Low-Income Families, Maternal Labor Supply, and Welfare Reform*

Viola Garstenauer†

and

Nawid Siassi‡

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Abstract

In this paper, we examine reforms that alleviate large employment disincentives induced by child-related transfers for married mothers. We develop a life-cycle model where married couples face labor market, child care and fertility risk, and make joint labor supply and consumption-saving decisions. The evolution of female human capital is endogenous and shaped by mothers' employment decisions. We calibrate the model to the U.S. using data from the Current Population Survey. We show that participation tax rates exceed 25 percent for most mothers in our sample, and can be as high as 60 percent when including child care expenses. We then evaluate reforms to existing tax credits for working couples. We find that (i) expanding child care tax credits and (ii) introducing a secondary earner EITC deduction lead to substantially higher employment rates among married mothers. Both reforms are easily implementable, self-financing, and welfare-improving. A combination of both reforms closes the maternal employment gap altogether.

JEL Classification Codes: H24, H31, J12, J22

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†Garstenauer: TU Wien, viola.garstenauer@tuwien.ac.at.

‡Siassi: TU Wien, nawid.siassi@tuwien.ac.at.

1 Introduction

Over the last decades, the labor force participation rate of women in the United States has risen from just 48% in 1968 to 76% in 2019. While the gap between female and male participation rates has become considerably smaller, it still remains large for married people. This holds particularly true for low-income married couples with children, with only 61% of married mothers participating in the labor force, compared to 95% of married fathers.[1] Recent studies suggest that the low employment rate of married women with children can be explained by the design of child-related transfers (Hannusch (2022)). In the United States, the cost of formal child care and the structure of the tax-transfer system often induce large participation tax rates for secondary earners. Low-income families face particularly strong employment disincentives, because adding the income of a secondary earner –typically the female– will often push the couple out of the eligibility region for means-tested transfers such as the Earned Income Tax Credit (EITC). Moreover, if a couple does not have access to informal child care arrangements, it often lacks the earnings potential to pay for formal daycare.

While previous literature has established a relation between low maternal employment rates and child-related transfers, possible reforms to close the maternal employment gap have been largely unexplored. Against this backdrop, we ask in this paper: (1) How can the current tax-transfer system and, in particular, child-related tax credits be reformed to lower the participation costs for secondary earners in married couples? How large are the effects on maternal labor supply? (2) What are the expected consequences of a reform that makes child care more affordable, versus a reform that tries to repair the adverse effects of means-tested transfers (such as the EITC)? (3) To what extent are the main tradeoffs at play shaped by differential child care needs across married couples? And what role does the evolution of female human capital play?

To answer these questions, we build a dynamic structural life-cycle model where married couples face uninsurable idiosyncratic labor market, child care cost and fertility risk. Family labor supply includes a participation decision for fathers, and a participation and work intensity decision for mothers. Our model further embeds the following three key ingredients. First, we account for the observed variation in the number of children, child care expenditures associated with labor market participation, and access to informal child care. Compared to other studies, in our model child care needs and the arrival of children are stochastic and thus constitute a source of uncertainty for the family. Secondly,

[1]Source: Current Population Survey.

the evolution of labor market productivity for females is endogenous and reflects both the accumulation of skills when employed and the depreciation of skills when out of work. Our choice of modeling human capital formation is important in order to correctly capture the dynamic costs and benefits of participating in the labor market. Thirdly, we model the U.S. income tax scheme and transfer programs in great detail, embedding the eligibility and benefits criteria with all their kinks and non-convexities. This allows us to quantify the effects of easily implementable reforms within the current system by modifying existing child-related tax credits.

We calibrate the model to the U.S. using data from the March Supplement of the Current Population Survey (CPS). Our population of interest consists of married couples with children where neither spouse has a college degree. The calibrated model matches well important moments from the data, such as employment rates and the distribution of earnings and child care costs, even when disaggregated by the age and number of children. We then use the benchmark model to measure the labor market participation tax rate incurred by married mothers, i.e. the share of additional income that is implicitly lost through higher taxes paid and lower transfers received. We find that married mothers' participation tax rates exceed 25 percent for most couples in our sample and are particularly high for those where the husband earns less than $40,000 per year– the eligibility region of the EITC. Remarkably, when also taking into account the child care expenses associated with labor market participation, the implicit tax rate can be as high as 60 percent. Using our model, we then perform a decomposition analysis to quantify the contribution of taxes and transfers in creating these large participation tax rates. We show that, counter to its original purpose of promoting participation, the EITC in its current form is actually one of the largest contributors to married mothers' high participation costs.

We then evaluate the effects of policy reforms that aim at lowering participation tax rates for married mothers. Our first reform expands the Child and Dependent Care Tax Credit (CDCTC) and allows couples to claim the full amount of their child care expenditures as a tax credit. We find that this reform would induce an increase in married mothers' employment rates from 60.7 percent in the benchmark to almost 67 percent after the reform. Employment effects are significantly larger in families with pre-school children who have limited or no access to informal child care and therefore choose to send only one adult member to the labor market, even if both parents' labor productivities are relatively high. The reform would lead to higher average wages for females and a smaller gender wage gap, a result that is shaped by the endogenous formation of human capital.

Strikingly, our results indicate that the reform would be self-financing for the government, and it would be welfare-improving for entering couples.

Our second reform introduces a full deduction on the earnings of the secondary earner for the purpose of claiming the EITC. This reform directly addresses the adverse effects mentioned above and is bound to affect low-income couples where the primary earner makes between \$20,000 and \$40,000 a year, spanning the plateau and phase-out regions of the EITC. We find that reforming the EITC would raise maternal employment rates by 6 percentage points. While the magnitude of this increase is similar to the first reform, employment effects are spread out more uniformly across all couples, independent of the age of their children. The reform is revenue neutral and creates welfare gains for entering couples. Finally, we simulate a combination of the two reforms. We find that expanding tax credits for child care expenses and for earned income creates highly complementary effects. Married mothers' employment increases to almost 74 percent, thus essentially closing the maternal employment gap.

Our paper contributes to a recent strand of literature that studies child-related transfers and their effects on maternal labor supply. In an important paper, Guner et al. (2020) explore reforms to child-related policies, with a focus on contrasting transfers that are conditional on market work with those that are not. These authors also include singles in their analysis, whereas our focus is on married couples. On the other hand, their model is completely deterministic, while we embed various sources of risk which we think are important for this population. Building on the framework developed by Guner et al. (2020), Hannusch (2022) finds that differences in the design of child-transfers can explain the large variation in mothers' employment rates across countries. Her analysis points to the relevance of child care costs and the design of the tax-transfer system for creating large participation tax rates. Her model also abstracts from any source of uncertainty, and she does not consider policy reforms that can close the maternal employment gap.

More broadly, our paper contributes to a growing literature that uses dynamic structural models to study the effects of the tax-transfer system on married women's labor supply. A central focus of this literature is on the distinction between joint and separate tax filing for couples. For instance, Guner et al. (2012) and Bick and Fuchs-Schündeln (2017) argue that moving from joint to separate filing generates large responses in married females' labor supply. In a similar vein, Bick and Fuchs-Schündeln (2018) find that differences in married women's hours worked across countries can be largely accounted for by differences in the structure of the tax systems. More recently, Borella et al. (2023) build a rich structural life-cycle model to estimate the effects of marriage-related provisions on the participation of married women. These authors find that, in addition to joint tax filing, Social Security spousal and survivor benefits tend to discourage female labor supply.[2]

A different line of research evaluates the effects of welfare reforms, with a special focus on low-income households. Blundell and Shephard (2012) build a structural model of labor supply to study the optimal design of income support for lone mothers. They find that there is scope for Pareto improving reforms. Single parents are also the focus in Ortigueira and Siassi (2023) who characterize the optimal reform of income transfers for this population. Similar to our study, they carefully model the current U.S. tax-transfer system including all the major anti-poverty programs. Guner et al. (2023) take a more fundamental approach to studying reforms of the welfare system. Starting from nonlinear approximations to the current income tax and transfer functions, they explore the consequences of entirely replacing the current system by universal basic income and negative income tax type programs. In comparison to their study, we show that even mild reforms to existing programs can have large, welfare-improving effects. In this sense, our paper is closely related to Ortigueira and Siassi (2022) who describe how tax credits and assistance programs in the United States shape households' labor supply and saving choices. The interaction of public insurance with intrahousehold insurance and family labor supply is also emphasized in Blundell et al. (2016) and Wu and Krueger (2021), among others. Our paper further contributes to a recent strand of literature that incorporates paid child care in dynamic models of labor supply, including Domeij and Klein (2013) and Bick (2016).[3] Compared to other studies, our model embeds a larger extent of heterogeneity in child care needs, beyond a binary flag of informal child care availability. Finally, there is a large empirical literature that tries to estimate the labor supply responses to expansions of tax credits (see, e.g., Eissa and Hoynes (2004), Eissa and Hoynes (2006), Meyer (2002) and Nichols and Rothstein (2016)).

The remainder of the paper is organized as follows. Section 2 describes our structural model and its parameterization. We then present our data and calibration strategy in Section 3. Section 4 evaluates the model fit and investigates participation incentives for married mothers. We conduct our main policy experiments in Section 5, and Section 6 concludes.

[2]Kaygusuz (2015) and Nishiyama (2019) are two earlier papers studying the relation between Social Security and couples' labor supply.

[3]Ho and Pavoni (2020) derive the constrained efficient design of child care subsidies in a static Mirrleesian model of labor supply.

2 The Model

We consider a dynamic partial equilibrium life-cycle model where the safe interest rate and the wage rates are taken as exogenous. Time is discrete and a model period corresponds to one year.

2.1 Economic Environment

Demographics. Our population of interest consists of married couples with one, two or three dependent children. Each couple consists of a female (f) and a male (m) of the same age. Let $s \in \{1, 2, \ldots, 63\}$ denote the couple's age, where the initial model age $s = 1$ should be interpreted as a biological age of 20 years. The life cycle is modeled as follows. Each couple enters the economy with a newborn child, and some couples have more children later on in life. Specifically, at age $\tilde{s}_1 = 4$, a second child enters the household with probability q_1. A second fertility draw occurs at age $\tilde{s}_2 = 9$, where the child arrival probability equals q_2 for parents of one, and q_3 for parents of two (namely those who received a second child already at $\tilde{s}_1$).[4] The ages of the children in the household are denoted by k_1, and if present, k_2 and k_3 (otherwise $k_2 = \emptyset$ resp. $k_3 = \emptyset$). For notational convenience, we will summarize the number and age mix of children by $k = (k_1, k_2, k_3)$. Children do not provide utility. They live with their parents until they reach age 18, at which point they leave the household and can no longer be claimed as dependents. This implies that all couples aged $\tilde{s}_2 + 18$ years do not have dependent children in the household anymore. They retire at age 67 ($s = 48$) and spend 15 years in retirement until they die together at age 82 ($s = 63$).

Preferences. Preferences are described by a household utility function $U(c, l_f, l_m; k)$ and by a discount factor β. Household consumption is denoted by c, and we include equivalence scales to account for changes in the size of the household. The time endowment for each individual is normalized to 1. Hours worked are denoted by l_g, $g = f, m$, and the remaining hours, $1 - l_g$, are allocated to non-market activities (leisure, time spent with the children, etc.). As will become clear below, the presence and number of children in the household, k, affects utility through equivalence scales, and the disutility from working. We allow females to choose their labor supply both along the intensive and extensive margin. Males either work full-time, $l_m = \bar{l}$, or not at all.

[4]This fertility process generates a demographic composition over the life cycle that matches the empirical pattern well (cf. Appendix A). At the same time, it restricts the number of possible combinations of childrens' ages and thus allows us to keep the state space tractable.

Labor productivity, earnings, income, and assets. Individuals differ in their labor productivity. For males, labor productivity is given by $\omega(s)zw$, where $\omega(s)$ is a deterministic age-specific component, z is an idiosyncratic stochastic component, and w is an exogenous wage rate per efficiency unit. For females, labor productivity hzw includes the stock of productivity-enhancing human capital h. We assume that the evolution of female human capital accumulation is endogenous and depends on participation in the labor market. It can be described by a law of motion

$$h' = \mathcal{H}(h, l_f). \tag{1}$$

For both females and males, the idiosyncratic productivity component z evolves according to a random walk with innovation ϵ,

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

where σ_ϵ^2 is gender-specific. We assume that shocks to labor productivity are uncorrelated across spouses. Upon entering the economy, each individual draws her/his initial idiosyncratic productivity level, z_0, from a log-normal distribution $LN\big(0, \sigma_{\epsilon,0}\big)$, where $\sigma_{\epsilon,0}$ differs between females and males. We denote household earnings by $e = e_f + e_m = hz_f wl_f + \omega(s)z_m wl_m$. Couples have the possibility to save in a risk-free one-period bond at real interest rate r. Asset holdings are denoted by a. Newborn couples start without assets, and borrowing is not permitted. Retired couples receive Social Security benefits denoted by b (we assume that b is homogeneous across all couples; this avoids keeping track of a couple's earnings history to link pensions to actual contributions).

Child care costs. Married couples where both parents supply positive market hours may incur child care costs while working. We denote a couple's child care cost function by $\Gamma(l_f, l_m, k, \eta)$. Child care costs are assumed to depend on the number and age mix of the children, and on idiosyncratic characteristics η. We think of the latter as characteristics determined by the couple's social network, which may provide a number of hours of free child care when the parents are at work (family members that do not live in the household, friends, neighbors, a church, etc.). Couples who enter the economy draw an initial value of η from a distribution specified below. After that, a couple draws a new value of η in two instances: (i) whenever a new child is born; and (ii) whenever a child in the household turns 5. We think of these two events as circumstances where child care needs and access to informal child care arrangements might change. In all other cases, couples retain the same value of η.

Taxes and transfers. Our model embeds the following tax-transfer programs: Income and payroll taxes; the Earned Income Tax Credit (EITC); the Child Tax Credit

(CTC); the Child and Dependent Care Tax Credit (CDCTC); Temporary Assistance for Needy Families (TANF); the Supplemental Nutrition Assistance Program (SNAP); and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). We model these tax and transfer programs very closely to the actual programs, including all their kinks and non-convexities. Specifically, the income tax scheme in the model contains the seven tax brackets, the tax deduction, and the personal exemptions. The payroll tax is a flat rate with a tax cap. The EITC is refundable, and the CTC has two tranches, one refundable and one non-refundable. The CDCTC is non-refundable and conditional on child care costs being paid. TANF and SNAP are assistance programs that provide guaranteed income to eligible applicants.[5] The WIC provides food to pregnant women and small children. We include the actual eligibility criteria, tax credit rates, out-of-work income support, and phase-outs.

Online Appendix B presents detailed descriptions of these taxes and transfers, and provides an account of the non-convexities created by each program on the budget constraint of married couples. We denote the net tax paid by a couple (income and payroll taxes paid minus tax credits and assistance transfers) by $TT(a, e_f, e_m, k, \eta)$, that is

$$\begin{aligned} TT(a, e_f, e_m, k, \eta) = &\underbrace{\Big(T(a,e) + T_p(e_f, e_m)\Big)}_{\text{income and payroll taxes}} - \Big(\underbrace{EITC(a,e,k) + CTC(a,e,k) + CDCTC(a, e_f, e_m, k, \eta)}_{\text{tax credits}} \\ &+ \underbrace{TANF(a,e,k) + SNAP(a,e,k,\eta) + WIC(a,e,k,\eta)}_{\text{assistance transfers}}\Big). \end{aligned}$$

Figure 1 displays the transfer functions for the relevant tax-transfer programs for married couples with two children where both parents work and child care expenses are zero.

Bellman equation. We now write down the recursive problem solved by married couples in our economy. The Bellman equation of a working-age couple (i.e. in model periods $1 \leq s \leq 47$) is

$$v^s(a, z_f, z_m, h, k, \eta) = \max_{c, l_f, l_m, a'} \left\{ U(c, l_f, l_m; k) + \beta \mathbb{E}\left[v^{s+1}(a', z'_f, z'_m, h', k', \eta') \right] \right\}, \quad (3)$$

[5] TANF is organized at the state level, with varying rules in terms of generosity, earnings disregards, and eligibility. Since implementing all these variations in our structural model is not computationally feasible, we implement a scheme that reflects an average version of state-dependent TANF rules. We also abstract from modeling work requirements and time limits (see Online Appendix B for details).

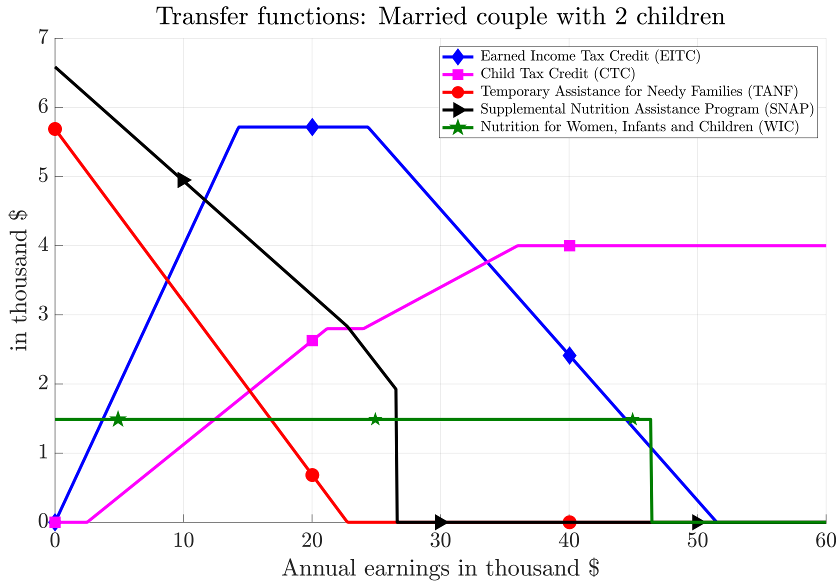


Figure 1: Transfer programs for married couples with two children

subject to the budget constraint, laws of motion and feasibility restrictions

$$
\begin{aligned}
& c + \Gamma(l_f, l_m, k, \eta) + a' = e + (1+r)a - TT(a, e_f, e_m, k, \eta), \\
& h' \text{ evolves according to (1)}, \; z_f' \text{ and } z_m' \text{ evolve according to (2)}, \\
& k' \text{ and } \eta' \text{ evolve according to the laws of motion described in the main text}, \\
& l_f \in [0,1], \; l_m \in \{0, \bar{l}\}, \text{ and } a' \geq 0.
\end{aligned}
$$

In model periods $48 \leq s \leq 62$, couples are retired. They receive Social Security benefits b and solve a consumption-saving problem. In the last period of life, $s = 62$, they consume any remaining wealth. The Bellman equation for retired couples reads

$$
\begin{aligned}
v^s(a) &= \max_{c,a'} \left\{ U(c) + \beta v^{s+1}(a') \right\} \\
\text{s.t.} \qquad & c + a' = b + (1+r)a, \qquad a' \geq 0,
\end{aligned} \tag{4}
$$

where $v^{62}(a) = U(b + (1+r)a)$.

2.2 Parameterization

Preferences. We adopt the following utility function:

$$
U(c, l_f, l_m; k) = \frac{(c/\psi(k))^{1-\sigma} - 1}{1-\sigma} + \varphi \frac{(1-l_f)^{1-\zeta} - 1}{1-\zeta} - \nu_f(k) \mathbb{1}_{l_f > 0} - \nu_m \mathbb{1}_{l_m > 0}, \tag{5}
$$

where σ is the coefficient of relative risk aversion, $\varphi > 0$ is a utility weight, and $\zeta > 0$

controls the Frisch elasticity of labor supply of mothers. Consumption equivalence scales $\psi(k) = \psi(k_1, k_2, k_3)$ depend on the number of children in the household. The last two terms in (5) are utility costs of labor market participation, which are allowed to depend on the presence of children in the household. For females, we will distinguish between $\nu_{f,1}$ for households with children, $k \neq (\emptyset, \emptyset, \emptyset)$, and $\nu_{f,0}$ for those where all children have left the household, $k = (\emptyset, \emptyset, \emptyset)$.[6]

Child care costs. As mentioned above, couples may incur child care costs if both adult members supply positive market hours. The child care cost function is parameterized as

$$\Gamma(l_f, l_m, k, \eta) \;=\; \max\{\eta, 0\} \times \mathbb{1}_{\{l_f > 0 \,\wedge\, l_m > 0\}} \;, \qquad \eta \sim F(k), \tag{6}$$

with η being idiosyncratic child care needs. As we will document empirically below, child care expenditures change significantly once all the children in the household are in school age. Furthermore, our data suggest that the share of couples paying for child care, if all children are 13 years or older, is negligible. Based on these two observations, we assume that child care needs η are determined as follows. We distinguish between couples where the youngest child is between 0 and 4 years of age (y), and those where the youngest child is between 5 and 12 years old (o). We further assume that some couples have access to informal child care and thus do not have to pay child care costs even if both parents work. Formally, with probability κ_i the value for η is set to zero; with probability $1 - \kappa_i$, the value for η is drawn from a Normal distribution $N(\mu_i, \sigma_i)$, $i = y, o$. Note that the actual fraction of couples who have access to informal child care ($\eta \leq 0$) exceeds κ_i, because some couples may draw a negative value for η from $N(\mu_i, \sigma_i)$.

Human capital accumulation. To parameterize the law of motion for female human capital, we follow Attanasio et al. (2008) and Hannusch (2022) and adopt the following functional form:

$$h' = \mathcal{H}(h, l_f) = \exp\left[\ln(h) + \alpha \mathbb{1}_{l_f > 0} - \delta(1 - \mathbb{1}_{l_f > 0})\right], \tag{7}$$

where $\alpha > 0$ governs the gains in future productivity that come along with current employment, and $\delta > 0$ reflects depreciation in human capital associated with nonparticipation. Note that rather than modeling the investment in human capital directly, e.g. by

[6] These utility costs reflect psychological and other non-economic costs, such as being unable to share meals with the children or missing their wake-up and bedtime hours. As will become clear below, our estimated utility costs for females are substantially higher if children are present. We have also experimented with differential utility costs for males and found them to be unnecessary in terms of attaining an adequate model fit.

dedicating time and/or resources, this specification can be thought of as a learning-by-doing type of process.

Numerical solution. We solve the maximization problem using a discrete-state value function iteration approach. Note that in our model the presence of kinks and non-differentiabilities in the budget constraint generated by the tax-transfer system renders Euler equation methods inapplicable. We describe our numerical approach in more detail in Appendix A.

3 Data and Calibration

3.1 Data

We use data from the Annual Social and Economic (ASEC) Supplement of the CPS for the years 2018, 2019 and 2020. Our sample selection criteria for married couples with one, two or three children without a college degree are as follows. The couple is married, opposite-sex, and lives with their child(ren) who is (are) under 19 years of age. The average age of the two parents is between including 20 and 60 years, with neither parent being older than 65. Apart from the married couple and their children, nobody else lives in the same dwelling. The highest educational attainment of wife and husband is some college, but no degree. Neither wife nor husband are in the armed forces. The family does not receive any income from: business and/or farm activities, disability, retirement, social security, veterans income, and survivors' benefits. We also exclude families with one of the parents (i) working less than 100 hours per year but earning an hourly wage above the median hourly wage, (ii) earning an hourly wage above the 99th percentile or (iii) an hourly wage less than half of federal minimum wage. Our final sample of married couples without a college degree and with one to three children consists of 6,048 households. Among these households, there are 2,049 with one child, 2,589 with two children and 1,410 with three children.

3.2 Parameters set externally

The real interest rate is set at $r = 0.025$, and we choose the coefficient of relative risk aversion to be $\sigma = 1.5$. We set males' positive working hours to correspond to a full-time working week of 40 hours, translating to a share of 38 percent of the time endowment spent on working, $\bar{l} = 0.38$. The female human capital depreciation rate is set to $\delta = 0.009$, as estimated by Hannusch (2022) for females without a college degree. The initial

Table 1: Externally calibrated parameters

Description	Param.	Value	Description	Param.	Value
Real interest rate	r	0.025	Male full-time hours	$\bar{l}$	0.38
Coeff relative risk aversion	σ	1.5	Male productivity by age	$\omega(s)$	CPS
Curvature non-market time	ζ	3	Depreciation human capital	δ	0.009
Equivalence scale	ψ_0	1.414	Child arrival prob. at $\tilde{s}_1$	q_1	0.45
Equivalence scale	ψ_1	1.899	Cond prob second child at $\tilde{s}_2$	q_2	0.55
Equivalence scale	ψ_2	2.158	Cond prob third child at $\tilde{s}_2$	q_3	0.66
Equivalence scale	ψ_3	2.404			

value of human capital for entering females is set to one. We employ the equivalence scales used by the CPS to account for the different household sizes in our model. The formula reads $\psi_0 = 2^{0.5}$ for married couples whose children have left the household and $\psi_n = (2 + 0.5 \cdot n)^{0.7}$ for couples with n children. The deterministic age-dependent part of the labor productivity of fathers, $\omega(s)$, is based on the estimated wage profile in the CPS. To match the empirical fertility pattern, we set the arrival probability of a second child at $\tilde{s}_1$ to 45 percent. Furthermore, we set the probability of having another child at $\tilde{s}_2$ for parents of one child to 55 percent, and for parents of two children to 66 percent. The parameter ζ, which affects the Frisch elasticity of labor supply, is set to 3.[7] Table 1 presents a list of externally calibrated parameters. Online Appendix C contains a detailed account of the tax-transfer parameters.

3.3 Parameters calibrated internally

The remaining parameters are calibrated jointly within the model to match the following key data targets (we report in parenthesis the most closely associated parameter for each moment):

1. The employment rate is 94.8 percent for fathers, 60.6 percent for mothers, and 68.0 percent for females in households where the children have left the household. (ν_m,$\nu_{f,1}$,$\nu_{f,0}$)
2. Conditional on working, mothers spend on average 31.4 percent of their time endowment on market work. (φ)
3. Average hourly earnings are \$19.4. (w)

[7]It should be noted that in models like ours where budget constraints contain kinks and preferences are discontinuous due to fixed costs of labor market participation, this parameter is difficult to pin down. We have conducted a sensitivity analysis setting $\zeta = 4$ instead, and found our results to be very similar.

Table 2: Internally calibrated parameters

Description	**Param.**	**Value**	**Moment**	**Target**	**Model**
Discount factor	β	0.997	Average wealth†	82.2	80.7
Utility weight	φ	0.0810	Average hours	0.314	0.311
Participation cost	$\nu_{f,1}$	0.0660	Empl rate f (kids)	0.606	0.608
Participation cost	$\nu_{f,0}$	0.0287	Empl rate f (no k.)	0.680	0.679
Participation cost	ν_m	0.0540	Empl rate m	0.948	0.948
Wage rate	w	63.2	Avg hourly wage	19.4	19.4
Human cap. growth	α	0.0245	Wage growth rate	0.026	0.026
Initial productivity	$(\sigma^f_{\epsilon,0}, \sigma^m_{\epsilon,0})$	(0.19,0.43)	IQR wages 20-22	(4.4,8.1)	(4.3,6.0)
Random walk innov.	$(\sigma^f_\epsilon, \sigma^m_\epsilon)$	(0.09,0.09)	IQR wages 35-37	(10.3,14.8)	(10.4,14.6)
Informal child care	(κ_y, κ_o)	(0.05,0.68)	Frac child care	(0.38,0.18)	(0.37,0.17)
Mean CC distr.	(μ_y, μ_o)	(12.5,4.1)	Avg child care†	(7.1,4.5)	(7.0,4.3)
Std CC distr.	(σ_y, σ_o)	(12,4.5)	IQR child care†	(6.4,4.6)	(6.0,5.0)
Retirement benefit	b	39.0	AIME formula	–	–

NOTES: † In thousand dollars.

4. The share of dual-earner couples with at least one child under 5 that pay child care is 38.1 percent. Across couples with at least one child under 13 (but none below 5), the share is 17.7 percent. (κ_y,κ_o)

5. Conditional on paying child care, couples with at least one child under 5 pay on average $7,054 annually. For couples of older children, average child care costs are $4,519. (μ_y,μ_o)

6. The interquartile range of child care costs paid by couples with at least one small child is $6,395, while for couples with older children the interquartile range is $4,600. (σ_y,σ_o)

7. Hourly wages of working mothers grow at an average annual rate of 2.6 percent. (α)

8. The interquartile range of hourly wages for working mothers resp. fathers at the beginning of their life cycle (ages 20 to 22) is $4.4 resp. $8.1. Fifteen years later (ages 35 to 37), the interquartile range equals $10.3 for women and $14.8 for men. $(\sigma^f_{\epsilon,0},\sigma^m_{\epsilon,0},\sigma^f_\epsilon,\sigma^m_\epsilon)$

9. Households in our sample have an average wealth of $82,211 as estimated from the 2019 Survey of Consumer Finances. (β)

10. Retirement benefits are set to equal mean pension benefits calculated with the formula for average indexed monthly earnings (AIME). We take the 35 years with the highest average earnings to determine the retirement benefit. (b)

Table 2 presents a list of all internally calibrated parameters.

4 The Benchmark Model

4.1 Model fit

We now assess to what extent our benchmark model is capable of matching important statistics from the data that we did not target in our calibration. We are particularly interested in mothers' labor supply, child care expenditures, and female participation elasticities since these moments are tightly connected to the core of the paper, the participation burden on secondary earners in low-income families.

Employment, hours worked and earnings. Summary statistics on labor supply and earnings are presented in Table 3. Panel A shows that employment rates by married mothers are strongly declining in the number of children: While almost 68 percent of married mothers in families with 1 child participate in the labor market, the share drops to 60 percent in families with 2 kids, and declines even further to 51 percent with 3 children in the household. The data also show a large disparity related to the age of the children: In households with at least one child below the age of 4, the maternal employment rate is significantly lower at 53 percent, compared to families where all children are already of school age (65 percent). As can be seen in the table, our benchmark model replicates these patterns reasonably well. Note that while we have targeted the overall employment rate by mothers in our calibration, the disaggregated numbers are endogenous outcomes in our model.

Our data further reveal that hours worked among working mothers are widely dispersed, justifying our choice of modeling the intensive margin (Table 3, Panel B). The model captures this dispersion fairly well. We also note that a large majority of married fathers in our sample works 40 hours a week (in the model, this is true by construction). Finally, Panel C reports summary statistics on the distribution of earnings across mothers, fathers, and couples. Despite its parsimonious specification, the model does remarkably well in accounting for the empirical earnings distributions. For our study, this is particularly important: As we will show below, the (dis)incentives for married mothers to participate in the labor market are critically shaped by the position in the earnings distribution. While the model underestimates earnings inequality at the top, this is less problematic in our context since our focus is on low-income households.

Child care expenditures. Table 4 presents the model fit with respect to child care

Table 3: Model fit– Employment, hours worked and earnings

	Data	Model		Data	Model
A. Mothers' employment (%)					
1 child	67.60	66.06	y children†	53.09	53.89
2 children	60.51	60.24	o children†	65.42	65.39
3 children	50.80	39.69			
B. Hours worked					
Mothers			Fathers		
Average	1,718	1,700	Average	2,125	2,080
p25	1,300	1,451	p25	2,080	2,080
p75	2,080	1,997	p75	2,080	2,080
C. Earnings ($)					
Mothers			Fathers		
Average	30,311	29,886	Average	49,119	44,409
p25	16,495	16,808	p25	29,109	31,767
p75	39,289	38,348	p75	61,910	54,651
Households					
Average	64,954	60,008			
p25	36,000	40,692			
p75	85,000	75,642			

Notes: † Here, y refers to married couples with at least one small child (between 0 and 4 years), and o refers to married couples with children who are all at least 5 years old. All statistics for hours worked and earnings are conditional on working.

expenditures. As can be seen, families with pre-school children are twice more likely to incur formal child care costs, and their average expenditures significantly exceed those by families where all children are of school age. Note that these data moments were targets in our calibration. Importantly, child care expenditures are not homogeneous across couples, even among those paying child care. This implies that differential child care needs and availability may crucially shape family labor supply, justifying our strategy of modeling this dimension of heterogeneity. The model generates a distribution of child care expenditures that comes close to its empirical counterpart, even though our child care cost function is quite parsimonious.

Age profile of wages. In Figure 2 we plot the evolution of mothers' average hourly wages in our benchmark model against the corresponding empirical life-cycle profile in the CPS. In the model, this profile is shaped by maternal participation in the labor market, in conjunction with the underlying human capital accumulation process. Overall, the

Table 4: Model fit– Child care expenditures

	At least one child under 5		All children aged 5+‡	
	Data	Model	Data	Model
Share paying child care* (%)	38.1	37.3	17.7	17.3
Child care paid† ($)				
Average*	7,054	7,025	4,519	4,323
Median	5,206	5,000	3,068	4,000
p25	3,000	3,000	1,293	1,000
p75	9,395	9,000	5,893	6,000

NOTES: * Calibration target. † Conditional on paying child care. ‡ Couples where the youngest child is between 5 and 12 years of age.

model lines up reasonably well with the empirical pattern.

Labor supply elasticities. Next, we examine the labor supply responses to changes in the wage rate and in child care prices. Starting with the former, we compute the extensive-margin elasticities of labor supply, defined as the percentage change in the employment rate in response to a one percent change in net wages. We calculate elasticities based on positive and negative wage changes, and we also differentiate between short-run and long-run elasticities. Short-run elasticities are computed holding the distribution of couples across the state space fixed at the benchmark solution, while long-run elasticities are based on the new stationary distribution arising after the change in wages. Table 5 reports our results. Overall, the long-run extensive-margin elasticity of mothers in our model is roughly 0.8. We find that labor supply responses are more concentrated among mothers of young children, and that participation tends to be more elastic in couples with multiple children. Interestingly, we find large differences between short-run and long-run elasticities. The intuition is that adjustments in maternal labor supply translate into changes in human capital, which is a stock variable that tends to adjust gradually over time. Along this adjustment process, changes in accumulated human capital can therefore feed back into employment decisions. Related to this, in the short run, the dynamic effects of human capital are bound to deliver asymmetric responses for positive and negative wage changes, an intuition that is confirmed by our results.

There are several remarks worth making at this point. First, our focus here is on extensive-margin labor supply elasticities. We have also computed total hours elasticities, capturing both the extensive and the intensive margin of labor supply. Our results suggest that the participation margin is considerably more relevant than the hours margin. We refer to Appendix A for a more detailed discussion. Second, we have computed

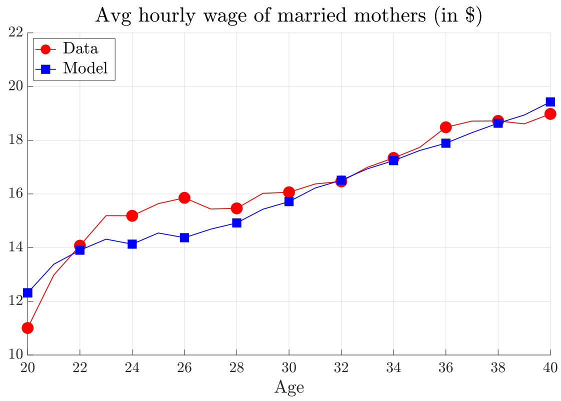


Figure 2: Hourly wage of married mothers

fathers' extensive-margin elasticities as well. Across all fathers, the long-run elasticity is 0.25, with a slightly larger value for fathers of pre-school children (0.42) than for those with older kids (0.10). We present these results in more detail in Appendix A. Finally, we note that the model-generated elasticities are generally in line with empirical estimates, even though the comparability is somewhat limited by the selected population group.[8]

We now turn to examining the responsiveness of labor supply to changes in the cost of child care. In a recent summary of the empirical literature, Morrissey (2017) reports a range of elasticities of female employment with respect to child care prices spanning from -0.025 to -1.1, where the relevant population sample in most studies comprises mothers with child(ren) below the age of 6. When computing this elasticity in our model, we obtain a value of -0.74. This falls well into the range of empirical estimates, even though again comparability is partially limited by the selected population group (Anderson and Levine (1999) report that less educated mothers respond more elastically than women with more education).

4.2 (Dis)Incentives for Married Mothers' Employment

Equipped with our benchmark model, we now explore to what extent child care needs and the tax-transfer system influence married mothers' employment behavior. To this end, we compute the participation tax rates faced by married mothers in our model. The participation tax rate is a well-established measure summarizing labor supply incentives at the extensive margin. It is defined as the share of a mother's earnings that is taxed away if she chooses to work compared to the case where she does not work, holding the income of the male earner constant. Put differently, the participation tax rate describes

[8]Eissa and Hoynes (2006) and Chetty et al. (2013) provide surveys of the empirical literature. More recently, Bastian (2020) studies the introduction of EITC in 1975 and its impact on maternal employment. For the full sample of women, he reports an extensive-margin elasticity of 0.63.

Table 5: Extensive-margin labor supply elasticities of mothers

	Positive wage change		Negative wage change	
	Long run	Short run	Long run	Short run
All mothers	0.77	1.02	0.82	0.40
$y^{\dagger}$ children	0.91	1.05	0.85	0.50
$o^{\dagger}$ children	0.69	0.98	0.79	0.33
1 child	0.75	0.99	0.72	0.25
2 children	0.79	1.06	0.91	0.51
3 children	0.86	1.10	1.02	0.76

NOTES: † Here, y refers to married couples with at least one small child (between 0 and 4 years), and o refers to married couples with children who are all at least 5 years old.

the difference in taxes paid or transfers received between a one- and a two-earner couple, as a share of the mother's earnings. The female participation tax rate, PTR_f, is defined as

$$PTR_f \;=\; \frac{TT(a, e_f, e_m, k, \eta) - TT(a, 0, e_m, k, \eta)}{e_f}\,. \tag{8}$$

We compute the participation tax rates of mothers across the distribution of married couples with children in our model. For dual-earner couples, they can be readily obtained by setting a mother's earnings to zero. For couples where only the father works, we impute the participation tax rate by assuming that the mother works part-time. Note that a higher participation tax rate generally implies a lower incentive to supply positive market hours. Figure 3 displays the participation tax rates faced by married mothers in our model as a function of their husbands' earnings. The figure reveals that the participation tax rate tends to be larger in couples where the earnings of the male are relatively low. For instance, if he makes $30k which is roughly the 25th percentile of the distribution of fathers' earnings (cf. Table 3), the participation tax rate equals 30 percent. We will argue below that the shape of the Earned Income Tax Credit is a key factor behind the large participation tax rate in this part of the earnings domain.

Next to the design of the tax-transfer system, maternal labor supply is also crucially affected by a couple's child care needs. Our structural model allows us to identify the actual participation cost borne by working mothers when child care costs are included. Building on this notion, we construct an augmented measure where expenditures on child care are incorporated. We define

$$PTR_f^C \;=\; \frac{TT(a, e_f, e_m, k, \eta) - TT(a, 0, e_m, k, \eta) + \Gamma(l_f, l_m, k, \eta)}{e_f} \tag{9}$$

as the share of the mother's earnings that is either being taxed away, or that needs to

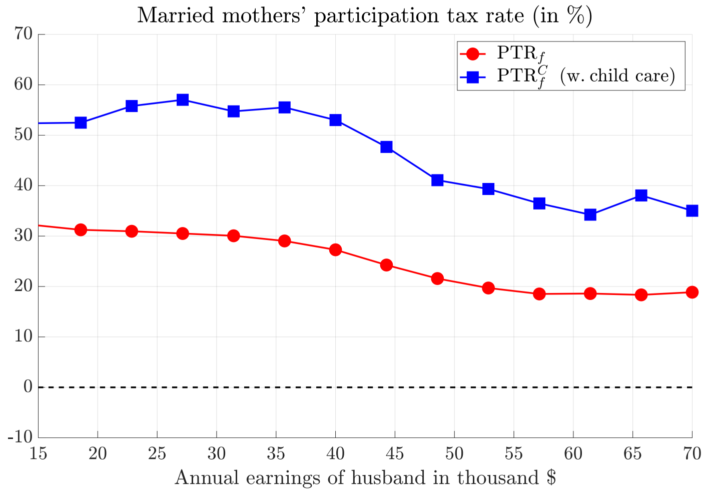


Figure 3: Married mothers' participation tax rates along the stationary distribution

be spent on child care if both parents work. Note that we can readily compute potential or actual child care costs $\Gamma(l_f, l_m, k, \eta)$ in our model based on the distribution of couples across the state space (including the unobserved component η). Our augmented participation tax rate measure is depicted in Figure 3 (blue line marked with squares). Strikingly, the cost of married mothers' participation consistently lies more than 20 percentage points higher once expenditures on child care are accounted for. For instance, for couples where the father earns $30k a year, mothers are taxed more than half of their earnings if they choose to participate in the labor market.

Our findings so far suggest that both the design of the tax-transfer system and child care needs are prime candidates in generating large participation tax rates for married mothers. Before turning to possible reforms to the welfare system, our aim is to get a better understanding how the individual anti-poverty programs shape participation costs for married mothers. To this end, we perform a decomposition where the total participation tax rate is split up into four different components: (i) Income and payroll taxes; (ii) the Earned Income Tax Credit; (iii) the Child Tax Credit and the Child and Dependent Care Tax Credit; and (iv) the assistance transfers (SNAP, TANF and WIC). Following the same logic as in equation (8), for each component we compute the difference in the tax paid or transfer received between a one- and a two-earner couple, as a share of the mother's earnings.[9] Then, by construction, the four components add up to the total participation tax rate.

Figure 4 displays the ensuing results of this decomposition. As expected, income and

[9] For instance, the component attributed to the EITC is computed as $-\big(EITC(a, e_f + e_m, k) - EITC(a, e_m, k)\big)/e_f$. The other three components are defined accordingly.

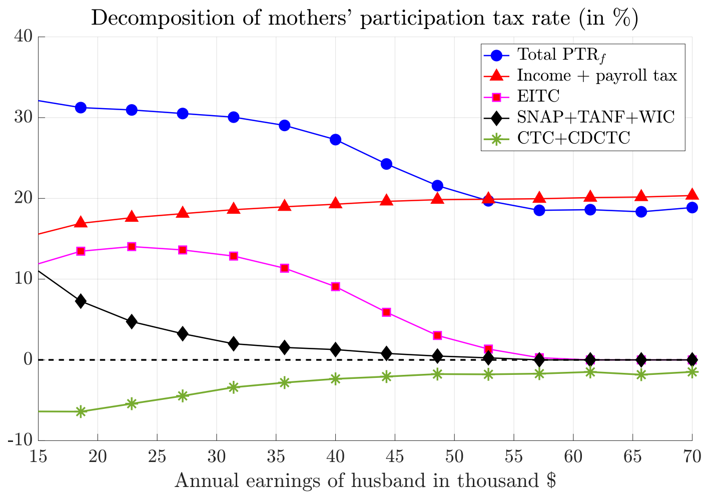


Figure 4: Decomposition of married mothers' participation tax rates

payroll taxes are major contributors to the participation tax, because adding a second income increases taxed paid. Due to the joint filing tax system, this is true even for low values of female earnings. More strikingly, the Earned Income Tax Credit shows up as the second largest contributor to the participation tax. The corresponding line in Figure 4, magenta-colored and marked with squares, exhibits a hump-shaped pattern peaking at roughly $25k annual earnings by the husband. This result may be surprising at first, because the original purpose of introducing an Earned Income Tax Credit was to promote participation in the labor market. But since the size of the Earned Income Tax Credit for married couples depends on household earnings, not individual earnings, it actually reduces incentives to participate for a secondary earner, especially in low-income households. The reason is that adding a secondary income will often push the couple out of the eligibility region of the EITC, thereby increasing the participation tax rate.[10] By contrast, the Child Tax Credit (CTC) and the Child and Dependent Care Tax Credit (CDCTC) lower the participation tax rates for working mothers (the green line marked with stars lies below zero). As for the CDCTC, the intuition is that dual-earner couples are able to claim part of their expenditures on child care as a tax credit. For couples without access to informal child care, this tax credit therefore alleviates the participation tax on mothers' labor supply. Finally, we observe that the assistance programs SNAP, TANF and WIC raise participation tax rates, because eligibility and benefit size decline with household earnings.

In Table 6, we provide summary measures from this decomposition by aggregating across

[10] Ortigueira and Siassi (2022) find empirical evidence of a U-shaped relation between husbands' earnings and their wives' employment rate. They argue that this relation can be traced back to the hump-shaped pattern in participation tax rates created by the EITC.

Table 6: Decomposition of married mothers' participation tax rates

	All		1 child		2 children		3 children	
Overall		24.8		23.7		26.2		25.1
Income and payroll tax	+	19.0	+	19.0	+	19.0	+	19.2
EITC	+	6.4	+	4.6	+	8.3	+	9.6
SNAP + TANF + WIC	+	2.5	+	2.0	+	2.6	+	3.3
CTC + CDCTC	−	3.0	−	1.8	−	3.6	−	7.1

NOTES: The first row in this table reports average participation tax rates for married mothers based on the stationary distribution in our benchmark model. The decomposition into the various components of the tax-transfer system is described in the main text. Adding up the numbers can lead to small deviations due to rounding.

the stationary distribution of couples in our benchmark model. The average participation tax rates of married mothers is equal to 24.8 percent. We find that this value is roughly the same for couples with one, two or three children. After income and payroll taxes, the EITC is the second-largest contributor to the participation tax rate, with an average value of 6.4 percent. Our results indicate that this measure increases considerably with the number of children: Because the size of the EITC is larger for couples with multiple children, they tend to lose more if both parents go to work. Again, this suggests that the current design of this tax credit runs counter to the original purpose of facilitating labor market participation, especially in families with multiple children. The CTC and the CDCTC, on the other hand, lower participation tax rates for married mothers, by an average value of 3.0 percent. Moreover, we find that this measure becomes significantly more important as the number of kids increases. For instance, for couples with three children, these two tax credits lower the participation rate by as much as 7.1 percentage points.

To summarize, married mothers face large labor market participation tax rates, especially when child care costs are taken into account as well. These participation tax rates tend to be larger in households where husbands' earnings are relatively low, a pattern that is significantly shaped by the design of anti-poverty income transfers and tax credits. In the next section, we turn to analyzing policy reforms of these tax credits, and gauging their impact on maternal labor supply.

5 Policy Analysis

The good fit of our model to non-targeted moments, and in particular with regard to family labor supply and expenditures on child care, lends support for its use as a tool for counterfactual policy evaluation. An important conclusion from our analysis in the previous section is that the U.S. tax-transfer system in its current form holds back married mothers' labor supply. In this section, we set out to quantify the effects of reforms to existing tax credits that could potentially lower participation tax rates for secondary earners in married households with children. Our focus will be on the two most relevant tax credits for families with children, namely the Earned Income Tax Credit (EITC) and the Child and Dependent Care Tax Credit (CDCTC).[11] That is, instead of redesigning the welfare system from scratch, we will explore easily-implementable reforms to the current design of these two tax credits. In particular, we will conduct the following three counterfactual experiments:

R1: The Child and Dependent Care Tax Credit (CDCTC) allows couples to claim part of their child care expenses as a tax credit. There are upper limits of $3,000 (one child) or $6,000 (more children) to expenses that can be used, and couples can claim 20-35 percent of them. In this reform, we eliminate the upper limits and allow couples to claim the full amount of their child care expenses as a tax credit.

R2: The Earned Income Tax Credit (EITC) is based on household earnings. In this reform, we introduce a full deduction on the earnings of the secondary earner in married couples. That is, eligibility and size of the EITC are based on the earnings of the higher-earning spouse.

R3: A combination of reforms R1 and R2.

We focus our analysis on the long-run effects of these reforms by comparing the stationary distribution in our benchmark economy with the one arising after the reform. Later on, when assessing welfare effects, we consider transitional dynamics as well.[12]

[11] The Child Tax Credit (CTC) is paid out conditional on positive household earnings as well. In contrast to the EITC, however, the phase-out region starts only at annual earnings of $400,000. Since virtually all couples in our model (and in the data) have positive labor earnings, the CTC effectively resembles a lump-sum transfer which only depends on the number of children. Therefore, we focus our analysis on the EITC and the CDCTC.

[12] In what follows, we focus our exposition of results on couples with children in the household, because the reforms virtually only affect this subgroup of households. While the EITC reform, in principle, also applies to couples without dependent children, the earnings limits for this group are so low that the

5.1 Expanding Tax Credits for Child Care Expenses (R1)

In our first counterfactual experiment, we simulate a reform that allows couples to claim the full amount of their expenses on child care as a tax credit. This reform is bound to affect families who have limited or no access to informal child care and therefore choose to send only one adult member to the labor market, even if both parents' labor productivity is relatively high.[13] Table 7 presents our results. We find that expanding the Child and Dependent Care Tax Credit (CDCTC) raises the maternal employment rate by about 6 percentage points, from 60.8 percent to 67.0 percent. Notably, this increase is mostly concentrated in families with pre-school children. In these families, mothers' employment goes up by more than 10 percentage points, from 53.9 percent to 64.1 percent. Our findings also suggest that families with multiple children respond relatively more to this reform. For instance, the participation rate by mothers of three in our model increases from 39.7 percent to 48.3 percent. Expanding the CDCTC also affects the employment rates of fathers. The intuition is that in families with high child care needs, the couple typically sends the parent with the higher earnings potential to the labor market, and in some couples this may be the mother. In this vein, we find that reforming the CDCTC raises the employment rates of both parents, and the share of dual-earner couples increases from 55.6 percent to 62.8 percent. Interestingly, maternal labor supply also rises along the intensive margin: Average hours worked, conditional on working, go up slightly from 1,700 hours to 1,725 hours. This suggests that some mothers who decide to participate in response to the reform actually have a relatively high labor productivity and, therefore, upon entering also choose to work longer hours.

These labor supply effects translate into changes in wages, earnings and wealth (Table 7, panel A). With more parents participating in the labor market, household earnings and disposable income (defined as after-tax income minus child care expenses) display a marked increase. Average wealth goes up as well because some of these additional resources are put into savings. Notably, the average hourly wage of working mothers increases from $16.3 to $16.6. In our model, there are two opposing forces influencing the average wage per hour. The first one is a selection effect. Mothers who switch from non-participation to participation tend to have a lower labor productivity than those that

reform effectively does not lead to any behavioral responses along the stationary distribution in our benchmark model.

[13] Recently, under the American Rescue Plan Act (ARPA), the Child and Dependent Care Tax Credit was temporarily expanded for the year 2021. Among other things, the upper limits were increased from $3,000 to $8,000 (one child), and from $6,000 to $16,000 (two or more children) respectively, along with higher credit rates for low-income households.

Table 7: Main results– Policy analysis

	Benchmark	Reform		
		CDCTC	EITC	Both
A: LABOR SUPPLY				
Mothers' employment rate (%)	60.77	66.99	66.84	73.48
y children	53.89	64.09	59.60	70.82
o children	65.39	68.94	71.70	75.27
1 child	66.06	71.69	70.32	76.30
2 children	60.24	66.52	67.36	74.11
3 children	39.69	48.29	50.75	59.93
Fathers' employment rate (%)	94.81	95.83	95.78	96.54
Share of dual-earner couples (%)	55.58	62.82	62.62	70.02
Mothers' avg hours worked	1,700	1,725	1,684	1,710
Household earnings ($)	60,008	62,829	61,499	64,399
Avg hourly wage of mothers ($)	16.3	16.6	16.1	16.5
Avg hourly wage of fathers ($)	21.3	21.2	21.2	21.1
Gender wage gap* (%)	23.5	21.6	23.8	22.0
Disposable income ($)	56,979	59,417	58,573	61,107
Household wealth ($)	80,672	96,298	80,879	95,601
B: TAXES AND TRANSFERS				
Avg participation tax rate (%)	24.8	20.9	18.1	14.4
EITC recipients (%)	34.9	30.6	58.0	56.3
EITC per HH (cond., $)	2,604	2,670	2,789	2,789
CDCTC recipients (%)	10.9	17.4	14.6	21.3
CDCTC per HH (cond., $)	666	4,881	699	4,541
SNAP/TANF/WIC recipients (%)	20.4	18.0	17.2	14.5
SNAP/TANF/WIC per HH (cond., $)	1,411	1,471	1,357	1,414
Taxes paid per HH† ($)	9,110	9,307	9,098	9,287
C: CHILD CARE				
Share paying child care (%)				
y children	37.3	50.5	44.3	55.1
o children‡	17.3	22.2	19.6	23.7
Avg child care paid** ($)				
y children	7,025	8,832	7,721	9,126
o children‡	4,323	4,934	4,629	5,108

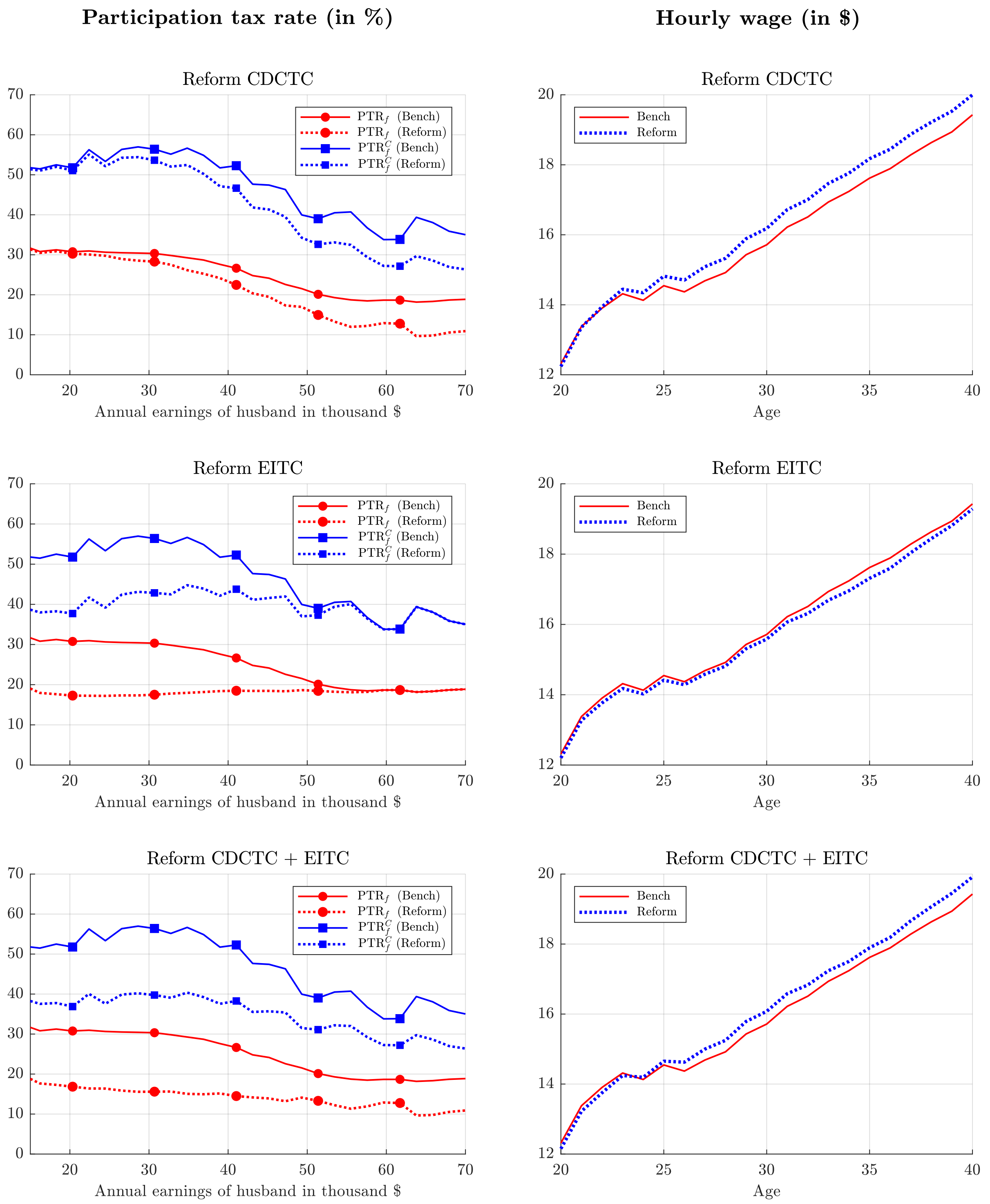
NOTES: This table reports summary statistics for married couples with children for our benchmark economy and for the three reforms. *Defined as the ratio between mothers' average hourly wage and fathers' average hourly wage. †This includes all working-age households, i.e. households with and without children. **Conditional on paying child care. ‡Couples where the youngest child is between 5 and 12 years of age.

were already working before. This depresses the average wage. On the other hand, there is a dynamic effect due to human capital formation: Working mothers tend to accumulate a larger stock of human capital, which raises their productivity later on in life. We find that the second effect dominates in response to the CDCTC reform, thus also partially closing the gender wage gap. Figure 5 shows that average hourly wages of mothers tend to increase already as early as at the age of 23 (top right panel).

How much would the government have to spend on the reform? We find that, in the long run, the reform is actually self-financing (Table 7, panel B). The net tax paid per household, including those where the children have already left, increases from \$9,110 to \$9,307. At first glance, this result may seem surprising, because the reform induces more families to claim the CDCTC (the share of recipients goes up from 10.9 percent to 17.4 percent), and the tax credit paid per household increases considerably from \$666 to \$4,881. However, there are countervailing forces on the government budget as well. For one, expenditures on other means-tested programs decline, because families with higher incomes are less likely to be eligible. This is true for SNAP, TANF and WIC, but also for the EITC, as dual-earner couples are often pushed out of the eligibility region. Moreover, the government collects more revenues from income and payroll taxes. Note that the latter effect is amplified by the endogenous formation of human capital, because working mothers also tend to pay higher income taxes later on. Succinctly, these forces more than offset the additional resources spent on the Child and Dependent Care Tax Credit, making the reform self-financing.[14]

Figure 5 illustrates how the reform shapes mothers' participation tax rates along the stationary distribution of our model (top left panel). We find that expanding tax credits for child care expenses lowers participation tax rates, especially in those families where the father earns more than \$40k per year. These are families with relatively high child care needs who decide to keep the mother at home, thus forgoing the additional income of a secondary earner, because this would come at the cost of paying for formal child care. Expanding tax credits for child care expenses effectively alleviates their participation burden and induces more families to send both parents to work. Overall, this reduces the average participation tax rate of mothers from 24.8 percent to 20.9 percent as more couples are willing to pay for child care (Table 7, panels B and C).

[14] We note that this statement applies to the sample of low-income families, which is our population of interest in this paper. In other words, we are not able to infer the fiscal costs of a general expansion of the CDCTC as this would require extending the model to include other types of households as well.



NOTES: The left panels in this figure show married mothers' participation tax rates as a function of their husbands' earnings along the stationary distribution. The participation tax rates PTR_f and PTR_f^C are defined in equations (8) and (9) in the text. The right panels show married mothers' average hourly wage by age.

Figure 5: Married mothers' participation tax rates and wages (benchmark vs. reform)

5.2 Expanding Tax Credits for Earned Income (R2)

We now turn to our second counterfactual, a reform of the Earned Income Tax Credit (EITC). An important result from our analysis in subsection 4.2 is that the EITC, instead of promoting participation in the labor market as originally intended, actually reduces incentives to participate for secondary earners in married couples. The reason is that eligibility and size of the EITC are based on the pooled taxable income of both spouses. For low-income families, this often implies that adding the income of a secondary earner will push the couple out of the eligibility region of the EITC. In our second reform, we directly address this issue by applying a simple modification to the current design of the EITC. Namely, we introduce a full deduction on the earnings of the secondary earner, such that eligibility and size of the EITC are based on the labor income of the higher-earning spouse.[15] This reform is bound to affect couples where the primary earner makes between \$20k and \$40k, spanning the plateau and phase-out regions of the EITC, and causing participation tax rates for secondary earners to be particularly large (cf. Figure 4).

Table 7 presents our results. We find that the EITC reform would raise the maternal employment rate by 6 percentage points, from 60.8 percent to 66.8 percent. Interestingly, this increase is very similar in magnitude to the one obtained under the CDCTC reform. However, there are important differences as well. While the employment effects of the CDCTC reform are mostly concentrated in families with pre-school children, the effects of the EITC reform are spread out more evenly across all families. For instance, this reform raises mothers' employment rates in families with older children from 65.4 percent to 71.7 percent, an increase that is roughly twice as large as under the first reform. Note that the EITC reform raises fathers' employment rates as well. Overall, the share of dual-earner couples increases from 55.6 percent to 62.6 percent, a similar increase as under the first reform.

At the intensive margin of labor supply, annual hours worked decrease slightly from 1,700 hours to 1,684 hours. Compared to the first counterfactual, this suggests that the reform induces mothers with more moderate labor productivities to join the labor force and then work shorter hours. This is also reflected in a decline in the average hourly wage from \$16.3 to \$16.1. That is, under this reform, the selection effect of having more

[15] A secondary earner deduction for the purpose of claiming the EITC has been part of the political debate for some time. For instance, Senator Patricia Murray (D) proposed a 20-percent deduction on the secondary earner's income as part of the "21st Century Worker Tax Cut Act", introduced to Congress in 2014.

low-productive mothers in employment outweighs the human capital effect of dynamic productivity gains. The gender gap actually widens a little bit. Figure 5 shows that average hourly wages of mothers exhibit a slight decrease for mothers in their thirties, which is when most children have reached school age (middle right panel).

Interestingly, we find that introducing a full secondary earner deduction is (almost) self-financing, paralleling our results for the first reform (Table 7, panel B, last row). The net tax paid per household, including those where the children have already left, decreases by merely $12 from $9,110 to $9,098. Note that the reform allows many more couples to claim the EITC, as reflected by a large increase in the share of EITC recipients from 34.9 percent to 58.0 percent. Since the average EITC per household remains almost the same, this implies that the government spends considerably more on this program. However, similar to the first reform, lower expenditures on other welfare programs and higher income and payroll tax revenues, amplified by human capital accumulation, constitute sufficiently large countervailing forces to almost offset the costs of the reform.

Figure 5 shows how a secondary earner deduction reshapes married mothers' participation tax rates in our model (middle left panel). We find that the reform leads to a massive reduction in participation tax rates for low-income couples where the father earns between $15k and $45k per year. Overall, the reform lowers the average participation tax rate of mothers from 24.8 percent to 18.1 percent. This confirms our intuition that the current design of the EITC induces many couples to forgo the additional income of a secondary earner, even if they only have moderate child care needs (Table 7, panels B and C).

5.3 Combination (R3)

Our results so far suggest that expanding tax credits for child care expenses and on earned income yield comparable increases in mothers' employment rates. At the same time, they appear to affect different subsamples of our population: While the CDCTC expansion predominantly influences families with high child care needs where both spouses are relatively productive, the employment effects of a secondary earner deduction for the EITC are more concentrated in low-productive couples. This motivates us to simulate a third counterfactual where we study the effects of a combination of both reforms. Our results are summarized in Table 7 (last column) and Figure 5 (bottom panels). In short, we find that reforming both tax credits yields highly complementary effects on maternal labor supply. The employment rate of married mothers increases from 60.8 percent to 73.5 percent. Note that the labor force participation rate across all women in the United States is 76 percent. This suggests that, through the lens of our model, a combination of easily-implementable reforms to existing tax credits can virtually close the maternal employment gap for low-income married mothers.

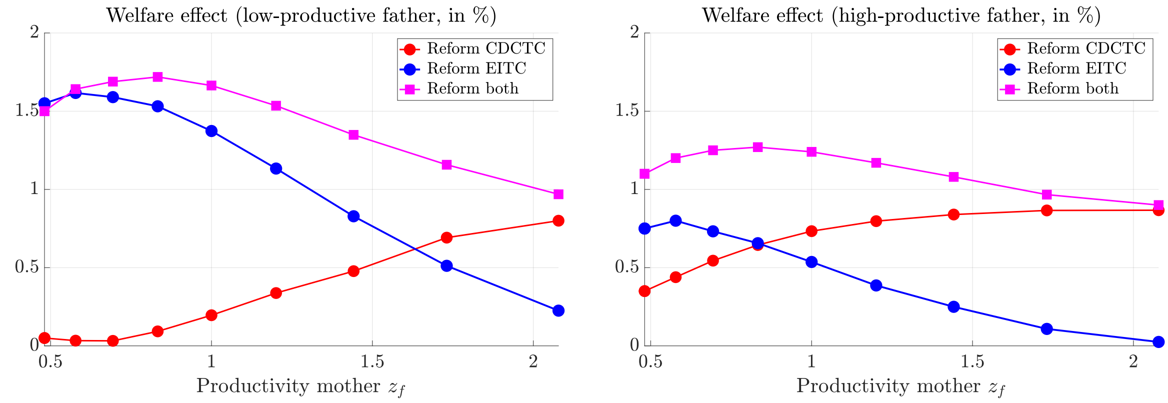
The reform has a particularly large impact on couples with pre-school children and on couples with three children. For instance, in the latter group, the participation rate of mothers goes up by as much as 20 percentage points (from 39.7 percent to 59.9 percent). Overall, the share of dual-earner couples would rise from 55.6 percent in the benchmark to more than 70 percent after the reform. This raises disposable incomes, and it allows couples to accumulate more savings. Importantly, we find that the joint reform is self-financing for the government. Again, the intuition is that larger expenditures on the two child-related tax credits are offset by higher tax revenues and lower spending on assistance programs. The reform induces a remarkable reduction in participation tax rates for married mothers as the average value declines by more than 10 percentage points from 24.8 percent to 14.4 percent. Indeed, Figure 5 illustrates that participation tax rates are now lowered uniformly across the entire domain of husbands' annual earnings. This highlights again the complementary nature of the two components of this reform.

5.4 Welfare Analysis

We find that all three reforms imply welfare gains for entering couples in our economy. Reform R1 yields a welfare gain of 0.30 percent in terms of lifetime consumption, reform R2 increases welfare by 0.93 percent, and the joint reform R3 implies a welfare gain of 1.33 percent.[16] Note that these values are based on ex-ante measures of expected lifetime utility, before initial realizations of labor productivities and child care needs are drawn. We further investigate the reforms' distributional effects by computing the welfare effects once the veil of ignorance is lifted and initial values are revealed. Figure 6 plots the welfare gain, again expressed in terms of a consumption-equivalent variation to the benchmark, as a function of both parents' productivities. As can be seen, welfare gains exhibit a marked increase in both parents' labor productivities for the CDCTC reform. Intuitively, high-productive couples are more likely to benefit from an expansion in child care tax credits, because they might face limited access to informal child care.[17] Conversely, the EITC reform yields larger welfare gains for low-productive couples. As explained above, these families are more likely to fall into the eligibility region of the EITC, and introducing

[16] In Appendix A, we describe how we compute welfare effects in terms of consumption equivalent variation.

[17] Note that our specifications for the fertility process and child care costs imply that all couples experience a new draw for their child care needs within the first five years after entering the model. This attenuates the importance of initial child care needs for welfare gains.



NOTES: The left panel shows the welfare effects for entering couples where the father's initial labor productivity is $z_m = 0.7$, and the right panel shows the welfare effects for couples where $z_m = 1.44$. In both panels, we select couples with median child care needs (results for other couples look similar). Welfare effects are expressed in terms of consumption-equivalent variations to the benchmark (cf. Appendix A).

Figure 6: Welfare gain for entering couples

a secondary-earner deduction allows them to claim larger tax credits on earned income. Interestingly, we find that the combined reform yields fairly homogeneous welfare effects across all families. This result lines up well with our previous analysis pointing to the complementary nature of the two reforms. Finally, we have computed welfare effects for the population alive at the time of the reform as well. We find that the average welfare gain across incumbent families amounts to 0.11 percent for reform R1, 0.45 percent for reform R2 and 0.57 percent for reform R3, respectively.

6 Concluding Remarks

It is well understood that the design of tax-transfer programs has important implications for family labor supply. In this paper, we address the question whether the low employment rate by married mothers in low-income families in the United States can be traced back to the design of child-related transfer programs, and to what extent easily-implementable reforms of existing tax credits can promote maternal labor supply. To this end, we develop a dynamic structural life-cycle model of married couples with children who face productivity, child care and fertility risks, and make consumption-saving and labor supply decisions. Our model integrates the dynamic trade-offs created by endogenous female human capital accumulation, it accounts for observed and unobserved heterogeneity in child care needs, and it embeds the U.S. tax-transfer system including all the major anti-poverty programs in great detail. In counterfactual simulations, we show that reforming tax credits for child care expenses and earned income can be self-financing, welfare-improving, and highly effective at raising mothers' employment rates.

Even though our model is rich in many dimensions, it necessarily abstracts from various features that can be worth exploring in future research. First, we have assumed that wage rate and the real interest rate are exogenous, thus neglecting the effects that our reforms may have on factor prices. For instance, in general equilibrium, an increase in labor supply by married couples in our model may be partially attenuated through lower market wages. Secondly, fertility in our model is exogenous, and there are no divorces. While the empirical literature has found little or no effects of taxes and transfers on fertility (Baughman and Dickert-Conlin (2009), Crump et al. (2011)), it may be worth investigating this quantitatively in future research. Similarly, we have abstracted from marital dissolution and the effects that fiscal reforms may have on divorces. Capturing this correctly would require a more complex environment where the continuation values for divorced singles are explicitly modeled as well. Perhaps more importantly, our analysis is silent about the effects of policy reforms on child outcomes. If higher employment rates by married mothers are associated with less parental time spent with children, this may affect children's skill formation and, ultimately, their productivity in the long run. We believe that studying this channel quantitatively is an interesting avenue for future research.

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A More on Model Fit and Numerical Solution

In this appendix we compare the model-generated fertility pattern with the demographic composition in the data. We also describe our numerical approach to solve the model, and we present further labor supply elasticities for mothers and fathers from our benchmark economy.

A.1 Fertility process

For convenience, we first repeat our modeling of the fertility process as laid out in the main text. Couples enter the economy with a newborn child. At age $\tilde{s}_1 = 4$, a second child enters the household with probability q_1. A second fertility draw occurs at age $\tilde{s}_2 = 9$, where the child arrival probability equals q_2 for parents of one, and q_3 for parents of two (namely those who received a second child already at $\tilde{s}_1$). This implies that there are four different family types in our model. We have households with: (i) one child who never have another one; (ii) two children early and no third child; (iii) a late second child; and (iv) three children. Table A1 compares the demographic composition of couples in the model with the empirical numbers. During the very early years, the model understates the share of families with multiple children. However, by the time couples reach the second half of their twenties, the differences between the data and the model become smaller and eventually almost vanish. We therefore conclude that, in spite of its simplicity, the fertility process comes reasonably close in matching the family structures from the data.

Table A1: Model fit– Demographic composition by age

Parents' age	20-23		24-27		28-32		33-37	
	Data	Model	Data	Model	Data	Model	Data	Model
1 child	68	89	50	55	25	25	21	25
2 children	26	11	38	45	47	45	45	45
3 children	7	0	12	0	28	30	34	30

NOTES: All numbers in percent. Parents' age in the data is the average between both parents' ages.

A.2 Numerical solution

Bellman equation. To solve the maximization problem of married couples we use a discrete-state value function iteration approach, as the kinks and non-differentiabilities in the budget constraint generated by the tax-transfer system render Euler equation methods inapplicable. Because of the presence of these kinks and non-convexities, it is crucial for us to capture as accurately as possible how labor supply choices respond to taxes and transfers. To this end, we discretize the hours choice for mothers on a much finer grid than the ones typically used when taxes and transfers are approximated by a smooth function. Specifically, we let mothers choose annual hours of work from a fine, quasi-continuous grid, where two adjacent nodes lie only 25 hours apart from each other. Given an annual time endowment of 5,475 hours, this implies an hours choice set of more than 200 different options. Then, for each point in the state space, for each value of hours worked in the grid (including zero), and for the two scenarios where the father participates or not, we compute the exact value of taxes and transfers. Based on this, we compute the optimal consumption and saving choice for each combination of hours and taxes/transfers; finally, we compute the joint optimal choice for hours worked by the mother and the participation decision by the father.

Asset holdings are discretized on a 45-node grid from zero to 1.3 million dollars, with considerably more nodes placed at the lower end of the domain. In addition, we allow the optimal decision rule for saving to lie off the grid by using piecewise-linear interpolation between grid points. The labor productivity processes for both spouses and the distribution of child care needs are discretized using 9 nodes, 9 nodes and 5 nodes, respectively. The stock of human capital is approximated on a 19-node unevenly-spaced grid. Due to the discrete nature of this grid, we embed stochastic transitions between adjacent points, which are consistent with the postulated law of motion, and we choose a grid spacing that reflects this rule as accurately as possible. Note that we have experimented with increasing even further the number of points for all of these grids, and we have found our results to be unaffected. With 63 different age groups for the parents, this implies that the state space consists of $(45 \times 9 \times 9 \times 5 \times 19 \times 63) \approx 21,815,000$ grid points. On top of this, the demographic structure in our model implies that there is a certain number of different family types that we need to consider: (1) one child throughout, (2) two children with early second child, (3) two children with late second child, (4) three children. Note that for each of these family types, we have to keep track of the ages of all children until they leave the household at the age of 18. This is important, because the age mix determines the timing of new draws for child care needs, the distribution from which the draw occurs, eligibility for WIC, etc. As is standard for this class of models, we solve the life-cycle problem by backward recursion, iterating backwards through all age groups.

Distribution. The distribution of married couples is approximated as a density across the state space. We use the transition functions constructed from all exogenous processes and the optimal decision rules obtained from the solution of the Bellman equation. Given the very large dimensionality of our state space, this method is highly superior to Monte Carlo-type methods that would suffer from sampling variation.

Consumption equivalent variation. To quantify the welfare effects of our reforms, we compute a measure based on consumption equivalent units. Let V_B denote expected lifetime utility in the benchmark economy, and let V_R be expected lifetime utility under the reform. The welfare effect in consumption equivalent units, CEV, is the value that solves

$$V_B(CEV) \;=\; \mathbb{E}_t \sum_{s=t}^{T} \beta^{s-t} U\big((1+CEV)c_B^s, l_{f,B}^s, l_{m,B}^s\big) \;=\; V_R,$$

where $V_B(CEV)$ is the expected lifetime utility for a given value of CEV, and c_B^s, $l_{f,B}^s$ and $l_{m,B}^s$ are the optimal age-s policy functions for consumption and hours worked by females and males in the benchmark economy. That is, CEV measures the percentage increase in consumption at each date and in each state in the benchmark economy that would leave a couple indifferent between remaining in the benchmark and living in the reformed economy. Importantly, due to the separability assumption in our specification of the utility function, it is not possible to solve for CEV in closed form based on the value functions. Instead, we have to calculate CEV numerically by computing the left-hand side for different values of CEV until we find the value that (approximately) solves the equation above.

A.3 Labor supply elasticities

We complement our presentation of labor supply elasticities in the main text by providing model-generated estimates for total hours elasticities of mothers, and by presenting labor supply elasticities of fathers. The total hours elasticity is defined as the percentage change in total hours worked in response to a one percent change in net wages. We calculate elasticities based on positive and negative wage changes, and we differentiate between short-run and long-run elasticities.

Table A2 presents our results for mothers. The long-run total hours elasticities generally exceed the extensive-margin elasticities, but the differences are quite small. This suggests that the participation decision is quantitatively more important for mothers than the intensive-margin decision of how many hours to work. In the short run, this holds true for positive wage changes as well. For negative wage changes, the differences between the extensive-margin elasticity and the total hours elasticity is slightly more pronounced,

Table A2: Total hours elasticities of mothers

	Positive wage change		Negative wage change	
	Long run	Short run	Long run	Short run
All mothers	0.86	1.06	0.77	0.31
$y^{\dagger}$ children	1.11	1.22	0.76	0.20
$o^{\dagger}$ children	0.71	0.91	0.77	0.38
1 child	0.89	1.09	0.70	0.13
2 children	0.83	1.05	0.83	0.39
3 children	0.84	1.02	0.95	0.76

NOTES: † Here, y refers to married couples with at least one small child (between 0 and 4 years), and o refers to married couples with children who are all at least 5 years old.

suggesting that the drop in employment rates is partially offset by intensive-margin adjustments of those mothers that choose to continue working. Turning to the labor supply elasticity of fathers, the participation decision is generally much less sensitive to wage changes than for mothers (Table A3). The long-run elasticity after a positive wage change is 0.25 for fathers, compared to 0.77 for mothers. Consistent with our finding for mothers, fathers with young children are more responsive than those with older children.

Table A3: Extensive-margin labor supply elasticities of fathers

	Positive wage change		Negative wage change	
	Long run	Short run	Long run	Short run
All fathers	0.25	0.17	0.22	0.22
$y^{\dagger}$ children	0.42	0.29	0.40	0.38
$o^{\dagger}$ children	0.10	0.08	0.09	0.11
1 child	0.26	0.16	0.20	0.20
2 children	0.20	0.16	0.24	0.26
3 children	0.30	0.24	0.26	0.24

NOTES: † Here, y refers to married couples with at least one small child (between 0 and 4 years), and o refers to married couples with children who are all at least 5 years old.

Online Appendix

B Taxes, Tax Credits, and Assistance Programs

In this appendix we describe in detail the U.S. federal income tax scheme and the payroll tax, the three tax credits we include in our calculations, and three income transfer programs to support low-income families. All of these taxes and transfers are included in our model as they are being described here, with all their kinks and discontinuities.

INCOME AND PAYROLL TAXES

In our model, all married couples file with the Internal Revenue Service (IRS) using the filing status 'married filing jointly'. Income taxes are calculated based on the gross income of couples, the sum of earnings and capital income, $e + ra$. The formula for income taxes before credits reads

$$T(e, a) \;=\; \sum_{i=1}^{7} \tau_T^i \max\left\{\min\left\{e + ra - d_T, b_T^i\right\} - b_T^{i-1}, 0\right\},$$

where $b_T^i \geq 0$ denote the break points for the income brackets and τ_T^i the corresponding tax rates. For readability, we have included a seventh upper limit, which is set to an arbitrarily large number never reached by households in our model. The standard deduction d_T reduces gross income by a certain amount, independent of household size.

Payroll taxes for a married couple with earned income $e = e_m + e_f$ are given by

$$T_p(e_f, e_m) \;=\; \tau_{SS}\big(\min\left\{e_f, \overline{e}\right\} + \min\left\{e_m, \overline{e}\right\}\big) + \tau_{MC} e + \tau_{AMC} \max\left\{0, e - \tilde{e}\right\},$$

where τ_{SS} is the employee's social security, τ_{MC} the Medicare and τ_{AMC} the Additional Medicare tax rate. Social security taxes are based on individual earnings while Medicare taxes are derived from joint earnings of the couple. The payroll tax cap is denoted as $\overline{e}$. Any earnings above $\tilde{e}$ are subject to the Additional Medicare Tax. Payroll taxes do not depend on family size.

TAX CREDITS

The Earned Income Tax Credit (EITC). The EITC is a refundable tax credit that targets low-income households with children. Married couples are eligible if: (i) their investment income ra does not exceed a certain level $\overline{ra}$; and (ii) their gross income $e + ra$ is below a certain threshold $\overline{y_E^n}$, which depends on the number of dependents n.

The EITC eligibility set of a married couple with $n = 0, 1, 2, 3$ children is defined as

$$\text{EES} \;=\; \{ra \;\leq\; \overline{ra}\} \cap \{e \;+\; ra \;\leq\; \overline{y_E^n}\}.$$

A married couple with earned income e, assets a and n children receives a refundable tax credit of the following size

$$EITC(e,a,n) \;=\; \begin{cases} \pi_1^n e & \text{if} \quad 0 \leq e < \overline{e_{E_1}^n} \text{ and } a \in \text{EES}, \\ \pi_1^n \overline{e_{E_1}^n} & \text{if} \quad \overline{e_{E_1}^n} \leq e < \overline{e_{E_2}^n} \text{ and } a \in \text{EES}, \\ \max\{\pi_1^n \overline{e_{E_1}^n} - \pi_2^n (e - \overline{e_{E_2}^n}), 0\} & \text{if} \quad \overline{e_{E_2}^n} \leq e \text{ and } a \in \text{EES}, \\ 0 & \text{if } a \notin \text{EES}. \end{cases}$$

The earnings subsidy rates in the phase-in region are denoted by π_1^n, while the phase-out rates are π_2^n. The parameter $e_{E_1}^n$ denotes the end of the phase-in region, and $e_{E_2}^n$ is the beginning of the phase-out region. If income lies between those two parameters, the EITC stays constant at its maximum amount $\pi_1^n e_{E_1}^n$. While the size of the EITC depends on the number of dependent children, the investment income threshold $\overline{ra}$ is independent of household size.

The Child and Dependent Care Tax Credit (CDCTC). The CDCTC is a non-refundable tax credit. Married couples are eligible if: (i) they have at least one child below the age of 13, $n_\Gamma \geq 1$; (ii) they have expenses for child care, $\Gamma > 0$; and (iii) both parents have positive earnings, $e_f > 0, e_m > 0$. The amount of child care expenses accountable for the CDCTC, Γ_a, for a family with n_Γ children below the age of 13 is calculated as

$$\Gamma_a \;=\; \min\{\overline{\Gamma} \times \min\{n_\Gamma, 2\}, e_f, e_m, \Gamma\},$$

where $\overline{\Gamma}$ denotes maximum per-child expenses on child care accountable for the CDCTC. If a spouse has lower earnings than the family's child care costs, the lowest individual earnings are used instead of the actual expenses.

The actual tax credit is a fraction of these child care expenses Γ_a. This fraction decreases with household income and then remains constant beyond a certain income limit. The formula for the potential CDCTC, say $CDCTC_p$, reads

$$CDCTC_p(e_f, e_m, a, n_\Gamma, \Gamma) \;=\; \sum_{i=0}^{15} \mathbb{1}_{(e+ra > b_C^i \;\wedge\; e+ra \leq b_C^{i+1})} \Gamma_a u_C^{i+1},$$

where b_C^i denote the break points for the income brackets with the corresponding shares of child care costs, u_C^i, reducing the tax burden. Similar to the income tax brackets, for readability we set the value of the last break point to a large number never reached by households in our model. Since the CDCTC is a non-refundable tax credit, the actual CDCTC cannot exceed the tax liability $T(e, a)$; therefore,

$$CDCTC(e_f, e_m, a, n_\Gamma, \Gamma) = \begin{cases} CDCTC_p(e_f, e_m, a, n_\Gamma, \Gamma) & \text{if } CDCTC_p(e_f, e_m, a, n_\Gamma, \Gamma) \leq T(e, a) \\ T(e, a) & \text{if } CDCTC_p(e_f, e_m, a, n_\Gamma, \Gamma) > T(e, a). \end{cases}$$

The Child Tax Credit (CTC) and the Additional Child Tax Credit (ACTC). The CTC is a non-refundable tax credit. The ACTC is refundable, but its size depends on the CTC. The largest possible CTC for a married couple with n dependent children and gross income $e + ra$ is

$$CTC_p(e, a, n) \;=\; \begin{cases} \theta n & \text{if } e + ra \leq \overline{y_C} \\ \max\{\theta n - \rho(e + ra - \overline{y_C}), 0\} & \text{if } e + ra > \overline{y_C}, \end{cases}$$

where θ denotes the amount of CTC per child, $\overline{y_C}$ the income threshold marking the beginning of the phase-out region, and ρ is the phase-out rate. However, since this credit is non-refundable just as the CDCTC, the sum of both tax credits cannot exceed the income tax liability. Therefore, the actual CTC is calculated as

$$CTC(e, a, n, CDCTC) = \begin{cases} CTC_p(e, a, n) & \text{if } CTC_p(e, a, n) + CDCTC < T(e, a) \\ T(e, a) - CDCTC & \text{if } T(e, a) \leq CDCTC + CTC_p \wedge CDCTC < T(e, a) \\ 0 & \text{if } CDCTC \geq T(e, a). \end{cases}$$

The ACTC can only be claimed if the taxes due are smaller than the maximum amount of CTC. The ACTC is given by

$$ACTC(e, a, n, CTC, CTC_p) = \min\{\min\{n\theta_A, \max(CTC_p - CTC, 0)\}, \max\{\phi(e + ra - \overline{y_A}), 0\}\},$$

with θ_A being the maximum ACTC amount per child, $\overline{y_A}$ the income threshold below which no ACTC is paid, and ϕ the share of the difference between gross income and the income threshold that is considered for the ACTC.

INCOME ASSISTANCE PROGRAMS

Temporary Assistance for Needy Families (TANF). This program is organized at the state level to support families with dependent children. In principle, every state has its own TANF rules with varying degrees of generosity. However, many features of the programs are common across states, and our modeling of the TANF reflects an average version of state-dependent TANF rules. Married couples are eligible if: (i) they have children, $n > 0$; (ii) their assets do not exceed a certain limit $\overline{a_T}$; and (iii) net family income $\iota_T(e, a)$ is not above the payment level $\overline{T^n}$. Net family income for TANF eligibility is calculated as

$$\iota_T(e, a) \;=\; e(1 - \kappa_T) + ra,$$

where $\kappa_T < 1$ is an earned income disregard parameter. These requirements define the TANF eligibility set of a married couple as

$$TES = \{a \leq \overline{a_T}\} \cap \{\iota_T(e, a) \leq \overline{T^n}\} \cap \{n > 0\}.$$

If eligible, the income transfer is determined by the difference between the payment standard $\overline{T^n}$ and net family income $\iota_T(e, a)$. That is, an eligible married couple with dependents is entitled to TANF benefits

$$TANF(e, a, n) = \max\{\overline{T^n} - \iota_T(e, a), 0\}.$$

Note that some states also impose work requirements and time limits (usually 60 months). Work requirements typically include unpaid work experience, job search, community service programs, vocational education and many more alternatives to what we consider work in our model. The extent of enforceability of time limits varies widely across states. Therefore, we do not include any work requirements or time limits in our calculation of TANF.

Supplemental Nutrition Assistance Program (SNAP). Even though this is a federal in-kind transfer program, we follow most of the literature and treat SNAP as near-cash transfers. For a married couple with n dependents, eligibility is determined by: (i) a resource limit $\overline{a_S}$, (ii) a gross income limit $\overline{y^n_{S_1}}$, with TANF also being considered as unearned income; and (iii) a net income limit $\overline{y^n_{S_2}}$. Net income considered for SNAP is

$$\iota_S(e, a, n, \Gamma) \;=\; e(1 - \kappa_S) + ra + TANF(a, e, n) - \Gamma - d^n_S,$$

where κ_S denotes an earned income disregard parameter, and d^n_S is a deduction that depends on household size. Note that child care expenses Γ are also deducted for the calculation of net income. Combining these eligibility criteria, we end up with the following eligibility set for SNAP:

$$SES \;=\; \{a \leq \overline{a_S}\} \cap \{e + ra + TANF(a, e, n) \leq \overline{y^n_{S_1}}\} \cap \{\iota_S(e, a, n, \Gamma) \leq \overline{y^n_{S_2}}\}.$$

If a married couple receives TANF, it is categorically eligible for SNAP and the income tests are disregarded. The size of SNAP benefits is defined as a maximum allotment depending on the household size, $\overline{S^n}$, minus the household's expected contribution towards food as a share ξ of net income,

$$SNAP(e, a, n, \Gamma) \;=\; \max\{\overline{S^n} - \max(\iota_S(e, a, n, \Gamma), 0)\xi, \underline{S^n}\},$$

with $\underline{S^n}$ being the minimum benefit.

Special Supplemental Nutrition Program for Women, Infants and Children (WIC). The WIC is an in-kind transfer program, targeted to pregnant, postpartum and breastfeeding women, as well as children up to their fifth birthday who are at nutritional risk. If there is no pregnant woman or child under the age of five in the household, the household is not eligible for WIC. We will denote the number of children below the age of 5 as ns. If the married couple is eligible for SNAP or TANF, the mother and her children in the household automatically qualify for WIC. Otherwise, the family's gross income needs to be below 185 percent of the federal poverty level $\overline{y_W^n}$, which leads to the WIC eligibility set

$$WES = \{ns > 0\} \cap \left(\{TANF(e, a, n) > 0\} \cup \{SNAP(e, a, n, \Gamma) > 0\} \cup \{e + ra < \overline{y_W^n}\}\right).$$

The size of WIC benefits, in principle, depends on whether it is a pregnant, breastfeeding or postpartum woman, the infant of a postpartum or breastfeeding woman or a child who receives WIC. For simplicity, we calculate the mean value of WIC a family receives per child, assuming that it receives WIC during all the child's first five years of life. Then the amount of WIC received when eligible is simply a lump-sum transfer

$$WIC(e, a, ns, TANF, SNAP) = W^{ns},$$

where the benefit W^{ns} depends on the number of children below 5.

C Tax-Transfer Parameter Values

This appendix presents the parameter values of the 2018 federal income tax schedule, payroll taxes and the six transfer programs in our model (the Earned Income Tax Credit, the Child and Dependent Care Tax Credit, the Child Tax Credit and the Additional Child Tax Credit, Temporary Assistance for Needy Families, the Supplemental Nutrition Assistance Program and the Special Supplemental Nutrition Program for Women, Infants and Children).

Income and Payroll Taxes

Table C1 presents the income tax brackets for filers under the married filing jointly status.

Table C1: Income Tax Brackets

Bracket	Parameter	Married filing jointly
1	b_T^0	0
2	b_T^1	19,050
3	b_T^2	77,400
4	b_T^3	165,000
5	b_T^4	315,000
6	b_T^5	400,000
7	b_T^6	600,000

NOTES: Income tax brackets in 2018, from IRS website.

Table C2 shows the remaining parameter values for income and payroll taxes.

Table C2: Income and Payroll Tax Rates

Description	Comment	Parameter	Value
Standard deduction (in $)	Married filing jointly	d_T	24,000
Marginal tax rate	Bracket 1	τ_T^1	0.10
Marginal tax rate	Bracket 2	τ_T^2	0.12
Marginal tax rate	Bracket 3	τ_T^3	0.22
Marginal tax rate	Bracket 4	τ_T^4	0.24
Marginal tax rate	Bracket 5	τ_T^5	0.32
Marginal tax rate	Bracket 6	τ_T^6	0.35
Marginal tax rate	Bracket 7	τ_T^7	0.37
Social Security tax	Employee's share	τ_{SS}	0.0620
Social Security Cap (in $)	Earnings cap	$\bar{e}$	128,400
Medicare Tax	Employee's share	τ_{MC}	0.0145
Additional Medicare Tax		τ_{AMC}	0.0090
Additional Medicare Cap (in $)	Earnings cap	$\tilde{e}$	250,000

NOTES: Parameter values for 2018, from IRS website.

Earned Income Tax Credit (EITC)

Table C3 presents the limits for investment and total income to be eligible for the EITC for married couples filing jointly with 0 to 3 children.

Table C3: Earned Income Tax Credit: Income Limits

	Max. investment income $\overline{ra}$	Max. total income $\overline{y_E^n}$
Married couple without children	3,500	20,950
Married couple with 1 child	3,500	46,010
Married couple with 2 children	3,500	51,492
Married couple with 3 children	3,500	54,884

NOTES: Parameter values for 2018, from IRS website.

Table C4 reports the phase-in and phase-out rates and the plateau region.

Table C4: Earned Income Tax Credit: Subsidy Rates and Earnings Thresholds

	Phase-in rate π_1^n(%)	Earnings end phase-in $\overline{e_{E_1}^n}$($)	Earnings beginning phase-out $\overline{e_{E_2}^n}$($)	Phase-out rate π_2^n (%)
Married couples				
with n = 0	7.65	6,750	14,200	7.65
with n = 1	34	10,150	24,350	15.98
with n = 2	40	14,250	24,350	21.06
with n = 3	45	14,250	24,350	21.06

NOTES: Parameter values for 2018, from IRS website.

Child and Dependent Care Tax Credit (CDCTC)

Table C5 presents the maximum expenses accountable for the CDCTC, the income brackets, and the corresponding fractions of expenses that can be claimed as tax credit.

Table C5: Child and Dependent Care Tax Credit

Desciption	Parameter	Value
Maximum expenses for child care (in $)	$\bar{\Gamma}$	3,000
Income limits (in thousand $)	$(b_C^0, b_C^1, b_C^2, b_C^3)$	(0,15,17,19)
Income limits (in thousand $)	$(b_C^4, b_C^5, b_C^6, b_C^7)$	(21,23,25,27)
Income limits (in thousand $)	$(b_C^8, b_C^9, b_C^{10}, b_C^{11})$	(29,31,33,35)
Income limits (in thousand $)	$(b_C^{12}, b_C^{13}, b_C^{14}, b_C^{15})$	(37,39,41,43)
Fraction of child care deducted	$(u_C^1, u_C^2, u_C^3, u_C^4)$	(0.35,0.34,0.33,0.32)
Fraction of child care deducted	$(u_C^5, u_C^6, u_C^7, u_C^8)$	(,0.31,0.30,0.29,0.28)
Fraction of child care deducted	$(u_C^9, u_C^{10}, u_C^{11}, u_C^{12})$	(0.27,0.26,0.25,0.24)
Fraction of child care deducted	$(u_C^{13}, u_C^{14}, u_C^{15}, u_C^{16})$	(0.23,0.22,0.21,0.20)

NOTES: Parameter values for 2018, from IRS website.

Child Tax Credit (CTC) and Additional Child Tax Credit (ACTC)

Table C6 shows the parameter values needed to determine the CTC and ACTC.

Table C6: Child Tax Credit and Additional Child Tax Credit

Description	Parameter	Value
Credit per child (in \$)	θ	2,000
Phrase-out income threshold (in \$)	$\overline{y_C}$	400,000
Phase-out rate (in %)	ρ	5
Refundable per child (ACTC) (in \$)	θ_A	1,400
Earnings limit (ACTC) (in \$)	$\overline{y_A}$	2,500
Weight on earnings gap (ACTC)	ϕ	0.15

NOTES: Parameter values for 2018, from IRS website.

Temporary Assistance for Needy Families (TANF)

In Table C7 we present the parameters used to calculate TANF eligibility and size.

Table C7: Temporary Assistance for Needy Families

Description	Parameter	3 Persons	4 Persons	5 Persons
Payment standard	$\overline{T^n}$	432	474	555
Asset test	$\overline{a_T}$	2,250	2,250	2,250
Earned income disregard	κ_T	0.75	0.75	0.75

NOTES: Parameter values reflect a customized TANF, taking representative values from the Welfare Rules Databook: State TANF Policies based on 2018 data.

Supplemental Nutrition Assistance Program (SNAP)

Table C8 shows the parameters needed for determining eligibility and size of SNAP.

Table C8: Supplemental Nutrition Assistance Program

Description	Parameter	2 Pers.	3 Pers.	4 Pers.	5 Pers.
Asset test (in \$)	$\overline{a_S}$	2,250	2,250	2,250	2,250
Gross income test (in \$)	$\overline{y^n_{S_1}}$	1,760	2,213	2,665	3,118
Net income test (\$)	$\overline{y^n_{S_2}}$	1,354	1,702	2,050	2,399
Standard deduction (in \$)	d^n_S	160	160	170	199
Earned income disregard	κ_S	0.2	0.2	0.2	0.2
Maximum allotment (in \$)	$\overline{S^n}$	352	504	640	760
Income share spent on food	ξ	0.3	0.3	0.3	0.3
Minimum benefit	$\underline{S^n}$	15	0	0	0

NOTES: Parameter values from the website of the U.S. Department of Agriculture, Food and Nutrition Service, for the time period October 2017 - September 2018.

Special Supplemental Nutrition Program for Women, Infants and Children (WIC)

Table C9 presents the distribution of participants and the food package costs for each group. Table C10 shows the income thresholds and the benefits calculated from the data in Table C9.

Table C9: Special Suppl. Nutrition Program for Women, Infants and Children

Participant Category	Percent of Participants	Pre-Rebate Food Package Cost ($)	Post-Rebate Food Package Cost ($)
Total Participants	100.0	57.60	35.79
Pregnant women	9.4	37.33	37.33
Breastfeeding women	8.2	37.76	37.76
Postpartum women	7.0	30.72	30.72
Infants	23.3	138.64	44.97
Children	52.1	31.78	31.78

NOTES: Parameter values from the WIC Participant and Program Characteristics 2018 Food Packages and Costs Final Report of the U.S Department of Agriculture, Food and Nutrition Service (monthly values).

Table C10: Special Suppl. Nutrition Program for Women, Infants and Children

Description	Parameter	One child below 5	Two children below 5
Income threshold	$\overline{y_W^n}$	38443	46435
Monthly benefits	W^{ns}	62	124

NOTES: Parameter values from the WIC Participant and Program Characteristics 2018 Food Packages and Costs Final Report of the U.S Department of Agriculture, Food and Nutrition Service (monthly values).