duration until the children leave the house, and hence the household leaves our population of interest, is 20 years; (6) the fraction of women without a college degree who remain childless throughout their childbearing years is 17 percent.⁹ Given the demographic structure of the model, these seven moment conditions uniquely identify the seven free parameters (Appendix A provides a detailed explanation of how we pin down the seven demographic parameters from these seven moments).

The elasticity of intertemporal substitution, labor productivities and the risk-free rate of return.—Standard values for the elasticity of intertemporal substitution, $1/\sigma$, range between 1 and $1/3$, so we choose an intermediate value and set $\sigma = 1.5$. The process governing the evolution of idiosyncratic labor productivity is assumed to be the same for females and males (as in Heathcote et al. 2010). The two parameters characterizing this process are set as in Flodén and Lindé (2001) who estimate $\rho = 0.914$ and $\sigma_\epsilon = 0.206$. We set the cross-spouse correlation for temporary shocks to 0.15 (see Hyslop 2001). The annual risk-free rate of return on savings is set to 3 percent.

Consumption commitments.—There is a number of assistance programs, which are not considered in our analysis, that directly impinge on households consumption commitments (reduced rent, public housing projects, energy assistance benefits). These programs disproportionately benefit single mothers living alone. For example, in our ASEC sample of households, we find that the fraction of single mothers alone benefiting from reduced rent, public housing or energy assistance is more than six times the fraction among households formed by couples with children. In addition, total tenant payment in public housing units is calculated as a fraction of household income, which implies a higher subsidy to one-earner households. We take all this as indication that consumption commitments are lower for single mothers alone. Using average household earnings among single mothers in our sample and the formula used to calculate the total tenant payment in public housing units, we set annual consumption commitments for a single mother with two children equal to \$2,000. We break down this total by setting $\hat{c}_0^{\ell_s} = 1,000$ and $\hat{c}_1^{\ell_s} = 500$. Although total consumption commitments for couples are calibrated internally, we set $\hat{c}_1^{\ell_{cp}} = \hat{c}_1^{\ell_c} = \hat{c}_1^{\ell_m} = 1,500$. This number is obtained by multiplying the minimum extra income needed to remain above the official poverty line per additional child (\$4,300 according to the U. S. Census Bureau) by the share of income spent on rent and utilities.

Child care and child support.—We set the value of α , which governs child care savings per child as the number of children in the household increases, using data on child care expenses from the

⁹Source: PEW 2010. This number is calculated as the fraction of women aged 40-44 without children. The share of childless women without a high school degree is 15%, while it is 17% for high school graduates and 18% for women with some college. We choose an intermediate value of 17%. All numbers are based on CPS data from 2006-08.

Survey of Income and Program Participation (SIPP). Among households with children under 15 years old, we find that families with 2 (3+) children spend on average 46% (64%) more on child care than families with 1 child. We set $\alpha = 0.5$ to be roughly consistent with these estimates. Finally, we set child support per child, ϑ , using information from the single mothers in our sample receiving child support. We find that single mothers with one child receive on average \$3,019, and single mothers with two children receive \$5,480. Based on these numbers, we set $\vartheta = 3,000$.

Distribution of asset holdings across single males.—The wealth distribution across single males, who make cohabitation or marriage proposals to single females, is treated as an exogenous object and will be kept fixed throughout our numerical experiments. We estimate this distribution from the 2013 wave of the Survey of Consumer Finances (SCF). Our sample consists of single males below 45 years of age who do not hold a college degree and who have never been married. From this sample we exclude individuals with negative net wealth or above \$500,000 (the wealthiest 3.0 percent). The empirical wealth distribution within the remaining sample is summarized in Table 2. As can be seen, there is substantial dispersion with regard to the assets that a potential cohabitant/spouse may contribute to the common pool of assets: more than 20 percent of single males hold less than \$1,000, while males from the upper decile own more than \$170,000. The median male making a cohabiting or marriage proposal owns roughly \$9,700.

TABLE 2—SINGLE MALES’ ASSET DISTRIBUTION (IN THOUSAND DOLLARS)

Decile	1	2	3	4	5	6	7	8	9	10
Net worth	0.2	0.8	2.9	6.5	9.7	13.5	22.7	41.0	77.8	174.6

Source: 2013 Survey of Consumer Finances (SCF).

4.3 Parameters calibrated endogenously

The remaining twelve parameters are calibrated internally: β , φ , ζ , η_f , ω_f , ω_m , \hat{c}_0^m , γ_1 , γ_2 , π_{ℓ_s} , $\pi_{\ell_{cp}}$, π_{ℓ_c} and π_{ℓ_m} . We set values to these parameters so that the steady state of our model economy matches thirteen moments from the data. In particular, the moments used as targets to calibrate the thirteen parameters are:

- 1-3)** The shares of the four household types are as follows: single mothers, 17.5 percent; two-parent cohabiting couples, 6.8 percent; mother-only-present cohabiting couples, 2.1 percent; married couples, 73.5 percent.
- 4)** The labor force participation rate of single mothers living alone is 80.5 percent (γ_2).
- 5)** Average hours worked by single mothers represent 23.1 percent of their time endowment (φ).

- 6) Labor force participation among married individuals (females and males) is 77.6 percent (γ_1).
- 7) Average hours worked by all married individuals (females and males) represent 27.6 percent of their time endowment ($\hat{c}_0^{\ell_m}$).
- 8) Average hours worked by working married females are 20.8 percent lower than those worked by working married males (μ).
- 9) Micro estimates of the intensive-margin Frisch elasticity of labor supply for males range between 0.2 and 0.7. We target a value of 0.53. It should be noted that this target, along with the average hours worked by working females, implies an intensive-margin Frisch elasticity for females of 0.77, which is in line with empirical estimates (Blundell and MaCurdy, 1999).
- 10) Median net worth among married households, conditional on non-negative net worth, is \$22,800 (2013 SCF) (β).
- 11) Average earnings across single mothers and married females are \$16,005 (ω_f).
- 12) The gender wage gap, defined as the mean log wage difference between full-time male and female workers, is 18 percent (ω_m) (U.S. Bureau of Labor Statistics 2014).

The parameter values that match these moments are presented in Table 3.

TABLE 3— PARAMETERS CALIBRATED ENDOGENOUSLY

Description	Parameter	Value	Moment	Data	Model
Discount factor	β	0.956	median wealth marr.	22,800	23,387
Regulates Frisch elasticity	ζ	3	males Frisch elasticity	0.53	0.53
Utility weight	φ	0.185	hours single females	0.231	0.233
Pareto weight	η_f	0.558	ratio hours	0.792	0.791
Female wage rate	ω_f	51.9	avg. earnings females	16,005	16,065
Male wage rate	ω_m	81.2	gender wage gap	0.180	0.178
Consumption commitment	$\hat{c}_0^{\ell_m}$	\$8,900	hours married indiv.	0.276	0.274
Work+child care costs (monthly)	γ_1	\$153	LFP married indiv.	0.776	0.776
Work+child care costs (monthly)	γ_2	\$564	LFP single females	0.805	0.809
Prob. no proposal	π_{ℓ_s}	0.795	population share ℓ_s	0.176	0.176
Prob. bpp-cohabitation proposal	$\pi_{\ell_{cp}}$	0.031	population share ℓ_{cp}	0.069	0.069
Prob. mop-cohabitation proposal	π_{ℓ_c}	0.005	population share ℓ_c	0.021	0.021
Prob. marriage proposal	π_{ℓ_m}	0.169	population share ℓ_m	0.735	0.734

4.4 Model fit

In this section we assess the fit of the model along dimensions which have not been used as targets. Our focus is on labor supplies, household earnings, EITC recipients and costs, and on the labor supply responses to the EITC. We compare moments generated by the steady state of our model economy with those from our sample of single mothers and married couples. Since our calibration does not use information from cohabitants, we postpone the discussion of this type of couples to the next section, where we address the effects of the differential tax-transfer treatment of married and cohabiting couples.

Labor supply.—While our targets above pin down the labor force participation rate and the average hours worked of single mothers alone, they do not uniquely pin down those of married females and married males separately. Hence, we start by comparing the average labor supply of married workers in the model with those in the data. As shown in panel A of Table 4, our model does well in accounting for both participation and average hours worked of married individuals. In particular, the labor force participation rate of married females in the model is 59.33 percent, against 62.11 percent in the data. Average annual hours worked by working married females are 1,656 in the model and 1,681 in the data. For married males, the model yields a participation rate of 95.91 percent, against 93.10 percent in the data. Average hours worked by working married males equal 2,094 in the model and 2,121 in the data.

The labor force participation rate within the population of married females varies with the level of their husbands' earnings. In our sample from the 2014 ASEC, this relationship is U-shaped, reaching the minimum when husbands' earnings are in the range from 20 to 25 thousand dollars. We find a similar U-shaped relationship in our model between married females' labor force participation rates and their husbands' earnings, with the minimum participation rate in the same earnings range as in the data. At higher levels of husbands' earnings, female participation rates in the model and the data are very close to each other. However, at lower levels of earnings, the model yields female participation rates substantially higher than in the data. We will return to this relationship below in our discussion of the effects of the EITC on married females' labor supply.

Household earnings.—For single mothers and married couples, tax liabilities, tax credits and assistance transfers are all based on household earnings. Panel B of Table 4 shows moments of household earnings in the model and in the data for each type of household. Average household earnings in the model are very close to those in the data for single mothers, and about 15 percent below the data for married couples. Volatility is lower in the model than in the data. This is a consequence of a thinner right tail in the model's distribution of households earnings. That is,

Table 4—DATA *vs.* MODEL: LABOR SUPPLY AND HOUSEHOLD EARNINGS

	Single mothers		Married couples	
	data	model	data	model
PANEL A. LABOR SUPPLY				
Labor force participation rates				
Females	80.55	80.86	62.11	59.33
Males	—	—	93.10	95.91
Distribution (# workers)				
1	80.55	80.86	40.03	44.75
2	—	—	57.59	55.24
Average hours worked [†]				
Females	1,567	1,566	1,681	1,656
Males	—	—	2,121	2,094
PANEL B. HOUSEHOLD EARNINGS [‡]				
Average	21,283	21,037	59,154	50,038
Std. Dev.	21,832	11,838	53,491	24,640
Median	17,290	17,154	50,000	47,594
p25	9,000	13,446	30,000	25,088
p75	29,000	26,050	76,000	67,458

Source: Data: Calculations from our 2014 ASEC sample of households; model: Simulations from steady-state equilibrium. [†]Conditional on positive hours; [‡]conditional on positive earnings.

our model generates less households with six-figure earnings than in the data. For instance, the model does not generate married couples with earnings above \$130,000. Since our interest is on anti-poverty policy, this inability of the model to generate high-earning households has no sizable implications for our results.

Median household earnings in the model are very close to those in the data, both for single mothers and married couples. The 25th earnings percentile for single mothers in the model is somewhat higher than in the data. This is because some single mothers in our sample have annual earnings as low as \$100, and our model does not generate households with such low annual earnings, as it would not be optimal for them after having paid the fixed costs of participation. The 75th earnings percentiles in the model are, on the contrary, lower than in the data. As said above, our model does not match well the measure of households at the top of the empirical earnings distribution.

EITC recipients and costs.—We now look at the fraction of households within each household type receiving the EITC and at the distributions of EITC recipients and costs by number of children. The percentage of households in the model receiving the EITC is quite close to that in the data, both for single mothers and for married couples (see panel A of Table 5). For instance, in the model 74.6 percent of single mothers receive the EITC, against 71.7 percent in our sample. Among married couples, the model yields 48.1 percent of households receiving EITC, against 43.5 percent in the sample.

Panel B of Table 5 presents the distribution of EITC recipients by household type and number of children. The model matches fairly well this distribution in the data, especially for married couples. The relatively low representation of single mothers with three children among EITC recipients in the model —0.55 against 4.69 in the data— is a result of our assumption of a constant arrival rate of proposals. That is, in our model single mothers with three children are more likely to move to cohabitation or marriage than in the data, rendering a lower fraction of these single mothers in the total population. This could be fixed by assuming (maybe realistically) that their probability of receiving proposals declines with the number of children. However, since single mothers with three children are not, in any case, a numerous group in the data, our aggregate results would not be significantly affected.

The distribution of EITC costs by household type and number of children is shown in Panel C of Table 5. EITC costs are the sum of the non-refundable reductions in tax liabilities and the amounts refunded to eligible tax filers. Again, with the exception of single mothers with three children, the model matches quite well this distribution in the data.

EITC effects on labor force participation.—There is an large empirical literature that has examined the labor supply responses to the EITC expansions of the 1980’s and 1990’s (TRA86, OBRA90 and OBRA93). A well-established consensus in this literature is that these EITC expansions increased the labor market participation of single mothers, with an estimated elasticity with respect to net income in the range of 0.69 – 1.16 (see Eissa and Hoynes 2006 for a review of this literature). Here, as another test of the model fit, we compute this elasticity in the model and then compare it to the range of estimated values.

Specifically, we consider an expansion of the EITC that increases the phase-in rates and the maximum credits by 20%, and increases the phase-out rates by 10% for all household types. This expansion amounts to an average increase in the maximum credit by \$950. We then solve the model under this expanded EITC and compute the single mothers’ participation elasticity with

TABLE 5—DATA *vs.* MODEL: EITC

	Single mothers		Married couples	
	data	model	data	model
A. EITC recipients (%)	71.76	74.61	43.58	48.18
B. Distr. of EITC recipients				
One child	10.78	17.63	17.86	12.99
Two children	9.38	5.22	29.54	29.67
Three children	4.69	0.55	15.61	20.22
C. Distr. of EITC costs				
One child	7.79	12.58	13.03	6.26
Two children	9.92	6.59	31.83	31.66
Three children	5.18	0.72	21.47	27.32

Notes: EITC recipients and EITC distributions in the data and in the model.

respect to net earnings. More precisely, we compute this participation elasticity as

$$\varepsilon_{\ell_s}^P = \frac{\partial \ln P_{\ell_s}}{\partial \ln E[1 - \tau_{\ell_s}^P]}, \quad (26)$$

where P_{ℓ_s} is the labor market participation rate of single mothers and $E[1 - \tau_{\ell_s}^P]$ is the mean net-of-participation tax rate. The participation tax rate of a working single mother is defined as

$$\tau_{\ell_s}^P = \frac{TT(a, e_f, n) - TT(a, 0, n)}{e_f}. \quad (27)$$

The function TT in the numerator of (27) is the tax-transfer function of single mothers alone, which includes taxes, tax credits and assistance transfers, i.e. $TT = IRS - B^u - F^u$. The numerator is the difference in tax-transfers between participation and non-participation. Note that in the computation of the two percentage changes in (26) we must use the time-invariant measures of the steady-state equilibrium (ψ^s in our equilibrium definition). If the measures used to calculate the participation rate and the mean net-of-participation tax rate after the EITC expansion are those of the steady-state equilibrium pre-policy reform, we obtain the short-run participation elasticity. In this case, the change in the wealth distribution and the change in living arrangements triggered by the EITC expansion are not taken into account. If, on the other hand, we use the measures of the steady-state equilibrium post-policy reform, we obtain the long-run participation elasticity, which accounts for changes not only in the policy functions, but also in wealth and living arrangements of single mothers.

We find short- and long-run participation elasticities for single mothers equal to 0.66 and 0.7, respectively. Although a comparison of these two elasticities with those estimated in the empirical

literature it is not straightforward, they are within the range of estimated values. On the one hand, most papers in the empirical literature examining the labor supply response of unmarried mothers include also those who live with a partner or at home with their parents or other family members. In our model, however, a single mother lives alone with her children and is hence unable to engage in within-household risk sharing and share household consumption commitments. On the other hand, while the empirical elasticities are estimated from the equilibrium prior to the 1980's and 1990's EITC expansions, our elasticity is computed from the equilibrium after these reforms, and it may well be that this elasticity is not constant.

The single mothers' participation elasticity computed from (26) masks substantial heterogeneity in participation elasticities within the population of single mothers. For instance, the long-run participation elasticities among single mothers with one, two and three children are, respectively, 0.49, 1.01 and 2.16. When disaggregated by asset holdings, we find the highest elasticity, 0.93, among single mothers with assets in the first quartile, and the lowest elasticity, 0.01, among those with assets in the top quartile.

We have also computed the single mothers' participation elasticity with respect to induced EITC income. To do this, we replace the percentage change in the mean net-of-participation tax rate in the denominator of (26) by the percentage change in mean EITC income, i.e. $\partial \ln E[I^s(e_f, n)]$. We obtain an elasticity of 0.2, which is below the 0.36 elasticity estimated by Hoynes and Patel (2015). Once again, we must emphasize that our sample of single mothers is restricted to those living alone with their children.

Regarding married mothers, the empirical literature has shown that the EITC reduced their labor force participation. In our model, we find that the EITC expansion described above reduces married mothers labor force participation by 2.5 percentage points, from 59.3 to 56.8. This reduction comes primarily from married mothers in households where the male is the primary earner and household earnings are at, or slightly above, the phase-out region of the credit before the expansion. For these households, both income and substitution effects reduce the labor force participation of the secondary earner. By contrast, we find that the labor force participation of married fathers is practically unaffected by the EITC expansion. Overall, we obtain a reduction in total labor supply of married couples with children, a result that is consistent with the findings in Eissa and Hoynes (2004).

EITC effects on hours worked.—The estimation of responses in hours worked to EITC expansions is inherently more elusive than responses in participation, and has consequently received less attention in the empirical literature. One of the main challenges faced in the estimation

of hours effects is the change in the working sample after a EITC reform.¹⁰ Most papers (e.g., Eissa and Liebman 1996 and Rothstein 2005) find that the EITC has no impact on hours worked, conditional on working, by low-educated single mothers. This finding contrasts with the expected effects, since the EITC introduces negative income and substitution effects to most single mothers (those whose earnings fall in the flat and phase-out regions of the credit).

To shed light on this discrepancy between estimated and expected EITC hours effects, we use our model to compute the long-run change in hours worked induced by our EITC expansion under two scenarios concerning the working sample. In the first scenario, we maintain the working sample unchanged, which is the one formed by single mothers working both before and after the expansion. In the second scenario, which tries to replicate the working samples observed by the econometrician, we compute the change in hours worked from the samples of working single mothers before and after the expansion. Note that in the latter sample some of the working single mothers did not work before the expansion, which creates the above-mentioned challenge for the estimation of the hours effects. We obtain a decline in hours worked by working single mothers of 3.5 percent under the first scenario, and of 3.1 percent under the second. This shows that while sample selection introduces a downward bias in the size of the hours response, it is not enough to explain the lack of effects found in the empirical literature. The focus of this literature on unmarried mothers, without restricting the sample to those living alone with their children, could explain the zero estimated effect.

Among working married mothers, the empirical literature has found that the EITC expansions reduced their hours worked between 1 and 4 percent. In our model, the EITC expansion described above reduces hours worked by working married mothers by 2.2 percent under the first scenario (i.e. holding the working sample fixed), and by 1.5 percent under the second (i.e. using the samples of working married mothers before and after the expansion). It should be noted, however, that the combined expansions of the 1980's and 1990's amounted to larger increases in the maximum credit than the expansion considered in our exercise.

EITC effects on marriage.—The consensus in the empirical literature (Rosenbaum 2000, Eissa and Hoynes 2003, Herbst 2011) is that while EITC expansions have overall negative effects on marriage, they have been found to raise marriage among those at the very bottom of the income distribution.

We compute the change in the number of new marriages brought about by the EITC expansion

¹⁰A recent attempt to circumvent this difficulty is Chetty et al. (2013), who exploit local variation in knowledge about the EITC schedule and the change in eligibility at the birth of the first child to estimate the EITC labor supply effects.

introduced above. To pin down the immediate effect, which is the one typically estimated by the empirical literature, we calculate the number of new marriages after the expansion holding the wealth distribution and the measure of unmarried females fixed at the pre-expansion steady state. We first compute the overall effect, i.e. without conditioning on income, and obtain that new marriages decline by 0.47 percent. Then we look at the effect within each of the following three income groups: bottom (up to \$30,000), middle (from \$30,000 to \$60,000) and high (more than \$60,000). We find that new marriages increase by almost 10 percent in the bottom group, declines by 3.6 percent in the middle group, and declines by 2.2 percent in the high group.

4.5 Cohabitation *vs.* Marriage

We start by comparing the cohabiting couples' labor supply decisions in the model and the data. This comparison is not intended to assess the fit of the model for cohabiting couples, nor to validate our model assumption that cohabiting and married couples are ex-ante identical. Still, since our calibration uses information from married couples, but not from cohabitants, we find it useful to ask our model to which extent cohabiting couples in our sample behave as married couples would under the tax-transfer schemes of the cohabiting.

We find that the labor force participation rate of cohabiting males in the model is about 9 percentage points higher than that in the data; for cohabiting females it is about 20 percentage points higher. In terms of hours worked, cohabiting males in the model work about 55 hours more than in the data, and cohabiting females work about 200 hours more. This substantial discrepancy between the model and the data in terms of cohabiting couples' labor supply suggests the existence of ex-ante differences between cohabiting and married couples other than those brought about by the tax and transfer schemes. As pointed out by the literature, cohabitants are likely to be less committed to their partners than married individuals, and hence to engage in less within-household risk sharing than married couples. Lower commitment may also affect the extent to which they allocate hours of work to save on child care. Among cohabiting couples where the male is not the father of children, the contribution of the male to child care may as well be limited by factors other than lack of commitment.

The differential tax-transfer treatment of cohabiting and married couples.

To shed light on the existence of a marriage penalty in the tax-transfer system, relative to cohabitation, and on the behavioral response to such penalty, we now compare the model's labor supplies of these two types of couples. As noted above, in our model any difference in their labor supply decisions is a behavioral response to their tax-transfer schemes. We find that the

labor force participation rate of cohabiting males is only 3 percentage points higher than that of married males. However, the labor force participation rate of cohabiting females is 30 percentage points higher than among married females. As for average hours worked (conditional on working), cohabiting males work 50 hours less per year than married males. Working females cohabiting with the father of her children work about 60 hours more than married females. Working females cohabiting with a male who is not the father of her children work almost 70 hours less than married females. This shows that, everything else equal, the differential tax-transfer treatment of cohabiting and married couples has sizable labor supply effects, especially for females at the extensive margin. These results suggest that the labor force participation of married mothers is significantly hindered by their tax-transfer scheme. The implied cost in terms of annual household earnings goes from \$6,000 (if compared both-parents-present cohabiting couples) to almost \$3,000 (if compared to mother-only-present cohabiting couples).

Labor force participation tax rates of cohabiting and married mothers.—To understand the disincentives introduced by the tax-transfer scheme on female labor supply, Figure 1 (left panel) shows the participation tax rates of cohabiting and married mothers as a function of the number of children and the earnings of their partners/husbands. More specifically, we use the tax-transfer system to calculate the participation tax rate of working females earning \$20,000 as

$$\frac{TT(0, 20,000 + e_m, n) - TT(0, e_m, n)}{20,000},$$

where TT is the respective tax-transfer function of cohabiting or married couples. Note that these female participation tax rates correspond to couples with no assets; however, similar qualitative results would have been obtained under different levels of wealth or female earnings upon participation. Also note that these are not equilibrium tax rates.

Figure 1 shows that married mothers face higher participation tax rates than cohabiting mothers. The maximum difference between their tax rates is reached at male earnings between \$30,000 and \$45,000, which is the earnings interval that has most of the male workers in our sample. It is interesting to note how both-parents-present cohabiting mothers can obtain negative participation tax rates by filing as head of household when their partners earnings are at or above the third kink of the EITC schedule. When male earnings are too high to gain EITC income, if the female works and takes over by filing as head of household the couple can continue to receive EITC income. This is in contrast to married couples, for whom the EITC is based on household earnings.

Labor force participation of cohabiting and married mothers.—We now use our model to obtain the behavioral labor supply response to this differential in participation tax rates. Figure 1 (right panel) shows the model’s labor force participation rates of cohabiting and married mothers,

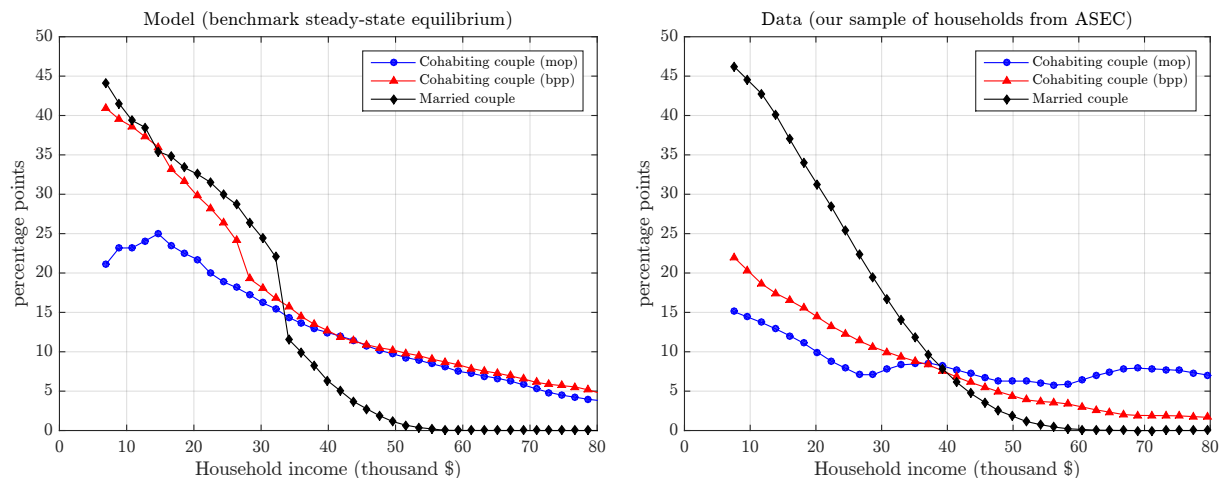


FIGURE 2. DIFFERENCE BETWEEN EFFECTIVE TAX RATES BEFORE AND AFTER TAX CREDITS

Notes: This figure shows the difference between effective tax rates before and after tax credits in the model (left panel) and in our data (right panel).

conditioning on the number of children and the earnings level of their partners/husbands. Married females have the lowest labor force participation rates, except when male earnings are below 9,000 dollars. The maximum gap in participation rates between cohabiting and married mothers occurs at male earnings around 30 thousand dollars. This shows the large disincentives introduced by the EITC on married mothers (vis-a-vis cohabiting mothers), especially when their husbands' earnings are in the phase-out region of the credit.

Effective tax rates of cohabiting and married couples.—As a final inquiry into the marriage penalty, we compare the difference between effective tax rates before and after tax credits across cohabiting and married couples. We find that, up to household earnings of about \$35,000, married couples gain more from tax credits than cohabiting couples. However, for household earnings above this level, it is cohabiting couples who make a wider use of the tax credits (see left panel of Figure 2). Further, while cohabiting couples with combined earnings above 80 thousand dollars still remain entitled to tax credits, married couples lose entitlement at combined earnings over \$50,000. This is explained by the ability of cohabiting working females to file as head of household, and earn EITC income, regardless their partners' earnings. As explained above, both-parents-present cohabiting couples may find it optimal that the secondary earner takes over as head of household as soon as the primary worker's earnings fall into the phase-out region of the EITC.

To show that these implications of the model are also present in the data, we compute the difference between effective tax rates before and after credits for households in our ASEC sample

(right panel of Figure 2). We obtain the same patterns found in the model: married couples gain more from tax credits at low levels of combined earnings, but cohabiting couples remain entitled to tax credits further beyond the level of earnings at which married couples lose their entitlement.

5 An Evaluation of Three EITC Reform Plans

The good fit of our model to non-targeted empirical moments, and especially to the estimated responses in labor supply and marriage to EITC expansions, provides support for its use as a tool for counterfactual policy evaluation. This section sets out to evaluate three recent proposals to reform the EITC. The first proposal aims to ameliorate married mothers’ labor supply disincentives present in the current schedule. The second proposal amounts to an across-the-board reduction of the EITC. The third one calls for an EITC schedule based on personal rather than family earnings.

Reform 1: A new deduction for two-earner married couples. This plan to reform the EITC was engineered by Melisa S. Kearney and Lesley J. Turner (2013), and then included in the “21st Century Worker Tax Cut Act”. This Act was a legislative proposal introduced on March 26, 2014 to the 113th Congress by Patricia Murray (D), then Chairwoman of the U.S. Senate Budget Committee.¹¹ The reform would create a new deduction for married couples with children of 20 percent of the lesser of \$60,000 and the earnings of the secondary worker. The deduction would be applied before computing EITC eligibility.¹² That is, the income requirement for EITC eligibility for a married couple with n children would be

$$e_f + e_m + ra - 0.2 \min\{60,000, \min\{e_f, e_m\}\} \leq y_I^{jn}. \quad (28)$$

Household earnings for the purpose of calculating the EITC for eligible married couples would be

$$e \equiv e_f + e_m - 0.2 \min\{60,000, \min\{e_f, e_m\}\}. \quad (29)$$

To evaluate the long-run effects of this reform, we replace the current EITC income requirement and definition of household earnings by the ones proposed in (28) and (29), respectively. We then compute the steady-state equilibrium under the new EITC schedule, keeping all other schedules for taxes and transfers unchanged. We do not impose revenue neutrality because we are interested in ascertaining the cost of this reform plan.

¹¹The bill was read twice and referred to the Finance Committee, but it did not advance further.

¹²A plan similar to this one had already been put forward by Brewer, Saez and Shephard (2010) to reform the UK tax-transfer system. Among their list of suggestions for immediate reform, these authors advocate for improving the incentives of secondary earners to enter work. In particular, they propose expanding earnings disregards for secondary earners in order to increase the amount they can earn before a family’s tax credits are withdrawn.

Our results are shown in column [2] of table 6 as percentage changes with respect to the benchmark steady-state equilibrium (column [1]). Although the effects of this reform are largest for married couples, it also affects single mothers decisions and hence living arrangements. The labor force participation rate of married females increases by more than 3 percent, and the fraction of two-earner married households by almost 5 percent (panel C). Average hours worked, by contrast, do not change much: married females reduce hours by 0.84 percent, and married males by 0.42 percent. As a result of this expansion in labor supply, the poverty rate (measured using the guidelines of the Census Bureau) among married couples with children goes down by 3.35 percent. Interestingly, even though the new deduction increases the fraction of EITC recipients and EITC costs per household, it also reduces the sum of TANF and SNAP costs. Overall, this reform increases the married couples' net contribution to the federal budget (per married couple) by 1.85 percent.

Panel B shows the effects on single mothers. Although their EITC schedule remains unchanged under this reform, the new deduction increases the value of marriage and hence single mothers' marriage acceptance rate. In particular, they accept 0.39 percent more marriage proposals than in the benchmark steady state. The increased prospects of marriage lead single mothers to save less, as they need less precautionary savings. Average household wealth declines by 0.76 percent, and the poverty rate increases by 0.13 percent. Panel A shows that the higher marriage acceptance rate reduces the populations of single mothers and cohabiting couples, and increases the population of married couples. Consequently, this reform yields a reduction in the rate of births outside of marriage (0.45 percent) and in the share of children living in poverty (2.33 percent).

Finally, we compute the economy-wide cost of this reform plan. To this end, we divide the sum of the net contributions to the federal budget (taxes minus transfers) by the total number of households. We obtain that under this reform the net contribution per household would be \$1,066, against \$1,035 in our benchmark steady state. This implies an increase in federal revenues of \$31 per non-college-educated household with children. It should be noted that the increase in federal revenues brought about by this reform is in part explained by the reduction in the fraction of single mother households, who are net recipients of federal funds, and by the increase in the fraction of married couples, who are net contributors.

Reform 2: A Comprehensive reform of taxes and tax credits. This EITC reform plan is part of the "Tax Reform Act 2014", presented on February 26, 2014 by Dave Camp (R), then Chairman of the Ways and Means Committee.¹³ This Act is a comprehensive tax-transfer

¹³This tax reform plan was introduced as a discussion draft, and not as a legislative proposal.

reform plan, which in addition to changes to the EITC, also proposes the elimination of the head-of-household filing status, a reduction in tax rates and in the number of income brackets, the elimination of the personal exemptions, and increases in the standard deduction and the child tax credit. We evaluate the effects of this comprehensive reform plan by replacing the current schemes by those proposed in this Act. As far as the EITC is concerned, this Act reduces subsidy rates and the maximum credit to almost all filers, save for families with one child with earnings between \$25,000 and \$35,000.

The proposed changes to the income tax schedule include a reduction in the number of tax rates to three (10, 25 and 35 percent), and a reduction in the number of rate schedules to two (one for married filing jointly and other for all others). The lowest income bracket for married filers, which would continue to be taxed at 10 percent, is extended from \$17,850 to \$71,200. Concerning the child tax credit, the plan increases the subsidy per child to \$1,500, and the phase-out thresholds to \$623,000 for joint filers and \$411,800 for all other filers. (Standard deductions, income brackets and the EITC parameters under this plan are shown in the online appendix.)

The effects of this reform plan are presented in column [3] of table 6, again as percentage changes with respect to the benchmark steady state. Its effects are notably larger than those of reform plan 1 for all household types. Panel B shows that the lower EITC subsidy rates brings about a reduction in the labor force participation rate of single mothers by 16.21 percent, and an increase in their hours worked by 8 percent. Poverty among single mothers increases, and so does their marriage acceptance rate. Importantly, the large drop in EITC income received by single mothers leads to a reduction in the net federal transfers they receive by 23 percent. Panel C presents the effects for married couples. The reduction in tax rates and, especially, the expansion of the lowest income bracket, yield an increase in labor force participation of married individuals, notwithstanding the lower EITC subsidy rates. For instance, married females' labor force participation goes up by almost 10 percent, which contributes to increasing the fraction of two-earner households by 13 percent. Hours worked also increase, especially among married males. This expansion in labor supply yields a significant drop in the poverty rate of married households. However, transfers from the EITC, TANF and SNAP fall sharply, which increases the net contribution of married households to the federal budget by 10 percent.

This reform plan implies economy-wide federal savings amounting to \$364 per household. In this case, the extra federal revenue results both from the sharp reduction in the amount redistributed to single mothers, and from the increase in the net contribution of married households to the federal budget.

Reform 3: An EITC based on personal earnings. This reform plan, put forth by Elaine Maag (2015) from the Urban Institute’s Tax Policy Center, calls for replacing the current EITC schedule with a worker credit based on personal rather than household earnings. This is a bolder reform proposal which would overhaul the EITC schedule for two-earner married couples. The new worker credit would be blind with respect to filing status and number of children. The intended objectives of this credit are the mitigation of marriage penalties and the work disincentives for secondary earners present in the current schedule. It would also eliminate the cost and high error rates associated with determining who has qualifying children. Our implementation of this reform plan offers all workers in households with children the current EITC schedule for single mothers with one child.

Column [4] of table 6 presents the effects of this reform plan. Among single mothers (panel B) it causes a reduction in the labor force participation rate, which is explained by the reduction in the EITC for single mothers with two or more children. Since this reform makes marriage more valuable to single mothers, they accept marriage proposals at a higher rate and save less in anticipation of the lower needs for precautionary savings once married. The lower labor force participation and savings rates bring about a sharp increase in poverty among single mothers. There is also a reduction in per-household net transfers from federal programs.

By contrast, married couples (panel C) would increase their labor force participation, especially married females. The percentage of two-earner households increases by 50 percent. As a result, poverty among married couples goes down significantly. There is a large increase in households’ EITC income, but a reduction in transfers from TANF and SNAP. Overall, their per-household net contribution to the federal budget goes down by 27 percent.

The economy-wide cost of this reform plan for the federal government amounts to \$279 per household. This cost stems mainly from the sharp decline in the net contribution of married households to the federal budget and, in particular, from the large increase in EITC costs for these households.

Participation tax rates and labor force participation across the three reform plans

In order to better understand the effects of each of these three reform plans on the labor force participation of married females, Figure 3 shows their average participation tax rates and labor force participation. From the left panel of this figure, it is apparent that the 20 percent deduction introduced by reform plan 1 yields a modest reduction in the participation tax rates of married females only when their husbands’ earnings are between \$10,000 and \$30,000. This reduction fosters labor force participation among these married females up to 5 percentage points, relative to the benchmark steady state. Reform plan 2 is more effective than reform 1 at lowering

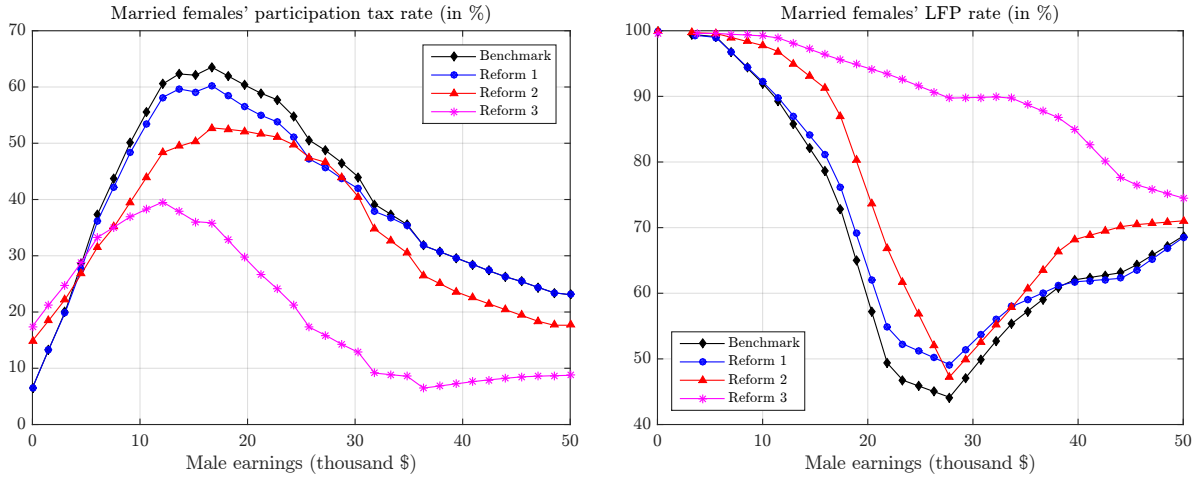


FIGURE 3. MARRIED FEMALES PARTICIPATION TAX RATES AND LABOR FORCE PARTICIPATION

Notes: Married females participation tax rates (left panels) and married females labor force participation rates (right panels) under the three reform plans.

married females' participation tax rates, especially among those whose husbands earn between \$5,000 and \$25,000, boosting their labor force participation by up to 10 percentage points, relative to reform 1. Interestingly, participation tax rates when husbands' earnings are between \$25,000 and \$30,000 are the same under reform plan 1 and 2. Finally, reform 3, by transforming the EITC into a personal, rather than a household tax credit, brings about the largest reduction in married females' participation tax rates. And, consequently, it yields the largest increases in their labor force participation.

6 Conclusion

TABLE 6—LONG-RUN EFFECTS OF EITC REFORMS

	Benchmark	Steady state post-reform: % change		
		Reform #1	Reform #2	Reform #3
PANEL A. DEMOGRAPHICS				
	[1]	[2]	[3]	[4]
Single mothers (%)	17.64	-0.27	-2.94	-7.88
Married couples (%)	73.42	+0.35	+4.34	+10.62
Cohabiting couples (%)	8.94	-2.34	-29.83	-71.69
New marriage rate [†]	12.51	+0.44	+16.31	+62.60
% all births outside of marriage	58.46	-0.45	-2.72	-8.52
% children living in poverty	21.59	-2.33	-57.94	-42.41
PANEL B. SINGLE MOTHERS				
Marriage acceptance rate	63.99	+0.39	+3.07	+13.79
Labor force participation (%)	80.86	-0.03	-16.21	-7.63
Avg. hours worked [‡]	1,566	+0.00	+8.67	+1.47
Avg. household earnings [‡]	21,169	-0.05	+15.41	+3.37
Avg. household disposable income	25,697	-0.04	-6.05	-5.07
Avg. household wealth	3,955	-0.76	+14.74	-6.07
Poverty rate (%)	30.70	+0.13	+5.02	+21.06
EITC recipients (%)	74.61	-0.02	-24.78	-12.78
EITC costs*	2,419	-0.03	-51.92	-26.72
SNAP + TANF costs*	2,895	+0.09	+1.06	+7.16
Net transfers from federal budget*	4,429	+0.07	-23.02	-11.36
PANEL C. MARRIED COUPLES				
Labor force participation (%)				
Females	59.33	+3.36	+10.11	+41.03
Males	95.91	+0.61	+1.42	+3.52
Two-earner households (%)	55.25	+4.67	+13.33	+50.17
Avg. hours worked [‡]				
Females	1,656	-0.84	+0.96	-5.60
Males	2,094	-0.42	+2.65	-1.95
Avg. household earnings [‡]	52,277	+0.27	+3.24	+3.32
Avg. household disposable income	52,001	+0.18	+3.33	+4.22
Avg. household wealth	70,875	-0.32	+13.21	-9.11
Poverty rate (%)	15.24	-3.35	-75.35	-59.97
EITC recipients (%)	48.18	+8.91	-12.08	+70.03
EITC costs*	1,894	+2.43	-33.04	+77.98
SNAP + TANF costs*	1,894	-5.93	-35.69	-42.37
Net contrib. to federal budget*	2,400	+1.85	+10.33	-27.23

Notes: [†]The new marriage rate is the number of new marriages in a given period divided by the number of unmarried mothers in that period. [‡]Conditioning on positive hours. *Per household in the relevant subpopulation.

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(NOT INTENDED FOR PUBLICATION)
 ONLINE APPENDIX FOR

**Anti-poverty Income Transfers in the U.S.: A Framework for the
 Evaluation of Policy Reforms**

February 7, 2014

This appendix has three parts: In appendix A we present tax-transfer parameter values, other parameters calibrated outside of the model and the EITC parameters under David Camp’s reform plan. In appendix B we derive the transition functions introduced in the definition of the steady-state equilibrium. In appendix C we present the calibration of the fertility process.

**Appendix A: Tax-transfer parameter values and other parameters
 calibrated outside of the model**

TABLE A1—INCOME BRACKETS (ALL VALUES IN \$)

Brackets	Parameter	Single ($j = s$)	Head of household ($j = \bar{h}$)	Married ($j = x$)
1	$b^{j,0}$	0	0	0
2	$b^{j,1}$	8,925	12,750	17,850
3	$b^{j,2}$	36,250	48,600	72,500
4	$b^{j,3}$	87,850	125,450	146,400
5	$b^{j,4}$	183,250	203,150	223,050
6	$b^{j,5}$	398,350	398,350	398,350
7	$b^{j,6}$	400,000	425,000	450,000

Source:

TABLE A2—INCOME AND PAYROLL TAX RATES

Description	Comment	Parameter	Value
Standard deduction (in \$)	Single	d_T^s	6,100
Standard deduction (in \$)	Head of household	d_T^h	8,950
Standard deduction (in \$)	Married	d_T^x	12,200
Personal exemption (in \$)	Per person	ξ_T	3,900
Marginal tax rate	Bracket 1	τ_y^1	0.10
Marginal tax rate	Bracket 2	τ_y^2	0.15
Marginal tax rate	Bracket 3	τ_y^3	0.25
Marginal tax rate	Bracket 4	τ_y^4	0.28
Marginal tax rate	Bracket 5	τ_y^5	0.33
Marginal tax rate	Bracket 6	τ_y^6	0.35
Marginal tax rate	Bracket 7	τ_y^7	0.396
Social Security tax	Employee's share	$\tau_{p,SS}$	0.0620
Medicare tax	Employee's share	$\tau_{p,MA}$	0.0145
Social Security cap (in \$)	Earnings cap	\bar{e}	113,700

Source:

TABLE A3—EARNED INCOME TAX CREDIT: ELIGIBILITY

	Max. investment	Max. total	
	income, $\bar{r}a_I$ (\$)	income, y_I^{jn} (\$)	
	$j = s, \bar{h}, x$	$j = s, \bar{h}$	$j = x$
No children, $n = 0$	3,300	14,340	19,680
One child, $n = 1$	3,300	37,870	43,210
Two children, $n = 2$	3,300	43,038	48,378
Three children, $n = 3$	3,300	46,227	51,567

Source:

TABLE A4—EARNED INCOME TAX CREDIT: CREDIT RATES AND EARNINGS THRESHOLDS

	Phase-in	Earnings end	Earnings beginning		Phase-out
	rate, κ_1^{jn} (%)	phase-in, $e_{I_1}^{jn}$ (\$)	phase-out, $e_{I_2}^{jn}$ (\$)		rate, κ_2^{jn} (%)
	$j = s, \bar{h}, x$	$j = s, \bar{h}, x$	$j = s, \bar{h}$	$j = x$	$j = s, \bar{h}, x$
No children, $n = 0$	7.65	6,350	8,000	13,350	7.65
One child, $n = 1$	34.0	9,550	17,550	22,900	15.9
Two children, $n = 2$	40.0	13,400	17,550	22,900	21.0
Three children, $n = 3$	45.1	13,400	17,550	22,900	21.0

Source:

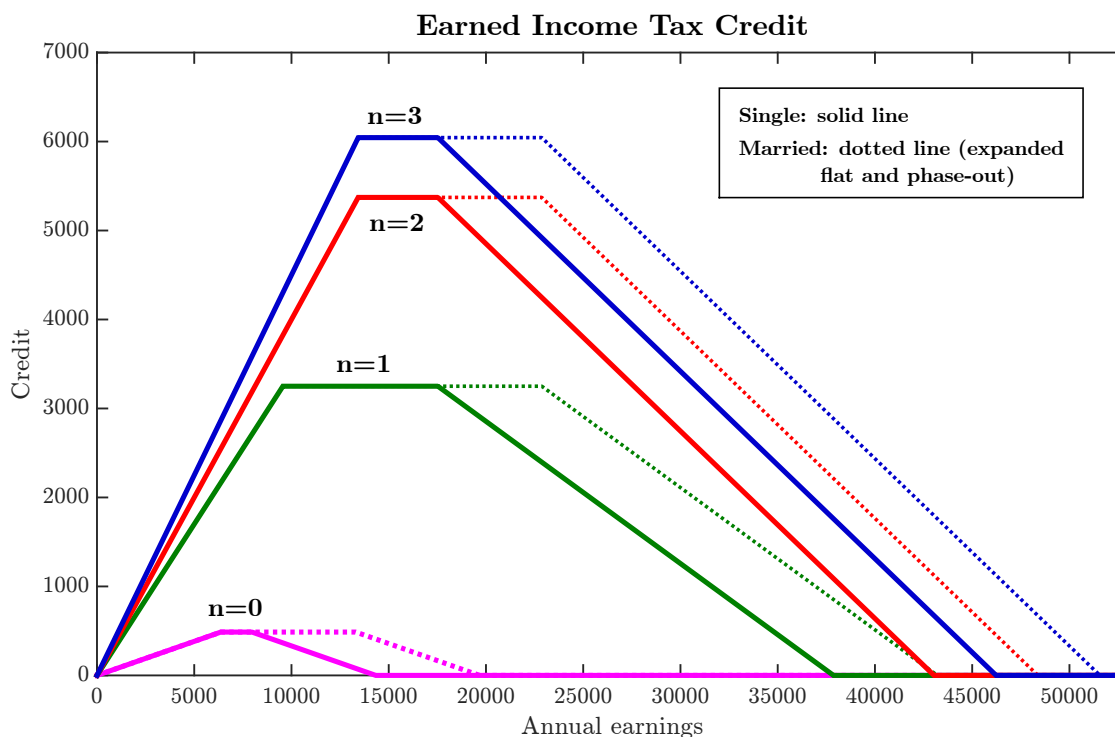


Figure 1: Earned Income Tax Credit by number of children and filing status: single/head of household (solid line) and married filing jointly (dotted line with expanded flat and phase-out region)

TABLE A5—CHILD TAX CREDIT: CREDIT RATES & INCOME AND EARNINGS THRESHOLDS

Description	Parameter	Value
Credit per child	θ	1,000
Phase-out income threshold ($j = s, \bar{h}$)	y_{CTC}^j	75,000
Phase-out income threshold ($j = x$)	y_{CTC}^j	100,000
Phase-out rate	η	5%
Earnings limit (ACTC)	δ	3,000
Weight on earnings gap (ACTC)	ϕ	0.15

Source:

TABLE A6—TEMPORARY ASSISTANCE FOR NEEDY FAMILIES (TANF)

Description	Parameter	Size assistance unit				
		1 person	2 persons	3 persons	4 persons	5 persons
Standard of need	S^m	638	855	1073	1290	1508
Work deduction (per worker)	d_{B1}	90	90	90	90	90
Child care deduction	d_{B2}	0.5	0.5	0.5	0.5	0.5
General deduction	d_{B3}	30	30	30	30	30
Maximum grant	\bar{B}^m	201	270	338	407	475
Gross income test	y_{B1}^m	1180	1581	1985	2386	2789
Net income test	y_{B2}^m	638	855	1073	1290	1508
Asset test	a_B	2,000	2,000	2,000	2,000	2,000
Generosity	ς	0.5	0.5	0.5	0.5	0.5
Earned income disregard	σ_B	2/3	2/3	2/3	2/3	2/3

Notes: TANF is a monthly program and the dollar amounts in this table are monthly values. Since the length of a period in our model is one year, we annualize these values to fit our model.

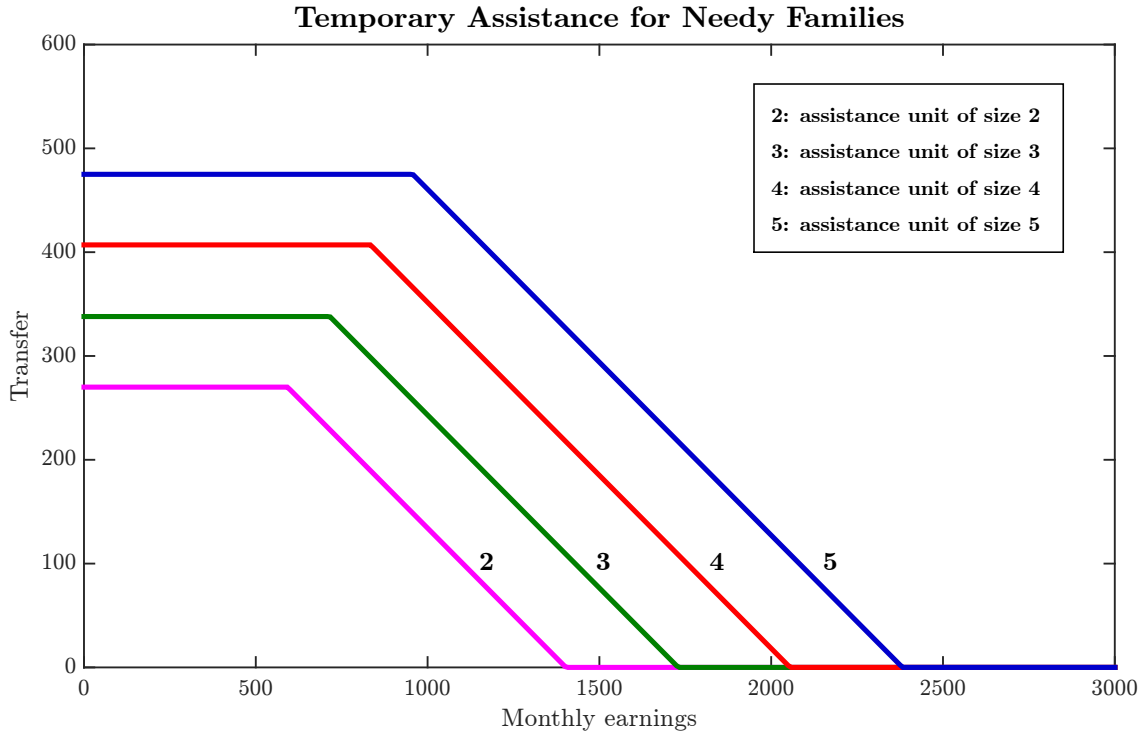


TABLE A7—SUPPLEMENTAL NUTRITION ASSISTANCE PROGRAM (SNAP)

Description	Parameter	Size assistance unit				
		1 person	2 persons	3 persons	4 persons	5 persons
Asset test	a_F	2,000	2,000	2,000	2,000	2,000
Gross income test	y_{F1}^m	1,245	1,681	2,116	2,552	2,987
Net income test	y_{F2}^m	958	1,293	1,628	1,963	2,298
Child care deduction	d_{F1}	0.5	0.5	0.5	0.5	0.5
Standard deduction	d_{F2}	152	152	152	163	191
Earned income disregard	σ_F	0.8	0.8	0.8	0.8	0.8
Maximum allotment	\bar{F}^m	200	367	526	668	793
Weight on net income	χ	0.3	0.3	0.3	0.3	0.3
Minimum benefit	\underline{F}^m	15	15	0	0	0

Notes: SNAP is a monthly program and the dollar amounts in this table are monthly values. Since the length of a period in our model is one year, we annualize these values to fit our model.

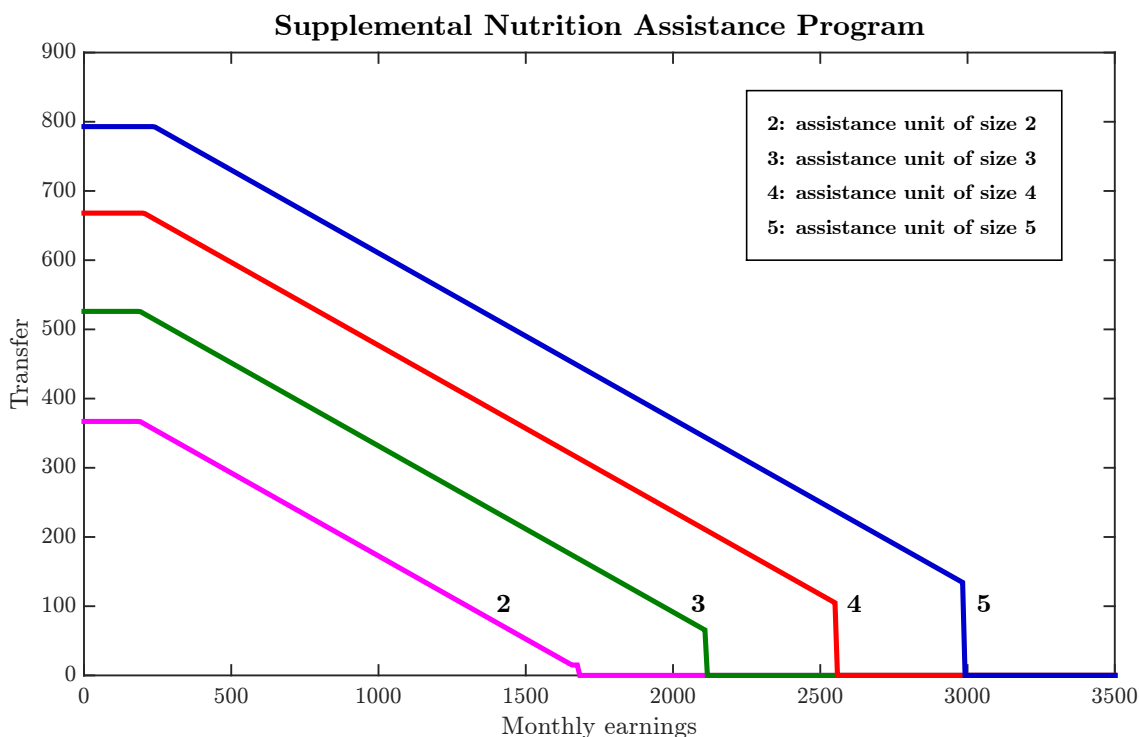


TABLE A8—OTHER PARAMETERS CALIBRATED OUTSIDE OF THE MODEL

Description	Parameter	Value	Description	Parameter	Value
Risk-free rate of return	r	0.03	Consumption commitment	$\hat{c}_0^{\ell_s}$	\$1,000
Elasticity intertemp. subs.	σ	1.5	Consumption commitment	$\hat{c}_1^{\ell_s}$	\$500
Fertility process	m_{00}	0.0410	Consumption commitment	$\hat{c}_1^{\ell_m}$	\$1,500
Fertility process	m_{10}	0.0500	Work+care curvature	α	0.50
Fertility process	m_{01}	0.1935	Child support	ϑ	\$3,000
Fertility process	m_{02}	0.0065	Productivity process	ρ	0.914
Fertility process	m_{12}	0.0793	Productivity process	σ_ϵ	0.206
Fertility process	m_{13}	0.0027	Cross-correlation	ϱ	0.15
Fertility process	m_{23}	0.0225			

Appendix B: Transition functions

The state space of single mothers is $Z^f \times A \times N$, where Z^f is the set of productivity levels for females. A is the set of asset holdings and $N = \{0, 1, 2, 3, \emptyset\}$ is the number of children. We denote by \mathcal{B}^s the Borel σ -algebra on $Z^f \times A$. The projection of $B \in \mathcal{B}^s$ on Z^f is denoted by B_{z_f} , and the projection on A by B_a .

The state space of couples is $Z^f \times Z^m \times A \times N \times L \setminus \ell_s$, where Z^m is the set of productivity levels for males, and $L^c = \{\ell_{cp}, \ell_c, \ell_m\}$ is the set of living arrangements for couples. (Note that in our model the sets of productivity levels for males and females are the same. However, for notational convenience we distinguish them with a superscript.) We denote by \mathcal{B}^c the Borel σ -algebra on $Z^f \times Z^m \times A$. The projection of $B \in \mathcal{B}^c$ on $Z^f \times Z^m$ is denoted by B_z , the projection on Z^f is denoted by B_{z_f} , the projection on Z^m is denoted by B_{z_m} and the projection on A by B_a .

Transition functions

Single mothers' transition function: The probability that a single mother living alone with labor productivity z_f , assets a_f , and n children will have productivity and assets lying in set $B \in \{\mathcal{B}^s \cup \mathcal{B}^c\}$, will have n' children and will move to living arrangement $\ell' \in L$ next period is denoted by $P^s(z_f, a_f, n; B, n', \ell')$.

The probability that a single mother of n children, with labor productivity z_f and wealth a_f will transit next period to living arrangement $\ell \in L \setminus \ell_s$, their labor productivities and assets will lie in set B and the number of children will transit to n' is

$$P^s(z_f, a_f, n; B, n', \ell) = m_{nn'} \pi_\ell \int_A \int_{B_z} \mathbb{1}_{\{a'_m + a'_f \in B_a\}} \times \\ \mathbb{1}_{\{v_f^\ell(z', a'_m + a'_f, n') \geq v_f^{\ell_s}(z_f, a'_f, n')\}} f_{a_m}(da'_m) f_{z_m}(dz'_m) f_{z_f}(dz'_f | z_f),$$

where π_ℓ is the probability that the single mother gets an offer to form a living arrangement ℓ ; a'_f are single mother savings as given by her policy function evaluated at z_f, a_f, n ; a'_m denotes the suitor's asset holdings; v_f^ℓ is the value for the female under living arrangement ℓ and $v_f^{\ell_s}$ is her value of remaining single and living alone; $f_{a_m}(\cdot)$ is the density function of the suitors asset holdings; $f_{z_m}(\cdot)$ is the unconditional density function of the suitors' labor productivity; $f_{z_f}(\cdot/z_f)$ is the single mother's density function of next-period labor productivity conditional on current productivity z_f .

Finally, the probability that a single mother living alone at (z_f, a_f, n) will remain single and

living alone next period with labor productivity and assets in set B and n' children is

$$\begin{aligned}
P^s(z_f, a_f, n; B, n', \ell_s) &= m_{nn'}(1 - \pi_{\ell_{cp}} - \pi_{\ell_c} - \pi_{\ell_m}) \mathbb{1}_{\{a'_f \in B_a\}} \int_{B_{z_f}} f_{z_f}(dz'_f | z_f) + \\
& m_{nn'} \sum_{\ell \in L \setminus \ell_s} \pi_{\ell} \mathbb{1}_{\{a'_f \in B_a\}} \int_A \int_{Z^m \times Z^f} \mathbb{1}_{\{v_f^{\ell}(z', a'_m + a'_f, n') < v_f^{\ell_s}(z'_f, a'_f, n')\}} \times \\
& \mathbb{1}_{\{z'_f \in B_{z_f}\}} f_{a_m}(da'_m) f_{z_m}(dz'_m) f_{z_f}(dz'_f | z_f)
\end{aligned}$$

Couples' transition functions: The probability that a couple with productivities z^f and z^m , assets a , n children and in living arrangement ℓ will transit to productivities and assets lying in set $B \in \mathcal{B}^c$, will have n' children and will move to living arrangement $\ell' \in L \setminus \ell_s$ next period is denoted by $P^c(z_f, z_m, a, n, \ell; B, n', \ell')$.

The probability that a cohabiting couple in state $\ell \in \{\ell_{cp}, \ell_c\}$, with labor productivities z_f and z_m , assets a and n children will transit next period to marriage with productivities and assets in set B and n' children is

$$P^c(z_f, z_m, a, n, \ell; B, n', \ell_m) = m_{nn'} \mathbb{1}_{\{a' \in B_a\}} \int_{B_z} \mathbb{1}_{\{V^{\ell_m}(z', a', n') \geq V^{\ell}(z', a', n')\}} f_z(dz' | z), \quad (30)$$

where a' is the level of assets given by the policy function of the cohabiting couple evaluated at the current state; V^{ℓ_m} is the value of marriage for the couple, and V^{ℓ} is the value of living arrangement ℓ ; and $f_z(\cdot | z)$ is the joint density of labor productivities conditional on current productivities z . The probability that the cohabiting couple will not marry next period and will remain cohabiting with productivities and assets in B and n' children is

$$P^c(z_f, z_m, a, n, \ell; B, n', \ell) = m_{nn'} \mathbb{1}_{\{a' \in B_a\}} \int_{B_z} \mathbb{1}_{\{V^{\ell_m}(z', a', n') < V^{\ell}(z', a', n')\}} f_z(dz' | z). \quad (31)$$

Finally, the probability that a married couple with productivities z , assets a and n children will have productivities and assets in set B and n' children is

$$P^c(z, a, n, \ell_m; B, n', \ell_m) = m_{nn'} \mathbb{1}_{\{a' \in B_a\}} \int_{B_z} f_z(dz' | z). \quad (32)$$

Appendix C: Calibration of fertility process

In this appendix, we describe how to pin down the seven parameters in the transition matrix M , namely m_{00} , m_{01} , m_{02} , m_{10} , m_{12} , m_{13} , m_{23} , using the seven moment conditions laid out in the main text. Let us start from moment condition (1): the expected number of years for a childless female until a child is born, conditional on having a child, is 5 years, that is

$$5 = \frac{1}{m_{01} + m_{02}} \quad \implies \quad m_{01} + m_{02} = 0.2. \quad (\text{A1})$$

Next, condition (7) imposes that the probability of remaining childless is 17 percent:

$$\frac{m_{00}}{m_{01} + m_{02} + m_{00}} = 0.17 \quad \implies \quad m_{00} = \frac{0.17 \cdot (m_{01} + m_{02})}{1 - 0.17}. \quad (\text{A2})$$

Combining (A1) and (A2) determines the first probability:

$$m_{00} = 0.0410. \quad (\text{A3})$$

Next, we use that the conditional probability of having a twin birth is 0.0326, both for childless females and for mothers of one child, the two moment conditions in (4). Let us start with childless females

$$m_{02} = 0.0326 \cdot (m_{01} + m_{02}). \quad (\text{A4})$$

Combine with (A1) to obtain

$$m_{01} = 0.1935 \quad \text{and} \quad m_{02} = 0.0065. \quad (\text{A5})$$

Now, we use the moment condition for mothers of one child and obtain

$$m_{13} = 0.0326 \cdot (m_{12} + m_{13}). \quad (\text{A6})$$

Moment condition (5) imposes that the expected duration until a household with children reaches the absorbing state is 20 years; thus,

$$m_{10} = \frac{1}{20}. \quad (\text{A7})$$

In order to pin down the remaining three probabilities, m_{12} , m_{13} and m_{23} , we need to describe the stationary population measures in the first four states in the Markov chain. Let us denote by μ_n the stationary measure of females in state $n \in \{0, 1, 2, 3\}$. Without loss of generality, we normalize the total population of females in this subset of N to $\mu_0 + \mu_1 + \mu_2 + \mu_3 = 1$. It is then

straightforward to derive the following population measure equations:

$$\mu_0 = m_{00}\mu_0 + \psi_0^s \quad (\text{A8})$$

$$\mu_1 = m_{11}\mu_1 + m_{01}\mu_0 \quad (\text{A9})$$

$$\mu_2 = m_{22}\mu_2 + m_{02}\mu_0 + m_{12}\mu_1 \quad (\text{A10})$$

$$\mu_3 = m_{33}\mu_3 + m_{13}\mu_1 + m_{23}\mu_2, \quad (\text{A11})$$

where ψ_0^s is the measure of newborn females, which replace an equal measure of females that have transited to the absorbing state, i.e. $\psi_0^s = m_{00}\mu_0 + m_{10}(\mu_1 + \mu_2 + \mu_3)$. (It should be noted that we have made use of the assumption $m_{10} = m_{20} = m_{30}$.) Rearranging (A8) yields:

$$\mu_0 = m_{00}\mu_0 + m_{00}\mu_0 + m_{10}(1 - \mu_0) \quad \implies \quad \mu_0 = \frac{m_{10}}{1 - m_{00} - m_{00} + m_{10}}, \quad (\text{A12})$$

or,

$$\mu_0 = \frac{m_{10}}{m_{01} + m_{02} + m_{10}} = 0.2. \quad (\text{A13})$$

Thus, our calibration for the fertility process implies that 20 percent of the population of females in states $N = \{0, 1, 2, 3\}$ are childless ($n = 0$), while the remaining 80 percent are mothers ($n = 1, 2, 3$). Recall that the latter subsample constitutes our actual population of interest, and that all the statistics in the paper refer to that subsample. Now, to set values to the remaining three parameters m_{12} , m_{13} and m_{23} , we make use of the two moment conditions that have not been used so far, namely (2) and (3)

$$\frac{\mu_1}{\mu_1 + \mu_2 + \mu_3} = 0.3665 \quad (\text{A14})$$

$$\frac{\mu_2}{\mu_1 + \mu_2 + \mu_3} = 0.4242. \quad (\text{A15})$$

Combining (A9) and (A14) yields:

$$m_{11} = \frac{\mu_1 - m_{01}\mu_0}{\mu_1} = 0.8679, \quad (\text{A16})$$

which in conjunction with (A6) implies

$$m_{12} = 0.0793 \quad \text{and} \quad m_{13} = 0.0027. \quad (\text{A17})$$

Finally, combine (A15) with (A10) to pin down the last probability, m_{23} , as

$$\mu_2 = 0.4242 \cdot (1 - 0.2) = 0.3394 \quad \implies \quad m_{23} = 1 - m_{22} - m_{20} = 0.0225. \quad (\text{A18})$$

Appendix D: The Dave Camp Tax Reform Plan

TABLE A9—INCOME TAX BRACKETS UNDER DAVE CAMP PLAN

Brackets	Parameter	Single ($j = s$)	Head of household ($j = h$)	Married ($j = x$)
1	$b^{j,0}$	0	0	0
2	$b^{j,1}$	35,600	35,600	71,200
3	$b^{j,2}$	400,000	400,000	450,000

Notes: This table presents income brackets under Camp plan for taxable years beginning after 2017 (in \$2013). Source: “Tax Reform Act”, 2014, and Nunns *et al.* (2014). The Tax Reform Act can be accessed at <http://waysandmeans.house.gov>.

TABLE A10—STANDARD DEDUCTIONS & TAX RATES UNDER DAVE CAMP PLAN

Description	Comment	Parameter	Value
Standard deduction (in \$)	Single	d_T^s	11,000
Standard deduction (in \$)	Head of household	d_T^h	16,500
Standard deduction (in \$)	Married	d_T^x	22,000
Personal exemption (in \$)	Per person	ξ_T	0
Marginal tax rate	Bracket 1	τ_y^1	0.10
Marginal tax rate	Bracket 2	τ_y^2	0.25
Marginal tax rate	Bracket 3	τ_y^3	0.35

Notes: This table presents standard deductions and tax rates under Camp plan for taxable years beginning after 2017. Standard deductions are in \$2013. Source: “Tax Reform Act”, 2014, and Nunns *et al.* (2014). The Tax Reform Act can be accessed at <http://waysandmeans.house.gov>.

TABLE A11—EITC: CREDIT RATES AND EARNINGS THRESHOLDS UNDER DAVE CAMP PLAN

	Phase-in	Earnings end		Earnings beginning		Phase-out
	rate, κ_1^{jn} (%)	phase-in, $e_{I_1}^{jn}$ (\$)		phase-out, $e_{I_2}^{jn}$ (\$)		rate, κ_2^{jn} (%)
	$j = s, \bar{h}, x$	$j = s, \bar{h}$	$j = x$	$j = s, \bar{h}$	$j = x$	$j = s, \bar{h}, x$
No children, $n = 0$	7.65	1,307	2,615	8,000	13,350	7.65
One child, $n = 1$	15.3	15,686	15,686	20,000	27,000	19.0
Two children, $n = 2$	15.3	19,610	26,145	20,000	27,000	19.0
Three children, $n = 3$	15.3	19,610	26,145	20,000	27,000	19.0

Notes: This table presents credit rates and earnings thresholds under Camp plan for taxable years beginning after 2017. Earnings thresholds are in \$2013. Source: “Tax Reform Act”, 2014, and Nunns *et al.* (2014). The Tax Reform Act can be accessed at <http://waysandmeans.house.gov>.