Does the Earned Income Tax Credit Help Single Women Climb the Wage Ladder?*

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Abstract: In order to understand the impact of the EITC on life-cycle wage paths of single women, I build and estimate a dynamic labor supply model that takes into account human capital accumulation, borrowing constraints and unobserved heterogeneity in skills and preferences. In the model, the EITC has an impact on women's decisions through two main channels. First, it alters the rewards from work by shifting the per-period budget constraint. This in turn causes the women to make different hours of work and saving decisions. Second, through the change in the experience stock, the EITC also alters future rewards from work. This channel leads to a further change in the current hours of work and saving decisions of women. The results indicate that EITC is effective in promoting wage growth for single women over the life-cycle. Further analysis reveals that the change in the experience stock, rather than the immediate effect of the EITC on the per-period budget constraint, plays the prominent role in generating wage growth. Moreover, the change in net worth as a result of the tax credit indicates that EITC provides debt relief for women with negative net worth while it leads to an increase in the consumption expenditures for those with positive net worth. Using the estimated model, I conduct three distinct counterfactual experiments. First, I analyze the impact of imposing an asset test with a value that is similar to the asset limits in other federal cash transfer programs for low-income individuals. Second, I examine how single women without children respond to the adjustments in the credit schedule that are proposed by President Obama. Finally, I evaluate alternative designs for the EITC, such as different cutoffs for the payment regions or different subsidy amounts, with respect to their effectiveness in promoting wage growth.

Keywords: EITC, Female Labor Supply, Dynamic Structural Models.
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1 Introduction

Earned Income Tax Credit (EITC), the dominant tax-based cash assistance program in the U.S., is commonly credited for causing taxpayers to choose work over welfare dependency. This pro-work effect is found to be more pronounced particularly for single women with children[1], as several studies find EITC expansions to be the prime reason why employment rose among single women with children during the 1990s (Eissa and Liebman, 1996; Meyer and Rosenbaum, 2001). However, without promoting wage growth in the long run, EITC can create dependency on another form of government transfer - tax-credits. A key question to ask, then, is: What is the impact of the EITC on wage growth?

The objective of this paper is to take a first step at evaluating whether the EITC helps single women climb the wage ladder. To provide an answer to whether the EITC promotes wage growth, I first develop and estimate a dynamic labor supply model. I then use the estimated model to simulate life-cycle labor supply, employment, wage and net asset paths of women with and without the tax credit. This allows me to assess the impact of the EITC on wage growth by comparing the magnitude of the dynamic, long-term effects of the EITC to its immediate impact through easing the budget constraint on the life-cycle profiles of single women. Next, I conduct three distinct counterfactual experiments. First, I consider the consequences of an expansion in the credit schedule for childless workers as proposed by President Obama. Second, I assess the significance of imposing an assets test with a value similar to the asset limits in other federal cash transfer programs for low-income individuals. Finally, I evaluate whether it is possible strengthen the impact of the EITC on wage growth by altering the parameters of the credit schedule such as the cutoffs for payment regions or the amount of the subsidy.

The analysis in this paper is based on the estimation of a life-cycle labor supply model in which forward-looking single women make joint work and saving (or borrowing) decisions. Specifically, starting from the year they complete education and enter the labor market, single women decide on annual hours of work and the level of net savings under borrowing constraints. Based on these decisions, the amount of the EITC a woman receives is determined as the level of the tax credit depends on her labor market earnings in the previous year. In the model, I also allow for participation in other government transfer programs such as the Temporary Assistance to Needy Families (TANF) and Supplemental Nutrition Assistance Program (SNAP). I do not model participation in these programs as endogenous decisions, rather I specify the probability of receiving any benefit as exogenous stochastic processes that depend on women's observable characteristics. The model also takes into

[1] The EITC did not offer any credit to childless women until 1994.

account any changes in the family composition over the life cycle, in the form of arrival and departure of a child. In addition, by incorporating observed and unobserved heterogeneity in skills and preferences, I try to match the rich dynamics that are observed in the data.

The theoretical and empirical framework in this paper focuses on three dynamic mechanisms that have significant impact on the wage growth of single women. The first one is human capital accumulation[2] which is exploited by several studies in the literature, e.g., Eckstein and Wolpin (1989); Van der Klaauw (1996); Altuğ and Miller (1998); Francesconi (2002); Keane and Wolpin (2010); Keane et al. (2011). Human capital accumulation creates a link between the work choice and future wages. In particular, a woman's work choice adds to the stock of work experience, which in turn affects future wages and thus, future work choices. This feature of the model creates an 'investment return' to the current choice of work hours. Second, the model imposes borrowing constraints by setting a lower bound on the level of assets that depends on women's characteristics such as age and educational attainment, similar to Keane and Wolpin (2001). By limiting the extent to which women can transfer resources across periods, this borrowing constraint alters the work choices of women, and thus modifies the wage growth path as well as human capital accumulation over the life cycle. Nevertheless, the existence of borrowing constraints does not eliminate the consumption smoothing motives created by a positively sloped age-earnings profile over the life cycle. Finally, the credit schedule of the EITC creates one other dynamic channel. The amount of tax credit, determined by annual earnings, is received in the following year as a tax refund. Therefore, the current work choice of a woman can alter her monetary resources for the following period through the level of tax credit she receives. By easing the budget constraint, the tax credit creates an additional channel through which current work hours affect future labor supply decisions.

My analysis focuses on single women for three main reasons. First and foremost, single women form the prime population for tax-based cash assistance along with welfare programs as they are generally characterized with low levels of education, low income and high poverty (see Blundell et al. (2013)). Furthermore, as Gladden and Taber (2000) point out, learning-by-doing or human capital accumulation is crucial for workers with low income and low levels of education since wage growth differences between the low and moderately skilled workers stem mainly from differences in the level of work experience. Since any change in the work experience would be translated into a different path of wage growth, low-income women form the prime group to evaluate whether a tax-credit helps climbing the wage-ladder. Finally, I

[2]In this paper, when I use the term human capital accumulation I refer to experience accumulation. Moreover, the fact that higher experience leads to wage growth does not necessarily imply skill formation. Experience in the labor market is valuable because it may convey information on a worker's unobserved characteristics such as punctuality, reliability or motivation.

restrict my analysis to single women as they lack the safety net created by spousal earnings. This implies that external factors such as household bargaining or spousal preferences over women's leisure do not affect the labor supply decisions made by single women.

For the empirical analysis, I use data from the Panel Study of Income Dynamics (PSID). This data set is well suited for the analysis for two main reasons. First, it collects detailed information on annual hours of work, annual earnings, the level of education, number of children, cost of childcare, participation in welfare programs as well as on the assets and debt of single women. Moreover, the PSID provides data over a significantly long time frame, contrary to other similar data sets such as the Survey of Income and Program Participation (SIPP). One drawback of PSID, however, is that it doesn't present any information on the level of the EITC individuals receive. I resolve this issue by calculating the amount of credit each woman receives using the actual policy parameters set by the federal and the state governments, depending on annual earnings and size of the family.[3]

I estimate the parameters of the model using a two-step method. In the first step, I estimate the parameters of the exogenous processes in the model, such as child care costs, participation in other government programs and the change in family composition. In the second step, I estimate the remaining parameters using method of simulated moments (MSM). Specifically, I simulate a data set using the parameters from the model, and I match the moments from the simulated data to the moments from the observed data. The choice of the estimation method is dictated mainly by the data structure provided by the PSID. Although PSID gives detailed information on the variables that are key to the model, it only does so at a few points in time. Furthermore, it doesn't give information on women's work experience stocks[4] as developed in the model. As a result, by using a simulation-based estimation approach, I am able to fill the gaps in the data on assets and work experience. The identification of the impact of the EITC comes from the variation in the policy parameters across time and states.

The results of the estimation display significant returns to experience for low-income single women. In particular, a one percent increase in the experience stock constructed based on annual work hours, leads to a 0.22% increase in the wage rate of a woman. The parameter estimates from the wage equation further highlight the importance the detrimental effect of career breaks on women's life-cycle earnings. In particular, a woman who worked full-time in the previous year earns an average wage almost 6.7% higher than a woman who took a

[3] With this calculation I am assuming every EITC eligible individual claims tax credit. Given that the EITC participation rates vary between 80-86% (Scholz (1994)) implies that this assumption is reasonable.

[4] I construct a woman's experience stock as the total hours of work she has worked since she entered the labor market. Because the PSID switched to biennial interviewing, I cannot observe the experience stock of some women from the data.

career break in the previous period. Using the parameter estimates from the model, I then assess the impact of the EITC on labor supply, wage and net worth paths of single women over the life cycle. Using the 2002 schedule for the tax credit, I show that employment rate increases by 4 percentage points as a result of the EITC. Moreover, I find that the EITC generates significant intensive-margin responses[5], contrary to what previous literature has argued, once the dynamic effects of the EITC are taken into consideration. This result is in line with the findings of Imai and Keane (2004); Keane (2009, 2011); Keane and Rogerson (2012) which argue intensive-margin responses might be underestimated if human capital accumulation is not explicitly taken into account. Furthermore, I show that as a result of the labor supply responses to the tax credit, the average wage rate of a single women increase by 5% as a result of the EITC. Further analysis proves that this increase in the wages is actually generated by the additional human capital accumulation created by the tax credit. I then consider the heterogeneity in the responses to the EITC and find that high school dropouts along with women who have two or more children are the two groups that benefit the most from the tax credit. Additionally, I show that receiving the tax credit early in the life cycle generates a higher wage growth.

The counterfactual experiments in the paper analyze adjustments to the design of the credit schedule for the EITC. Specifically, I first consider an expansion of the tax credit received by childless women as recently proposed by President Obama[6]. The results show that the expansion is successful in generating an increase in the employment rate and average wages without disincentivizing work hours and savings. Next, I investigate the impact of introduction of an asset limit as part of the eligibility requirements for the tax credit. Such asset limits exist in major public benefit programs, e.g., Temporary Assistance to Needy Families (TANF), Supplemental Nutrition Assistance Program (SNAP), and Supplemental Security Income (SSI). The results show that this additional restriction for eligibility might inhibit single women's ability to move along the path to financial security and self-sufficiency. Specifically, the asset test causes significant declines in the employment rate and the average net worth compared to their values under the current EITC schedule. The decline in net assets is especially disturbing as the sample in consideration consists of single women who lack the safety net provided by spousal earnings. This result also implies that an asset test possibly makes these women more vulnerable to the labor market shocks they may face, by eliminating the protection created by their asset stocks. This finding on the detrimental impact of an asset test may provide insight to the recent discussions in the policy circles[7]

[5]Intensive-margin responses refer to the change in hours of work conditional on employment. Extensive-margin responses, on the other hand, refer to the change in the employment decisions.

[6]See www.whitehouse.gov/sites/default/files/docs/eitc_report.pdf

[7]For example, see http://goo.gl/Fgs3fc or http://goo.gl/KZtt9b.

that argue imposing asset limits as a requirement for eligibility might be hindering the effectiveness of government cash-transfer programs.

The rest of the paper is organized as follows. Section 2 presents the literature this paper contributes to and Section 3 explains the details on the credit schedule as well as the eligibility requirements of the EITC. Section 4 describes the sample used in the empirical analysis and displays some key facts from the data. In Section 5, I introduce the life-cycle labor supply model developed in this paper and discuss the solution method. Section 6 presents the empirical analysis by describing the estimation method, identification arguments and then, by interpreting the parameter estimates. In Section 7, I explore the impact of the EITC on the extensive and intensive margin responses along with wage growth and net asset accumulation. Section 8 looks at policy experiments in which the credit is expanded for childless women and the eligibility for the tax credit requires an asset test in addition to the requirements concerning labor market earnings. Section 9 concludes.

2 Related Literature

There is a large literature on the static labor supply effects of the EITC. Blundell (2006); Eissa and Hoynes (2006, 2011); Hotz and Scholz (2003); Hoynes (2009); Liebman (1998) are a few examples of excellent surveys that provide vast evidence on how EITC payments increase the labor force participation in the population. Nevertheless, comparatively little research has connected life-cycle decisions and EITC payments[8]. One notable exception comes from Heckman et al. (2002), who study the potential effects of wage subsidies on skill formulation by comparing on-the-job training models with learning-by-doing models and argue that the learning-by-doing models, which are favored by provisional evidence, indicate that wage subsidies promote skill formation. Even though the paper does not take into account the potential endogenous labor market entry effects of the EITC, it quantifies the change in the average human capital stock of single women with low levels of education. The results show that EITC may reduced the long-term wages, even though the skill levels do not decline. Blank (2012), is an other example that constructs a dynamic-discrete choice model of employment and welfare participation, and estimates it using a sample of single women from PSID. Without taking into account the saving or borrowing decisions or heterogeneity in skills or preferences, she finds that the EITC only leads to an increase in part-time employment.

[8]Ben-Shalom et al. (2011); Hotz and Scholz (2003) both consider the dynamic impact of EITC payments in the form of human capital accumulation and they argue that EITC should theoretically decrease the returns to human capital accumulation in the phase-out region by taxing both current and future income, whereas it should have an opposite effect in the subsidy region. Neither of these papers provides any empirical analysis.

However, the paper does not explicitly consider the effect of the tax credit on life-cycle wage paths of individuals. The most recent study on this topic is by Athreya et al. (2014). In a setting where wages are exogenous, they find that the EITC reduces consumption volatility along with an increase in the labor supply of unskilled single mothers, especially at the extensive margin. In sum, to the best of my knowledge, none of the papers in the literature considers the impact of the EITC on life-cycle wage paths of women through the changes in their optimal behavior concerning employment, hours of work and saving/borrowing.

One other related literature this paper contributes to studies the dynamic structural links created by welfare or earnings subsidy programs that are similar to the EITC. One example is the seminal paper by Miller and Sanders (1997) that estimates a dynamic model to conduct an empirical analysis on how AFDC affects the educational attainment and subsequent labor market performance of young women. Their results show that negative duration dependence in welfare overwhelms the human capital effect. A more recent example is a paper by Blundell et al. (2013), which sets up a dynamic model of education, labor supply and saving decisions of women in order to understand the ramifications of the reform on Working Families Tax Credit, the dominant earnings subsidy program in UK. In particular, they consider the insurance value created by the tax credit and analyze whether women with different levels of educational attainment prefer increases in income support or tax cuts that are equally costly.

Finally, this paper contributes to the literature on structural estimation of dynamic models of female labor supply. A number of studies emphasized the link between women's labor force participation and human capital accumulation, often examining how marriage, fertility and participation interact (Keane et al., 2011). Examples include Eckstein and Wolpin (1989); Van der Klaauw (1996); Altuğ and Miller (1998); Francesconi (2002); Keane and Wolpin (2010). However, almost all papers in the literature ignore the saving or borrowing decisions of women. Blundell et al. (2013) is one exception, though they only allow for borrowing for the schooling investment. To the best of my knowledge, this paper is the first to develop and estimate a dynamic female labor supply model that incorporates the saving and borrowing decisions of women along with the effect of credit constraints.

3 Institutional Background

EITC, which was enacted in 1975 primarily as a temporary credit to offset Social Security taxes, is a refundable tax credit for low-income individuals. Congress made the credit permanent in 1978 and repeatedly increased its value until 1987. After that, EITC has undergone three major expansions; with the Tax Reform Act (TRA) of 1986, the Omnibus Reconciliation Act (OBRA) of 1990 and with OBRA of 1993. OBRA 1993 was the largest among these expansions as it almost doubled the payments to eligible individuals along with sharply increasing the benefits to families with two or more children (Eissa and Hoynes, 2006).

3.1 Eligibility

In order to claim EITC, an individual must file an annual income tax return. Among the individuals who file their tax returns, those who have a Social Security number and who are U.S. citizens or resident aliens all year or are married to U.S. citizens or resident aliens are considered for the tax credit. Furthermore, before 1994 a taxpayer had to have a "qualifying child" subject to certain age, relationship and residency tests in order to be eligible. Since 1994, childless adults may also claim EITC, as long as they are older than 25. Finally, EITC has special rules for members of the military, ministers, members of the clergy and those receiving disability benefits[9].

EITC is a means-tested cash transfer program and thus, the most important eligibility rule for the program is concerned with labor market earnings of individuals. In particular, individuals or families must have positive earnings in order to be eligible. The labor market earnings is formally defined as "the sum of wage, salary and self-employment income" by the IRS[10]. The restriction of positive earned income implies that at least one individual in a family must be working in order to claim EITC. One other condition for receiving the tax credit is to have earned income and adjusted gross income (AGI)[11] less than the EITC limit which varies by the number of children and marital status for certain years. Although EITC did not include an asset test originally, starting with 1996 limitations on investment income came into effect. In terms of tax credit purposes, the definition of investment or asset income includes earned interest, dividends, capital gains, royalties and rent from personal property, and returns from passive activities such as business pursuits in which the person is not actively involved[12]. Specifically, the investment income limit was $2,350 for the first year it came into effect while it increased slightly to $2,800 in 2006.

[9]http://goo.gl/Q4JJCe

[10]http://www.irs.gov/Individuals/What-is-Earned-Income%3F

[11]AGI is an individual's total gross income minus allowances for personal exemptions and itemized deductions.

[12]http://www.cbo.gov/budget-options/2013/44810

3.2 The Credit Schedule

There are three important factors that define the credit schedule for the EITC. First and foremost, the credit schedule depends on earned income. Specifically, the schedule consists of three regions: subsidy (phase-in), flat (plateau) and phase-out. At the lowest level of earnings, or in the subsidy region, EITC benefit equals to a fixed percentage of earnings and an individual with a level of earnings that is equal to the subsidy region threshold receives the maximum credit. Taxpayers with earnings above the subsidy region threshold continue receiving the maximum credit for a small interval of earnings. However, once the level of earnings reaches the flat region threshold, EITC benefits are taxed away at the phase-out rate. Therefore, the subsidy rate, phase-out rate, and two earnings thresholds, which determine the end of the subsidy and the flat regions, define the credit schedule. Table 1 presents the credit schedule for the tax year 2013. In the table, credit rate represents the subsidy rate and the minimum income for maximum credit represents the threshold that defines the end of the subsidy region.

Second, as can be seen from Table 1, there are separate credit schedules for different family sizes. In particular, the credit rate and the phase-out rate increase with the number of children. However, the increase in the phase-out rate is much lower than the increase in the credit rate. Moreover, the maximum credit varies significantly with the number of children. As an example, while the maximum credit is \$487 for taxpayers with no child, it increases to \$6,044 for taxpayers with three or more children. The eligibility range for earnings is also considerably larger for families with more children. Since more generous payments are offered to taxpayers with more children, EITC is generally considered as a pro-natal policy. On the other hand, the EITC has been criticized for imposing substantial marriage penalties as single and married individuals faced the same earnings thresholds until 2002. This means that, if a single parent receiving the EITC got married before 2002, the addition of the spouse's earnings may have reduced or eliminated the credit, even though the spouse was also eligible for the credit. To address this issue, the Economic Growth and Tax Relief Reconciliation Act of 2001 raised the level of beginning income for the phase-out region for couples to \$3,000 above the level of beginning income for single individuals. Moreover, the American Recovery and Reinvestment Act of 2009 (ARRA) has increased that amount to \$5,000 in 2009 and indexed the threshold to inflation.

Finally, the EITC is defined as a refundable transfer program, which means that if the credit exceeds a taxpayer's income tax liability, the excess amount is paid as a tax refund. This refundable portion on the EITC is usually referred to as the outlay component. Eissa and Hoynes (2006) show that the outlay component of the EITC amounts to a significant portion of the total payments. In particular, in 2004 $35 billion out of a total cost of $40 billion was due to the outlay component. This fact is crucial for the analysis in this paper as I focus on the outlay component of the EITC in the empirical analysis and assume the tax credit payments determined by labor market earnings are received as a tax refund in the following year.

3.3 State-level EITC Programs

Starting in late 1980s, states began to enact their own EITC schedules as add-in programs to the federal EITC. The first state to approve an EITC program as a supplement to the federal EITC was Maryland in 1987. These state EITC rules are usually simpler than the federal schedule as they are mostly defined as a fixed percentage of the federal EITC. As an example, for the tax year 2001 the EITC rate in Maryland was 16%, which implied that Maryland residents were to receive an additional supplement that amounted to 16% of the federal EITC.

State EITC rates vary a lot across years and across states. In 1996, the only states that provided EITC supplements were Iowa, Maryland, Minnesota, New York, Rhode Island, Vermont and Wisconsin. However, as of 2013 the number of states with EITC programs increased to 22. Moreover, the generosity of these programs range from 3.5% in Louisiana to 40% in the District of Columbia for the tax year 2013. Another difference in the state-level EITC schedules across states comes from the refundability of the benefits. Although most of the states that provide EITC supplements offer refundable benefits, there are still some states such as Delaware, Maine and Virginia with a non-refundable benefit system. In these states, EITC supplements act only to decrease the state tax liability of individuals and families.

4 Data

I utilize the Panel Study of Income Dynamics (PSID) to create the sample I use in the empirical analysis. The PSID is a longitudinal study that began in 1968 with a core nationally representative sample called the Survey Research Center (SRC) sample, and an oversample that mainly represents low-income and black families, called the Survey of Economic Opportunity (SEO) sample. The PSID added an additional Latino sample in 1990 but dropped the individuals in this sample after 1995, due to missing out on the full range of post-1968 immigrants. Still, in order to continue its nationally representative sample, the PSID included a sample of post-1968 immigrants after 1997.

Until 1997, the PSID collected annual data on demographic characteristics, labor market earnings, annual work hours, childcare expenditures, receipts from welfare and other government programs every year. However, after 1997 PSID switched to biennial interviewing due to insufficient funding which makes tracking individuals' labor market histories harder[13]. In the analysis, I use PSID waves from 1993 to 2007, which provide demographic information for the years between 1993 and 2007. However the labor market information obtained from these waves refer to the years 1992-2006. Furthermore, I include both the SRC and the SEO samples in order to create a sample of low-income individuals. I drop the observations that belong to the Latino and the immigrant samples due to two main factors. First, these samples do not represent the full range of post-1968 immigrants. Secondly, the PSID stopped interviewing the majority of the individuals that belong to these samples after 1995 due to insufficient funding. Information on demographic characteristics, labor market status, earnings, annual work hours, childcare costs along with welfare and food stamp benefits come from the individual and family files of the PSID. Making use of the Supplemental Wealth Files the PSID provides, I construct net asset[14] profiles. The PSID collected wealth information every 5 years until 1999, and every 2 years after that. In construction my net asset measure, I use the wealth files from 1994,1999, 2001, 2003, and 2005. The asset information provided by the PSID is very comprehensive as it includes the values of real estates, farms or businesses, vehicles, stocks, mutual funds, bonds, and liquid assets. The wealth files also specify the value of home equity and other debts.

I restrict the sample I use for the empirical analysis to single women who are classified as never married for the years I observe them in the data. Moreover, I include observations for a given woman only if she is between ages 16 and 70, is not self-employed, has valid data on education, race, state of residence, number of children, annual work hours and labor market earnings. I also exclude observations from women who change their state of residence as well as women who are students, who are in the military, who are retired or disabled. Finally, I drop the observations of women who are interviewed only once during the years 1992 to 2006. The remaining sample consists of 1,407 women with 7,090 observations over 15 years[15]. Out of these 1,407 women, 50% are observed for at most 8 years and 21% over the whole period. For this sample of women, I use information on age, years of education, state of residence, number of children, age of youngest child, annual earnings[16], annual work hours,

[13]PSID continues to collect data on Supplemental Nutrition Assistance Program benefits for each year, even after switching to biennial interviewing.

[14]Throughout the paper, I use the term net assets to refer to the net worth of individuals. Net worth or net assets is defined as assets minus the liabilities an individual has.

[15]Out of these 7,090 observations I observe labor market information such as earnings or annual work hours for 4,593 and the value of assets for 2,573 observations

[16]All monetary variables are adjusted to 2006 dollars.

child care expenditures, welfare benefits, food stamp benefits and net worth. Although the PSID does not provide information on the amount EITC benefits a woman is entitled to, I use federal and state EITC policy rules to calculate the annual tax credit a woman receives[17]. Furthermore, in order to remove the effect of outliers, I censor earnings, annual work hours, child care expenditures and net worth at the top and bottom 5 percentiles for each wave of the data I'm using. Finally, in constructing the net worth measure I use in the rest of the paper, I exclude the value of home equity. The reasons for excluding the value of home equity are twofold. First, in the data only 102 observations have a value of home equity different from 0. Second, these 102 observations form a considerably wide range of home equity values, from $-121,000 to $143,000. One explanation for this observation might be the housing bubble that emerged around 2001.

Table 2 provides summary statistics for the sample. As can be seen from the table, women are on average around 33 years old and mostly black. The fraction of black women in the sample is high due to including observations from the SEO sample that overrepresents blacks. In terms of the level of education, the sample consists mainly of high school graduates. On average, these women have one child and the age of youngest child is around 3 years old[18]. The fact that women on average have only one or no child might be the result of having a young sample of women. As for the labor market status, more than 85% of the women in this sample are employed and these women who are employed, on average, work a little less than full-time. Full-time jobs usually necessitate working 8 hours a week and 50 weeks a year, which add up to around 2,000 work hours per year. Since the women in this sample work around 1,800 hours on average, the average working hours is less than the hours a full time job necessitates. Furthermore, this sample can be described as consisting of low-income women as the annual earnings of the average woman is a little more than $25,000. Due to the low levels of labor market earnings, 38% of the total observations fall in the eligibility range of the EITC based on labor market earnings. More specifically, the average federal ETIC received is about $1,900 while the maximum credit can be as high as $4,645. The average of the state EITC, however, is very low mostly even among the women who are eligible for the EITC mostly because only a few states offered state EITC programs until the early 2000s. The fraction of TANF and SNAP recipients in the sample is significantly lower than the fraction of EITC recipients. However, even though the fraction of TANF and

[17]I am not using information on asset income from the PSID. This is mainly because the asset income information is not consistent with the asset levels reported in the Supplemental Wealth Files. In addition, since the asset information is provided only for 5 years out of the whole observation period, I cannot impose the asset income restrictions to the data while calculating the EITC amount each woman receives.

[18]The number of children is capped at 2 as for tax credit purposes having more than 2 children is not different from having 2 children. Imposing this restriction decreases the average number of children from 1.01 to 0.88 in the sample.

SNAP recipients are low, the average benefits for the eligible women are considerably higher than the average benefits the EITC provides. The final key variable for the analysis is net worth, which is defined as the value of checking accounts, stocks, and vehicles less any debt. The most striking aspect of net worth in the sample is its wide range, from around -$33,032 to $72,133. Still, even though some women have high levels of net worth, the average in the sample is only $3,249. Moreover, 26% of the sample has negative net worth, while 20% has zero and 54% has positive net worth. The distribution of the net worth in the sample is displayed in Figure 2.

Since the sample in consideration consists of low-income women, the age-earnings profile is flatter than the education-earnings profile. The top panel in Table 3 presents how average earnings and annual work hours vary across age groups. As expected, average annual earnings increase with age even though the increase is not significant. Moreover, earnings rise with age, even though older women tend to work fewer hours annually. In particular, the women in the sample work the most between ages 25 and 30. Since the average earnings of older women are higher even though they are working less, it can be inferred that the wage rate increases as women get older. With respect to the tax credit, the table shows that more than 40% of the women who are younger than 40 receive EITC. The percentage of EITC recipients is slightly lower for women who are younger than 25, mainly because of the eligibility rule that states childless individuals can receive EITC only if they are 25 years old or older. Since the average level of earnings rise as women age, it is not surprising to see that the EITC recipiency rate declines with age. Furthermore, this trend in the percentage of EITC recipients across age groups is reflected in the average EITC payments. For this reason, the average amount of tax credit is the highest for the women who are aged between 25 and 30.

The bottom panel of Table 3 displays the trends for average earnings, work hours and EITC receipts across education groups. Most significantly, average earnings increase with the level of educational attainment of women. Furthermore, more educated women work for considerably more hours than less educated women. These two observations lead to a steep decline in the EITC recipiency rates as women get more educated. Furthermore, not only the fraction but also the average tax credit the eligible women receive declines as the education level of the women gets higher.

In order to understand the group of women who receive the EITC a little better, Table 4 provides information on the age, education and annual work hours of EITC recipients. According to the table, half of the recipients are above age 30, while most of them are between ages 30 and 40. As for education, almost half of the women who receive the tax credit are high school graduates. Interestingly, high school dropouts are less likely to receive the tax credit than high school graduates in the sample. Further analysis of the data reveals that this is because high school dropouts are less likely to work than the high school graduates. Finally, the last column of the table shows how much EITC recipients work annually. Since EITC recipients have low labor market earnings, one might think that they also have short working hours. However contrary to this belief, the table provides evidence that in fact more than 65% of the women who receive the EITC work either full time or have more than one part time job. Note that, a part time job requires about 1,000 annual work hours while a full time job requires about 2,000 annual work hours. With these definitions, the last column of the table reveals that the majority of EITC recipients work more than 1,300 hours. In order to have more than 1,300 annual work hours, these women must either work full-time or have more than one part-time job. The fact that these women have long working hours but low earnings leads to the conclusion that they suffer from low wages. Figure 3 provides evidence for this argument by comparing the average wage of EITC recipients with that of non-recipients across ages. This figure also shows the extent of an OLS bias. More specifically, if the wage level is regressed on EITC eligibility along with some controls, this OLS regression would reveal that being eligible for the EITC is correlated with receiving low wages. This might lead to the wrong conclusion that EITC actually leads to women receiving low wage rates. However, the fact that EITC eligibility requires having low earnings should also be taken into consideration.

To sum up, women in the sample I construct for the empirical analysis tend to have noticeably low labor market earnings and net worth. In addition, almost 40% of the observations are coupled with earnings that fall in the eligibility region of the EITC. Further analysis reveals that EITC recipients are mostly high-school graduates and are between ages 30 and 40. Most notably, the women who receive tax credit have long working hours and low earnings. This leads to the conclusion that these women suffer from low wages. A natural question is: how much does EITC help these low-wage women over their labor market careers in terms of human capital accumulation and wage growth? To answer this question, the next section presents a life-cycle labor supply model.

5 Model

In this section, I provide a life-cycle model for single women who rationally choose their optimal life-cycle paths for net savings (or borrowing and consequently consumption) and annual hours of work. In the model, I allow for participation in welfare and food stamp programs as well as family composition changes over the life-cycle in the form of arrival and departure of a child. However, these dynamics are exogenously determined in the model.

I start modelling women's decisions as they complete their education and enter the labor market. The age at which a woman enters the labor market, thus, depends on her education level and is denoted by t_{0i}. Specfically, I assume that high school dropouts start working at age 16, high school graduates at age 18, college dropouts at age 20, and finally college graduates and those with post-college education enter the labor market at age 22. After entering the labor market, women make annual decisions concerning their work hours and levels of net saving. Working life is assumed to end deterministically at age 60, but I assume women live for 10 more years and consumer their accumulated assets.

The model accounts for three important dynamic mechanisms, first and foremost being human capital accumulation. By working more hours, women accumulate experience which have long lasting effects on their earnings. Specifically, the wage rate a woman faces depend on the experience stock, persistent unobserved heterogeneity, previous and current work hours choices as well as the market skill rental price. The impact of the previous work hours choice on the wage rate is crucial for incorporating the detrimental effect of taking time out of the labor market for single women. Even though having a career break does not cause a decline in the experience stock in the model, by allowing the wage rate to depend on previous hours choice, the model captures the detrimental impact of taking time out of the labor market and thus, the dynamic links in the earnings processes of women.

Secondly, the model allows for saving and borrowing. By deciding on how much to save, women in fact determine the amount of funds to transfer across different stages of their life-cycle. Since I focus on low-income women in this paper, I also incorporate borrowing constraints to the model. In particular, the model imposes a lower-bound for the level of assets which depend on women's age and schooling level. However, I allow this lower bound to be negative, which implies that women can borrow even when their net worth is negative. In addition to the borrowing constraint, the model imposes a lower bound for consumption. In particular, women's saving or borrowing choices are feasible only if the level of consumption exceeds a consumption floor, $\underline{c}$.

The final intertemporal link comes from the structure of the EITC. By deciding on how many hours to work, a woman essentially determines the amount of tax credit she receives next period, taking as given the policy parameters[19]. In addition, I assume that women have static expectations concerning the tax system, which implies that any change in the tax credit or tax policy comes unexpectedly. This assumption is motivated by previous work

[19] As mentioned earlier, EITC payments are received as a tax refund. A tax refund based on the earnings from the current year is generally received between January and May of the following year. Since I am modelling the annual decisions of women, I assume the EITC payment based on the labor market earnings from the current period is received in the following period.

in the literature documenting the lack of knowledge of the tax policies[20].

In addition to these dynamics, the model also accounts for participation in government transfer programs such as the Temporary Assistance to Needy Families (TANF) and Supplemental Nutrition Assistance Program (SNAP). However, rather than explicitly modelling the decisions to participate in these programs, I model the probabilities of receiving any benefits that capture both eligibility and the participation decision as stochastic processes.

In the remaining of this section, I describe the details of the model with specific parametrizations, provide a discussion on the predictions of the model and explain the solution method.

5.1 The Choice Set

At each age t, a single woman i chooses a pair $d_{it} = \left(d_{it}^h, d_{it}^s\right)$, where $d_{it}^h \in \mathcal{D}^h$ represents the choice for annual hours of work and $d_{it}^s \in \mathcal{D}^s$ represents the level of savings (or borrowing) net of interest income. The alternative choices each of these decisions entail are described as:

$$d_{it}^h = \begin{cases} 0 & \text{No work,} \\ 1 & \text{Less than 1300 hours,} \\ 2 & \text{Between 1300 and 1950 hours,} \\ 3 & \text{Between 1950 and 2200 hours,} \\ 4 & \text{More than 2200 hours,} \end{cases} \tag{1}$$

$$d_{it}^s = A_{i,t+1} - (1+r)A_{it} \in \{a_1, \ldots, a_{10}\}, \tag{2}$$

where A_{it} is woman's level of assets.

The annual hours of work choice includes 5 alternatives: no work, working less than 1300 hours, between 1300 and 1950 hours, between 1950 and 2200 hours and more than 2200 hours. If a woman chooses an alternative that requires work, I assume the woman's annual work hours is equal to the midpoint of each bin. For example, if a woman chooses alternative 2 which implies that she chooses to work less than 1300 hours, I assume she works for 650 in that period[21]. The net saving decision[22], on the other hand, involves choosing from one of the 10 discrete alternatives between -\$5,000 and \$15,000. Note that, through the choice of net savings, a woman also decides on her level of consumption conditional on the receipts and expenditures defining her budget constraint. The model also allows for borrowing which

[20] See for example Olson and Davis (1994) and Romich and Weisner (2000)

[21] The intervals determining the alternatives for the hours of work choice are constructed so that the mean and the standard deviation of work hours based on this definition is approximately equal to the annual hours of work distribution in the data.

[22] I follow Keane and Wolpin (2001) in this particular formulation for the saving decision.

implies that d^s_{it} can take on negative values. I discretize annual work hours and net saving in order to make a women's choice set entirely discrete. This specification is crucial for the analysis as it increases the tractability of the problem.

5.2 Preferences

Period utility, given in equation (3), defines a woman's preferences over the choice variables, d^h_{it} and d^s_{it}, conditional on observed state variables X_{it} and the preference shock, ϵ^h_{it}.

$$
\begin{aligned}
U(c_{it}, d^h_{it}, d^h_{i,t-1}; X_{it}, \epsilon^h_{it}, k) = \lambda_c(X_{it}, k)\frac{c_{it}^{\theta_c}}{\theta_c} &+ \lambda_h(X_{it}, \epsilon^h_{it}, k)\big[\mathbb{1}\{d^h_{it} = 1\} \\
&+ \alpha^u_2 \mathbb{1}\{d^h_{it} = 2\} + \alpha^u_3 \mathbb{1}\{d^h_{it} = 3\} + \alpha^u_4 \mathbb{1}\{d^h_{it} = 4\}\big] \\
&+ \alpha^u_5 \mathbb{1}\{d^h_{it} = 1\}\mathbb{1}\{d^h_{i,t-1} = 1\} + \alpha^u_6 \mathbb{1}\{d^h_{it} = 2\}\mathbb{1}\{d^h_{i,t-1} = 2\} \\
&+ \alpha^u_7 \mathbb{1}\{d^h_{it} = 3\}\mathbb{1}\{d^h_{i,t-1} = 3\} + \alpha^u_8 \mathbb{1}\{d^h_{it} = 4\}\mathbb{1}\{d^h_{i,t-1} = 4\}.
\end{aligned} \tag{3}
$$

The period utility is seperable between consumption and leisure. Furthermore, the first component of the period utility defines the value of consumption while the second component represents the value of leisure, or equivalently the disutility from work. The utility from consumption has an augmented CRRA form with the constant relative risk-aversion parameter, $1 - \theta_c$. To ensure the concavity of flow utility with respect to consumption, I assume $\theta_c < 1$. The function, $\lambda_c(.)$ captures the differences in the marginal utility of consumption resulting from observed and unobserved heterogeneity. More specifically, this function is defined as

$$
\begin{aligned}
\lambda_c(X_{it}, k) = \sum_{j=1}^{K} \alpha^c_{0j} \mathbb{1}\{k = j\} \exp\big(&\alpha^c_1 \mathbb{1}\{y_{it} \leq 25\} + \alpha^c_2\{y_{it} \leq 30\} + \alpha^c_3 \mathbb{1}\{y_{it} \geq 40\} \\
&+ \alpha^c_4 \mathbb{1}\{y_{it} \geq 50\} + \alpha^c_5 N_{it}\big),
\end{aligned} \tag{4}
$$

where X_{it} represents observed characteristics of the woman such as the number of children, N_{it}; the education level and age[23], y_{it}. In this formulation, the parameters α^u_2, α^u_3, and α^u_4 represent the varying disutility a woman gets from choosing different work alternatives as well as the fixed psychic cost from work. The remaining parameters α^u_5-α^u_8 refer to the capture the decrease in the disutility from work if the woman chooses the same work alternative as she did the last period. Permanent unobserved heterogeneity enters the model through the woman's latent type[24], $k \in \{0, 1, \ldots, K\}$, which captures the persistence in preferences for

[23] I use both t and y_{it} to denote age. However, t refers to the periods of the model which can also be defined as a year.

[24] Although the woman knows her own type, it cannot be observed by the econometrician.

saving and leisure and its correlation with the observed characteristics of a woman.

Similarly, $\lambda_h(.)$ refers to a function that shifts the marginal disutility of work based on observable and unobservable characteristics of a woman.

$$\lambda_h(X_{it}, k) = \alpha_0^h + \sum_{j=2}^{K} \alpha_{1j}^h \mathbb{1}\{k = j\} + \alpha_2^h \{y_{it} \leq 25\} + \alpha_3^h \mathbb{1}\{y_{it} \leq 30\} + \alpha_4^h \mathbb{1}\{y_{it} \geq 40\} \\ + \alpha_5^h \mathbb{1}\{y_{it} \geq 50\} + \epsilon_{it}^h. \tag{5}$$

According to the specification given by equation (5), marginal disutility of work depends on a woman's latent type, age, along with a random preference shock, ϵ_{it}^h which follows a normal distribution.

5.3 The Woman's Problem

Given the preferences and the choice set, I now define a woman's life-cycle problem formally. A woman maximizes her present discounted lifetime utility from age t_{0i} to the terminal age T_i, both determined by the woman's educational attainment. The choice set $\mathcal{D}$ in each period, t, is constructed by the Cartesian product of the sets of discrete alternatives $\mathcal{D}^h \times \mathcal{D}^s$. Let $\mathfrak{d}_{it}$ denote a vector of dummy variables $\mathfrak{d}_{it}^j$, $j = 1, \ldots, 50$ such that $\mathfrak{d}_{it}^j$ is equal to 1 if the woman chooses jth element of $\mathcal{D}$. In addition, let U_{it}^j be the utility associated with this choice. Then, the maximized utility at any period t is given by:

$$V(X_{it}) = \max_{\mathfrak{d}_{it}} \mathbb{E}\big[\sum_{\tau=t}^{60} \sum_{j=1}^{50} \beta^{\tau-t} U_{i\tau}^j \mathfrak{d}_{i\tau}^j | X_{it}\big], \tag{6}$$

where X_{it} is the state space at period t, which represents the information set of the woman at that period. The state variables at period t include the age of the woman y_{it}, the level of her assets A_{it}, schooling level S_i, the state she resides in SR_i, her race R_i, experience stock H_{it}, the federal and state earned income tax credit to be received at that period $EITC_{it}$, the number of children N_{it}, the age of her youngest child N_{it}^k, the calendar year v_{it} and the contemporaneous shock vector $\epsilon_{it} = \Big[\epsilon_{it}^h, \epsilon_{it}^w, \epsilon_{it}^{cc}, \epsilon_{it}^{tanf}, \epsilon_{it}^{snap}\Big]$. Next, I define the transitions for each of these state variables in detail.

5.4 Constraints

A woman's annual income is composed of her earnings, $w_{it}h_{it}$; federal and state EITC payments received, $EITC_{it}$; the amount of SNAP benefits the woman receives, $SNAP_{it}$;

as well as the amount of TANF benefits, $TANF_{it}$. Out of this annual income, the woman pays federal and state income taxes T_{it}, child care costs CC_{it} if she has a child, and makes consumption expenditures. The remaining amount earns interest and is transferred to future periods to determine the level of assets for the next period, $A_{i,t+1}$. I further assume that there exists a consumption floor, so that a choice pair (d^s_{it}, d^h_{it}) is feasible only if consumption is above the minimum consumption threshold, $\underline{c}$. Even though the budget constraint defines the transition for the woman's assets, the model also imposes a borrowing constraint that is determined by woman's age and educational attainment. This borrowing constraint requires the level of assets to stay above some nonpositive threshold every period. In sum, the intertemporal budget constraint a woman faces can be summarized by the following three equations:

$$\begin{aligned} A_{i,t+1} = (1+r)A_{it} + w_{it}h_{it} + EITC_{it} - T_{it} - CC_{it}\mathbb{1}\{N_{it} > 0\} \\ + \mathbb{1}\{P^{SNAP} = 1\}SNAP_{it} + \mathbb{1}\{P^{TANF} = 1\}TANF_{it} - C_{it}. \end{aligned} \tag{7}$$

$$c_{it}(d^s_{it}) \geq \underline{c} \tag{8}$$

$$A_{i,t+1} \geq \underline{a}_{i,t+1} = -\exp\left(\alpha^b_0 + \alpha^b_1 y_{i,t+1} + \alpha^b_2 y^2_{i,t+1} + \alpha^b_3 S_i\right) \tag{9}$$

Next, I explain each component of the budget constraint in detail.

As mentioned in the preceeding section, I define annual work hours h_{it} based on the annual work hours choice of the woman

$$h_{it} = \begin{cases} 0 & \text{if } d^h_{it} = 0, \\ 650 & \text{if } d^h_{it} = 1, \\ 1625 & \text{if } d^h_{it} = 2, \\ 2075 & \text{if } d^h_{it} = 3, \\ 2600 & \text{if } d^h_{it} = 4, \end{cases} \tag{10}$$

and given this definition, I calculate woman's annual labor market earnings by multiplying the annual work hours h_{it} with the wage she earns, w_{it}.

The wage process is determined as an exponential function of the woman's latent type, hours of work choice, age, race, schooling level, experience stock, previous hours of work choice, and the calendar year as in the following equation.

$$\begin{aligned}\ln w_{it} = \alpha_0^w + \sum_{j=1}^{K-1} \alpha_{1j}^w \mathbb{1}\{k = j+1\} + \sum_{j=1}^{3} \alpha_{2j}^w \mathbb{1}\{d_{it} = j+1\} + \alpha_3^w y_{it} + \alpha_4^w R_i + \alpha_5^w S_i \\ + \alpha_6^w \ln(H_{it}+1) + \sum_{j=1}^{4} \alpha_{7j}^w \mathbb{1}\{d_{i,t-1}^h = j\} + \alpha_{8j}^w v_{it} + \alpha_{9j}^w SR_i + \epsilon_{it}^w,\end{aligned} \tag{11}$$

where k is the latent type of the woman, y_{it} is the age, R_i is the race, S_i is the educational attainment, SR_i is the state of residence and H_{it} is the accumulated hours of work. The existence of the latent type in the wage equation captures the impact of the unobserved skill endowment of a woman on the wage level. Furthermore, the third term in equation (11) reflects the varying returns to different hours of work choices. More specifically, the parameters α_{2j}^w for $j = 1, 2, 3$ represent the differences in the wage offers a woman faces when she chooses different annual work hours. The parameter α_4^w measures the difference in the skill rental prices between the black and white women due to discrimination against black women in the labor market. In order to measure the discrimination, the variable R_i is defined as a dummy that takes on a value of 1 if the woman is black. In addition, the dynamic wage process allows for endogenous state dependence through experience accumulation and a change in the current wage offer depending on the previous hours of work choice of the woman. The following equation defines the process for experience accumulation.

$$H_{i,t+1} = H_{it} + h_{it}. \tag{12}$$

Finally, I assume that the idiosyncratic wage shock ϵ_{it}^w is serially independent. In particular, the random wage shock and the preference shock are assumed to be jointly normally distributed such that

$$\begin{bmatrix} \epsilon_{it}^h \\ \epsilon_{it}^w \end{bmatrix} \sim N\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_h^2 & \sigma_{hw} \\ \sigma_{hw} & \sigma_w^2 \end{pmatrix} \right). \tag{13}$$

The federal and state EITC payments received by the woman depends on previous period's earnings. As previously mentioned, in this analysis I only consider the outlay component of the EITC which implies that a woman receives federal and state EITC in the form of a tax refund[25]. Note that, in this formulation, I am implicitly assuming that a woman makes all necessary tax payments during the year. For this reason, when she files for taxes she will

[25]Since I assume the decision period of the model to be a year and that all the decisions are made at the beginning of a year, even if the tax refund is received in January, the credit will be a part of next period's income and thus, enter next period's budget constraint.

not be liable for any additional taxes and she will not receive any tax refund. Therefore, the only posibility for a woman to receive a payment in the form of a tax refund is to be eligible for federal and thus, state EITC if she lives in a state that offers a state EITC program.

The federal tax credit that a woman is going to receive in the next period is determined based on her earnings for the current period and is described in equation (14).

$$FEITC_{i,t+1} = \begin{cases} r_{1it}E_{it} & \text{if } E_{it} \leq b_{1it}, \\ r_{1it}b_{1it} & \text{if } b_{1it} < E_{it} \leq b_{2it}, \\ \max\{r_{1it}b_{1it} - r_{2it}(E_{it} - b_{2it})\} & \text{if } E_{it} > b_{2it}, \end{cases} \tag{14}$$

Each component of this piecewise function defines a particular payment region of the EITC schedule. If the earnings of the woman is less than b_{1it}, then the woman is in the subsidy region and the tax credit is equal to a percentage r_{1it} of her earnings E_{it}. However, if the woman's earnings fall between b_{1it} and b_{2it}, then she is in the flat region and receives the maximum level of the tax credit possible, which equals to $r_{1it}b_{1it}$. Finally, if the woman's earnings are above the threshold b_{2it}, then the woman is either in the phase-out region or she is not eligible for the tax credit at all. In the phase-out region, the amount of credit is taxed away depending on how far the level of the woman's earnings is compared to the threshold b_{2it} whereas the amount of credit simply equals to zero if the woman is not eligible for EITC. The policy parameters r_{1it}, r_{2it}, b_{1it} and b_{2it} depend on the number of children, marital status and the calendar year.

If a woman is eligible for federal EITC and if she resides in a state that offers a state EITC program, then she also receives tax credit from the state. The level of tax credit the woman receives from the state is determined as a percentage of the federal EITC she is entitled to. More specifically,

$$SEITC_{i,t+1} = r_{3it}FEITC_{i,t+1}, \tag{15}$$

where the policy parameter r_{3it} is set by the state and varies with the calendar year and for some states, with the number of children. Finally, the total EITC payments a woman receives is simply the sum of the federal and state EITC benefits.

$$EITC_{i,t+1} = FEITC_{i,t+1} + SEITC_{i,t+1} \tag{16}$$

Due to the complicated structure of the tax system, I assume women have static expectations concerning the evolution of the federal and state EITC schedule parameters so that $\mathbb{E}(r_{ji,t+1}) = r_{jit}$, $\forall j \in \{1, 2, 3\}$ and $\mathbb{E}(b_{ji,t+1}) = b_{jit}$, $\forall j \in \{1, 2\}$. Therefore, any change in the policy rule comes as a surpise. Moreover, I assume that women can face up to four policy regimes over their life-cycles. In particular, I adopt the 1990, 1993, 1996 and 2002 regimes and assume they operate over the periods prior to 1990, between 1991 to 1995, between 1996 to 2001 and 2002 onwards, respectively.

The federal and state income tax a woman pays enter the budget constraint through T_{it}. In order to calculate the amount of the federal tax liability, I use the actual tax brackets and the marginal tax rates for a given calendar year. In these calculations, I assume women pay taxes as the head of the household and use the appropriate tax policy parameters for that status. In order to find the state income tax a woman needs to pay given the level of her earnings and the state she resides in, I use the tax simulator, TAXSIM, developed by the National Bureau of Economic Research.

A woman incurs child care costs only when she has a child. The child care cost depends on the number of children the woman has, the age of her youngest child, and her hours of work choice. In particular, I assume the child care costs vary depending on whether the youngest child is an infant, a toddler, a child or a teenager. A woman might pay child care costs even when she is not working. This means that the child care costs might involve the expenditures a woman makes for her child's care and that these expenditures do not necessarily only include the costs of day care or schooling. However, in the data, there are also several mothers who don't make any child care expenditures. Therefore, I consider the child care costs to be a truncated version of a latent variable process. In particular, I assume the latent process to have the following structure.

$$\begin{aligned} CC^*_{it} = \alpha^{cc}_0 + \alpha^{cc}_1 N_{it} + \alpha^{cc}_2 \mathbb{1}\{3 \leq N^y_{it} \leq 5\} + \alpha^{cc}_3 \mathbb{1}\{6 \leq N^y_{it} \leq 10\} \\ + \alpha^{cc}_4 \mathbb{1}\{11 \leq N^y_{it} \leq 17\} + \alpha^{cc}_5 d^h_{it} + \epsilon^{cc}_{it} \end{aligned} \tag{17}$$

where the random child care expenditure shocks are normally distributed, $\epsilon^{cc}_{it} \sim N(0, \sigma^2_{cc})$. Furthermore, the actual child care cost process is given by

$$CC_{it} = \max\{0, CC^*_{it}\}. \tag{18}$$

In the model, TANF and SNAP participation decisions are not endogenous but rather defined as stochastic processes. Still, according to the model a woman makes her life-cycle decisions conditional on TANF and SNAP participation and receipts. More specifically, I model the probabilities of receiving any TANF or SNAP benefits as seperate logistic functions. The rules for the welfare program state that a woman is eligible for TANF benefits if she passes an income eligibility test. Moreover, the thresholds for this income eligibility test vary with the state of residence and the family size. In terms of the welfare participation decision, previous work in the literature shows that the stigma from welfare participation depends on observable characteristics such as the level of educational attainment, age and race. For these reasons, I model the TANF participation probability as a logistic function that is determined by the earnings of the woman, her education level, how many children she has, her race, her age, the calendar year, and the state she resides in. Note that this probability captures the eligibility for the program as well as the participation decision.

$$\Pr(P_{it}^{TANF} = 1) = \frac{\exp(\mathbf{X}_{it}^{pt}\alpha^{pt})}{1 + \exp(\mathbf{X}_{it}^{pt}\alpha^{pt})}, \tag{19}$$

where $\mathbf{X}_{it}^{pt} = [E_{it}, E_{it}\mathbb{1}\{v_{it} > 1996\}, S_i, R_i, y_{it}, v_{it}, SR_i]$. If the woman participates in welfare, the actual benefits are determined based on earnings and a policy rule that is state and family-size dependent. For this reason, I approximate the benefit determination function as an exponential function given by

$$\ln TANF_{it} = \alpha_0^{tanf} + \alpha_1^{tanf} SR_i + \alpha_2^{tanf} v_{it} + \alpha_3^{tanf} E_{it} + \alpha_4^{tanf} N_{it} + \epsilon_{it}^{tanf}, \tag{20}$$

where ϵ_{it}^{tanf} is a normally distributed random shock with zero mean, $\epsilon_{it}^{tanf} \sim N(0, \sigma_{tanf}^2)$.

Similar to welfare, eligibility for SNAP is determined by an income test for which the thresholds are specific to state of residence and the family size. In addition, net income test for SNAP also takes into account the amount of welfare receipts a woman is entitled to. Taking the eligibility rules into account, the probability of participating in SNAP is approximated as

$$\Pr(P_{it}^{SNAP} = 1) = \frac{\exp(\mathbf{X}_{it}^{ps}\alpha^{ps})}{1 + \exp(\mathbf{X}_{it}^{ps}\alpha^{ps})}, \tag{21}$$

where $\mathbf{X}_{it}^{ps} = [E_{it}, S_i, TANF_{it}, v_{it}, y_{it}, R_i, SR_i]$. Once again, the inclusion of woman's age, race and schooling level is meant to capture the varying stigma from the participation decision based on the observable characteristics of the woman.

If eligible, a woman's actual SNAP benefits are determined by a policy rule that takes into account her earnings and welfare benefits. This policy rule changes according to state policies, calendar year and the family size. Therefore, I model the amount of SNAP benefits of an eligible woman as an exponential function that depends on these variables.

$$\ln SNAP_{it} = \alpha_0^{snap} + \alpha_1^{snap} SR_i + \alpha_2^{snap} v_{it} + \alpha_3^{snap} E_{it} + \alpha_4 TANF_{it} + \alpha_5^{snap} N_{it} + \epsilon_{it}^{snap}, \tag{22}$$

where $\epsilon_{it}^{snap} \sim N(0, \sigma_{snap}^2)$.

The transition in the number of children and the age of the yougest child are modeled so as to match the dynamics in the data. First, in order to limit the size of the state space I cap the number of children, so that a women can at most have 2 children[26]. Secondly, from the data I observe that the change in the number of children does not only happen through birth or the child exceeding the age of 17. Adoption, taking custody of an existing child, the death of a child or the child leaving the house to live with another family member are also common events. This means, the number of children a woman has can increase or decrease at any age. For these reasons, I specify the transition in the number of children as follows.

$$\Pr(N_{i,t+1} = m) = \frac{\exp\left(\mathbf{X}_{it}^{n}\alpha_m^n\right)}{1 + \sum_{j=1}^{2}\exp\left(\mathbf{X}_{it}^{n}\alpha_j^n\right)} \quad \forall m \in \{1, 2\}, \tag{23}$$

$$\Pr(N_{i,t+1} = 0) = 1 - \sum_{m=1}^{2}\Pr(N_{i,t+1} = m), \tag{24}$$

where $\mathbf{X}_{it}^{n} = [y_{it}, S_i, N_{it}^{y}\mathbb{1}\{N_{it} > 0\}, N_{it}]$. In this specification, the probability of a change in the number of children varies with the woman's age, her schooling level, age of her youngest child if she has a child, and the number of children she already has.

For the reasons explained above, the age of the youngest child is not deterministically changing in the data. In order to deal with this, I construct four groups for the age of the youngest child and calculate the transition matrix for the age of a woman's youngest child so that the probability of a change in the age of the youngest child is determined by the age of the woman and how many children she has according to the following process.

$$\Pr(N_{i,t+1}^{y} = m) = \frac{\exp\left(\mathbf{X}_{it}^{k}\alpha_m^k\right)}{1 + \sum_{j=2}^{4}\exp\left(\mathbf{X}_{it}^{k}\alpha_j^k\right)} \quad \forall m \in \{2, 3, 4\}, \tag{25}$$

$$\Pr(N_{i,t+1}^{y} = 1) = 1 - \sum_{m=2}^{4}\Pr(N_{i,t+1}^{y} = m), \tag{26}$$

where $\mathbf{X}_{it}^{k} = [y_{it}, N_{it}, N_{it}^{y}]$.

5.5 The Solution Method

The life-cycle maximization problem of a woman can be reformulated in a dynamic programming framework. Specifically, the value function can be written as the maximum over alternative-specific value functions denoted as V^j for $j = 1, \ldots, 50$ that satisfy the Bellman

[26]Having more than two children matters only for the state EITC policy of Minnesota.

equation:

$$V(X_{it}) = \max\left\{V^1(X_{it}), \ldots, V^j(X_{it})\right\}, \tag{27}$$

$$V^j(X_{it}) = U^j_{it} + \beta\mathbb{E}\left(V(X_{i,t+1})|\mathfrak{d}^j_{it} = 1, X_{it}\right). \tag{28}$$

The expectation in equation (28) is taken over the joint distribution of the random shocks as well as the future values of the state variables. Furthermore, the terminal-period alternative-specific value functions consist only of the contemporaneous utilities. In particular, I assume there is no value for death and that there is no bequest motives. Therefore, for all values of $X_{i,T+1}$ and $j = 1, \ldots, 50$, I set $V^j(X_{i,T+1}) = 0$.

Due to the finite-horizon structure of the model, I use backward recursion as the solution method. Backward recursion entails solving the model as a function of the entire state space for each period. More importantly, the solution of this optimization problem necessitates finding the values of $\mathbb{E}\left(V(X_{i,t+1})|\mathfrak{d}^j_{it} = 1, X_{it}\right)$ for all points in the state space. Given the continuation value in period t, the optimal saving decision conditional on each hours of work alternative is calculated for by comparing the remaining discounted utility on a grid of possible consumption levels implied by the different saving/borrowing decisions, for each of the five alternatives for the hours of work choices.

In order to reduce the computational burden created by evaluating the value functions over the entire state space, I utilize two methods. First, I reduce the size of the state space by discretizing the continuous state variables. If, however, a value outside the grid of an element of the state space needs to be computed, I use linear interpolation and extrapolation. Secondly, I use an approximation method developed by Keane and Wolpin (1994) which requires the calculation of the function $\mathbb{E}\left(V(X_{i,t+1})|\mathfrak{d}^j_{it} = 1, X_{it}\right)$ for a subset of the state space at each t and estimating a regression function as a polynomial in those state space elements. The values from the fitted polynomial are used to pinpoint the value of this function for the remaining points in the state space. Finally, in order to calculate the multivariate integrals when taking expectations, I use Monte Carlo integration.

5.6 Theoretical Predictions on the Impact of the EITC

The static labor supply theory predicts that the EITC will encourage employment among single women as the program gives incentives that decrease the disutility from work for those people who are unemployed without the credit[27]. However, the impact of the tax credit on

[27]This prediction is actually concerned with labor force participation. The tax credit provides incentives to those women who choose to remain out of the labor force. Nevertheless, the model does not take into account labor force participation decision of the women. Therefore, the predictions on labor force participation are fully reflected in employment decisions

hours of work of single women depends on which region the women's earnings fall into before the credit is introduced. In particular, in the subsidy (phase-in) region EITC acts as a wage subsidy, which leads to a negative income effect and a positive substitution effect due to leisure becoming more expensive. Still, without further assumptions on the preferences, it is not possible to determine theoretically whether the income effect or the subsidy effect dominates. Consequently, the direction of the intensive-margin responses of the women who are in the subsidy region is theoretically ambiguous. In the flat region, the budget constraint of a woman shifts out by an amount that is equal to the level of the maximum credit. Therefore, in this region the EITC creates a negative income effect that leads to a reduction in the work hours. Since the amount of the tax credit declines with each dollar earned when a woman is in the phase-out region, the EITC acts as a tax that decreases the net wage earned by the single woman. For this reason, the EITC produces a negative income effect along with a negative substitution effect as labor becomes less rewarding. Accordingly, the overall impact of the EITC on work hours depends on the distribution of women across the payment regions. Although the theoretical prediction of the static labor supply model on the impact of the EITC on work hours is ambiguous, as more EITC recipients have earnings in the flat and phase-out regions the expectation is for the EITC to reduce the work hours of eligible single women.

On the other hand, the model in this paper takes into consideration another channel through which the EITC has an effect on employment and hours of work, i.e., human capital accumulation. Human capital accumulation in this model works in a way to increase the rewards from work as it takes into account the impact of current hours of work decisions on future wages. More specifically, by working more in a given period, a woman increases her experience stock and thus, faces higher wage offers in the future.

The dynamic model predicts positive employment effects similar to the static labor supply model. As before, the tax credit provides incentives that decrease the disutility from work and thus, leads some of the women who choose to remain unemployed without the credit to start working. In addition to this, the dynamic model also takes into account that the introduction of the credit increases the future rewards from work for women who are unemployed without the credit. Therefore, the expectation is to have a higher change in the employment rate resulting from the introduction of the tax credit in the dynamic model.

In order to understand the prediction of the model on hours of work, once again the behavioral responses of the women in each region need to be separately evaluated. Note that, in all payment regions the human capital effect works in the same direction. Essentially, no matter in which region a woman's earnings fall, due to human capital accumulation she always has a motive to work more in order to achieve a higher wage level. Whether this human capital effect dominates the income and substitution effects that are created by each payment region, however, requires more elaboration. As mentioned above, in the subsidy region the credit creates a substitution and an income effect that operates in the opposite directions. The dynamics of the model adds the human capital effect into the picture, which works in the same direction of the substitution effect. In other words, the human capital effect leads to an increase in the hours of work similar to the substitution effect that operates on the women in this region. Still, it is not possible to theoretically identify whether the income effect cancels out the favorable intensive-region responses created by the substitution and human capital effects. Even so, it is possible to compare the prediction of the dynamic model to that of the static model. Due to human capital accumulation, in the dynamic model the intensive-margin responses are expected to be higher, i.e. the change in the work hours of the women in this region should either be less negative or more positive in the dynamic model. The same argument follows for the flat and phase-out regions as well. Even though the EITC taxes both the current and future rewards from work in the phase-out region, the dynamic model introduces a link through which women are incentivized to work more in order to increase the future rewards from work. In both of these regions, the human capital effect counteracts the negative income or substitution effects created by the credit. However, it is not possible to provide a statement whether this human capital accumulation channel completely cancels out the incentives created by the program to decrease hours of work in these regions. Moreover, the strength of the human capital channel depends on the age of the woman, marginal disutility she gets from work based on her observed and unobserved characteristics and the experience stock she currently has. Nevertheless, contrary to the static model, the impact of the EITC on work hours of single women is theoretically ambiguous in the flat and phase-out regions in the dynamic model. Consequently, estimating the model will provide further insight on the magnitudes of these individual effects as well as the net impact of the EITC on intensive-margin responses. Note that, the above analysis is made by ignoring the changes in the asset stocks of these individuals. If the borrowing or saving motives of individuals are also taken into account, it gets even harder to determine the direction of the change in work hours. In that setting, the marginal utility of consumption based on the woman's observed and unobserved characteristics, her current asset stock as well as her impatience are also crucial for understanding the net impact.

The impact of the EITC on asset accumulation can not be analyzed through the static labor supply model. One contribution of the model in this paper is to allow for such an evaluation. In this model, the EITC might have an effect on the net asset stock, which is defined as assets minus liabilities, through two main channels. First of all, the tax credit increases the resources available to a woman in each period as long as she remains eligible.

This means that, if the woman were to spend the same amount on consumption expenditures, EITC leads to asset accumulation. However, due to human capital accumulation, the woman adjusts her consumption expenditures as well. More specifically, human capital accumulation implies that the woman expects to experience an increase in her earnings as she grows older. This is simply due to an increase in her experience stock with every year she works. The expectation of a positive age-earnings relation implies that the woman has consumption smoothing motives in order to achieve a stable path of consumption over the life cycle. If the EITC is increasing the slope of this age-earnings profile, or in other words if the EITC is helping women to achieve higher wage levels over the life-cycle, then the women will have stronger desires for consumption smoothing which implies that the level of consumption expenditures especially in younger ages will rise. Once again, the EITC creates two competing forces. Whether the income effect or the human wealth effect dominates depend on the discount factor, the coefficient of relative risk aversion, the interest rate and the degree of disutility a woman gets from working. For this reason, the model's prediction for the impact of the tax credit on asset accumulation is also ambiguous.

In sum, even though the model in this paper predicts that the EITC leads to an increase in the employment rate, it fails to provide a definite conclusion on the direction of intensive-margin responses and asset accumulation. This creates the need for an empirical analysis through which the forces mentioned in this section, such as the human wealth effect, are identified and the net effect can be evaluated. The rest of the paper is an attempt to provide such an analysis.

6 Estimation and Results

In this section I first describe the estimation method I use in this paper. Next, I explain the identification arguments and discuss the parameter estimates. Finally, I assess the success of the model in terms of fitting the patterns observed in the data. The parameter estimates presented in this section are used in the rest of the paper to perform counterfactual experiments.

6.1 Estimation Method

I estimate the parameters of the model following a two-step procedure. In the first step I estimate the exogenous transitions in the state variables, such as the number of children, the age of the youngest child, the child care cost, TANF participation and benefits along with SNAP participation and benefits. In addition, I set the discount factor β to 0.96

and the risk-free interest rate r to 0.02. The predetermined values for the risk-free interest rate and the discount factor imply that women have some degree of impatience, since the interest rate is slightly lower than the discount rate. In the second step, I estimate the remaining parameters of the model using the method of simulated moments (MSM). More specifically, the estimation procedure follows an iterative process. First, I estimate the exogenous elements of the model from the data and set the values for the discount factor and the interest rate. Then, I calculate the moments from the data. In the third step, given an initial guess of the parameter vector, I solve the life-cycle optimization problem of single women conditional on the estimated exognous elements from the first step. Next, I simulate 7 paths for each woman reproducing the age and time structure of the data. Simulating 7 paths for each woman leads to a total of 9,849 paths. Finally, I calculate the moments from the simulated data and calculate the weighted average distance between the sample moments and the simulated moments from the model. The iterative process continues until this distance is minimized.

More formally, let Ω denote the parameter vector, $\widetilde{M}^S(\Omega)$ denote the vector of moments from the simulated data and $M_N(\Omega)$ denote the vector of moments from the observed data. Then, the estimated parameter vector $\hat{\Omega}$ solves the following objective function:

$$\hat{\Omega} = \arg\min_{\Omega}(M_N - \widetilde{M}_S(\Omega))' W_N (M_N - \widetilde{M}_S(\Omega)), \tag{29}$$

where W_N is a symmetric, positive-definite weighting matrix. Following Del Boca et al. (2014), I construct this weighting matrix as the inverse of the covariance matrix of M_N, which is estimated by resampling the data[28]. In particular, I compute the vector M_N^g for each of the Q resamples from the original N data points which leads to the following covariance matrix for M_N:

$$W_N = \left(Q^{-1} \sum_{g=1}^{G} (M_N^g - M_N)(M_N^g - M_N)' \right)^{-1}, \tag{30}$$

where the number of draws, Q is set to 200.

The moments that form M_N and consequently $\widetilde{M}_S(\Omega)$ include the mean and the standard deviation of annual work hours by age, education, and the number of children; employment rate by age,education, and the number of children; mean wage by age,education, and the number of children; the mean net assets by age and eduation groups; along with the 10^{th}, 25^{th}, 75^{th} percentiles of net assets. I also calculate the correlations between wage and work hours, contemporaneous wage and lagged hours, as well as the correlation between the con-

[28]Del Boca et al. (2014) show that the estimator $\hat{\Omega}$ is consistent for any given positive-definite weight matrix given that the model is identified. Note that the weight matrix W_N is positive-definite by construction.

temporaneous and lagged hours choices.

6.1.1 Type Probabilities and Initial Conditions

The initial conditions for the model consist of the values for schooling, race, the state a woman resides in, the number of children she has, the age of her youngest child, previous period's choice of work hours, the level of net assets and the amount of EITC she is entitled to at t_{0i}, the initial period of the model. I take the values of the woman's schooling, race, state of residence and the level of net assets as given in the data. For the women whose initial net worth is missing in the data, I draw a value of net assets from the distribution of initial assets conditional on these women's educational attainment. Note that, in the model a woman starts her working career at an age determined by her educational attainment. For this reason, I assume that a woman has no experience and no children at the time she starts her working career[29]. The assumption that the initial level of experience is zero implies that any experience a woman gains during school years is not effective enough to increase her human capital stock. In addition, since t_{0i} marks the first period a woman works, I further assume that previous period's work hours choice and the level of EITC a woman receives is zero in this period.

Although the schooling level of a woman is taken as given in the data, it is unlikely that this variable is exogenous. The schooling choice a woman makes earlier in life, or the decision to stop schooling and to start working may reflect skill endowments or innate ability that I cannot observe. Moreover, these skill endowments would further affect the work choices of the woman later in the life cycle. In sum, the educational attainment of a woman might be the outcome of an endogenous process that is not taken into account by my model. In order to tackle with the possible bias this endogeneity might entail, I assume that the educational attainment of a woman is exogenous conditional on her latent type, k. In turn, the type probability is specified as a logistic function of the schooling level of a woman.

$$\pi_k = \frac{\exp\left(\alpha_{0j}^t + \alpha_{1j}^t \mathbb{1}\{S_i = 1\} + \alpha_{2j}^t \mathbb{1}\{S_i > 2\}\right)}{1 + \sum_{l=2}^{K} \exp\left(\alpha_{0l}^t + \alpha_{1l}^t \mathbb{1}\{S_i = 1\} + \alpha_{2l}^t \mathbb{1}\{S_i > 2\}\right),} \quad \forall k \in \{2, \ldots, K\}, \tag{31}$$

$$\pi_1 = 1 - \sum_{k=2}^{K} \pi_k. \tag{32}$$

According to equation (31), the latent type of a woman is determined based on whether the

[29] In the data, if the woman has no child, the age of the youngest child is coded as 1. Therefore, the transition probabilities given in equations (23) and (24) can be calculated even if the woman has no child in a given period

woman is a high school drop out and whether she has at least some college education.

6.1.2 Measurement Error

The measurement error in the observed wage and asset data is crucial, as the wage and asset outliers significantly affect work and net saving choices and thus, the parameters of the model. In order to diminish this influence, I assume both wages and assets are subject to measurement errors. In particular, I assume the measurement error on wages have a multiplicative structure so that,

$$w_{it}^{observed} = w_{it} \exp(\eta_{it}^{w}), \tag{33}$$

where η_{it}^{w} is normally distributed as $\eta_{it}^{w} \sim N(0, \sigma_{mw}^{2})$. The measurement error on assets, on the other hand, is assumed to follow an additive process.

$$A_{it}^{observed} = A_{it} + \eta_{it}^{a}, \tag{34}$$

with $\eta_{it}^{a} \sim N(0, \sigma_{ma}^{2})$ and $\sigma_{ma} = \sigma_{ma,0} + \sigma_{ma,1} A_{it}$. With this additive structure for the measurement error, the variance of the measurement error varies with the level of assets. I further assume that the measurement errors on assets and wages are independent of each other and of the other error terms in the model, in addition to being serially independent.

6.2 Identification

The identification of the parameters of the model rely on a combination of functional form and distributional assumptions as well as two sets of exclusion restrictions. The first set of exclusion restrictions necessitates the existence of at least one variable that affects the selection of individuals into certain states while not changing the outcome equation. In the context of this paper, an example of the selection equation is the marginal utility of leisure while the outcome is the wage equation. In this setting, the number of children a woman has, serves the role of an exclusion restriction as it shifts the marginal utility of leisure even though it does not enter the wage equation. The second exclusion restriction requires at least one variable to shift the outcome equation while not altering the selection equation. Experience that enters the wage equation serves the role of this type of an exclusion restriction. A similar argument follows for the marginal utility of consumption and the borrowing constraint equations. The number of children a woman has, for example, shifts the marginal utility of consumption even though it does not have an impact on the borrowing constraint. Schooling level, on the other hand, is one of the determinants of the lowest asset threshold although it does not alter the marginal utility of consumption.

The coefficient of relative risk aversion, θ_c, which determines the curvature of the utility function and the intertemporal elasticity of substitution, $1 - \theta_c$ is identified through the differences in the net saving-age profiles of women with similar observable and unobservable characteristics. Furthermore, the marginal utility of consumption is specified as an exponential function in order to make the identification less challenging.

Next, the distribution of the latent types and type-specific parameters are identified through the panel structure of the data. Repeatedly observing the choices of the same woman conditional on the observable characteristics allow me to separate the persistent unobserved heterogeneity from transitory unobserved shocks. However, as types cannot be identified without a normalization, I impose a ranking on the skill endowments in estimation. I assume type 1 women have the lowest skill endowments while type 4 women have the highest.

Finally, the impact of the EITC is identified through the variation in the policy parameters across time and states. The number of states with state-level EITC programs varies a lot across years. For example, in 1986, only Maryland was offering state EITC while in 2001 the number of states with state EITC programs increased to 15. Moreover, the level of the tax credit differs substantially across states. In 2001, while EITC eligible individuals in Maine were receiving state-level tax credit that was equal to 5% of their federal EITC, in Vermont the state-level EITC was equal to 32% of the federal credit. This difference across states considerably varies across time which helps with the identification of the impact of the EITC on work hours, employment and asset accumulation.

6.3 Parameter Estimates

I first present the results from the first step of the estimation procedure which are used as an input in solving the life-cycle optimization problem of a woman. Next, I report the parameter estimates from the second step that utilizes MSM.

Table 5 presents the estimates for the cost of child care equation. The estimates show that childcare cost increases as the number of children increase, as expected. However, an additional child raises the cost of childcare only by 3 percent. This tells us that even though having more children necessitates higher childcare costs, the women also benefit from economies of scale when they have more children. One reason for this might be due to older child taking care of the younger one when a woman has more than one child, which can eliminate the need for a baby-sitter. Moreover, younger children may use the clothes, toys and other belongings of the older children. Among the women with the same number of children, those whose youngest child is an infant pay the highest child care costs. Although the cost of a toddler is not significantly different from an infant, the childcare cost considerably decreases when the youngest child is older than 6.

As mentioned before, the probability for TANF participation captures both eligibility and the participation decision. Table 6 reports that there is no significant difference between black and white women in terms of welfare participation. Moreover, even though states impose their own earnings thresholds, participation in welfare for women who live in different states is not significantly different. With regards to the TANF benefits observed in the data, the results display that a woman's earnings is the most important determinant. As expected, welfare receipts decline as annual earnings increase.

Similar to TANF participation, the black and white women do not differ in terms of the probability of SNAP participation as well. Nevertheless, SNAP participation is lower among women who are older, who have higher annual earnings and who are more educated. On the other hand, women with higher TANF benefits have higher SNAP participation. As for the benefits, having more children lead to a rise in the benefits while higher annual earnings and higher TANF benefits received lead to a decline. The reason for this is that the women's earnings and welfare receipts add to the eligibility income used for the calculation for benefits. As a woman's income increases, benefits are taxed away.

Finally, tables 8 and 9 present the estimates used in calculating the transition matrix for the number of children and the age of the youngest child.

The remaining parameters are estimated using MSM and tables 10-12 report the results. Note that, the parameter estimates themselves are not of key interest for the purposes of this paper. Rather, the behavioral patterns indicated by the model are the focus of the empirical analysis. Nevertheless, I next discuss the important findings based on the parameter estimates.

First, the CRRA parameter measured by θ_c is 0.5123 which implies a coefficient of relative risk aversion of $1 - \theta_c = 0.4877$. This estimate is in line with the findings of several papers in the literature such as Keane and Wolpin (2001), Gooree et al. (2003), Imai and Keane (2004), and Sauer (2004). In contrast, the CRRA parameter I estimate is considerably high compared to the typical value used in the life-cycle consumption literature. The value of θ_c commonly accepted in this literature is around -2 (Hubbard et al., 1994), which implies a lower willingness to substitute consumption intertemporally and a higher level of prudence. Keane and Wolpin (2001), who also include borrowing constraints in their analysis, argue that in models without borrowing constraints a high degree of prudence is needed in order to justify the observed pattern of young people with steep earnings profiles not to borrow heavily. That being said, the sample of women this paper focuses on are subject to income uncertainty and have a high willingness to substitute intertemporally as they are single low-income women. The fact that these women are single plays a crucial role for this argument, as they do not have a spousal income that serves the role of a safety net.

The lower bound for net assets shows the lowest amount of assets (or the highest amount of debt) held by the women in the sample before taking into account the measurement error in assets. To give an example, the highest level of debt allowed for a 25-year-old woman who is a high school dropout is around \$3,264 while it is \$64 for a 45-year-old high school dropout. On the other hand, schooling has a more significant impact on the amount of the highest amount of debt permitted, as for a 25-year-old woman who has a college degree or more, the bound becomes \$1,776. In addition to the borrowing constraint, I estimate a consumption floor and find that it is around \$2,118 for this sample of women.

The parameters of the wage equation are consistent with the literature. For example, the parameter of the educational attainment implies that an additional year of schooling increases the wage the woman faces by 4.1%. Moreover, the results display significant returns to experience. In particular, a 1% increase in the experience stock leads to a 0.14% increase in the wage rate. Consider a woman who worked part-time for 15 years. She would have 1,500 hours of experience stock. Next, consider a woman who worked full-time for 15 years. This woman would have 3,000 hours of experience. The estimated returns to experience indicates that the woman who worked full-time would face a wage rate that is 14% higher than the wage rate of the woman who worked part-time. The estimates further show that the wages of black women are 17% lower than the wages of white women. This estimate might reflect the discrimination in the labor market in terms of lower skill rental prices for black women or that black women have lower skill endowments independent of the type, which cannot be captured by model. Finally, the wage equation estimates also show the importance of career breaks. For instance, a woman who worked between 1950 and 2200 hours last period receives a wage rate that is 6.7% higher than the wage rate of a woman who had a career break in the previous period.

In terms of the latent types of the women, I find that unobserved heterogeneity plays an important role in explaining differences in the outcomes. In particular, I estimated the model with four latent types and in the estimation I imposed a ranking on the skill endowments ascending from type 1. The estimates suggest that types differ substantially. For example, in the log wage equation, types 3 and 4 are estimated to earn wages about 6% higher than either type 1 or 2. Although types 1 and 2 have similar skill endowments, type 1 women get a greater utility from consumption and less disutility from non-leisure time. Type 3 and type

4 women have high skill endowments and include most of the women with college education. Type 4 women have lower utility from consumption and a slightly higher disutility from work. Furthermore, the type probability equations imply that women with more education are much more likely to be of high skill types.

Figure 4 displays the within sample fit of the simulated model to the life-cycle profiles of mean log wage, mean asset, employment and mean annual hours of work. In general, the model is able to fit the shape of the life-cycle profiles for mean wage, employment rate and mean work hours well. The figure shows that the model underestimates the mean net assets between ages 50 and 60. At the same time, it slightly underestimates the mean log wage before age 30. A comparison of data moments and the simulated moments also show that the model does a good job in predicting the employment rates, work hours choices and wage rates across demographic groups[30]

7 The Impact of the EITC on Single Women

I now examine the predictions of the model with regards to the impact of the EITC on women's wage growth over the life-cycle. I first consider the differences in women's behavior with and without the EITC. The simulations with the EITC assume that the 2002 tax schedule is in effect. Next, I consider the life-cycle effects of an EITC introduction. More specifically, I first simulate the consequences of an EITC introduction early in the working life and compare the results life-cycle profiles generated by an EITC introduction later in the life cycle.

Table 13 displays the impact of the tax credit on mean employment, annual hours of work, log wage, and net assets. The first two columns present the average of these variables when the human capital accumulation channel is closed. In particular, these simulations assume that the experience stock or the choice of previous work hours have not effect on the wage rate. The change in the employment rate and in the intensive-margin responses or in other words, the change in the average work hours of the women conditional on employment is consistent with the findings of the previous studies. In particular, the change in the employment rate without allowing for human capital accumulation is 2.6% or 2 percentage points. The change in the average work hours of employed women is -0.15% which is not significantly different than zero. Unfortunately, it is not possible to compare the change in average wages and average net assets to any studies as to the best of my knowledge there is

[30]The tables that compare the simulated moments with the moments from the data are provided in the online appendix.

no paper in the literature that present any evidence on those. However, Table 13 indicates that the average wage rate increases by 0.27% with the EITC, which is due to the rise in the employment rate. Net assets on the other hand increase more significantly than the other key variables. This is due to the debt relief the EITC provides as it is directly increasing the period income of the single women.

The last three columns of Table 13 provides evidence on the importance of the human capital accumulation channel for the impact of the EITC. More specifically, once the wage rate reacts to the experience stock as well as the previous work choices of women, the EITC has an additional effect of increasing the future rewards from work. Therefore, both the extensive and the intensive-margin responses become stronger with EITC once human capital accumulation channel becomes functional. As a result of the stronger employment and hours of work responses, the EITC significantly raises the average wages in the population. Note that, the percentage changes reported in this table are for the whole sample, while only 38% of the women are eligible for the EITC. As a result, the 5% increase in the average wages in fact corresponds to a 20% increase in the average wages of the women who are EITC eligible. For this reason, it is clear that EITC is influential in helping single women in climbing the wage ladder.

Figure 5 presents the distribution of the change in the work hours for the EITC target group. For this simulation, I mark the woemn who are eligible for EITC at least once over their life-cycles in a setting where EITC is not offered. Then I track their intensive-margin responses under EITC. The table shows the distribution of the change in the average work hours over the life-cycle as a result of the EITC. The resulting average change in the work hours of these women is around 5%. However, the figure provides evidence that almost 70% of the women in this target group respond to tax credit by increasing their work hours. Even though the theoretical predictions of the dynamic model on the change in hours of work is ambiguous, this exercise indicates that the human wealth effect is in fact stronger than the income effect in the payment regions of the credit schedule.

The life-cycle wage path of women who are in the target group is displayed in Figure 6. In fact, the figure shows how successful EITC is in helping women climb the wage ladder. Evidently, EITC leads to a significant rise in the wages for women at all ages. The main reason for this is the rise in the employment and annual hours of work as a result of the EITC. Since women work more under the tax credit, they accumulate a higher experience stock, which leads to higher wages. Furthermore, as the impact on the wage profile is generated from the accumulation of the experience stock, the wage growth is higher for older woman, even though their average annual work hours is lower than the average without the EITC. The increase in wages can go as high as 25% which means that the work incentives provided by the EITC are effective in generating wage growth for single women. Note that, the EITC leads to a wage growth even though for some women the intensive-margin responses are negative.

Table 14 decomposes the percent change in the wage rate across different age and education groups as well as with respect to the number of children a woman has. As can be seen from the table, women who are above 50, who are high school dropouts and who have two children or more benefit the most from the tax credit. Since the wage growth is almost entirely due to the additional human capital accumulation created by the credit, it is expected the older women to have a higher percentage change in the average wage rate. Moreover, high school dropout are the group with the lowest wages on average and therefore, they form the group that experiences the highest wage growth. Finally, women with two children or more receive the highest tax credit according to the EITC schedule. In addition, they are the women who work for the shortest hours. For this reason, the effect of the EITC is stronger on this group. The primary reason for the lack of any the small EITC impact on the group of childless women is the age restriction the EITC eligibility imposes on taxpayers without a qualifying child. More specifically, women without a child cannot benefit from the tax credit until age 25, and even after age 25, because the amount of the credit they are entitled to is not very high we see a relatively insignificant impact on these women's wage growth. The same argument applies for the small wage changes for the group of women who are younger than 25. These women are less likely to have a child and thus, face the least generous credit schedule.

Although Table 14 indicates that older women benefit more from receiving the EITC, if the tax credit is introduced at different ages over life-cycle the end result might be different. In order to investigate this, I next consider whether introducing EITC at different stages of the life cycle has varying impact on the wage growth profiles. In doing so, I first simulate the wage paths of single women with an unanticipated EITC introduction at age 25. Then, I simulate the wage paths of the same women once again, but this time the introduction of the tax credit happens at age 45. In both cases, I use the 2002 tax credit schedule for the simulations. Figure 7 shows that in both cases, the introduction of the EITC promotes wage growth. However, if the women experience the EITC introduction at an early age, then the impact on wage growth is more significant. Receiving tax credit later in life considerably shifts the wage profile as well. Nevertheless, the average wage level stays lower than the average wage level simulated with an early EITC introduction. The reasons for that are twofold. First, at later stages in the life cycle, women have higher average earnings and thus, are less likely to receive EITC. Second, as the tax credit promotes wage growth through human capital accumulation, the impact of a higher experience stock in early ages in the life cycle leads to a more considerable shift in the wage profile.

EITC can influence the net worth of women in two particular ways. First, the tax credit helps the women who are having a hard time in making ends meet. These women are highly indebted and due to credit constraints, they fail to make the expenditures they need. By providing cash transfers, the EITC offers debt relief to these women. More specifically, these credit-constrained women use the tax credit mostly to make expenditures such as paying the credit card debt or bills that are past due (Smeeding et al. (2000) and Mendenhall et al. (2012)). Second, because the tax credit generates human capital accumulation, it is increasing the slope of the age-earnings profile for the eligible women. The steeper age-earnings profile in turn creates stronger consumption smoothing motives, which lead to an increase in consumption especially in early ages. Whether the increase in the lifetime wealth or the increase in consumption dominates cannot be determined theoretically. However, the last row of Table 13 shows that without the human capital accumulation channel, the EITC leads to a 1.72% increase in the average net assets for the whole sample. Once again, considering the fact that only 40% of the women in this sample are eligible for the EITC, the change in the average net worth of the eligible women is almost 4.5%. The rise in net assets due to the tax credit is not surprising, because without human capital accumulation the consumption-smoothing motives are either very weak or non-existent. Once I allow for human capital accumulation in the model, however, the rise in the net assets falls significantly. The reason for that is the wage growth the EITC generates. As a result of the stronger wage growth over the life-cycle, age-earnings profiles of the women gets steeper and thus, their consumption smoothing-motives cancel out a higher percentage of the increase in the life-time wealth due to the tax credit. Note that, the less significant rise in the net assets implies that the women who are eligible for the EITC are actually using the tax-credit for consumption purposes. This is in line with the findings of Mendenhall et al. (2012) who interviewed the EITC recipients in Chicago and asked how they are using the credit. Their findings indicate that only 38% of the recipients use the credit for saving while others use the credit on consumption expenditures such as going to fancy restaurants, repairing their cars, moving to better school districts for their children, or even by taking their children to Disney World.

Figure 8 shows the distribution of the change in average of the net assets over the life-cycle for women who are eligible for EITC at least once in their life times. The resulting distribution shows that while the mean percent change in net assets is not different than zero, there is actually a significant increase in the net assets of the women who belong to the target group. Since net assets is a measure of both a woman's liabilities and assets, this result suggests that the effect of the debt relief provided by the tax credit is dominant for the majority of the women. A further investigation reveals that the women who experience a decline in their net assets have an average net worth of over $8,500. Evidently, for these women with relatively higher levels of net worth, the consumption-smoothing motive dominates the increase in the lifetime wealth as a result of the EITC.

8 Policy Analysis

Recently, the EITC has been the focus of the budget negotiations as well as the proposals concerning the cash transfer programs. Most notably, the recent proposals by President Obama and Congressman Ryan involve expansions in the credit for childless workers. In this section, I first analyze the long-term benefits and provide an estimate of the cost of such an expansion. Next, I consider imposing an asset test for the EITC similar to the asset limits in SNAP and TANF. Public benefit programs have historically included asset tests that prevent eligible individuals to accumulate assets and thus, move along the path to financial security. Even though the EITC does not have a formal asset test, in a counterfactual experiment, I analyze the impact of such a limit on women's behaviors in hope of shedding some light on the possible programs these asset tests create for the other public programs' recipients.

8.1 Expanding the Tax Credit for Childless Women

Since its implementation, the EITC has undergone major expansions that increased the generosity of the credit as well as the range of eligibility. However, childless taxpayers have benefited the least from these expansions. To give an example, a childless single women who works full time at the minimum wage is not eligible for the tax credit as the level of her labor market earnings is above the eligibility threshold that childless taxpayers face. As a result, the credit fails to provide cash assistance to many low-wage childless taxpayers.

Recently several proposals have been made to expand the credit schedule for the childless workers. Most notably, both President Obama and Congressman Ryan proposed to lower the eligibility age for this group to 21, to double the maximum credit to $1,000, and to raise the ending income for the tax credit to $18,000. These changes imply that both the credit rate and the phase-out rate are doubled to 15.3% for the childless workers. Moreover, this proposal is estimated to have a cost around $60 billion.

Table 15 presents the estimated change in the employment, hours of work, average wages and net assets for single women under the proposed EITC expansion. The results show that under the new credit schedule, the employment rate for single women is expected to rise by

2.2%. However, conditional on employment, the responses in work hours are less responsive to the expansion in the credit schedule. There are two main reasons that generate this result. First, in the sample that I'm using for the empirical analysis, only 30% of the single women have earnings less than $18,000 which is the threshold for eligibility. Thus, the change in the hours of work for eligible women is in fact 3.13%. Second, among the payment regions of the credit schedule, the subsidy region provides the strongest work incentives. However, even with the EITC expansion for the end income for the subsidy region is quite low. More specifically, for a childless woman to be in the subsidy region, the level of her earnings needs to be lower than $6,570 under the proposed credit schedule. That being said, only 6% of the childless women in my sample have earnings that fall in the subsidy region. As a result, only a few women are subject to the full extent of the work incentives the tax credit provides. Nevertheless, the average wage rate still rises by 1.41% for single childless women. This means that the EITC eligible women experience an increase in the average wage rate by 4.7%. Even though the credit cannot extend the work incentives to the majority of eligible women, because the eligibility age is lowered to 21 with the proposed expansion the effect of human capital accumulation is significant. Finally, the eligible women increase the average net assets by %1.53 (= 0.46/0.3). This result suggests that the consumption smoothing motives for childless women is dominated by the wealth effect created by the EITC.

8.2 Imposing an Asset Test

The second policy analysis I consider in this paper is imposing an asset test as one of the eligibility requirement for the EITC. Recent discussions on the effectiveness government transfer programs focus on eliminating the asset tests on SNAP and TANF. The advocates of eliminating the asset limits for government programs argue that these limits provide incentives to drive down assets or to not save at all. However, considering the target population for cash transfer programs, it is evident that helping these individuals in reaching financial security is a key component for eliminating dependency on government transfers and thus, for promoting self-sufficiency. In line with these arguments, recently several states have eliminated the asset limits for SNAP.

In order to assess whether these asset tests in fact decrease the effectiveness of the government programs, in this section I analyze the responses of single women to an introduction of an asset limit for EITC eligibility. For the analysis I first use the 2002 tax and credit schedule and simulate life-cycle paths for single women. Next, I again use the 2002 tax and credit schedule with an additional requirement for EITC eligibility. More specifically, I impose an asset limit of $5,000 and simulate the life-cycle paths of single women to see if there is any change in their responses. The results from this exercise are presented in Table 16.

As can be seen from the table due to the asset test, the work incentives provided by the EITC reach out to fewer women and thus the extensive-margin responses to EITC are weaker. In particular, the employment rate fall by 1.5 percentage points or 1.7% as a result of the asset test. The decline in the employment rate is generated by the behavior of women who are not working but living off of their assets. The intensive-margin responses on the other hand are not significantly altered by the introduction of an asset test. This is due to two main factors. First, with the introduction of the asset test, fewer women are now eligible for the EITC. More specifically, the fraction of EITC-eligible women falls from 39% to 34%. Second, the women who are eligible for the EITC work more than they do without the asset test. Since the incentives created by the tax credit discourage saving, these women use their labor market experience as an insurance that replaces the insurance provided by assets. The change in the wage growth is also negative but insignificant. The decline in the wage growth with the asset test stems from the decline in the employment rate. As mentioned before, career breaks have a detrimental impact on the wage rate a single woman faces. However, due to the asset test, some women cannot benefit from the work incentives the EITC provides and thus, remain unemployed. This, in turn, leads to a decline in their future wages. Finally, the last row of the table indicates that the average net assets of single women fall with the introduction of an asset test. There are two main channels that generate this result. First, the women who remain unemployed as a result of the introduction of an asset test miss on labor market earnings for that period and thus, fail to accumulate assets. In fact, some of these women even dissave as they live off of their assets. Second, low-income women whose assets are slightly above the asset limit decumulate their asset stock in order to be eligible for the tax credit. Third, the women who are eligible for the EITC even with the asset limit cannot accumulate assets unless their earnings are far above the income limit for the tax credit. Therefore, the asset accumulation process slows down considerably. Considering the fact that these women lack the safety net provided by spousal earnings, this decline in the average net assets is quite dangerous. If there is a labor market shock that leaves these women unemployed, they'd be dependent on the government programs as they wouldn't have the necessary savings that would act as a buffer in the periods they remain unemployed.

9 Conclusion

This paper develops and estimates a female life-cycle labor supply model with human capital accumulation, borrowing constraints and unobserved heterogeneity in skills and preferences to assess whether the work incentives provided by the EITC is sufficient to promote wage growth. In the analysis, I study the changes in the behavior of single women primarily because they lack the safety net created by spousal earnings. Estimates of the structural parameters, derived using the Panel Study of Income Dynamics shed light on the importance of human capital accumulation and career breaks on wage growth. Comparing the life-cycle profiles simulated under the 2002 tax credit schedule to those without the EITC, I find that EITC is successful in helping single women climb the wage ladder. Further analysis reveals that this wage growth mostly results from the human capital accumulation generated by the tax credit, rather than its immediate effect on the per-period budget constraint.

Using the parameter estimates from the model, I first show that the expansion of the credit for childless workers promotes further wage growth. However, unless the eligibility range of the credit is increased even further, the impact of the EITC would be constrained. In particular, a flatter but longer subsidy region might be more influential in helping childless single women climb the wage ladder. Next, I investigate whether asset tests limit the benefits of government transfers. In particular, I impose an asset limit of $5,000 as an eligibility requirement for the EITC and find that both the work incentives and the wage growth created by the EITC is hindered. More significantly, the asset test slows down the asset accumulation process considerably and thus, leaves single women more vulnerable to labor market shocks.

A task for future research is to account for partnering and fertility decisions in the model. By doing so, both the marriage penalties and the pro-natal features of the EITC can be better understood. Moreover, as I am only focusing on single women in this paper, the data I am using is not nationally representative. By utilizing a more representative data and a model that can replicate the coupling and fertility dynamics in the data, it would be possible to make a sound cost-benefit analysis for possible reforms on the tax credit. Further research could also extend the model by endogenizing participation in welfare and food stamp programs. This would enable an analysis on whether EITC expansion crowds out welfare dependency. One final extension to this paper could be to add the firm side to the model and to analyze the general equilibrium effects of the EITC. Such an examination would allow an understanding of the complementarities between minimum wage policies and the EITC as both policy instruments target the same group of people. Moreover, by adding the firm side to the analysis, one can investigate the role of the EITC in protecting individuals during recession times against macroeconomic shocks.

10 Tables

Table 1: The Credit Schedule for 2013

	Credit rate (%)	Minimum income for maximum credit	Maximum credit	Phase-out rate (%)	Phase-out Range: Beginning income	Phase-out Range: Ending income
No child	7.65	6,370	487	7.65	7,970	14,340
One child	34	9,560	3,250	15.98	17,530	37,870
Two children	40	13,430	5,372	21.06	17,530	43,038
Three children	45	13,430	6,044	21.06	17,530	46,227

Table 2: Summary Statistics

	Mean	Std. Dev.	Min.	Max.
Age	33.06	9.59	16	66
Fraction of blacks	0.65	0.48	0	1
Fraction of high school dropouts	0.15	0.36	0	1
Fraction of high school graduates	0.4	0.49	0	1
Fraction of college dropouts	0.25	0.44	0	1
Fraction of college graduate	0.19	0.39	0	1
Number of children	0.87	0.88	0	2
Age of youngest child	3.3	4.21	1	17
Fraction employed	0.86	0.34	0	1
Annual work hours among employed	1,819	682.9	10	3,576
Annual earnings among employed ($)	26,836	17,661	123	69,756
Fraction receiving EITC	0.38	0.49	0	1
Federal EITC among EITC recipients ($)	1,900	1,338	1	4,645
State EITC ($)	29.95	134.95	0	1,587.6
Fraction receiving TANF	0.12	0.33	0	1
Average TANF among recipients ($)	3,063	1,721	23	6,494
Fraction receiving SNAP	0.26	0.44	0	1
Average SNAP among recipients ($)	3,467	2,197	45	6,782
Net worth	3,545	12,347	-33,032	72,133

Note: All monetary values are in 2006 dollars.

Table 3: Earnings and EITC Recipients by Age and Education Groups

	Avg. Earnings	Avg. Hours	% of EITC Recipients	Avg. EITC	Number of Observations
Age≤25	17,680	1,500	36.3	1,966	1,110
25<Age≤30	24,224	1,667	41.7	2,043	1.043
30<Age≤40	24,584	1,594	41.9	1,968	1,448
40<Age≤50	25,495	1,562	34.6	1,808	719
50<Age≤60	28,266	1,447	25.3	1,110	273
High School Dropouts	10,212	1,058	56.6	2,074	710
High School Graduates	18,571	1,483	47.6	1,997	1,843
College Dropouts	27,070	1,789	35.2	1,724	1,158
College Graduates	38,316	1,897	8.5	1,503	882

Note: Number of observations refer to the number of observations with non-missing labor market status. The average EITC amount reflects the average of the tax credit amont EITC recipients.

Table 4: Age, Education, and Hours Decomposition for EITC Recipients

Age		Education		Annual Work Hours	
Age≤25	22.87	HS Dropout	22.81	Hours<350	8.75
25<Age≤30	24.69	HS Grad.	49.77	350≤Hours<1300	23.85
30<Age≤40	34.39	Coll. Dropout	23.16	1300≤Hours<1950	27.65
40<Age≤50	14.13	Coll. Grad.	4.26	1950≤Hours<2200	27.31
50<Age≤60	3.92			Hours>2200	12.44

Note: The numbers refer to the percentage of EITC recipients that belong to each relevant group.

Table 5: Estimates for the Cost of Child Care

Parameter	Variable	Estimate
α_0^{cc}	Constant	15.641***
		(0.1763)
α_1^{cc}	Number of children	3.01***
		(0.5848)
α_2^{cc}	If youngest child is between the age of 3 & 5	0.198
		(0.7695)
α_3^{cc}	If youngest child is between the age of 6 & 10	−3.704***
		(0.778)
α_4^{cc}	If youngest child is between the age of 11 & 17	−9.227***
		(0.8838)
α_5^{cc}	Hours of work choice	0.412***
		(0.0296)
σ_{cc}	Standard deviation of the child care expenditure shock	14.007

Notes: Standard errors in paranthesis. * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; and *** indicates statistical significance at the 1 percent level. Child care cost is divided by 100.

Table 6: ESTIMATES FOR TANF PARTICIPATION AND BENEFITS

Parameter	Variable	Estimate
	PARTICIPATION	
α_0^{pt}	Constant	189.108***
		(31.8729)
α_1^{pt}	Annual earnings	−0.01***
		(0.0008)
α_2^{pt}	Education	−0.186*
		(0.0965)
α_3^{pt}	Whether the woman is black	0.278
		(0.2239)
α_4^{pt}	Age	−0.058***
		(0.0102)
α_5^{pt}	Year	−0.095***
		(0.0159)
α_6^{pt}	State of residence	−0.01
		(0.0462)
	BENEFITS	
α_0^{tanf}	Constant	31.082
		(23.9887)
α_1^{tanf}	State of residence	−0.051
		(0.0353)
α_2^{tanf}	Year	0.149
		(0.0946)
α_3^{tanf}	Annual earnings	−0.001**
		(0.0006)
α_4^{tanf}	Number of children	0.149
		(0.0946)
σ_{tanf}	Standard deviation of the TANF benefit shock	0.8794

NOTES: Standard errors in paranthesis. * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; and *** indicates statistical significance at the 1 percent level. All monetary variables including the benefits are divided by 100.

Table 7: ESTIMATES FOR SNAP PARTICIPATION AND BENEFITS

Parameter	Variable	Estimate
	PARTICIPATION	
α_0^{ps}	Constant	-75.315^{***}
		(21.2609)
α_1^{ps}	Annual earnings	-0.009^{***}
		(0.0005)
α_2^{ps}	Education	-0.22^{***}
		(0.0658)
α_3^{ps}	TANF benefits	0.038^{***}
		(0.005)
α_4^{ps}	Age	-0.03^{***}
		(0.0062)
α_5^{ps}	Year	0.0372^{***}
		(0.0106)
α_6^{ps}	Whether the woman is black	0.7
		(0.1477)
α_7^{ps}	State of residence	0.101
		(0.0336)
	BENEFITS	
α_0^{snap}	Constant	-20.698^{**}
		(10.3586)
α_1^{snap}	State of residence	-0.028
		(0.0175)
α_2^{snap}	Year	0.014
		(0.0052)
α_3^{snap}	Annual earnings	-0.002^{***}
		(0.0003)
α_4^{snap}	TANF benefits	-0.004^{***}
		(0.0011)
α_5^{snap}	Number of children	0.409^{***}
		(0.0362)
σ_{snap}	Standard deviation of the SNAP benefit shock	0.7309

NOTES: Standard errors in paranthesis. * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; and *** indicates statistical significance at the 1 percent level. All monetary variables including the benefits are divided by 100.

Table 8: Estimates of the Transition in the Number of Children

Parameter	Variable	Estimate
	$\Pr(N_{i,t+1} = 1)$	
α^n_{01}	Constant	-1.742^{***}
		(0.2935)
α^n_{11}	Age	-0.055^{***}
		(0.0094)
α^n_{21}	Education	-0.194^{**}
		(0.0888)
α^n_{31}	Age of youngest child if there is a child	0.077
		(0.1162)
α^n_{41}	Number of children	5.544^{***}
		(0.3521)
	$\Pr(N_{i,t+1} = 2)$	
α^n_{02}	Constant	-7.011^{***}
		(0.4397)
α^n_{12}	Age	-0.077^{***}
		(0.0138)
α^n_{22}	Education	-0.388^{***}
		(0.1265)
α^n_{32}	Age of youngest child if there is a child	-0.359^{***}
		(0.1378)
α^n_{42}	Number of children	10.556^{***}
		(0.3924)

Notes: Standard errors in paranthesis. * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; and *** indicates statistical significance at the 1 percent level. The probability of not having child is calculated using the above probabilities, as having no child is the base group in the estimation.

Table 9: ESTIMATES OF THE TRANSITION IN AGE OF THE YOUNGEST CHILD

Parameter	Variable	Estimate
	$\Pr(N^k_{i,t+1} = 2)$	
α^k_{02}	Constant	-1.21^{***}
		(0.3039)
α^k_{12}	Age	-0.022^{***}
		(0.0072)
α^k_{22}	Education	0.269^{***}
		(0.0679)
α^k_{32}	Number of children	0.208^{*}
		(0.1188)
α^k_{42}	Age of the youngest child	0.3864^{***}
		(0.081)
	$\Pr(N^k_{i,t+1} = 3)$	
α^k_{03}	Constant	-6.281^{***}
		(0.4078)
α^k_{13}	Age	-0.012
		(0.009)
α^k_{23}	Education	0.424^{***}
		(0.0836)
α^k_{33}	Number of children	0.594^{***}
		(0.1439)
α^k_{43}	Age of the youngest child	2.229^{***}
		(0.0994)
	$\Pr(N^k_{i,t+1} = 4)$	
α^k_{04}	Constant	-16.518^{***}
		(0.8201)
α^k_{14}	Age	0.035^{***}
		(0.0132)
α^k_{24}	Education	0.469^{***}
		(0.1189)
α^k_{34}	Number of children	0.682^{***}
		(0.2049)
α^k_{44}	Age of the youngest child	4.827^{***}
		(0.1862)

NOTES: Standard errors in paranthesis. * indicates statistical significance at the 10% level; ** indicates statistical significance at the 5% level; and *** indicates statistical significance at the 1 percent level. The probability of the age of youngest child being less than 2 is calculated using the above probabilities, as it is the base group in the estimation.

Table 10: ESTIMATES OF THE FLOW UTILITY PARAMETERS

Parameter	Variable	Estimate	Std. Error
θ_c	CRRA parameter	0.5123	0.0057
α_2^u	If the woman chooses to work between 1300 and 1950 hours ($d_{it}^h = 2$)	2.1522	0.0452
α_3^u	If the woman chooses to work between 1950 and 2200 hours ($d_{it}^h = 3$)	5.7481	0.0374
α_4^u	If the woman chooses to work more than 2200 hours ($d_{it}^h = 4$)	5.8303	0.0396
α_5^u	$d_{it}^h = 1$ and $d_{i,t-1}^h = 1$	0.1472	0.0591
α_6^u	$d_{it}^h = 2$ and $d_{i,t-1}^h = 2$	0.2031	0.0348
α_7^u	$d_{it}^h = 3$ and $d_{i,t-1}^h = 3$	0.8412	0.0913
α_8^u	$d_{it}^h = 4$ and $d_{i,t-1}^h = 4$	0.8532	0.0901
MARGINAL UTILITY OF CONSUMPTION SHIFTERS			
α_{01}^c	If the woman belongs to type 1	4.1033	1.4820
α_{02}^c	If the woman belongs to type 2	2.105	0.4361
α_{03}^c	If the woman belongs to type 3	3.915	0.2182
α_{04}^c	If the woman belongs to type 4	2.082	0.1421
α_1^c	If the woman is younger than 25	-0.467	0.0902
α_2^c	If the woman is younger than 30	-0.168	0.1203
α_3^c	If the woman is older than 40	-1.279	0.2035
α_4^c	If the woman is older than 50	0.6	0.4783
α_5^c	Number of children	1.038	0.2917
MARGINAL DISUTILITY OF WORK SHIFTERS			
α_0^h	Constant	-1.2675	0.0394
α_{12}^h	If the woman is of type 2	-0.057	0.0487
α_{13}^h	If the woman is of type 3	0.134	0.0213
α_{14}^h	If the woman is of type 4	0.192	0.0349
α_2^h	If the woman is younger than 25	-1.2881	0.0183
α_3^h	If the woman is younger than 30	-1.2564	0.0304
α_4^h	If the woman is older than 40	-0.2708	0.0151
α_5^h	If the woman is older than 50	-1.3569	0.0428

Table 11: Estimates of the Wage Equation and the Net Asset Lower Bound Parameters

Parameter	Variable	Estimate	Std. Error
Wage Parameters			
α_0^w	Constant	3.1791	1.2451
α_{12}^w	If the woman belongs to type 2	0.11	0.0385
α_{13}^w	If the woman belongs to type 3	6.42	0.9412
α_{14}^w	If the woman belongs to type 4	6.93	0.8463
α_{22}^w	If the woman chooses to work between 1300 & 1950 hours	0.4995	0.2739
α_{23}^w	If the woman chooses to work between 1950 & 2200 hours	0.8246	0.1826
α_{24}^w	If the woman chooses to work more than 2200 hours	0.894	0.1731
α_3^w	Woman's age	0.012	0.0247
α_4^w	If the woman is black	-0.1664	0.0318
α_5^w	Educational attainment	0.041	0.0129
α_6^w	Experience stock	0.135	0.0379
α_{71}^w	If the woman worked less than 1300 hours last year	0.0086	0.0403
α_{72}^w	If the woman worked between 1300 & 1950 hours last year	0.0452	0.0178
α_{73}^w	If the woman worked between 1950 & 2200 hours last year	0.0673	0.0225
α_{74}^w	If the woman worked more than 2200 hours last year	0.0668	0.0289
α_8^w	Calendar year	0.0035	0.0120
α_9^w	State of Residence	0.0921	0.0311
Asset Bound Parameters			
α_0^b	Constant	12.1543	0.9131
α_1^b	Age	-0.131	0.0126
α_2^b	Age-squared	-0.093	0.0899
α_3^b	Schooling	-0.2029	0.0244
$\underline{c}$	Minimum consumption floor	2,118	371

Table 12: Estimates of the Type Probabilities and the Error Distributions

Parameter	Variable	Estimate	Std. Error
Prob. of Being a Type 2 Woman			
α_{02}^t	Constant	1.953	0.7121
α_{12}^t	If the woman is a high school dropout	1.723	0.5234
α_{22}^t	If the woman has at least some college education	-0.261	0.1041
Prob. of Being a Type 3 Woman			
α_{03}^t	Constant	2.254	0.4551
α_{13}^t	If the woman is a high school dropout	-0.712	0.2717
α_{23}^t	If the woman has at least some college education	0.683	0.1903
Prob. of Being a Type 4 Woman			
α_{04}^t	Constant	0.879	0.2041
α_{14}^t	If the woman is a high school dropout	-0.547	0.1031
α_{24}^t	If the woman has at least some college education	1.426	0.1923
Error Distributions			
σ_h	Standard deviation of the preference shock	1.1979	0.1923
σ_w	Standard deviation of the wage shock	0.9897	0.0842
ρ_{hw}	Correlation between the preference and the wage shock	-0.5948	0.0679
σ_{mw}	Standard deviation of the measurement error in wages	0.262	0.0213
$\sigma_{ma,0}$	Constant of the standard deviation of the measurement error in assets	1.324	0.1387
$\sigma_{ma,1}$	Slope of the standard deviation of the measurement error in assets	0.141	0.0171

Table 13: The Impact of the EITC on Employment, Hours of Work, Wages and Net Assets

	Without HC Accumulation			With HC Accumulation		
	No EITC	With EITC	% Change	No EITC	With EITC	% Change
Employment	0.78	0.80	+2.6	0.84	0.88	+4.8
Hours of Work (cond. on employment)	1,310	1,308	-0.15	1,802	1,835	+1.84
Wage	11.12	11.15	+0.27	13.14	13.8	+5.02
Net Assets	3,143	3,197	+1.72	3,482	3,495	+0.37

Notes: The first two columns of the table show the simulations from the model when the human capital accumulation channel is closed. This means the experience stock and the work hours choice from the previous period has no effect on the wage level. The numbers in the 3rd and the 6th columns show the percent changes between the responses with and without the EITC.

Table 14: Percent Change in Wage under EITC (Target Group)

Age groups	% Change	Education Groups	% Change	Nr. of Children	% Change
Age<25	+4	HS dropouts	+16	No child	+4
25<Age<40	+13	HS grads	+14	One child	+9
40<Age<50	+20	Coll. dropouts	+8	Two children	+16
50<Age<60	+23	Coll. grads	+3		

Notes: The numbers show the percent change in the wage rate as between the simulation with and without the EITC.

Table 15: The Impact of an EITC Expansion for Childless Women on Employment, Hours of Work, Wages, and Net Assets

	Current EITC Schedule	With EITC Expansion	% Change
Employment	0.91	0.93	+2.2
Hours of Work (cond. on employment)	1,819	1,836	+0.94
Wage	15.01	15.43	+1.41
Net Assets	5,604	5,630	+0.46

Notes: The first column of the table reports the averages of the corresponding variables for single women from the simulations of the model using the current EITC schedule. The second column does the same using the simulations under an EITC expansion for childless workers. The numbers in the 3rd column shows the percent changes between the responses with and without the EITC expansion.

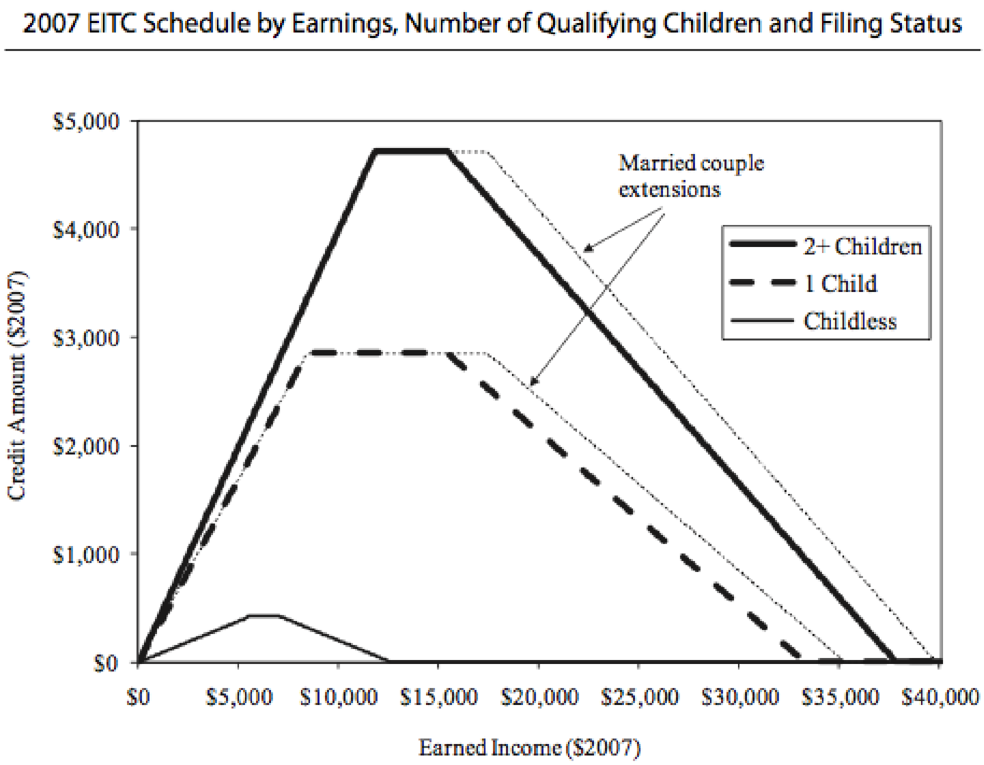
Table 16: The Impact of an Asset Limit on Employment, Hours of Work, Wages, and Net Assets

	Current EITC Schedule	With Asset Test	% Change
Employment	0.88	0.865	-1.7
Hours of Work (cond. on employment)	1,835	1,820	-0.82
Wage	13.8	13.4	-0.29
Net Assets	3,495	3,425	-2.01

Notes: The first column of the table reports the averages of the corresponding variables for single women from the simulations of the model using the current EITC schedule. The second column does the same using the simulations under an EITC expansion for childless workers. The numbers in the 3rd column shows the percent changes between the responses with and without the EITC expansion.

11 Figures

Figure 1: EITC Schedule



Source:Eissa and Hoynes (2006)

Figure 2: The Distribution of Net Worth in the Sample

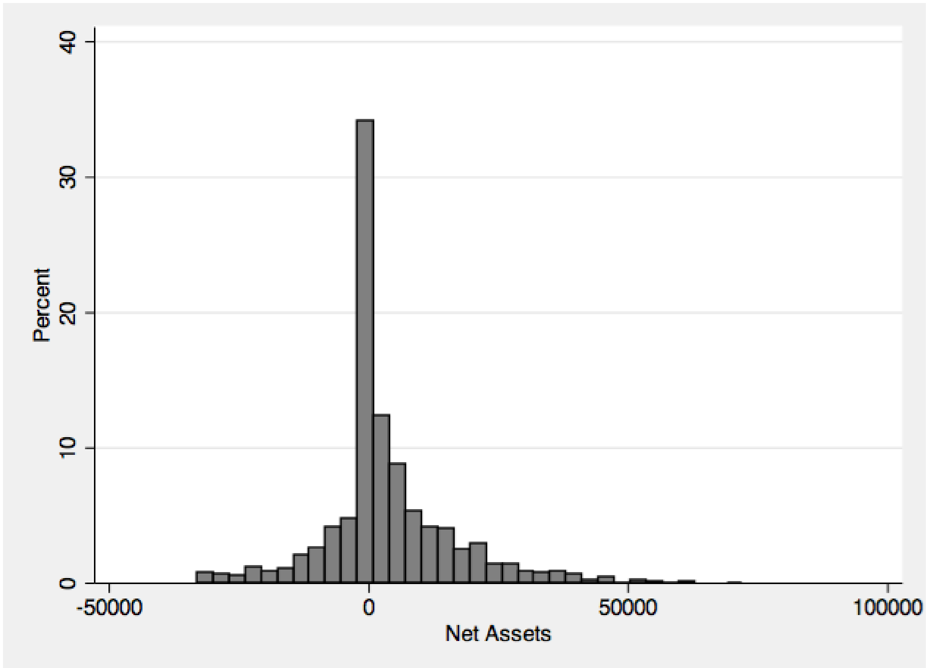


Figure 3: Average Wages by EITC Recipiency

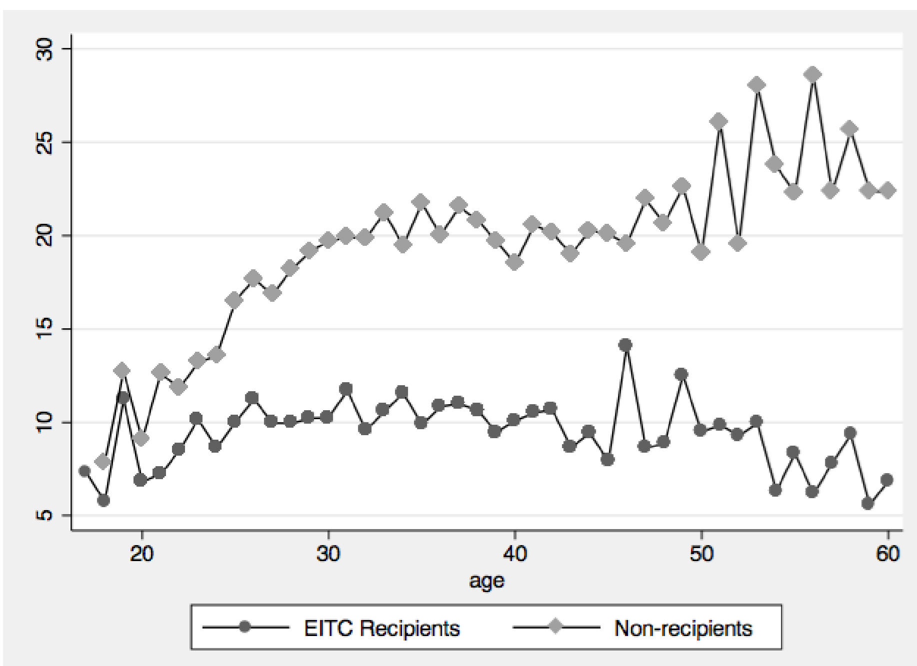
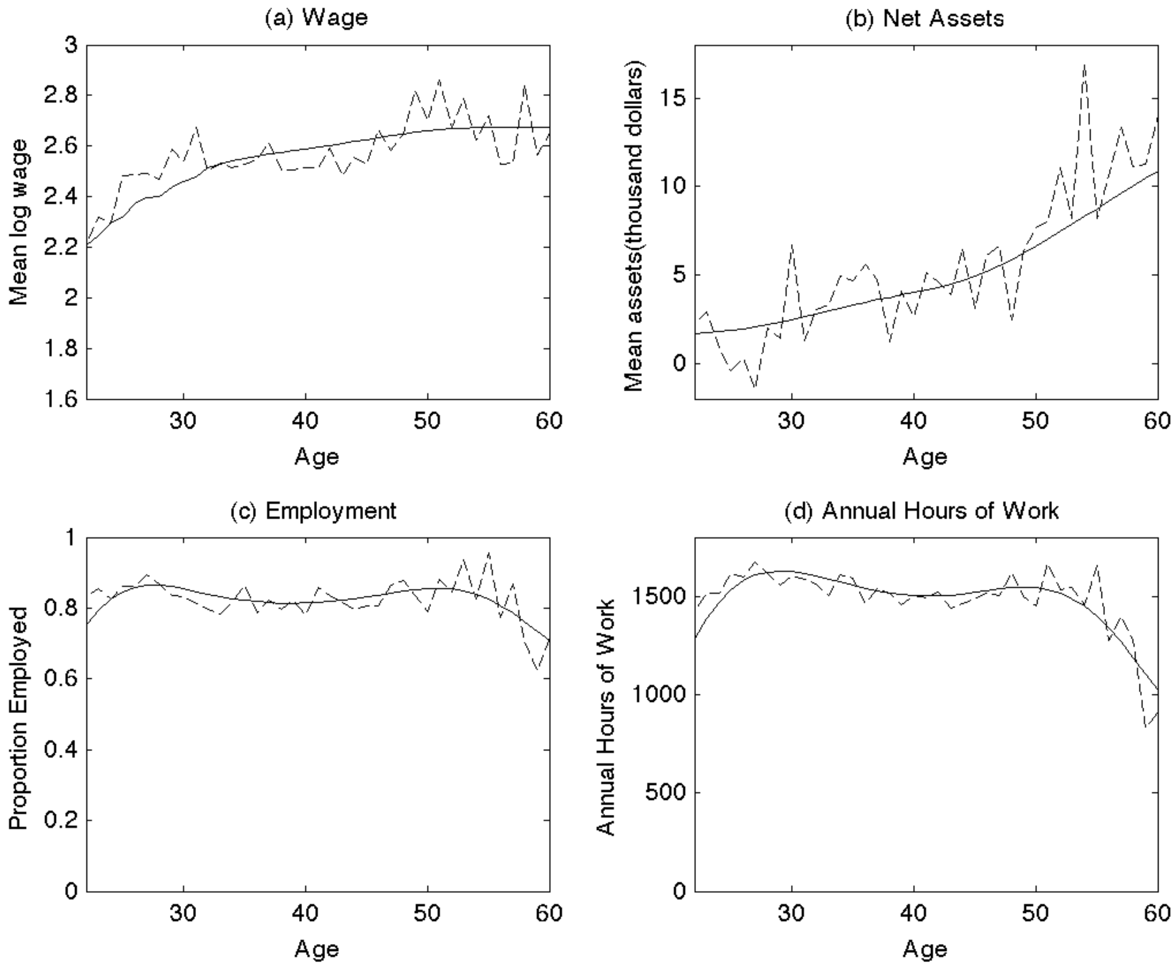
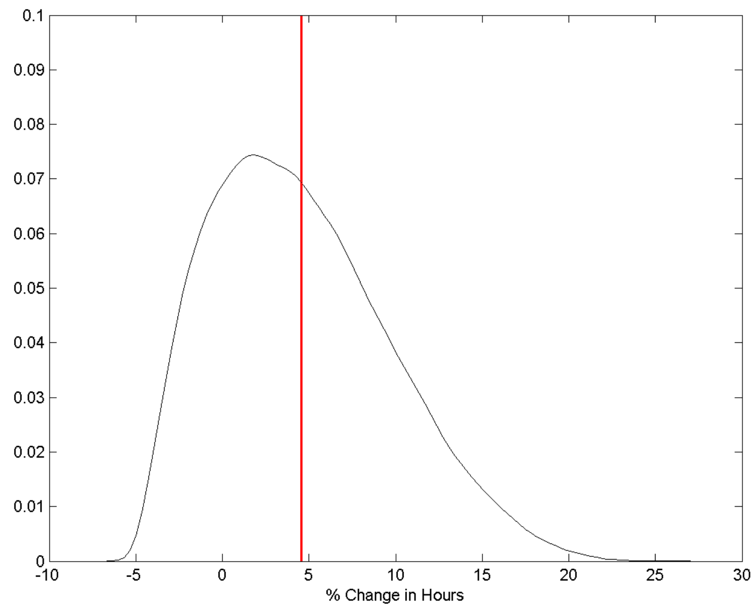


Figure 4: Within Sample Fit for Wage, Asset, Employment, and Hours of Work



Note: Dashed lines represent data and solid lines represent simulations.

Figure 5: The Distribution of the Change in Work Hours for the EITC Target Group



Note: The red line is the mean of the distribution.

Figure 6: The Life-Cycle Wage Path of the Women in the Target Group

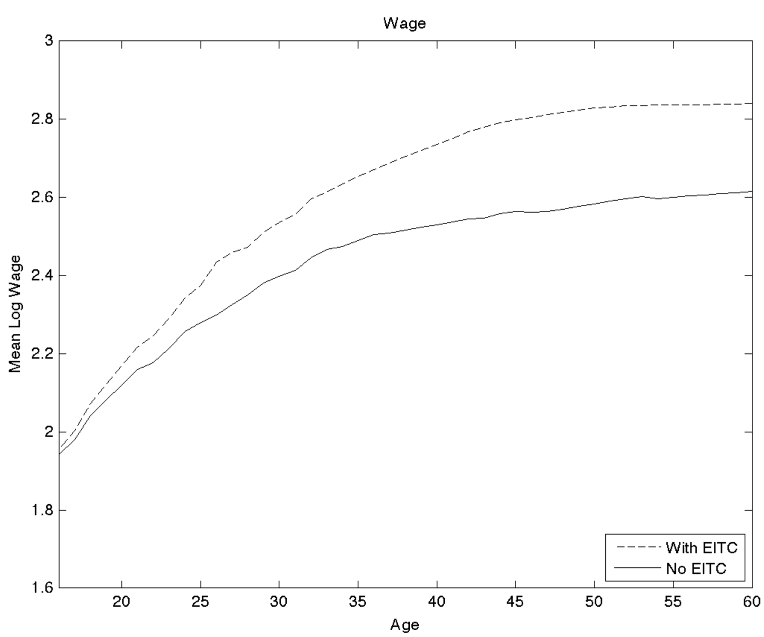


Figure 7: Introducing the EITC at Different Stages of the Life-cyce

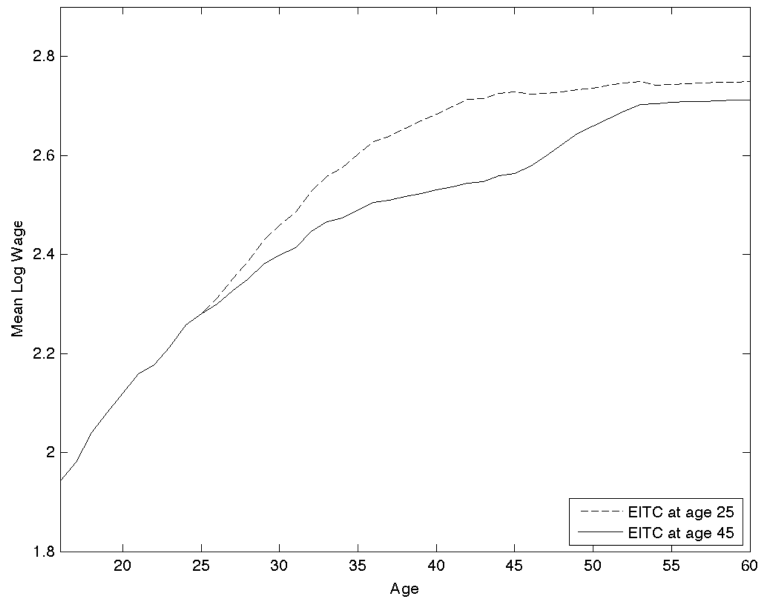
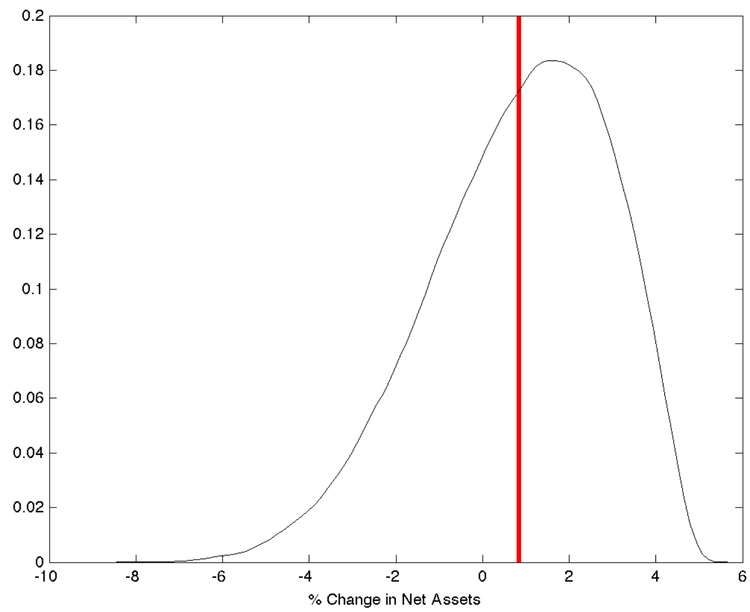


Figure 8: The Distribution of the Change in Net Assets for the EITC Target Group



Note: The red line is the mean of the distribution.

References

Altuğ, S. and R. A. Miller (1998): "The Effect of Work Experience on Female Wages and Labour Supply," *The Review of Economic Studies*, 65, 45–85.

Athreya, K., D. Reilly, and N. B. Simpson (2014): "Young Unskilled Women and the Earned Income Tax Credit: Insurance Without Disincentives?" The Federal Reserve Bank of Richmond, Working Paper Series.

Ben-Shalom, Y., R. A. Moffitt, and J. K. Scholz (2011): "An Assessment of the effectiveness of anti-poverty programs in the United States," National Bureau of Economic Research.

Blank, A. (2012): "Long-term Consequences of the EITC Program," Mimeo: Boston College.

Blundell, R. (2006): "Earned Income Tax Credit Policies: Impact and Optimality: The Adam Smith Lecture, 2005," *Labour Economics*, 13, 423–443.

Blundell, R., M. C. Dias, C. Meghir, and J. Shaw (2013): "Female Labour Supply, Human Capital and Tax Reform," National Bureau of Economic Research.

Celik, S. (2011): "The Impact of the Earned Income Tax Credit on the Educational Investments of Single Mothers: Evidence form State EITCs," Mimeo: University of Houston.

Chan, M. K. (2013): "A Dynamic Model of Welfare Reform," *Econometrica*, 81, 941–1001.

Cogan, J. F. (1981): "Fixed Costs and Labor Supply," *Econometrica*, 49, 945–964.

Connolly, H. and P. Gottschalk (2004): "Do Earnings Subsidies Affect Job Choice?" IZA Discussion Paper.

Del Boca, D., C. Flinn, and M. Wiswall (2014): "Household Choices and child development," *The Review of Economic Studies*, 81, 137–185.

Diamond, P. A. (1971): "A Model of Price Adjustment," *Journal of Economic Theory*, 3, 156–168.

Eckstein, Z. and K. I. Wolpin (1989): "Dynamic Labour Force Participation of Married Women and Endogenous Work Experience," *The Review of Economic Studies*, 56, 375–390.

Eissa, N. and H. W. Hoynes (2006): "Behavioral Responses to Taxes: Lessons from the EITC and Labor Supply," in *Tax Policy and the Economy, Volume 20*, The MIT Press, 73–110.

——— (2011): "Redistribution and Tax Expenditures: The Earned Income Tax Credit," *National Tax Journal*, 64, 689–730.

Eissa, N. and J. B. Liebman (1996): "Labor Supply Response to the Earned Income Tax Credit," *The Quarterly Journal of Economics*, 111, 605–637.

Francesconi, M. (2002): "A Joint Dynamic Model of Fertility and Work of Married Women," *Journal of Labor Economics*, 20, 336–380.

Gladden, T. and C. Taber (2000): "Wage Progression among Less Skilled Workers," in *Finding Jobs: Work and Welfare Reform*, ed. by D. Card and R. M. Blank, New York: Russell Sage Foundation, 160–192.

Grogger, J. (2005): "Welfare Reform, Returns to Experience, and Wages: Using Reservation Wages to Account for Sample Selection Bias," National Bureau of Economic Research.

Heckman, J., L. Lochner, and R. Cossa (2002): "Learning-by-Doing vs. On-the-Job Training: Using Variation Induced by the EITC to Distinguish Between Models of Skill Formation," National Bureau of Economic Research.

Hotz, V. J. and J. K. Scholz (2003): "The Earned Income Tax Credit," in *Means-Tested Transfer Programs in the United States*, ed. by R. A. Moffitt, University of Chicago Press, 141–198.

Hoynes, H. W. (2009): "The Earned Income Tax Credit, Welfare Reform, and the Employment of Low-Skilled Single Mothers," *Strategies for improving economic mobility of workers: bridging research and practice*, 65.

Imai, S. and M. P. Keane (2004): "Intertemporal Labor Supply and Human Capital Accumulation*," *International Economic Review*, 45, 601–641.

Keane, M. P. (2009): "Income Taxation in a Life Cycle Model with Human Capital," Unpublished Manuscript.

——— (2011): "Labor supply and taxes: A survey," *Journal of Economic Literature*, 49, 961–1075.

Keane, M. P. and R. Rogerson (2012): "Micro and Macro Labor Supply Elasticities: A Reassessment of Conventional Wisdom," *Journal of Economic Literature*, 50, 464–476.

Keane, M. P., P. E. Todd, and K. I. Wolpin (2011): "The Structural Estimation of Behavioral Models: Discrete Choice Dynamic Programming Methods and Applications," *Handbook of Labor Economics*, 4, 331–461.

Keane, M. P. and K. I. Wolpin (1994): "The Solution and Estimation of Discrete Choice Dynamic Programming Models by Simulation and Interpolation: Monte Carlo Evidence," *The Review of Economics and Statistics*, 648–672.

——— (2001): "The Effect of Parental Transfers and Borrowing Constraints on Educational Attainment," *International Economic Review*, 1051–1103.

——— (2010): "The Role of Labor and Marriage Markets, Preference Heterogeneity, and the Welfare System in the Life Cycle Decisions of Black, Hispanic, and White Women," *International Economic Review*, 51, 851–892.

Lee, Y. (2012): "Labor Supply Effects of the Earned Income Tax Credit under Labor Supply Restrictions," Mimeo: University of Wisconsin Madison.

Liebman, J. B. (1998): "The Impact of the Earned Income Tax Credit on Incentives and Income Distribution," *Tax Policy and the Economy*, 12, 83–119.

Mendenhall, R., K. Edin, S. Crowley, J. Sykes, L. Tach, K. Kriz, and J. R. Kling (2012): "The Role of Earned Income Tax Credit in the Budgets of Low-Income Families," *Social Service Review*, 86, 367–400.

Meyer, B. D. and D. T. Rosenbaum (2001): "Welfare, the Earned Income Tax credit, and the Labor Supply of Single Mothers," *The Quarterly Journal of Economics*, 116, 1063–1114.

Miller, R. A. and S. G. Sanders (1997): "Human Capital Development and Welfare Participation," in *Carnegie-Rochester Conference Series on Public Policy*, Elsevier, vol. 46, 1–43.

Moffitt, R. A. (2002): "Welfare Programs and Labor Supply," *Handbook of Public Economics*, 4, 2393–2430.

Neumark, D. and W. Wascher (2001): "Using The EITC to Help Poor Families: New Evidence and a Comparison with the Minimum Wage," *National Tax Journal*, 281–317.

Olson, L. M. and A. Davis (1994): *The Earned Income Tax Credit: Views from the Street Level*, Center for Urban Affairs and Policy Research, Northwestern University.

Romich, J. L. and T. Weisner (2000): "How Families View and Use the EITC: Advance Payment versus Lump Sum Delivery," *National Tax Journal*, 1245–1265.

Scholz, J. K. (1994): "The Earned Income Tax Credit: Participation, Compliance, and Antipoverty Effectiveness," *National Tax Journal*, 63–87.

Smeeding, T. M., K. R. Phillips, and M. O'Connor (2000): "The EITC: Expectation, Knowledge, Use, and Economic and Social Mobility," *National Tax Journal*, 1187–1209.

Van der Klaauw, W. (1996): "Female Labour Supply and Marital Status Decisions: A Life-Cycle Model," *The Review of Economic Studies*, 63, 199–235.