Taxation and Household Decisions: an Intertemporal Analysis[*]

Mary Ann Bronson[†]   Maurizio Mazzocco[‡]

September 2018 – PRELIMINARY

Abstract

We evaluate the effect of different taxation systems on choices and welfare. We start by providing descriptive evidence that distinct taxation systems create different incentives for primary and secondary earners and that these incentives affect important outcomes. We then develop and estimate using U.S. data a model in which single and married individuals make decisions on labor supply, household production, human capital accumulation, consumption, savings, marriage, and divorce. Lastly, we use the model to evaluate three tax policies that have been frequently debated: a shift from a joint to an individual taxation system; the introduction of a secondary earner deduction in a joint taxation system; and the addition of child care subsidies to a joint and to an individual taxation system. We find that all three policies have substantive effects on people's choices and welfare, with secondary earners being affected the most. Their labor force participation and labor supply increases at the expenses of lower hours devoted to household production, they accumulate more human capital, their intra-household decisions power increases, and they enjoy higher levels of welfare.

[†]Georgetown University, Dept. of Economics, Washington, D.C. Email: mary.ann.bronson@gmail.com.
[‡]UCLA, Department of Economics, Bunche Hall, Los Angeles, CA. Email: mmazzocc@econ.ucla.edu.

1 Introduction

How do different taxation systems – for instance individual vs. joint – affect people's decisions and welfare? Answering this question is important for two interconnected reasons. First, countries can choose among several taxation systems that differ in many relevant dimensions. Evidence of this is that some countries currently adopt an individual taxation system after long periods in which taxes were based on a joint system. The main examples are the United Kingdom, which shifted from a joint to an individual system in 1990, and Canada, which switched to an individual system in the same year. Other countries have adopted the same system throughout their history, but entertain regular discussions on the possibility of moving to a different taxation regime. The main examples are the United States (U.S.) with a joint taxation system, Sweden with an individual taxation system, and France which uses a hybrid system that incorporates elements of both systems. Second, the choice of a tax system has the potential to affect a number of potential outcomes that are of interest for economists and policy makers, such as labor supply choices over the lifecycle, the allocation of time between market and household production, the lifecycle accumulation of human capital and wealth, marriages and divorces, and welfare.

The main contribution of our paper is to provide an answer to the initial question. We proceed in four steps.

We first provide evidence that different taxation systems have distinct effects on individual and household choices. Using the Panel Studies and Income Dynamics (PSID) and the American Community Survey (ACS), we document that the joint taxation system creates incentives to supply time to the labor market for primary earners, but disincentives to work in the labor market for secondary earners, relative to an individual taxation system. The joint taxation system introduces the incentives in the form of higher take-home income (marriage bonuses), lower marginal tax rates for primary earners, and higher marginal tax rates for secondary earners. We then provide evidence that the existence of these incentives affect the individual decisions to work.

Given the evidence that a taxation system influences people's decisions, we evaluate these effects by developing, estimating, and simulating a model of individuals' and households' de-

cisions. For the simulation results to be credible, it is important to have reliable estimates of the model parameters that govern the people's response to changes in tax rates. We identify these parameters using as the primary source of variation the three main tax reform that took place in the U.S.: the Tax Reform Act of 1986 (the Reagan tax cuts), the 1993 Earned Income Tax Credit (EITC) expansion as part of Omnimus Budget Reconciliation Act (OBRA), and the Jobs and Growth Tax Relief Reconciliation Act of 2003 (the Bush tax cuts). In the second step, we describe the effects of these reforms on the labor force participation and labor supply decisions of single and married men and women and, hence, the type of variation we use to identify the parameters of interest. We find that the main impact of the Reagan and Bush tax cuts was to increase the labor force participation of married women, with larger effects for married women with young children. The 1993 EITC affected almost exclusively single women by increasing the number of hours they supply to the labor market.

In the third step, we introduce and estimate the model used to answer the question posed in the paper. To account for the fact that different taxation systems have different effects on people depending on their marital status, we consider an intertemporal model in which individuals are either single or married and the decisions to marry and divorce are endogenous. To capture the evidence that changes in tax rates influence the individual distribution of time to market and household activities, single and married individuals are allowed to choose how to allocated their time between market hours, household production, and leisure. In the model, the time decisions influence the individual accumulation of human capital to take into consideration that taxation systems that incentivize market activities may have life-long effects, especially for secondary earners. Since the model is estimated using U.S. data, we model in detail the U.S. taxation system by coding the year-on-year changes in tax brackets due to the tax code, to minor tax reforms, and to the three major tax reforms discussed above. Lastly, to account for the fact that the performance of a taxation system depends on the existing welfare system, we model in detail the main components of the U.S. safety net: Social Security Income (SSI) taxes and Medicare taxes, the EITC, the Child Tax Credit (CTC), the Child and Dependent Care Credit (CDCC), and the Supplemental Nutrition Assistance Program (SNAP).

In the last step, we use the estimated model to evaluate three of the most debated tax reforms: a shift from a joint to an individual taxation system; the introduction of a secondary

earner deduction in a joint taxation system; and the addition of child care subsidies to a joint and to an individual taxation system. Our results indicate that the transition from a joint to an individual taxation system has significant effects on choices and welfare, with married households in which only one spouse works being to most affected. We find that the labor force participation of secondary earners increase by as much as 5 percentage points and that the households that are impacted the most are the ones with high marginal tax rates for secondary earners under joint taxation. The move to individual taxation changes also how secondary earners allocate time between market and household activities. We find that they reduce the time they devoted on household production and increase the hours spend in the labor market, with the increase in labor hours that is smaller than the decline in household time. The corresponding increase in leisure for secondary earners is explained by a shift in decision power toward women of three percentage points generated by the tax reform. Lastly, using a welfare function that assigns equal weights to each household, we find that the shift to individual taxation produces welfare gains in the aggregate.

Some economists have proposed the introduction of a secondary earner deduction in place of a full transition to an individual taxation system, arguing that a shift to individual taxation is politically infeasible in most countries. Our results indicate that this alternative policy is a good substitute for the more drastic change to individual taxation, as the two policies have similar effects on choices and welfare. Analogously, to the first policy we evaluate, the introduction of a $20,000 secondary-earner deduction generates increases in the labor force participation of secondary earners that can be as large as 5 percentage points, produces a shift in the allocation of time from household production to market activities, and increases the overall welfare in the economy.

The last policy we simulate, child care subsidies under the joint and individual taxation systems, has also substantive effects on working decisions. The policy increases the fraction of secondary earners who work and their labor supply at the expenses of time devoted to household production under both the joint and individual taxation system. But the impact is larger under the individual system. For instance, the increase in labor force participation generated by this policy is between 1 and 2 percentage points larger under individual taxation.

Several papers have considered the effect of taxes on household decisions. Apps and Rees

(1999b) show theoretically that, in a static collective model of the household, a joint taxation system can never be welfare improving over an individual taxation system, even when household production is taken into account. In as separate paper, Apps and Rees (1999a) argue theoretically, using a static collective model of the household, that tax reforms should be evaluated using a model of the households with multiple members. Guner, Kaygusuz, and Ventura (2012) develop a dynamic equilibrium model in which men and women make labor supply decisions and use it to evaluate the effect of a change from joint to individual taxation on labor force participation and hours of work. Our paper differs in several respect. First, we provide evidence that the individuals affected the most by tax changes are married women with children younger than 6. For this reason, our model account for the presence of children of different ages and for household production, which is not the case in Guner, Kaygusuz, and Ventura (2012). Second, we estimate the model using micro data. This is particularly important because the effect of tax reform depends on the estimated intensive and extensive margin elasticities. Third, we model marriage and divorce decisions, which may play an important role when a country switches from a joint to an individual taxation system. One limitation of our paper relative to Guner, Kaygusuz, and Ventura (2012) is we do not consider general equilibrium effects, which are captured in their paper. Bick and Fuchs-Schndeln (2017) document that the cross-country correlation of average hours worked of working-age married men and married women is approximately zero. They then develop and simulate a static model of labor supply decisions for married men and women and provide evidence using the simulated data that differences in taxation systems across countries can explain the large differences in the labour supply behaviour of married men and married women across those countries. Gayle and Shephard (2016) develop and estimate a model of marriage and household decisions and use it to find the optimal tax structure for the U.S.. Differently from our model, in Gayle and Shephard (2016) there is no dynamics in household decisions. They can therefore only account for short run effects of changes in the tax structure. Their paper, differently from our, accounts for equilibrium effects in the marriage market, which we do not capture. In addition, they provide a formal proof of identification for their model whereas, given the complexity of our model, we can only provide a heuristic discussion of identification.

The paper proceeds as follows. In Section 2, we briefly discuss the data used in the paper.

Section 3 provides descriptive evidence of the effect of changes in tax rates on individual labor supply decisions. In Section 4, we document the effects that major tax reforms had on individual decisions. In Section 5, we develop the intertemporal model of the household. Section 6 describes the moments used in the estimation of the model. In Section 7, we report the estimation results, the fit of the model, and we discuss the effects of different taxation policies on household decisions. Section 8 concludes.

2   Data

In the paper, we use four data sets. We provide descriptive evidence using the 2000 Census and the American Community Survey (ACS), sample period 2001-2015. We employ the two data sets to compute labor force participation, hours of work, earnings, income, education, and demographic variables for primary and secondary earners. These variables are used to evaluate the effect of the Bush Tax cut on labor supply behavior. We perform the structural estimation using the Panel Studies of Income Dynamic (PSID), the CPS (1980-2016), and the American Time Use Survey (2009-2011).

3   Joint vs Individual Taxation Systems

Economists have documented that the choice of a taxation system and its main features can have significant effects on household decisions, especially on labor supply choices. The most intriguing evidence about the effects of joint vs. individual taxation is provided by Bick and Fuchs-Schundeln (2018), who document a correlation between the type of taxation system in a country and the aggregate labor supply of its men and women. While differences across countries in household behavior can be generated by any one of the many features that distinguish them, the findings presented by Bick and Fuchs-Schundeln, especially the negative effects of joint taxation on married women's labor supply, are striking.

In this Section, we provide descriptive evidence that taxation systems have important effects on individual decisions even within the same country. We proceed in two steps. We first describe the main differences between the individual and joint taxation systems and discuss

the incentives to supply labor they generate. We then provide evidence that these differences affect the individual labor supply decisions.

3.1   A Realistic Example

Relative to an individual taxation system, a joint system generates incentives to work for primary earners in married households and disincentives for secondary earners. To illustrate this point, we employ an example that represents a simplified version of the U.S. taxation system.

Consider a household composed of a person earning $80,000 in pre-tax income and a second person earning $30,000 in pre-tax income. As separate individuals, they are subject to the following tax schedule. No taxes on the first $10,000. They pay 15% on the subsequent income up to $40,000. They are taxed at 40% on the remaining income. As a married couple under a joint system, these brackets simply double. The tax scheduled are depicted in Figure 1. Table 1 reports the corresponding marginal and average tax rates, and after-tax incomes for the two individuals under the joint and individual taxation system. We report the average tax rate – total taxes divided by before-tax income – in addition to the marginal rate because, as it will be clear from our analysis, the average rate has strong effects on labor supply decisions.

The Table highlights the main differences between the joint and individual taxation systems. In an individual taxation system, the two household members are taxed at rates that correspond to their individual income. In our example, the person who earns the most – the primary earner – pays no taxes on the first $10,000, pays taxes at a rate of 10 percent up to 40,000, and at 40 percent on the remaining income. All this adds up to produce an after-tax income equal to $57,000, a marginal tax rate of 40 percent, and an average tax rate of 26 percent. The same calculations apply to the person who earns the least – the secondary earner – generating an after-tax income of $25,750, a marginal tax rate of only 15 percent, and an average tax rate of 10. The pooled after tax income is therefore equal to $86,500, with an average tax rate of 21 percent.

In the joint taxation system, the two individuals are taxed based on their pooled income. No taxes are levied on the first $20,000 of household income, taxes are then levied at 10 percent up to $80,000 of household income, and then at the highest rate of 40 percent for

7

the remaining income. Since the primary earner is typically the person in the household with more attachment to the labor force, we compute the individual after-tax income under the assumption that her or his income is the first to be taxed, starting from the lower brackets, and the secondary earner's income is taxed next at higher tax rates. This assumption reflects the decision process of the typical two-earner household, in which the primary earner works regularly and the secondary earner adjusts his or her labor supply depending on the economic conditions. Under this assumption, we obtain an after-tax income equal to $68,000$ for the primary earner – $11,000$ more than with the individual taxation system –, with a marginal tax rate of 40 percent and an average tax rate of 11 percent – a decline of 15 percentage points. Instead, the secondary earner has an after-tax income equal to $17,250$ – $8,500$ less than with the individual taxation system –, a marginal tax rate of 35 percent – 25 percentage points higher –, and an average tax rate of 40 percent – 30 percentage points higher. Their pooled after-tax income is therefore equal to $89,000$ – an increase of $2,500$ –, with an average tax rate that declines to 19 percent.

This calculations document that the joint taxation system has two main effects on individual decisions. First, it generally produces marriage bonuses by increasing the pooled after-tax income of married households. This effect, which we will denote with the term 'income effect', reduces the secondary earner's incentives to supply labor. Second, it decreases the marginal and average tax rates paid by the primary earner at the expenses of the secondary earner, who experiences substantial increases in those rates. This effect, which we will denoted with the term 'price effect', increases the primary earner's incentive to work, but provides disincentives for the secondary earner to supply labor.

3.2   Descriptive Evidence on the Income and Price Effects

The U.S. joint taxation system is more complex than the two-tax-bracket system used in our example. But it is possible to document that the income and price effects illustrated by our simple example are important features of the U.S. taxation system and that those effects generate the incentives and disincentives discussed in the previous subsection.

In Figure 2, we provide evidence on the existence of the income effect, by plotting the percentage change in income generated by the U.S. joint taxation system relative to an individual

taxation system, as a function of household income. To illustrate how the income effect changes with the degree of intra-household specialization, we consider three types of couples: a couple in which only one spouse works (full specialization); and a couple in which the primary earner provides 80 percent of income (limited specialization); and a couple in which both spouses earn the same fraction of household income (no specialization). For each type we compute the after-tax household income if they are married, the same variable if they are not married, and plot the percent change. In all cases, the after-tax household income is generated using the NBER Taxsim for the sample of California households without dependents.

The graph documents that, in the U.S. taxation system, the income effect has two features. First, the majority of married households experience large bonuses. Second, the size of the bonuses declines with the degree of intra-household specialization and the level of pooled income, with tax penalties for households that choose sufficiently low degree of specialization and have sufficiently high pooled income. Married households in the U.S. have therefore strong incentives to increase the degree of intra-household specialization, by choosing long and regular labor hours for the primary earner and short or no hours for the secondary earner.

In Figure 3, we document that the price effect is not only a theoretical concern but it influences the labor supply decisions of households. In the figure, we plot the average tax rate on the wife's first $15,000 of earnings, the share of wives not employed, and the density function of couples in the data, all as a function of the husband's earnings. In the computation of the average tax rate, we also include government transfers, such as the Earned Income Tax Credit and the Child Tax Credit, which explain the step increase in the average tax rate at very low levels of income and the subsequent decline for households with income between $20,000 and $40,000. The graph is based on the idea that husbands, being primary earners in most households, supply an amount of labor hours that is approximately fixed and all the adjustment at the margin is made by wives. This is clearly only an approximation, but it is useful to study the effect of tax rates on individual decisions.

The graph indicates that there is a strong positive correlation between the fraction of wives not employed and the average tax rates on their earnings. When the tax rate decreases, the fraction of wives not working declines. When the tax rate increases, the fraction rises rises. The variable share of wives not working is noisier for households with a husband who earns more

than $200,000$. But this is to be expected given that only a small fraction of households belong to that group, as the density function of couples in the data document. This evidence confirms the insight provided by our example that the high tax rates for secondary earners introduced by the joint taxation system have strong disincentives effects on the labor supply of women. It also indicates that, to evaluate different taxation systems, it is important to model primary and secondary earners as separate decision units that make joint choices.

4   Tax Reforms and Labor Supply Behavior

The evidence provided in the previous section indicates that the choice of a tax system has the potential to have large effects on individual and household behavior. To evaluate these effects, we will structurally estimate a model of household decisions and use it to evaluate through simulations the performance of different taxation systems. For the results of the model simulations to be credible, it is crucial to have reliable estimates of the parameters that govern the individual response to tax changes. The general consensus among economists is that the best source of variation to identify the responses of women and men to tax changes is represented by tax reforms (Keane (2011)). We will therefore structurally estimate those parameters using the main tax reforms that took place in the U.S. in the last four decades: the Tax Reform Act of 1986 (the Reagan tax cuts), the 1993 EITC expansion as part of Omnimus Budget Reconciliation Act (OBRA), and the Jobs and Growth Tax Relief Reconciliation Act of 2003 (the Bush tax cuts). In this section, we describe the variation in labor supply behaviors generated by the three tax reforms, which represents the variation we will employ in the structural estimation to identify the model parameters related to the individual labor supply responses.

We start by providing evidence that the three tax reforms generated significant changes to the tax schedule. In Figure 4, we depict the tax schedule for a married couple without dependents before and after the Reagan tax cuts. It reveals that families with pooled income above $30,000$ enjoyed significant reductions in marginal tax rates. Figure 5 reports the tax brackets for the same group of households before and after the Bush tax cuts. In this case, the reduction in tax rates was smaller, but still substantial, for most fami. But some households, particularly the ones with total income between $57,000$ and $70,000$, experienced declines of

the same order of magnitude as for the Reagan tax cuts. Lastly, in Figure 6 we describe the tax schedules before and after the EITC reform. This reform modified the tax brackets by changing the EITC program. It therefore affected only low-income households, as our Figure documents, with most of them experiencing a significant increase in their marginal tax rates.

We now document the responses to the tax reform using two datasets: the Panel Studies of Income Dynamics (PSID) and the American Community Survey (ACS). The PSID has the advantage of being a panel. This feature enables us to study the labor supply responses of married and single men and women using standard techniques. The main limitation of the PSID is that its sample size is small. It is therefore not possible to estimate the responses for different demographic groups. To deal with this limitation, we also estimate the responses using the ACS, which is not a panel, but its sample size is significantly larger. For reasons that will be clear later in the section, since the ACS is not a panel, we can only study the response of married women.

4.1   Labor Supply Responses to the Tax Reforms: The PSID

To quantify the effects of tax changes on labor supply decisions, we use the panel structure of the PSID. We start by documenting the response of married women. We proceed in two steps. First, for each household, we construct the marginal tax rate before and after the tax reform. The change in tax rate reported in the PSID is composed of two parts: the change in rate introduced by the reform; and the movement along the tax schedule produced by the optimal labor supply decision made by a person after the reform. To isolate the first part, we compute the tax rate before and after the reform using in both cases the husband income before the reform took place. In the second step, we compute the labor supply response of married women, by regressing their labor force participation or labor supply on the marginal tax rate described above, household fixed effects and control variables.

Formally, we estimate the following fixed effect regression:

$$y_{it} = \alpha_i + \beta_1 \hat{\tau}_{it} + \beta_2 X_{it} + \gamma_t + \varepsilon_{it}$$

where y_{it} is either the logarithm of work hours in period t or an indicator for whether the married

11

woman works in that period, α_i is a household fixed effect, $\hat{\tau}_{i,t}$ is the predicted marginal tax rate on the wife's first dollar of income computed using the method described above, and X_{it} is a set of time-varying controls that includes experience, the number of children, whether the households have children younger than 6 at the time of the reform.

The results, reported in Table 2, indicate that married women responded to the Reagan and Bush tax cuts by significantly reducing reducing their labor force participation. We find a 10 percentage points reduction in the marginal tax rate is associated with an increase in labor force participation of 1.75 percentage points in the Reagan reform and with a 1.55 percentage points in the Bush reform. The response to the EITC reform is not statistically significant probably due to the fact that it only affected low-income households. When we divide the sample between women with and without young children, we find that women with young children responded the most, with an increase in labor force participation of 2.58 percentage points in the Reagan tax reform and of 3.31 in the Bush tax reform. The reforms had no impact on hours of work of married women.

To study the response of married men and single women and men, we estimate the same fixed-effect regression, except that the change in marginal tax rate is computed using household total income before the reform. The meaning of the coefficient on the change in marginal taxes is therefore less precise, since we can no longer interpret our measure of $\hat{\tau}_{it}$ as the tax rate on the individual's first dollar of income. The estimated coefficients on $\hat{\tau}_{i,t}$ are described in Table 3. We find no statistically significant change in labor force participation for these three groups, which should be expected since their participation rate is close to one. We estimate, however, significant negative responses on the intensive margin for the Reagan tax cuts, with single women that reduce their labor supply by 1.78 percentage points as the tax rate increases by 10 percentage points, and married men that reduce their hours of work by 1.16 percentage points. The Bush reform generate also large negative coefficients, but the standard errors are also very large generating insignificant coefficients. An interesting result reported in Table 3 is that the EITC reform has strong effects on the labor force participation of single women, the group that is more likely to participate in that program, with reductions in hours of work that are about one to one with the increase in tax rates.

4.2 Labor Supply Responses to the Tax Reforms: The ACS

Since the PSID has small sample size, the individual responses to tax cuts are not very precisely estimated and we cannot study the responses by different demographic groups. For married women, we can address this issues by using the ACS. As the ACS started to collect data in 2001, we can only study the response to the Bush tax reform.

Because the ACS is not a panel, we cannot follow the same person over time and estimate directly the response to tax reforms. We can, however, determine the average response to tax changes of individuals that are similar. For married women, we can achieve this by constructing income bins for the husband's income and then estimate the average response to tax cuts, by comparing the labor supply decisions of wives whose husband had an income in a given bin before the reform with the decisions of wives with a husband whose income belonged to the same been after the reform. By keeping the income bin constant, this approach enable us to isolate the changes in tax rates generated by the reform from the changes that are produced by the optimal labor supply response of women and men to the tax reform. The main limitation of this method is that we can only used it to study married women.

Formally, let inc_k be a dummy variable equal to one if the husband's income falls in quantile k of the income distribution. We can then estimate the following regression:

$$y_{it} = \sum_k \alpha_k inc_k + \sum_k \pi_k inc_k \cdot post_t + \beta_2 X_{it} + \gamma_t + \varepsilon_{it}$$

where the y_{it} is the logarithm of work hours in period t or an indicator for whether the married woman works in that period, $post_t$ is a dummy equal to one if a person is observed after the tax reform, and X_{it} is a set of time-varying controls that includes experience, the number of children, whether the households have children younger than 6 at the time of the reform. The parameter of interest is π_k.

The results are described in Table 4. In the first column, we report the income quintile for the husband income, in the second column we present the corresponding average changes in marginal tax rate, and in the last column we describe the estimated coefficients π_k. Of the ten income quintile we consider, five experience a large cut in marginal tax rates, with the cuts ranging from 2.5 percentage points for the income quintile $75 - 90K$ to 9.3 percentage

points for the quintile $52 - 57K$. In the four cases with the largest tax cuts, women responded by significantly increasing their labor force participation. The largest increase belong to the income quintile with the largest tax cut, with a rise in employment rate of 1.7 percentage points.

In Table 5, we report the changes in labor force participation by demographic group for the married women in the income quintile with the largest responses. Analogously to the results obtained using the PSID, married women with young children are affected the most by the cuts in marginal tax rates, with increases in labor force participation that, at 2.7 percentage points, are almost three times as large as the changes for married women without children. Why do women in the two groups react differently to the policy? Women with young children and not employed before the reform are more likely to have high reservation wages, since they have high opportunity costs for their time. We would therefore expect high responses for the relatively high earning-potential women that were not employed. Married women without young kids, however, are more likely to have lower reservation wages and, hence, to be employed before the reform. This explanation is confirmed by the participation rate of this two groups of married women, which 52% for women with young children and 81% for women without young children.

We then divide the sample in married women with and without college degree and find that both have significant responses, but married women without a college degree increase their employment rate by about twice as much. The difference by education is explained by the lower participation rate of married women without a college degree and, hence, by a larger fraction of them being at the margin.

5 Model

In this section, we develop a model that enables us to evaluate the effects of choosing one of the available taxation systems. We consider a model with the following features. To account for the fact that individuals are generally taxed using different rules depending on their marital status, in the model people can be married, never married, or divorced. To produce a realistic fraction of married and divorced individuals and to allow for lasting effects of changes in tax regimes, we consider an intertemporal model in which married couples make efficient decisions with limited commitment. Limited commitment – defined as the inability to commit to future

allocations of resources – allows for divorces in which both spouses agree to divorce (mutual consent) and divorces in which only one spouse is better off divorced (unilateral divorce). Chiappori and Mazzocco (2017) provide a detailed discussion of the differences between full and limited commitment. To account for changes in the time devoted to labor and household production in response to changes in tax regimes, in the model people make labor supply and household production decisions, in addition to the standard consumption and saving choices. Since responses to tax reforms vary by the presence of young children and education, the model includes fertility events and individuals are allowed to vary by education. The next subsections describe the model in details.

5.1 Timing

People enter their adult life with or without a college degree. Their adult life is divided into two stages: the working stage and the retirement stage. During their working stage, conditional on their education, each person chooses marital status, labor supply, the time spent on household production, consumption, and savings. If a person enters a period in this stage as single, he or she meets a potential spouse and chooses whether to marry. If instead the person enters the period as married, she or he chooses whether to divorce. At the end of the working life, people enter the retirement stage, in which they only choose consumption and savings until their death.

5.2 Preferences and Technology

Preferences. Individual i has preferences over private consumption c^i, leisure l^i, a household-produced good Q. Preferences depend also on labor force participation δ_h^i, to account for possible fixed utility costs of working due, for instance, to commuting time. We allow the fixed utility costs to vary with age. Lastly, if i is married, the preferences depend also on a the quality of the marriage θ. The preferences can be characterized using the utility function $u^i\left(c^i, l^i, Q, \delta_h^i\right)$ if single and $u^i\left(c^i, l^i, Q, \delta_h^i, \theta\right)$ if married. Individuals discount the future at a factor β.

In the estimation of the model, we assume that the utility function takes the following form

for singles:

$$u^i\left(c^i, l^i, \delta_h^i, Q\right) = \frac{c_t^{1-\rho}}{1-\rho} + \gamma_1 \frac{l_t^{1-\sigma}}{1-\sigma} + \gamma_2 \log Q_t + \gamma_3 \delta_h^i.$$

Married individuals have the same utility function, except that it also includes match quality:

$$u^i\left(c^i, l^i, Q, \delta_h^i, \theta\right) = \frac{c_t^{1-\rho}}{1-\rho} + \gamma_1 \frac{l_t^{1-\sigma}}{1-\sigma} + \gamma_2 \log Q_t + \gamma_3 \delta_h^i + \theta.$$

Match quality follows the random walk

$$\theta_t = \theta_{t-1} + z_t,$$

where z_t drawn from a normal distribution with mean 0 and variance σ_z, and the first realization of θ at the time of marriage is drawn from a normal distribution with mean μ_θ and variance σ_θ.

Education and Savings. In the model, people differ depending on whether the enter the working stage of their life as college graduates. A college degree has two types of returns. It endows graduates with better wage processes and it makes them more productive in the production of the the home-good Q. People can save using a risk-free asset with gross return R. We will denote by b_t the amount saved.

Wage Processes and Experience. Conditional on education g and ability a, individual i's wage process takes a standard functional form that depends on a quadratic term in experience e^i, and an idiosyncratic shock ϵ^i, i.e.

$$\ln w^g = w^g(e, a) = \beta_0^{g,a} + \beta_1^{g,a} e + \beta_2^{g,a} e^2 + \epsilon^{g,a},$$

where $\epsilon_t^{g,i} \sim N(0, \sigma_\epsilon^g)$, g is high school or college, and a is low or high.

Labor market experience evolves according to the following simple process. If a person works full time in a period, the individual's experience increases by one. If the person works part-time, experience increases by a fraction $\lambda > 0$. If someone does not work in the period, the person's experience declines by $0 \leq \delta \leq 1$ to capture the depreciation of human capital.

Taxes. The tax schedule varies depending on the tax system and the marital status of an individual. We will denote by $\tau^s(w_t h_t)$ the function that determines the income taxes that must be paid by a single individual with earnings equal to $w_t h_t$, and by $\tau^m(w_t^1 h_t^1, w_t^2 h_t^2)$ the taxes levied on a married couple with the first spouse earning $w_t^1 h_t^1$ and the second spouse $w_t^2 h_t^2$.

The function $\tau^s(w_t h_t)$ is constructed accounting for the year-on-year changes in tax brackets that are codified in the tax law, other year-on-year changes produced by minor tax reforms, and the three major tax reforms discussed in Section . To solve the model, we have to make assumptions on the people's beliefs about the tax changes. We assume that people anticipate the year-on-year changes in tax brackets generated by the tax code and by minor tax reforms. With regard to the major tax reforms, to keep the model tractable, we can make one of the following assumption: people have perfect foresight; or people believe that the future tax rates will be equal to the current ones. The second assumption introduces complexity to the model, as it requires the computation of a separate value function for each tax referm. But, since it is more realistic, it is the one we adopt. Under this assumption, the variation generated by the tax reforms identifies the intertemporal uncompensated elasticity. However, since we observe multiple tax reforms with different wealth effects, we can also identify the intertemporal compensated elasticity.

Changes to the income tax schedule have different effects depending on the social security system adopted by a country. For instance, an increase in marginal tax rates for low-income families should have smaller effects on individual welfare in places with a well-developed food-stamp system. To account for the interactions between the social security and the tax system, we model the U.S. social security system by allowing the household budget constraint to depend on (i) Social Security Income (SSI) taxes and Medicare taxes, (ii) the Earned Income Tax Credit, (iii) the Child Tax Credit, (iv) the Child and Dependent Care Credit, and (v) the Supplemental Nutrition Assistance Program (SNAP), also known as food stamp program. Modelling properly the social security system is also important because it creates kinks and non-convexities that economists have argued have substantial effects on individual decisions and, hence, on the impact of tax reforms (Saez (2010)).

Household Production Function. The household-produced good Q enters the model to account for the existence of consumption goods that cannot be purchased directly in the market. The typical example is represented by the quality of children. The good Q is produced using three types of inputs: the time spent by individual i in household production, d^i; market goods, m; and the number of children in the household, n.

In the estimation of the model, we assume that the production function has three characteristics. It allows for substitutability between time and market goods. To account for the evidence provided in Guryan, Hurst, and Kearney (2008), the productivity of time depends on the number of the children, whether they are of pre-school age ($age < 6$), and whether the parents have a college degree. Lastly, for couples, spouse 2's time can be substituted for spouse 1's time at the fixed rate ϕ. The production function of couples takes therefore the following translog form:

$$log(Q) = f\left(d^1, d^2, m, n\right) = \alpha_1^g \log(\phi d^1 + d^2) + \alpha_2 \log m + \alpha_3 \log\left(1 + n\right),$$

where

$$\alpha_1^g = \xi_0 + \xi_1^g \mathbb{I}_{\{n>0\}} + \xi_2^g \mathbb{I}_{\{age<6\}}, \qquad g = \text{High School}, \text{College}.$$

While for singles it is equal to

$$log(Q) = f\left(d, m, n\right) = \alpha_1^g \log d + \alpha_2 \log m + \alpha_3 \log\left(1 + n\right).$$

The sum of the time devoted to household production, the hours spend on labor, and leisure must add up to the total time available to an individual, which we denote by T.

Fertility and Child Care. Married and single women give birth according to a probability function that depends on their marital status, education, age, and current number of children. Women can therefore affect the number of children they conceive by choosing their marital status. For instance, they can delay fertility by postponing marriage. We use a linear probability model to characterize the fertility probability.

Children younger than 6 require child care if their parents work. A married couple has to purchase a number of child-care hours that is equal to the minimum between the labor hours

supplied by the husband and the wife. A single parent must pay for a number of child-hours that corresponds to the number of hours supplied to the market. The price paid for one hour of child care is independent of marital status and denoted by p^c.

The Marriage Market. We model the marriage market using a matching framework with search friction. Specifically, with some probability, single individuals meet a potential spouse with a given education and ability. The probability depends on own education and ability and declines linearly with age to account for the fact that the number of single individuals decreases as people become older. Single individuals who are divorced and have children incur a re-marriage penalty ψ to account for the observation that divorced individuals have lower marriage rates.

5.3 Decisions

Single's Decisions. If individual i decides to be single in period t, this person chooses labor supply, the time spent and goods used in household production, private consumption, and savings that maximize a standard single-agent problem. Let V_t^{es} be the value function of an individual who enters period t as single and V_t^{ds} the value function of a person who decides to be single in this period. The single-agent problem can then be written as follows:

$$V_t^{ds}\left(b_t, e_t, n_t, a\right) = \max_{h_t, d_t, m_t, c_t, b_{t+1}} u^i\left(c_t^i, l_t^i, Q_t\right) + \beta E_t\left[V_{t+1}^{es}\left(b_{t+1}, e_{t+1}, n_{t+1}, a\right)\right]$$

$$s.t. \quad c_t + m_t = w_t h_t - \tau^s(w_t h_t) + R b_t - b_{t+1} - p_t^c n_t$$

$$Q_t = f\left(d_t, m_t, n_t\right), \quad h_t + d_t + l_t = T, \quad \text{and} \quad w_t = w\left(e_t, a\right),$$

where the transition from n_t children to n_{t+1} children is governed by the fertility probability.

Couples' Decisions. If two individuals choose to be married in period t, they make efficient decisions with limited commitment. Efficient decisions means that they solve a Pareto problem. But, since they cannot commit to future allocations, the Pareto weights used to make decisions in period t may differ from the Pareto weights with which the two spouses entered the period. Denote with M_t^1 and M_t^2 the Pareto weights used to make efficient decisions in period t. We

will discuss later in this section how they are computed. Also, let $V_t^{em,i}$ be the individual i's value function if this person enters period t as married and $V_t^{dm,i}$ the value function if he or she decides to stay married in this period. Then, the couple chooses labor supply, household production time and goods, private consumption and savings as the solution to the following problem:

$$\max_{\{h_t^i, d_t^i, m_t^i, c_t^i, b_{t+1}\}_{i=1}^2} \sum_{i=1}^2 M_t^i \{ u^i(c_t^i, l_t^i, Q_t, \theta_t) + \beta E_t \left[V_{t+1}^{em,i} \left(b_{t+1}, e_{t+1}^i, n_{t+1}, a^i \right) \right] \}$$

$$s.t. \quad c_t^1 + c_t^2 + m_t = w_t^1 h_t^1 + w_t^2 h_t^2 - \tau^m(w_t^1 h_t^1, w_t^2 h_t^2) + R b_t - b_{t+1} - p_t^c n_t$$

$$Q_t = f\left(d_t^1, d_t^2, m_t, n_t \right), \quad h_t^i + d_t^i + l_t^i = T, \quad \text{and} \quad w_t^i = w^i\left(e_t^i, a^i \right), \quad i = 1, 2,$$

where the change from having n_t children to n_{t+1} children is governed by the fertility probability. Denote by $h_t^{i*}, d_t^{i*}, m_t^{i*}, c_t^{i*}, b_{t+1}^*$, for $i = 1, 2$, the solution to the couple's problem. Then, person's i value function if this individual has decided to stay married takes the following form:

$$V_t^{dm,i} \left(b_{t+1}, e_{t+1}^i, n_{t+1}, a^i \right) = u^i(c_t^{i*}, l_t^{i*}, Q_t^*, f_t^{i*}, \theta_t) + \beta E_t \left[V_t^{em,i} \left(b_{t+1}^*, e_{t+1}^i, n_{t+1}, a^i \right) \right].$$

Marriage, Divorce, and Renegotiation Decisions. Given the optimal choices and value functions of people who have decided to stay single and people who have selected to remain married, we can determine the optimal marriage decision. An individual who enters period t as single chooses to marry the potential spouse if the value of being married is larger than value of staying single for both of them, i.e.

$$V_t^{dm,i} \left(b_{t+1}, e_{t+1}^i, n_{t+1}, a^i \right) \geq V_t^{ds,i} \left(b_{t+1}, e_{t+1}^i, n_{t+1}, a^i \right), \quad i = 1, 2.$$

These inequalities are also known as participation constraints (Kocherlakota (1996), Marcet and Marimon (2011), and Chiappori and Mazzocco (2017)).

The participation constraints can also be used to determine whether it is optimal for a married couple to remain married, divorce, or renegotiate the current allocation of resources by changing the Pareto weights used to solve the Pareto problem. Consider two individuals who enter period t as married and with Pareto weights M_{t-1}^1 and M_{t-1}^2. Denote by

$z^{**} = \{h_t^{i**}, d_t^{i**}, m_t^{i**}, c_t^{i**}, b_{t+1}^{**}\}$ the solution of the couple's problem computed using the initial Pareto weights. If at the solution z^{**} the participation constraints are both satisfied, both spouses are better off married than single at the current optimal allocation of resources, and will choose to remain married at the existing Pareto weights. If the participation constraints of both spouses are violated, the marriage produces no surplus that can be shared. It is therefore optimal to divorce. The most interesting case is represented by a situation in which the participation constraint of one spouse is satisfied, but the participation constraint of the other is violated. In this case, there may exist a different allocation of household resources, at which both participation constraints are satisfied and, hence, at which both spouses are better off staying married. If such allocation exists, it can be achieved by increasing the Pareto weight of the constrained individual and, consequently, the share of resources allocated to this spouse. From an ex-ante perspective, the most efficient new allocation is the one that corresponds to a new set of Pareto weights M_t^1 and M_t^2 that make the constrained individual indifferent between staying married or being single (Kocherlakota (1996)). If such new allocation does not exist, the household does not generate surplus and it is optimal for the spouses to divorce.

5.4 Preference Parameters and Tax Reforms

The preference parameters ρ and σ govern how people responds to tax reforms. They can therefore be identified using the variation they generate. To provide some insight on the relationship between the two parameters and the tax reforms, for simplicity, consider the problem of a person who remains single her or his entire life. To simplify the notation, we will also assume that the household production function depends only on time, the tax schedule is linear, and there is no utility cost of working.

Using two-stage budgeting, the problem solved by this person in a given period can be written as follows:

$$\max \frac{c^{1-\rho}}{1-\rho} + \gamma \frac{l^{1-\sigma}}{1-\sigma} + \gamma_2 \log Q_t$$

$$s.t. \quad c + w(1-\tau)(l+d) = \bar{y} + wT,$$

$$Q = f(d), \quad h+d+l = T,$$

where $\bar{y}$ is the amount of resources optimally allocated by the household to a given period in the two-stage budgeting problem. The first order conditions for consumption and leisure can used to derive the standard optimality condition that relates the marginal utility of substitution between these two goods and their relative prices:

$$w\left(1-\tau\right)\left(\bar{y}+w\left(1-\tau\right)\left(T-l-d\right)\right)^{-\rho} \leq \gamma l^{-\sigma},$$

or

$$\ln\gamma - \sigma\ln l - \ln w - \ln\left(1-\tau\right) + \rho\ln\left(\bar{y}+w\left(1-\tau\right)\left(T-l-d\right)\right) \geq 0, \tag{1}$$

where the two relationships are satisfied as equality if the person supplies a positive amount of labor hours.

A person works if before-tax wage w is larger than the reservation wage w^*, where the reservation wage is the before-tax wage that satisfies the relationship (1) as an equality at hours of work equal to 0, .i.e.

$$\ln w^* = \ln\gamma - \sigma\ln\left(T-d\right) - \ln\left(1-\tau\right) + \rho\ln\bar{y}, \tag{2}$$

We will denote the before-tax wage introduced earlier with the notation $w = X\beta + \epsilon$, where ϵ is distributed normally with mean 0 and variance σ^2. Then a person works if

$$\ln w \geq \ln w^* \quad \leftrightarrow \quad X\beta + \epsilon \geq \ln\gamma - \sigma\ln\left(T-d\right) - \ln\left(1-\tau\right) + \rho\ln\bar{y}, \tag{3}$$

or equivalently,

$$-\ln\gamma + \sigma\ln\left(T-d\right) - \rho\ln\bar{y} + \ln\left(1-\tau\right) + X\beta \geq \epsilon.$$

Thus, since ϵ is normally distributed, the probability that a person works takes the following form:

$$P\left(work\,|Z\right) = \Phi\left(\frac{-\ln\gamma + \sigma\ln\left(T-d\right) - \rho\ln\bar{y} + \ln\left(1-\tau\right) + X\beta}{\sigma_\epsilon}\right). \tag{4}$$

where Φ is the cumulative density function of the standard normal distribution and $Z = (d, \bar{y}, \tau, X)$. Our empirical analysis measures the changes in labor force participation produced by the tax reform. In our model, these changes can be calculated by differentiating equation

(4) with respect to $(1 - \tau)$ to obtain

$$\frac{\partial P\left(work\,|Z\right)}{\partial\left(1-\tau\right)} = \frac{1}{\sigma_{\epsilon}\left(1-\tau\right)}\phi\left(\frac{-\ln\gamma+\sigma\ln\left(T-d\right)-\rho\ln\bar{y}+\ln\left(1-\tau\right)+X\beta}{\sigma_{\epsilon}}\right),$$

or, equivalently,

$$\frac{\partial P\left(work\,|Z\right)}{\partial\left(1-\tau\right)}\sigma_{\epsilon}\left(1-\tau\right) = \phi\left(\frac{-\ln\gamma+\sigma\ln\left(T-d\right)-\rho\ln\bar{y}+\ln\left(1-\tau\right)+X\beta}{\sigma_{\epsilon}}\right). \qquad (5)$$

Equation (5) highlights that the parameter σ determines how the labor force participation response to the tax reform varies across households that spend different amount of time on household production. All else equal, if household with small differences in time allocated to household production have labor force participation responses that are markedly different, σ should be large. Equation (5) also illustrates that the parameter ρ affects how the labor force participation decision varies in response a the tax reform across households that have different amounts of resources $\bar{y}$. The parameter σ can therefore be identified using the difference in the changes in labor force participation generated by the tax reforms between household that spend a low amount of time in household productions and household that allocate a large amount of time. Similarly, the parameter ρ can be identified using a similar difference for households with low and high $\bar{y}$.

Equation (5) can be used to identify ρ and σ if all the other parameters in the equation are known and one observes two different values for the left hand side of equation (5) – two tax reforms. To explain why, we will rewrite equation (5) in the following shorter form:

$$K_t = \phi\left(Z_t\right), \qquad for \quad t = 1, 2,$$

where $K_t = \frac{\partial P(work|Z)}{\partial(1-\tau)}\sigma_{\epsilon}\left(1-\tau\right)$ and $Z_t = \frac{-\ln\gamma+\sigma\ln(T-d_t)-\rho\ln\bar{y}_t+\ln(1-\tau_t)+\beta X_t}{\sigma_{\epsilon}}$, $t = 1$ is the time of the first reform, and $t = 2$ is the period of the second reform. The symmetry of the normal density function implies that, for each value of K_t, there are either two or zero value of Z_t that satisfy the equation, one positive $Z_{t,+}$ and one negative $Z_{t,-}$. Consider the more relevant case in which there are two values of Z_t. Because in the data the labor force participation of all the relevant demographic groups is above 0.5 before and after the reforms we consider, we can

eliminate the negative value and use the positive value to derive the two equations we can use to identify the two parameters, i.e.

$$Z_{t,+} = \frac{-\ln \gamma + \sigma \ln (T - d_t) - \rho \ln \bar{y}_t + \ln (1 - \tau_t) + \beta X_t}{\sigma_\epsilon}, \qquad for \quad t = 1, 2. \qquad (6)$$

We now have a linear system of two equations in the two unknowns ρ and σ, which implies that the two parameters can be identifies.

The parameters ρ and σ are also related to intensive margin elasticities. But in the empirical analysis, we did not find strong responses to tax reforms on the intensive margin. We will therefore use moments based on the extensive margin. But for completeness, we will also discuss the relationship between the two parameters and the intensive margin elasticities. For single individuals, the Frish or compensated intertemporal leisure elasticity is equal to $-\frac{1}{\sigma}$ and the Frish labor supply elasticity is equal to $-\frac{l}{h} \frac{\partial \ln l}{\partial \ln w} = \frac{l}{h} \frac{1}{\sigma}$. The uncompensated intertemporal leisure elasticity and the static Marshallian leisure elasticity have more complicated forms and are functions of both σ and ρ. Specifically, the static Marshallian leisure elasticity takes the following form:

$$e_{l,w}^M = \frac{w}{l} \frac{\partial l}{\partial w} = -\frac{\bar{y} + (1 - \rho)wh}{\sigma (\bar{y} + wh) + \rho lw}, \qquad (7)$$

where $\bar{y}$ is the amount of resources optimally allocated by the household to a given period in a two-stage budgeting problem, in which in the first stage the household distributes optimally its resources over periods and in the second stage it allocates optimally the resources available in a period between consumption and leisure. We can also derive the static Marshallian labor supply elasticity, which takes the following form:

$$e_{h,w}^M = -\frac{l}{h} e_{l,w}^M = \frac{l}{h} \frac{\bar{y} + (1 - \rho)wh}{\sigma (\bar{y} + wh) + \rho lw}. \qquad (8)$$

It is also informative to derive the static elasticity with respect to income, which can be written as follows:

$$e_{l,w}^I = \frac{w}{l} \frac{\partial l}{\partial \bar{y}} = \frac{\bar{y}\rho}{\sigma (\bar{y} + wh) + \rho lw}.$$

If the amount of resources allocated to a period $\bar{y}$ equals zero, it can be shown that the Frish elasticity is always more negative than the Marshallian elasticity. But if $\bar{y} >$, this inequality

may be reversed.

6   Moment Selection.

Preference Parameters: ρ, σ, $\gamma_1 - \gamma_3$, σ_z, μ_θ, and σ_θ. The parameters governing the response to tax rate changes, ρ and σ, are estimated using the variation in labor force participation generated by the three tax reforms discussed earlier. Spefically, we match the average labor force participation change of married women with and without children before and after the Bush tax cuts, as measured in the ACS, the same variable for married women before and after the Reagan tax cuts, as calculated in the PSID, the changes in labor supply by married and single men before and after the Reagan tax cuts, and the changes in labor supply of single women before and after the EITC reform.

The parameter measuring the preferences for leisure relative to private consumption is identifies using the average ratio of private consumption to leisure as observed in the PSID. The parameter on the public good γ_2 is normalized to one, since it is not possible to separately identify the parameters that govern the preferences for the public good from the production function parameters. We allow the parameter measuring the utility cost of working to vary across individuals that belong to different age bins (25-30, 31-35, ... , 56-60). We therefore identify these parameters using the fraction of men and women working in those age bins. We estimate the match quality parameter by matching the following moments: the share married for the age groups 22 to 26, 27 to 36, 37 to 50, and older than 50; the divorce hazards for the same age group; and the re-marriage hazards for those who are divorced and have children.

Wage and Experience Parameters: β_0^g, β_1^g, β_2^g, β_3^g, σ_ϵ^g, λ, and δ. The parameters of the wage processes are estimated outside the model using the group estimator developed in Bonhomme and Manresa (2015), with two groups for college graduates and two groups for individuals without a college degree. We estimate the processes separately for men and women and by education. To estimate the parameters λ and δ, we include in the wage regressions the number of years worked part-time and the number of years an individual stayed out of the labor force after the last employment.

Household Production Parameters: ξ_0, ξ_1^g, ξ_2^g, ϕ, α_2, α_3 . We estimate the coefficient on the time allocated to home production by targeting the amount of hours worked at home, which includes the time allocated to childcare, by gender, whether the family has children, and whether it has children under 6. To estimate the difference in productivities between men and women in the time allocated to home production, we use the share of women who earn more than their husband prior to birth but switch to part-time or non-employed after childbirth. To estimate the coefficient on children, we use the divorce hazards for individuals with and without children. The coefficient on the market good is estimated using average child expenditures for the first, second, and third quartile of household income in the PSID.

Matching Probabilities and Fertility Process. The probability of drawing a spouse with a particular education is estimated by matching the shares of married couples with spouses that have the same education. To match the probability of meeting a partner with a given ability, we match the correlation between the group fixed effect estimated for the wage process of husbands and the corresponding group fixed effect for wives. Allowing single individuals to match based on their ability, enables us to better capture the degree of assortative matching in the marriage market. The fertility process is estimated directly in the data using the PSID and a probit specification.

7 Results

7.1 Parameter Estimates

The parameter estimates are reported in Tables 6-9. The estimated value of σ implies a Frish leisure elasticity of 0.35 for both men and women. Since, on average, women and men have similar leisure to labor hours ratios around 0.8, the implied Frish labor elasticity is equal to 0.28, which is small but consistent with the estimates obtained in the labor literature (Keane (2011)). The utility cost of working increases with age to match the observation that the labor force participation declines with age, especially for women. The estimated production function parameters indicates that the productivity of the time spent on the public good increases when young children are present. They also indicate that the time individuals with a college degree

devote to the production of the public good is more productive than the time allocated by people without that degree. The wage parameters have the expected sign and size. Experience increases wages at a declining rate and its effect is smaller for workers without a college degree.

7.2 Model Fit

With the estimated parameters we match well the most relevant moments, which are reported in Table 10. The share married and divorced generated by the model (0.61 and 0.12) is very close to the shares observed in the data (0.65 and 0.11). Analogously, the share of married households with young children in our simulations (0.34) is only slightly lower than the share in the data (0.38). For the share employed, we match well the ranking and level by education and gender. The share employed for men with high school degree is 0.74 in our simulations and 0.79 in the data, whereas for men with college degree it is 0.91 in the model and 0.94 in the data. For women, we have similarly good results, with the share employed being equal to 0.64 for women with a high school degree in the simulations and 0.66 in the data. Women with a college degree work slightly more both in the model (0.79) and data (0.83).

We fit the production function moments reasonable well, but not as well as the previous moments. We slightly underestimate the hours spent by men in household production (12.3 in the simulations versus 14.1 in the data) and slightly overestimate the hours devoted by women to the production of the public good (25.2 in the model versus 21.2 in the data). We also do a relatively good job matching the share of households in which the wife is the higher earner conditional on the husband's education. This share is 29.3 in our model (33.7 in the data) for families with a husband without a college degree, and 26.2 (31.2 in the data) for households in which the husband has a college degree.

In Figure 7, we report the actual and simulated income distribution of men. It documents that we match well the full distribution of this variable in the data. There are two large mass points in the figure, one for men who earn annually between $0 and $7,000, and one for men who earn more than $165,000, as we collapse these two groups of individuals for better visual inspection. It is critical for us to match well the observed income distribution for three reasons. First, men's income has first-order effects on married women's labor supply through the taxes they have to pay on their earning, since higher husband's earnings imply that higher tax rates

will be levied on their earnings. Second, the husband's earnings have income effects on the wife's choices. These first two effects determine the household's choice of whether to allocate an additional hour of the secondary earner to the labor market or to household production. Lastly, matching this distribution correctly is important for our policy analysis. With one exception, all the policies we evaluate are revenue neutral, but they change the distribution of the tax burden in the population. Since the changes in individual tax burdens generated by a tax policy depend on the underlying income distribution, our policy exercises require that the model approximates well the income distribution observed in the data.

Figure 8 illustrates that we fit well the share of women with a college degree as a function of the husband's earnings observed in the data. Since education is a strong predictor of earnings potential, the figure documents that our model can account for marital sorting based on potential earnings of the spouse. This is important for our policy analysis, since high earnings-potential women are more likely to respond to changes in tax policies, all else equal.

In Figure 9, we report the share of women employed as a function of husband's earnings in the simulations and data, separately for women with and without college degree. We fit well the decline in the share employed when the husband's earning increases, for both groups of women. The only feature of the data we cannot account for is the increase in the share employed for high school women married to men who earn more than $150,000. In Figure 10, we describe the same variables, but we also condition on the presence of children younger than 6. Our model can account for the fact that women work less when young children are present in the household for both college and no-college women.

The last feature of the data for which we discuss the model fit is the labor supply over the life-cycle of women and men with and without college. For women, we match well the three main patterns observed in the data. First, women without a college degree supply fewer hours than women with a degree throughout their working life. Second, both groups of women experience a decline in hours work in the middle of their working life due to fertility events, but women without a college degree experience the decrease earlier due to the fact that they have children at younger ages. Third, the dip in labor supply generated by fertility is larger for women with a college degree. For men, we match the main pattern observed in the data, which is that men with a college degree work longer hours for most of their working life.

7.3 Policy Evaluation

Using the estimated model, we evaluate three policies that have been proposed by economists, policy makers, and politicians and could have strong effects on household labor supply decisions: (i) a change to an individual taxation system; (ii) a secondary earner deduction; and (iii) child care subsidies under the joint and under the individual tax systems. In all cases, we focus on the allocation of time to market and household activities and on distributional effects.

A direct switch from a joint to an individual taxation system is the most debated tax policy. To evaluate its effects, we study the changes generated by a shift from the current U.S. joint taxation system to a system in which all individuals are taxed based on the current individual tax brackets. We maintain the current tax rates, which implies that the reform is not revenue neutral, and the existing social programs for low-income households. Specifically, eligibility for the EITC is based on pooled income before and after the reform.

In Figure 12, we describe the first effects of the reform: the change in the labor force participation decisions of married women. These effects are illustrated by the solid line, whereas the dashed line describes the tax rate on the first dollar of the wife's earnings under the joint taxation system. Since under the individual taxation system ,the marginal tax rate on the first dollar is zero, the dashed line represents also the change in wife's marginal tax rate generated by the reform. The figure documents that the reform has substantial effects on the labor force participation of women who experience large redutions in their marginal tax rate. Married women whose husband earns between $50,000$ and $120,000$ increase their labor force participation by an amount that is between 2 and 5 percentage points. Married women with husbands earning more than $120,000$ increase their labor supply by only 1-2 percentage points even though the decline in marginal tax rates is large, due to strong income effects.

Table 11 reports the impact of the policy on other variables of interest. The policy increases the time that women supply in the labor market by slightly more than one hour and decreases the time devoted to household production by slightly more than two hours. Thus, women increase the time they spend on leisure by one hours. This result is explain by the shift in decision power toward women of about three percentage points due to the lower tax rates married women pay. Men change their allocation of time in opposite direction, with a reduction in the hours worked in the market and an increase in the time spend in the production of the

public good. But the changes are smaller due to the fact that most married men are primary earners who have accumulated substantial amounts of human capital. Because of this, men do not experience changes in their wages. This is not the case for women, who enjoy wage increases of 2.4% if they are between 30 and 45 years of age, and wage increase of 3.8% if they are older than 45 due to the additional time they have to accumulate experience.

One criticism of the first policy we study is that it is regressive. Economists and policy makers have based this conclusion on a static evaluation that uses current incomes and, hence, does not account for the optimal dynamic response of individuals. We report the results of this static analysis, which does not require the use of our model, in Figure 13. Our static findings are consistent with the common belief that a switch from a joint to an individual taxation system generates a transfer from medium and high income households to rich households. All married households with primary earner's income between $65,000 and $340,000 suffer a decline in their take-home income, whereas households with primary earner's income higher than $340,000 enjoy substantial increases. Figure 14 documents that the static results are driven by households with only one earner, as all households with two earners experience large gains independently of their total take-home income.

Using only data, one can only generate the static results reported in Figures 13 and 14. The model estimated in this paper, however, enables us to also account for the optimal response of people to the reform. The results obtained from this dynamic evaluation, which are described in Figure 15, paint a different picture. When the optimal response is considered, almost all households benefit from the transition to the individual taxation system. It is only households with primary earner's income that is between $170,000 and $320,000 who suffer an income loss. But, as Figure 3 illustrates, the fraction of households in that income group is small. Moreover, even for these households, the losses are substantially smaller than the static analysis predicts, with losses that are never larger than 1 percent of the primary earner's income. Figures 13 and 14 provide an explanation for the differences between the static and dynamic analysis. Without a change in decisions, only married households with one earner suffer economic losses from a transition to an individual taxation system. After the transition, however, for most one-earner households it is optimal to reduce the degree of intra-household specialization and have both spouses working, which reduces the number of households with economic losses and their size.

The results presented so far make clear that neither taxation system Pareto dominate, as there are always some households that lose from switching to a different system. But, using the model, we can evaluate welfare performance of the two systems using different welfare functions. When we employ a welfare function that assigns the same weight to each household, we find that shift to the individual taxation system generates welfare gains for the entire economy. Figure 15 also suggests that this is the case for most welfare functions: unless extremely high weights are assigned to the small fraction of households with primary earner's income between $170,000 and $320,000, the individual taxation system produces larger aggregate welfare than the current system. The intuition for this result is related to a point we made earlier. All two-earner households experience welfare gains from switching to individual taxation. Some one-earner households suffer welfare losses if they do not modify their decisions, but this is not optimal. One-earner families respond to the reform by increasing the time the secondary earner spends in the labor market and. This reduces the welfare losses for some households and transforms the losses in welfare gains for others.

In lieu of individual taxation, some economist have proposed a deduction for the secondary earner (e.g. Kearney and Turner (2013)). We can evaluate this alternative policy using our estimated model. We consider the introduction of a $20,000 secondary-earner deduction to the current joint taxation system. Specifically, the secondary earner pays no taxes on the first $20,000, and pays taxes at the rates established by the current tax brackets for any income above that threshold. In the example discussed in Section 5.2, the secondary earner would pay a marginal tax rate of 40% on every dollar above $20,000. To make the policy revenue-neutral, we eliminate the standard/personal deductions for the secondary earner, and adjust the marginal tax rates in each bracket. The labor force participation responses of married women are reported in Figure 16. The deduction policy has effects on the fraction of married women working that are similar to the shift to individual taxation, but slightly smaller in size: married women subjected to large marginal tax rates in the current joint taxation system increase their labor force participation with effects that decline with the primary earner income. This result is noteworthy because the secondary-earner deduction is simple to implement and should encounter less political opposition than a full shift to individual taxation. Table 12 provides some insight of why the deduction policy has similar effects to individual taxation.

The mean marginal tax rate paid by married women is substantially larger under the deduction policy. But their mean average tax rate, which is the tax main variable behind the labor force participation decisions, is similar in the two taxation systems due to the deduction of $20,000. Hence, the similar effects of the two policies.

The last policy we evaluate is a revenue-neutral child subsidy and its interactions with the joint and individual taxation systems. The policy pays for up to $7,000 in childcare costs to families who require it. We report the labor force participation responses of married women under the two systems in Figure 17 and we compare them to the responses to individual taxation. The childcare policy generates larger responses than the shift to individual taxation under both systems, with changes that are larger for families with secondary-earners who paid larger marginal tax rates under the current system. But it is noteworthy that the effects of the tax policy are substantially larger – by 1 to 2 percentage points – under the individual taxation system, with increases in the fraction employed that can be as large as 9 percentage points.

8   Conclusions

The objective of the paper is to evaluate the effect of different taxation systems on choices and welfare. We do this by providing descriptive evidence that distinct taxation systems produce different incentives for primary and secondary earners and that these incentives influence individual choices. We then develop and estimate using U.S. data an intertemporal model in which single and married individuals make decisions on labor supply, household production, human capital accumulation, consumption, savings, marriage and divorce. Moreover, the model accounts for the main features of the U.S. taxation and welfare systems. Lastly, using the estimated model we evaluate three popular tax policies: a shift from a joint to an individual taxation system; the introduction of a secondary earner deduction in a joint taxation system; and the addition of child care subsidies to a joint and to an individual taxation system. Our results indicate that all three policies have important effects on choices and welfare, with secondary earners that increase their labor force participation and labor supply, at the cost of lower hours spent on household production, accumulate more human capital, increase their intra-household decision power, and their welfare.

References

Apps, Patricia, and Ray Rees. 1999a. "On the taxation of trade within and between households." *Journal of Public Economics* 73 (2): 241–263 (August).

Apps, Patricia F., and Ray Rees. 1999b. "Individual Versus Joint Taxation in Models With Household Production." *Journal of Political Economy* 107 (2): 393–403.

Bick, Alexander, and Nicola Fuchs-Schundeln. 2018. "Taxation and Labor Supply of Married Couples across Countries: A Macroeconomic Analysis." *Review of Economic Studies*, no. Forthcoming.

Bick, Alexander, and Nicola Fuchs-Schndeln. 2017. "Taxation and Labour Supply of Married Couples across Countries: A Macroeconomic Analysis." *The Review of Economic Studies.*

Bonhomme, Stphane, and Elena Manresa. 2015. "Grouped Patterns of Heterogeneity in Panel Data." *Econometrica* 83 (3): 1147–1184.

Chiappori, Pierre-Andre, and Maurizio Mazzocco. 2017. "Static and Intertemporal Household Decisions." *Journal of Economic Literature* 55 (3): 985–1045 (September).

Gayle, George-Levi, and Andrew Shephard. 2016. "Optimal Taxation, Marriage, Home Production, and Family Labour Supply." *Working Paper.*

Guner, Nezih, Remzi Kaygusuz, and Gustavo Ventura. 2012. "Taxation and Household Labour Supply." *The Review of Economic Studies* 79 (3): 1113–1149.

Guryan, Jonathan, Erik Hurst, and Melissa Kearney. 2008. "Parental Education and Parental Time with Children." *Journal of Economic Perspectives* 22 (3): 23–46 (September).

Keane, Michael P. 2011. "Labor Supply and Taxes: A Survey." *Journal of Economic Literature* 49 (4): 961–1075.

Kearney, Melissa S., and Lesley J. Turner. 2013. "Giving Secondary Earners a Tax Break: A Proposal to Help Low- and Middle-Income Families." *Brookings Discussion Paper 2013-07.*

Kocherlakota, Narayana R. 1996. "Implications of Efficient Risk Sharing without Commitment." *Review of Economic Studies* 63:595–609.

Marcet, Albert, and Ramon Marimon. 2011. "Recursive Contracts." *Economics Working Paper, European University Institute*, no. eco2011/15.

Saez, Emmanuel. 2010. "Do Taxpayers Bunch at Kink Points." *American Economic Journal: Economic Policy*, no. 2:180–212.

Table 1: Effects on Outcomes: Joint vs. Individual Taxation

	Taxed As Individuals			Taxed Jointly As Married Couple		
	Pooled	Primary Earner	Secondary Earner	Pooled	Primary Earner	Secondary Earner
Pre-Tax Income	$110k	$80k	$30k	$110k	$80k	$30k
Marginal Tax Rate	-	0.40	0.10	0.40	0.40	0.40
After-Tax Income	$86.5k	$59.5k	$27k	$89k	$71k†	$18k†
Marriage Bonus	$0			$2.5k		
Average Tax Rate	0.21	0.26	0.10	0.19	0.11†	0.40†

† Calculation supposes that primary earner always works, while secondary earner supplements primary earner income.

Table 2: Labor Supply Responses to Changes in Tax Rates on First Dollar of Earnings, Based on Husband's Income

	All Women		Women with Young Children		Women without Young Children	
	LFP	Hours	LFP	Hours	LFP	Hours
1986 Reform	-0.175**	-0.059	-0.258**	0.203	-0.072	-0.001
	[0.013]	[0.553]	[0.034]	[0.070]	[0.444]	[0.261]
1993 Reform	-0.003	0.037	-0.030	0.383	0.007	0.118
	[0.963]	[0.829]	[0.846]	[0.251]	[0.938]	[0.596]
2003 Reform	-0.155*	0.117	-0.331**	0.311	-0.207*	-0.072
	[0.084]	[0.526]	[.102]	[0.492]	[0.051]	[0.733]

Notes: P-values in brackets. Coefficients presented are from the interaction between the change in marginal tax rate due to the tax reform, based on an individual's pre-reform income, and an indicator for the post-reform period.

Table 3: Response of Weekly Hours to Change in Marginal Tax Rate

	Married Men	Single Men	Single Women
1986 Reform	-0.116**	-0.225	-0.178*
	[0.034]	[0.190]	[0.075]
1993 Reform	0.018	-0.274	-1.184***
	[0.907]	[0.534]	[0.000]
2003 Reform	-0.090	-0.168	-0.054
	[0.270]	[0.652]	[0.729]

Notes: P-values in brackets. Coefficients presented are from the interaction between the change in marginal tax rate due to the tax reform, based on an individual's pre-reform income, and an indicator for the post-reform period.

Table 4: Labor Force Participation Responses of Married Women, Bush Reform, ACS

Husband's real income quantile	Avg. Δ in tax rate on wife's first dollar	Change in wife's employment rate
$35-38k	-0.1	-0.006
$38-42k	0.0	0.000
$42-47k	-0.1	0.002
$47-52k	**-3.2**	0.007*
$52-57k	**-9.2**	0.017***
$57-65k	**-5.5**	0.009***
$65-75k	**-2.8**	0.008*
$75-90k	-2.5	-0.003
$90-131k	1.2	0.001
$131k+	1.2	-0.005

Table 5: Labor Force Participation Responses of Married Women By Demographic Group, Bush Reform, ACS

All Women	0.017***	(0.003)
Women with children under 5	0.027***	(0.006)
Women without children	0.010**	(0.005)
Women with children over age 5	0.017***	(0.003)
Women, College	0.013***	(0.003)
Women, HS or less	0.025***	(0.006)

Notes: Coefficients reported for women whose husband earns $52-57k. Standard errors in parentheses.

Table 6: Preference Parameters

Parameter	Description:	Value
ρ	Private consumption power parameter	1.72
σ	Leisure power parameter	2.83
β	Discount factor	0.92
Utility parameters, private consumption relative to		
	Leisure, γ_1	0.68
	Public consumption, γ_2, normalized	1.00
Fixed utility cost of working:		
	γ_3, Ages 25-29 (normalized):	1.00
	...	...
	γ_3, Ages 35-39:	1.23
	...	...
	γ_3, Ages 55-59:	9.16

Table 7: Estimates I: Labor Productivity in Home Good Production

Description:	Estimate
High School:	
Baseline Productivity	0.166
Indicator for Children in Household	0.042
Indicator for Children <6	0.105
College:	
Baseline Productivity	0.399
Indicator for Children in Household	0.147
Indicator for Children <6	0.367
Women's productivity, relative to men's	1.070

Table 8: Estimates II: Marriage Market Parameters

Description:	Estimate
Probability of drawing a potential match:	
At age 22	0.85
Change with age	-0.09
Minimum probability of drawing a match (after age 40)	0.05
Probability of drawing a partner with the same education	0.72
Probability of drawing a partner with the same ability type, high school	0.45
Probability of drawing a partner with the same ability type, college	0.50
Cost of divorce	2.52
One-time re-marriage penalty for individuals with children:	2.91

Table 9: Estimates III: Wage Process Parameters

Description:	Men	Women
Experience:		
High School, Ability Type 1	0.03	0.03
High School, Ability Type 2	0.06	0.05
College, Ability Type 1	0.05	0.04
College, Ability Type 2	0.09	0.07
Experience Squared:		
High School, Ability Type 1	-0.001	-0.001
High School, Ability Type 2	-0.003	-0.002
College, Ability Type 1	-0.003	-0.002
College, Ability Type 2	-0.005	-0.002
Constant:		
High School, Ability Type 1	-0.15	-0.10
High School, Ability Type 2	0.25	0.11
College, Ability Type 1	0.22	0.15
College, Ability Type 2	0.38	0.26
Variance of Wage Shocks:		
High School, Ability Type 1	0.12	0.11
High School, Ability Type 2	0.14	0.09
College, Ability Type 1	0.13	0.11
College, Ability Type 2	0.16	0.12

Table 10: Summary Statistics, Data and Model Simulation

Moment:	Data	Model
Share Married, Ages 22 to 60	0.61	0.65
Share Divorced, Ages 22 to 60	0.12	0.11
Share w/Child < 6, Ages 22 to 38	0.34	0.38
Share Employed:		
Men, HS	0.74	0.79
Men, College	0.91	0.94
Women, HS	0.64	0.66
Women, College	0.79	0.83
Weekly Hours Spent in Home Production:		
Men	12.3	14.1
Women	25.2	21.2
Share of Households in which Woman is Higher Earner:		
When Husband is High School Graduate	29.3	33.7
When husband is College Graduate	26.2	31.2

Table 11: Simulation Results: Effects of the Individual Taxation Policy

	Men	Women
Weekly Hours Worked, Cond'l on Working	-0.7	1.1
Weekly Hours in Home Production	0.8	-2.1
Pareto weight	-0.03	0.03
Wages, 30-45	-0.1%	2.4%
Wages, 45+	-0.1%	3.8%

Table 12: Marginal and Average Tax Rates: Individual Taxation Vs. Secondary Earner Deduction

	Individual Taxation	Joint + Secondary Earner Deduction
Mean Women's Marginal TR	0.26	0.33
Mean Women's Average TR	0.16	0.19

Figure 1: Tax Schedule: Marginal Tax Rate
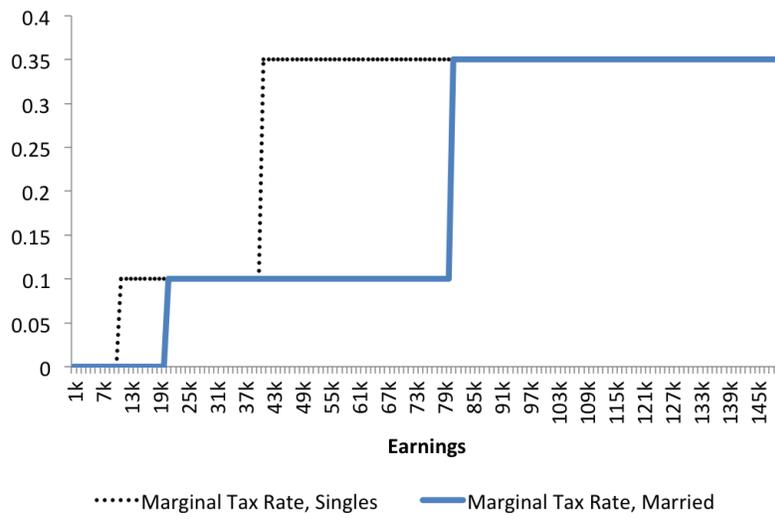
Figure 2: U.S. Tax Schedule: Marriage Bonuses and Penalties
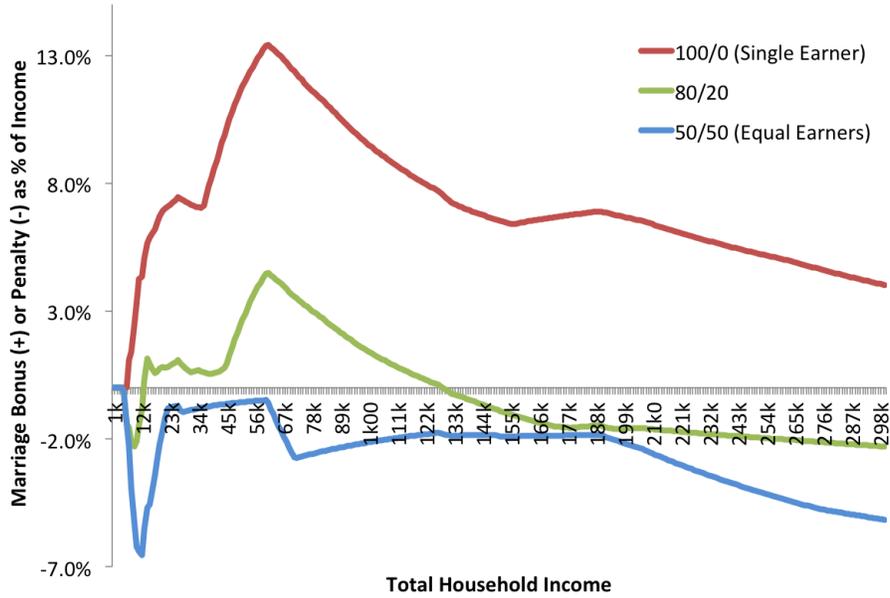
Figure 3: Tax Rate of Secondary Earner and Women's Non-Employment

41
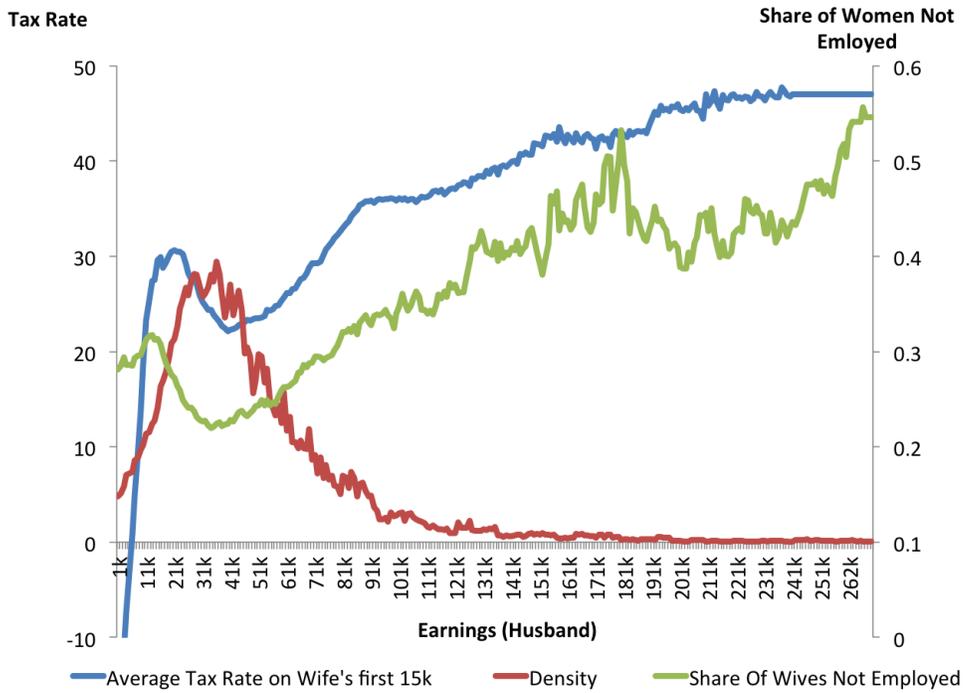
Figure 4: 1986 Reagan Tax Reform

Total Household Income (Year 2000 Dollars)

Pre-reform (1986) — Post-reform (1988)
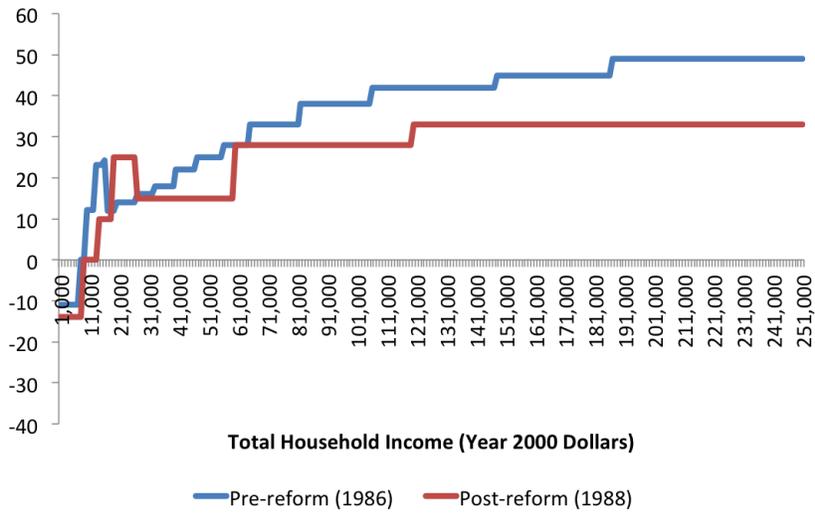
Figure 5: 2003 Bush Tax Reform

Total Household Income (Year 2000 Dollars)

Pre-reform (2002) — Post-reform (2004)
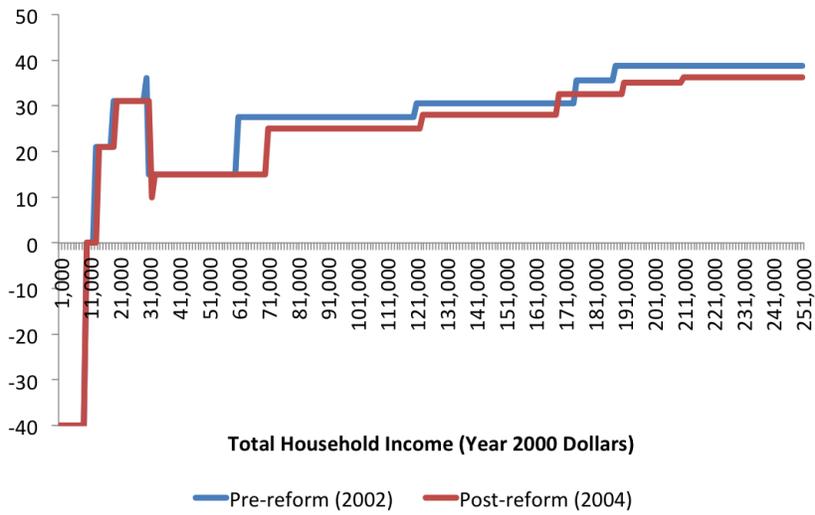
Figure 6: 1993 EITC Reform

Total Household Income (Year 2000 Dollars)

1992   1994
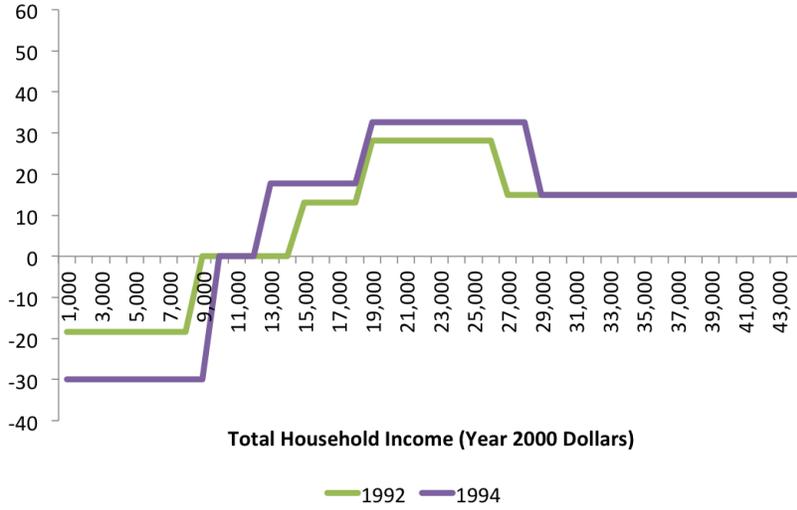
Figure 7: Income Distribution of Married Men (Ages 25-54)

Annual Income of Men, Ages 25-54 (Data)   Annual Income of Men, Ages 25-54 (Simulation)
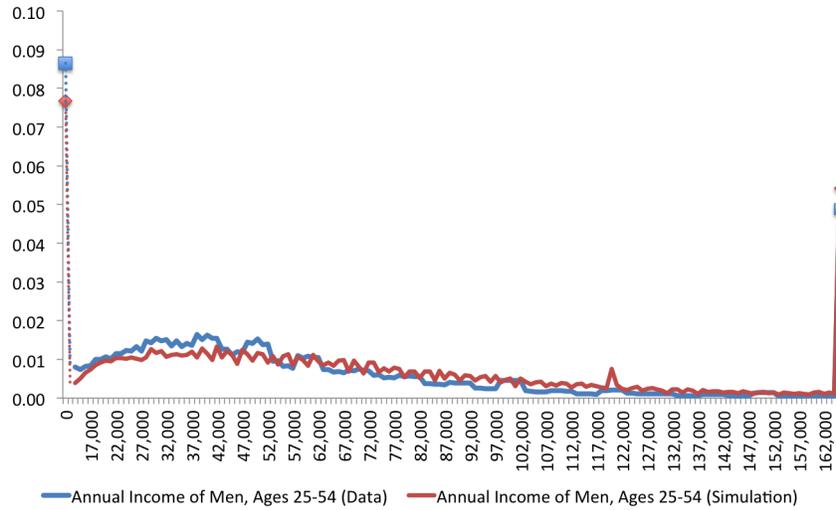
Figure 8: Share of Women With College Education, By Husband's Earnings
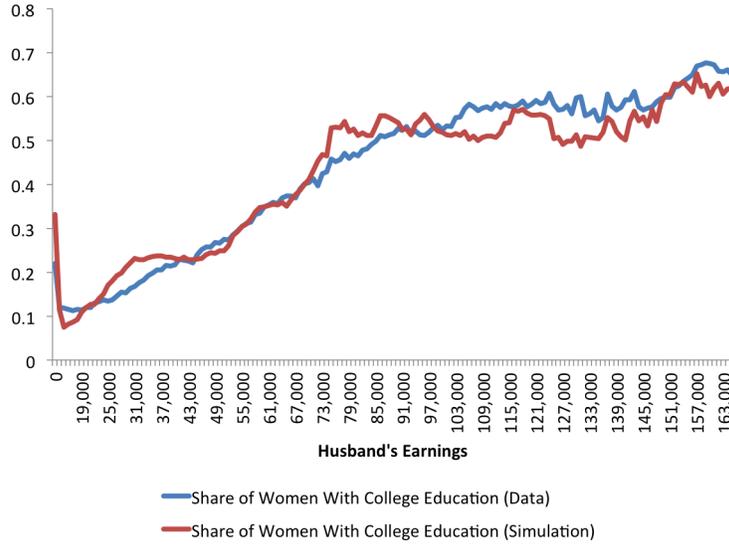
Figure 9: Share of Women Employed, By Husband's Earnings

44
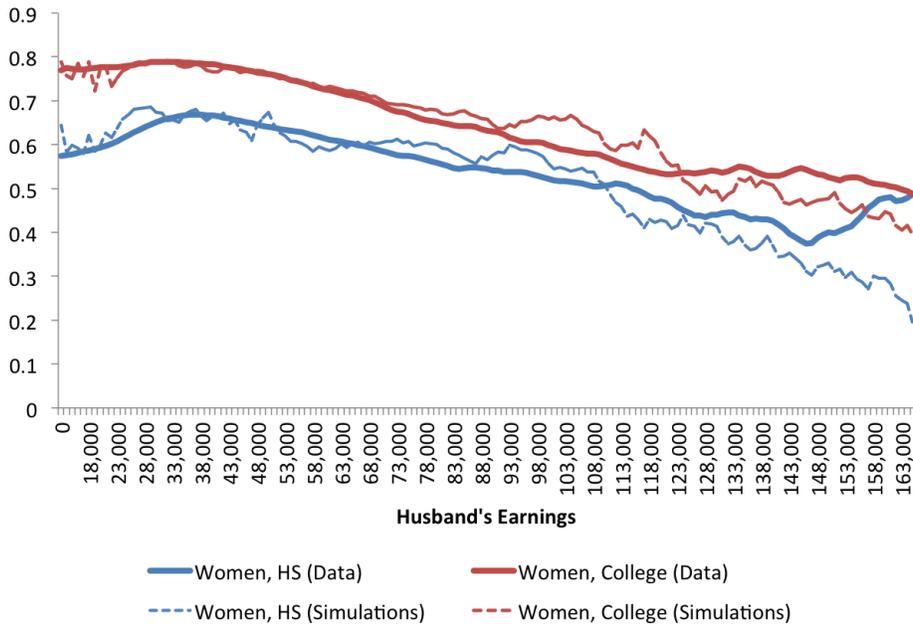
Figure 10: Share of Women Employed, By Husband's Earnings and Age of Child

High School-Educated Women

College-Educated Women

No young children (Data)   Children < 6 (Data)

No young children (Simulation) Children < 6 (Simulation)

No young children (Data)   Children < 6 (Data)

No young children (Simulation) Children < 6 (Simulation)

Husband Earnings
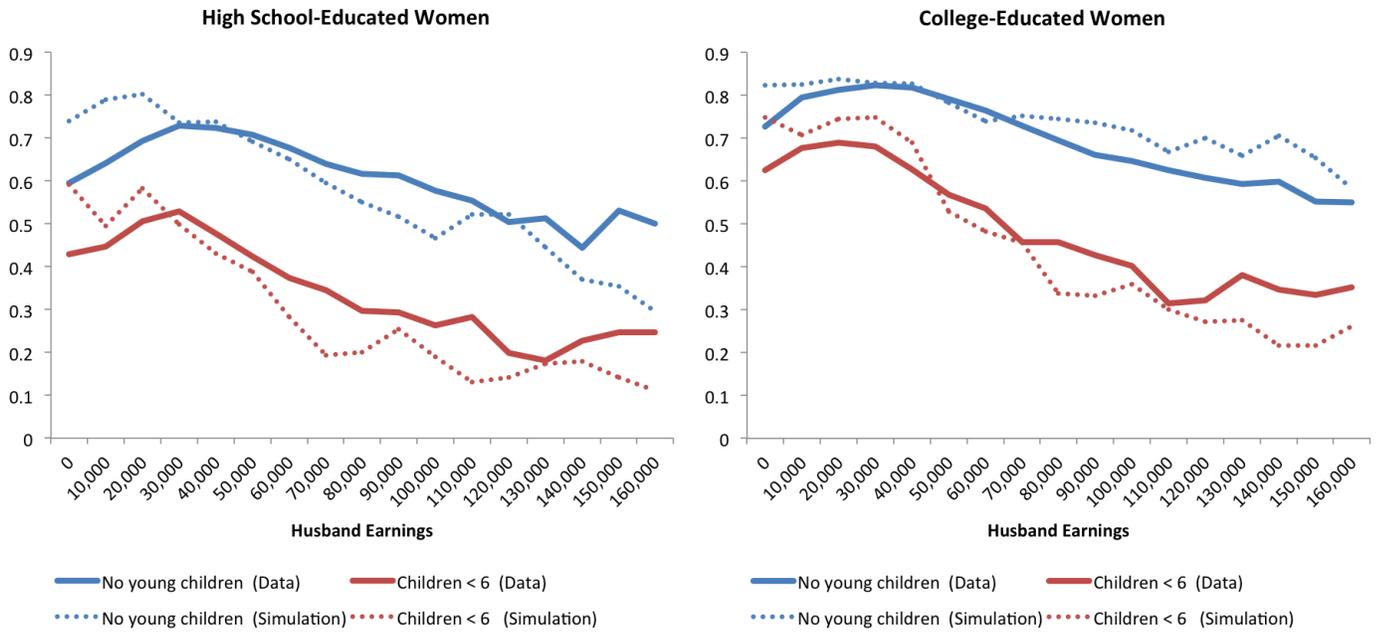
Husband Earnings

Figure 11: Weekly Hours Worked, Model and Data

HS

Col

HS (Data)

Col (Data)

HS

Col

HS (Data)

Col (Data)

45
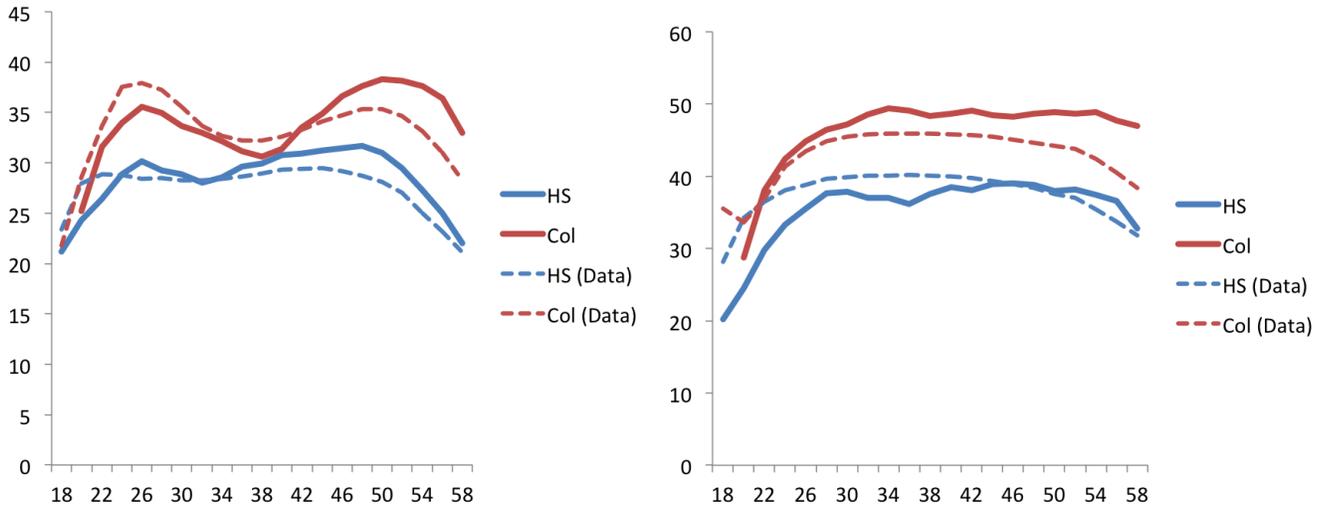
Figure 12: Change in Share of Women Employed, by Husband's Earnings
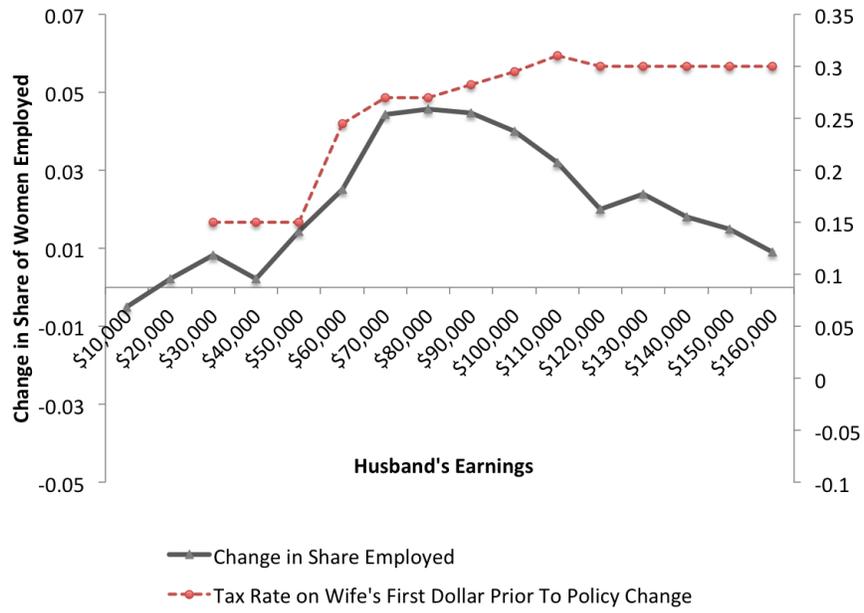
Figure 13: Change in Total Household Take-Home Income, by Income of Primary Earner: Static Evaluation
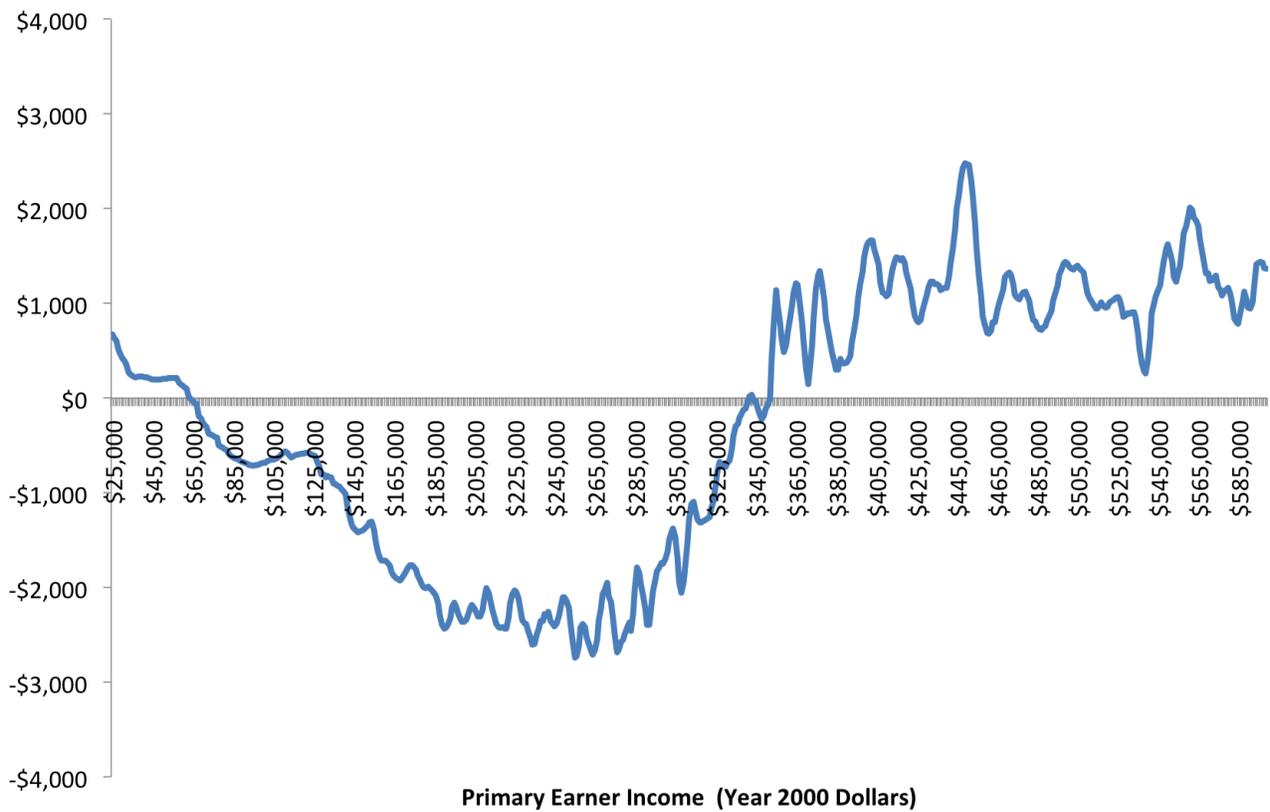
Figure 14: Change in Total Household Take-Home Income, by Income of Primary Earner: Static Evaluation, Two-Earner Households
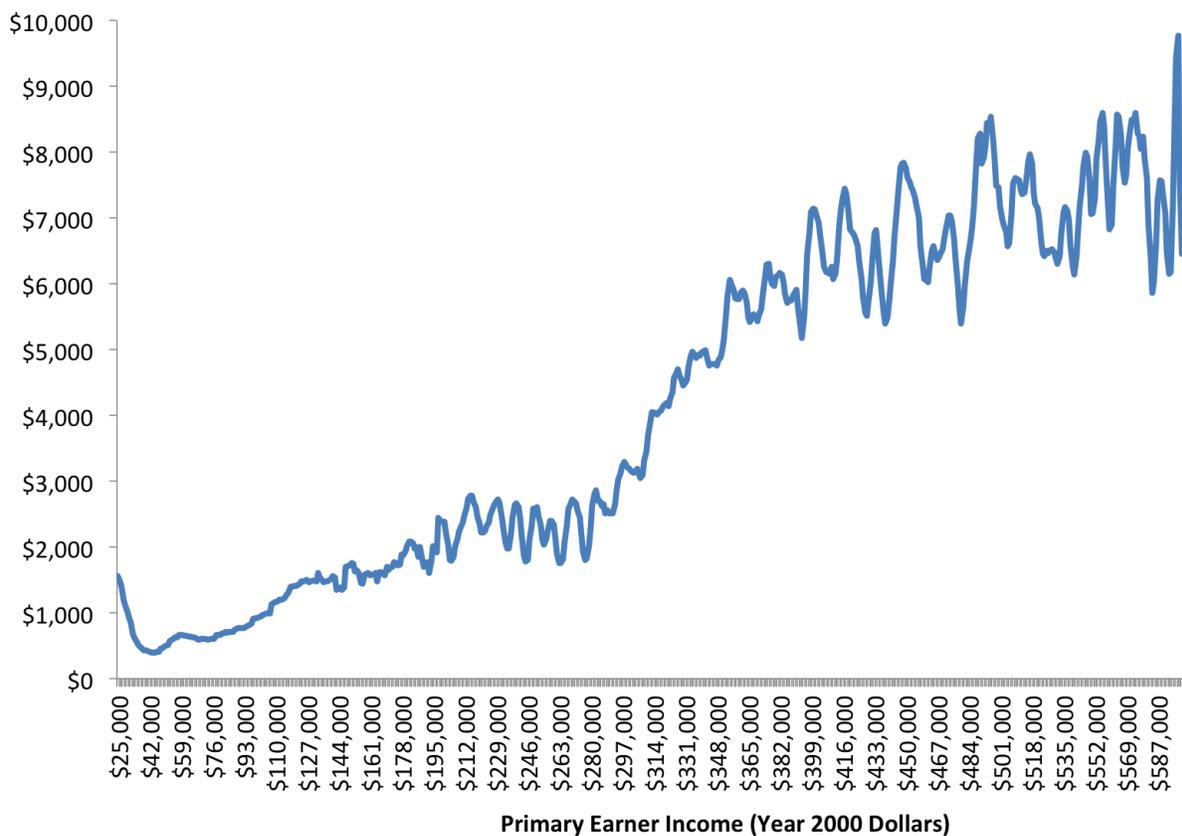
Figure 15: Change in Total Household Take-Home Income, by Income of Primary Earner: Dynamic Evaluation
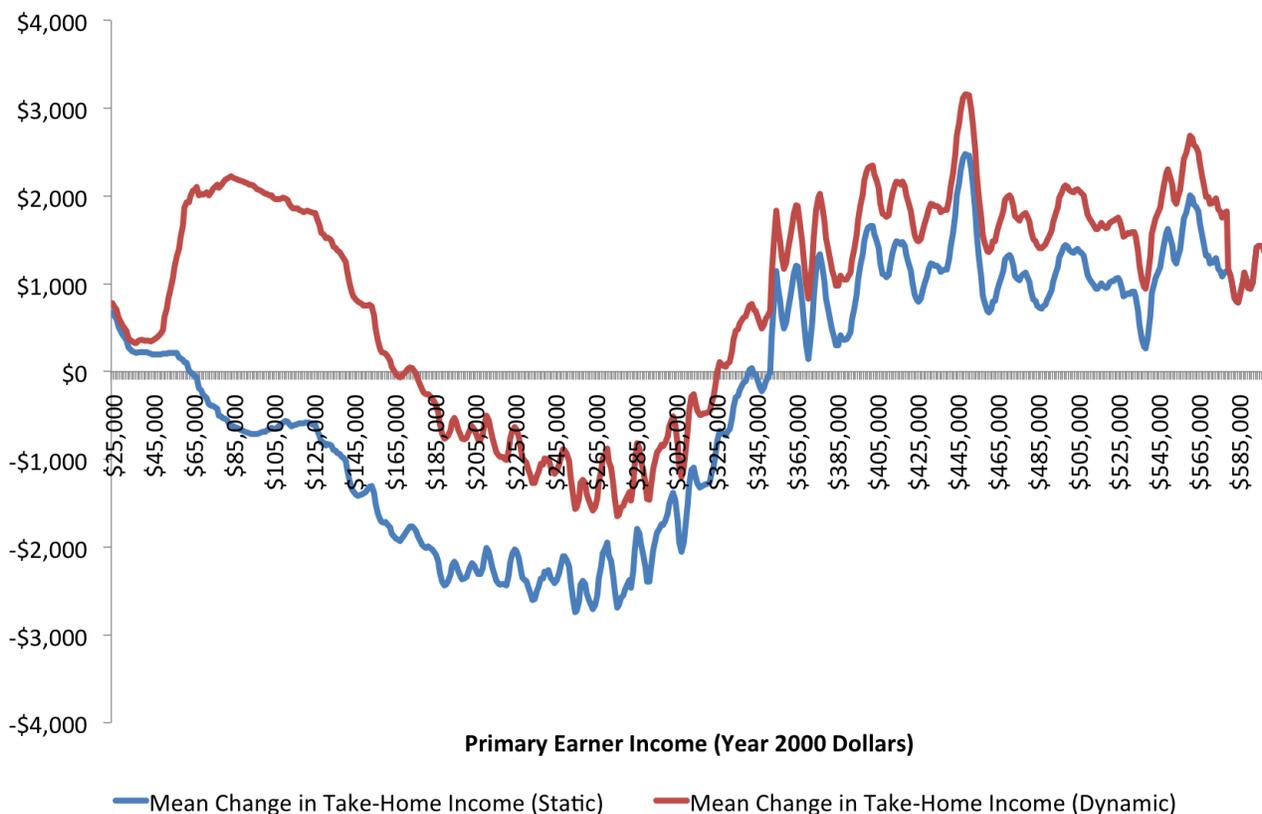
Figure 16: Labor Force Participation Responses to the Secondary Earner Tax Deduction ($20k) vs. Individual Taxation
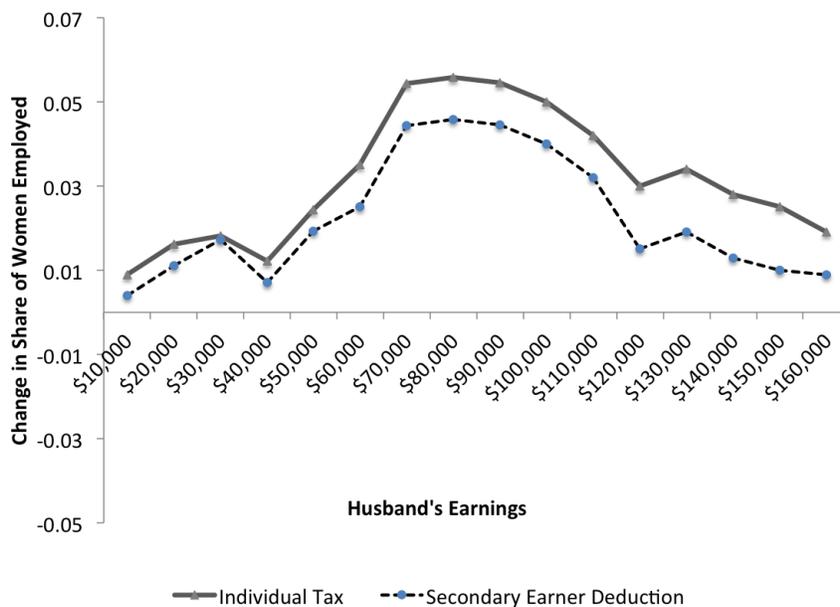
Figure 17: Labor Force Participation and the Childcare Policy (Max. $7,000)