Taxation and Household Decisions: an Intertemporal Analysis*

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Abstract

How do different income taxation systems – for instance individual vs. joint – affect people's decisions and welfare? We provide an answer to this question in three steps. We document that taxing married households jointly, as in the U.S., generates substantial disincentives for secondary earners to supply labor, and that secondary earners respond to these disincentives. Next, we develop a lifecycle model in which single and married individuals make decisions about labor supply, household production, human capital accumulation, consumption, savings, marriage, and divorce. We estimate the model using variation from past tax reforms in the U.S., as well as auxiliary time use and expenditure data. Lastly, we use the model to evaluate the effect on individual decisions and welfare of four tax systems: the standard joint taxation system currently adopted by the U.S.; the individual taxation system; a more general form of the standard joint system that allows for flexible dependence of tax rates on the spouse's earnings; the standard joint system with deductions for secondary earners. We find that the optimal individual system welfare-dominates the optimal standard joint system because it allows for more progressivity. But we also find that the optimal general joint system generates higher welfare than the individual one, as it allows for a high degree of progressivity without the negative effects that the individual system has on low-income married households. Lastly, our results indicate that the standard joint system with secondary-earner deductions welfare dominates the individual system, as it approximates well the general joint system.

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1 Introduction

Income taxes account for half of government revenues in the United States, and are similarly the main source of revenues for most developed countries. These revenues are used to redistribute resources across households and to provide public goods. Governments can choose not only progressivity, but also the type of income taxation, each one with different effects on a country's welfare distribution and income inequality. For example, Canada and Sweden adopt an individual system in which neither spousal earnings nor marital status determine the tax schedule of married individuals. By contrast, the U.S. and Germany use a joint system that consider pooled earnings of a couple when determining married individuals' tax rates. Other countries, like France and the U.K., have hybrid systems that borrow elements from both individual and joint schemes.

The main contribution of this paper is to answer the following two questions: What income taxation system maximizes a country's welfare? What effect does the optimal system have on welfare inequality? We find that an individual system welfare dominate the current joint system adopted by the U.S., but it also increases welfare inequality. We also find that a more general joint system that allows the tax rates of a married individual to depend flexibly on the spouse's income attains higher welfare than the individual system, while reducing welfare inequality. The general joint system may be difficult to implement because of its complexity. Our results indicate that the joint system currently adopted by the U.S. augmented to include a significant deduction for secondary earners achieves welfare and inequality outcome that approximate the ones attained by the general joint scheme.

We proceed in three steps. We first provide four pieces of evidence on the effects of different taxation schemes on individual choice. First, secondary earners face higher marginal and average tax rates under a joint than an individual tax system. The opposite is true for primary earners. Second, in the U.S., a married woman's average tax rate, as predicted by the earnings of her husband, is strongly correlated with her employment probability. In Canada, however, which has an individual tax system, there is no systematic relationship between a married woman's employment and her husband's income. Third, under a joint tax system, married single-earner households enjoy larger take-home incomes than under the individual system, whereas the opposite is true for married couples with relatively equal earnings. These three facts suggests that joint taxation creates incentives for married couples to have one spouse specialize in labor market activities and one in household activities. Lastly, we document that changes in tax rates generated by past U.S. tax reforms produce significant changes in labor force participation for one group of individuals: married women. We estimate that a 10 percentage-point decline in married women's average tax rate, as predicted based on her husband's earnings, is

associated with a 3 to 4 percentage point increase in their labor force participation in the short run. The response is about twice as large for married women with young children.

As a second step, we use the evidence discussed above to develop and estimate a dynamic model of household decisions. The facts indicate that, to credibly evaluate a tax reform, one should properly model primary and secondary earners, their interactions, and the possible selection in the way they match. Our evidence also makes clear that reduced-form methods are useful to document short-run effects of tax reforms. Assessing their long-run consequences requires a model that accounts for the dynamic aspects of tax reforms. To that end, we develop an intertemporal model in which individuals can be either single or married, where the marriage decision is endogenous. If married, the couple makes joint and efficient decisions, with the limitation that they cannot commit to future allocations of resources. Whether married or single, individuals choose labor supply on the extensive and intensive margins, consumption, savings, and the time and market inputs they invest in the production of a home-produced good. The efficiency of decisions jointly with the existence of the home-produced good allows us to generate intra-household specialization, which is an important feature of the data. Changes in taxation systems have the potential to produce in the long run changes in the number of marriages, selection into marriage, intra-household specialization, and number of divorces. We consider a model without commitment, because it allows for all types of divorces observed in the data – mutual consent and no fault – and for general changes in the degree of specialization. Individuals in the model accumulate human capital, and human capital depreciates when they do not work, allowing us to capture the long-run effects of changes in the tax system on individual decisions and outcomes. 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 tax reform implemented in 2003 by the Bush Administration (Bush tax cuts). Lastly, to account for the effects of the existing welfare system on the performance of a taxation scheme, 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). The model is estimated using as the main source of the variation the Bush tax cuts.

As the last step, we rely on the estimated model to determine the tax system that maximizes total welfare and the corresponding tax rates. We evaluate the four alternatives discussed about: the current U.S. joint system; the individual tax system; the general joint system; and the current joint system with secondary earner's deduction. For each scheme, we compute the tax rates that maximize

total welfare and compare the relevant outcomes. We find that the tax rates currently used in the U.S. are close to the ones that maximize welfare under a standard joint system. The optimal rates are moderately more progressive. The main limitation of the joint system is that it cannot attain large redistribution of resources from the top to the bottom of the earnings distribution, as an increase in tax rates at the top affects primary as well secondary earners, who have high labor supply elasticities. The individual taxation system is not affected by this shortcoming. As such, it produces higher welfare through more redistribution than the optimal joint, with taxpayers willing to pay on average 0.93% of their annual income vs the 0.82% for the optimal standard joint. The higher welfare under individual taxation comes at the cost of an increase in welfare inequality, since low-ability, low-education workers benefits only marginally from the lower tax rates at the bottom, given their low participation rates. At the same time, individual taxation reduces take-home income for single-earner households, which are more frequent at for low-ability, low-education families.

Our main finding is that the general joint system attains the highest level of welfare (willingness to pay 2.11%), as it can achieve a significant redistribution of resources across the earnings distribution while reducing welfare inequality. This is accomplished by exploiting its high degree of flexibility, which enables governments to choose tax rates that account for a larger set of labor supply elasticities, and to target the groups with that are less responsive. We also find that the general joint system provides the highest insurance against consumption risk. The main shortcoming of the general joint scheme is that it is complex, as one has to keep track of many more tax rates. Our other main findings is that the simple introduction of a substantial deduction for secondary earner in the current joint system approximate well the key outcomes of the general joint. Indeed, tax payers are willing to pay 1.15% of their annual income for the addition of a $20k$ secondary earner's deduction.

Our policy analysis indicates that there are some aspects of individual decisions that must be accounted for when evaluating tax reforms. First, it is crucial to allow for home-produced goods that are public within the household. We find that under individual taxation the production of these goods declines, with negative effects on welfare. If one ignores household production, the welfare improvements of individual taxation would be overestimated. Second, it is important to account for the substitutability between time and market inputs in the production of these home-produced goods. Our policy evaluations document that a shift to the general joint or to the current joint system with deductions induces a significant substitution from time to market inputs that allows families to attain a similar or higher level of public consumption. In the absence of market inputs, we would have underestimated the welfare effects of these two taxation schemes. Accounting for marriage decisions

is also critical. Part of the reason the general joint system produces the highest welfare is that it increases marriage rates, by providing higher marriage bonuses – the difference in take-home income between a married couple and the same couple not married.

Dynamics also plays an important role. To evaluate its effect on the optimal tax rates, we run an experiment where we reduce the rate at which human capital accumulate by 10% and re-derive the optimal rates for the general joint system. We find lower rates for the higher brackets and higher rates for medium, medium-high brackets, as many taxpayers move down the earnings distribution. Thus, without dynamics, the ability of a taxation system to redistribute resources would be underestimated. One last key feature of our analysis is matching based on observed and unobserved heterogeneity in ability. Our results document that the propensity to match assortatively has significant effects on the outcomes of tax reforms. We perform an experiment in which we reduce the correlation between the unobserved ability draws of potential spouses so that the correlation between married individuals is cut in half. We then re-derive the optimal tax rates for the general joint system. The results are similar to the experiment that deals with dynamics: lower optimal rates for the higher brackets and higher rates for medium and medium-high bracket, as many couples move that the earnings distribution.

Our paper builds on two particularly insightful papers. Kleven, Kreiner, and Saez (2009) is the first paper that analyzes theoretically an income taxation system with tax rates of one individual that can depend in a flexible way on the spouse's earnings. They study the optimal non-linear taxation of couples using a static unitary model in which the primary earner makes intensive margin labor supply decisions and the secondary earner makes extensive margin labor supply decisions. Using their framework they derive the optimal relationship between between the taxes paid by a married couples and the spouses' earnings. Gayle and Shephard (2019) develop and estimate a static model of marriage and household decisions to study empirically the general joint system introduced in Kleven, Kreiner, and Saez (2009) and to compare its performance to the current joint system used in the U.S. and to an individual system. They find that a flexible joint system produces the highest welfare, as suggested by Kleven, Kreiner, and Saez (2009). We extend Gayle and Shephard (2019)'s paper by allowing for dynamics, limited commitment within the household, and assortative matching based on unoberved ability. These extensions enable us to study the long-run effects of different tax reform. We also document that a simple modification to the joint system adopted by the U.S. – a secondary earner deducation – produces results that approximates the ones attained by the more complex general joint system.

Several other excellent 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. Rondina (2020) performs an exercise similar to Guner, Kaygusuz, and Ventura (2012), with the difference that the calibrated model is a collective model with limited commitment, but without the general equilibrium aspect. Bick and Fuchs-Schündeln (2017) document that the cross-country correlation of average labor supply 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 simulated data that differences in taxation systems across countries can explain the large differences in the labor supply behaviour of married men and married women across those countries. Alesina, Ichino, and Karabarbounis (2011) study the gender-based taxation of couples in a static collective model with linear and separable tax rates for the two spouses. Their main insight is that secondary earners should have lower marginal tax rates because they have lower labor supply elasticities. Our finding that individual taxation welfare-dominates the standard joint system in a dynamic model with taxation schedules that are non-linear and joint for couples is partially based on the same insight. Borella, De Nardi, and Yang (2019) estimate a lifecycle model of labor supply and saving decision of couples and study the effect of the dependence of taxes and social security benefits on marital status on the labor force participation decisions of women. They find that removing the dependence on marital status increases significantly the participation of women, which is consistent with our finding that the design of the taxation system has important effects on the choices of secondary earners.

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 household decisions. Section 6 provides heuristic arguments for model identification and describes the moments used in the model estimation. In Section 7, we report the estimation results and the fit of the model. Section 8 assesses different taxation reforms and Section 9 concludes.

2 Data

We use five data sets. We provide descriptive evidence and estimate the response to prior tax cuts using the Panel Studies of Income Dynamic (PSID) (1980-2010), the 2000 Census, and the Current Population Survey (CPS) (2001-2015). These data sets provide information about labor force participation, hours of work, earnings, income, education, and demographic variables for primary and secondary earners. We rely on the PSID and the Current Population Survey (CPS) (1980-2016) for all variables used in the structural estimation, with two exceptions. We use the American Time Use Survey (ATUS) (2000-2011) to compute the time invested in the production of the home-produced good, and the Consumer Expenditure Survey (CEX) (1980-2010) to calculate private consumption and the financial resources invested in the production of the home-produced good.

3 Differences in Common Taxation Systems

Among joint tax systems, "income splitting" systems are among the most common. Under income splitting, couples face the same tax schedule as single individuals, but with brackets that are double the size. Consequently, married couples are taxed as if they were two single individuals, each earning half of the total household income. This system characterizes the German system and approximates well the U.S. system, albeit with some deviations.[1] Throughout the paper, we will use the terms "standard joint" and "income splitting" interchangeably.[2]

How do standard joint income tax systems differ from individual systems, which do not consider marital status for taxation? To illustrate their distinguishing features, we begin with a simple example. We will then show that the example captures important empirical features of U.S. taxation, labor supply and income patterns, which will be important for understanding the tax reforms we consider in the last part of the paper.

3.1 Taxing Married Households: A Simple Example

To appreciate the different potential effects of joint vs. individual taxation, consider the following simple progressive tax schedule under a standard joint system. Single individuals pay no taxes on the first \$10,000, 15% on income between \$10,000 and \$40,000, and 40% on remaining income. For married individuals these brackets double, and their pooled income is taxed: i.e., they pay no taxes on

[1] NOTE: Briefly discuss deviations of the U.S. system from IS and include reference to additional details in Appendix.

[2] Of course, divergence from these prototypes is not uncommon among countries with joint tax systems. Include some examples of this here

their first $20,000, 15% on household income between $20,000 and $80,000, and 40% on the remaining income. This system has a similar (albeit much simplified) structure as the one in the U.S. Finally, we can also consider the same progressive tax schedule, but under a hypothetical individual system. In that case, all individuals – regardless of marital status – are taxed according to the schedule for singles.

In Table 1, we evaluate tax rates and take-home pay for a hypothetical couple with $80,000 and $30,000 in pre-tax income. The first and last three columns consider their outcomes under the individual and joint system, respectively. In this example, the primary earner has a marginal tax rate (MTR) of 40% under both systems. By contrast, the secondary earner's MTR increases significantly, from 10% to 40% when taxation changes from individual to joint. This increase in the secondary earner's MTR is a well-understood consequence of joint taxation, and possible reason for low married women's labor supply in countries with highly progressive schedules and joint taxation (e.g., Bick and Fuchs-Schündeln (2017)). Notice, additionally, that a comparison of the first and last three columns in Table 1 alternatively illustrates the hypothetical couple's change in taxation before vs. after marriage under the joint system: in this case, the secondary earner's MTR increases as soon as she marries, assuming pre-tax earnings do not change.

Next, Table 1 illustrates two additional, important differences between the two systems. The first is the change in take-home income after marriage under joint taxation. The married couple in the example brings home a total of $86,500 if taxed like two single individuals, but has $89,000 in after-tax income under joint taxation. This $2,500 "marriage bonus" under the joint system is explained by the greater share of the couple's pre-tax earnings that are taxed at the lower, 15% rate, after marrying. Even more strikingly, if the secondary earner had no income (or dropped out of the labor force), Table 1 shows that the couple's take home-pay would be $71,000 if taxed jointly, but only $59,500 if taxed individually – equivalent to a marriage bonus of $10,500, or about 13% of pre-tax earnings, under the joint system. The example illustrates an important broader point: the "marriage bonus" under the joint system is largest for couples with relatively unequal earnings, and thus subsidizes those types of marriages. It also generates an additional potential disincentive to work after marriage in the form of an income effect.

The third key difference between the two systems relates to average tax rates (ATRs), especially for secondary earners. To compute ATRs under joint taxation, we assume that the primary earner's 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 many two-earner

households, in which the primary earner works regularly and the secondary earner adjusts his or her labor supply depending on the couple's needs. Under this assumption, the secondary earner's contribution to after-tax household income is $\$18,000$, implying an ATR of 40% on the secondary earner's $\$30,000$ of pre-tax income. By comparison, her ATR is only 10% under the individual system. The effect on average tax rates is relevant as it influences discrete choices, such as labor force participation decisions, especially in the presence of fixed costs of work.

3.2 Descriptive Evidence

Taxation in the U.S. is more complex than in our example, but its features are well-captured by it. First, marriage bonuses are common for the majority of U.S. households, and as high as 9% of take-home income. Figure 1 plots marriage bonuses as a percent of total household after-tax income for three types of households: single-earner, equal-earner, and households in which one spouse earns 80% of income. Almost all married U.S. households that are fully specialized and most partially specialized households experience a marriage bonus. As a percent of household income, marriage bonuses are highest for single-earner households with somewhat above median earnings, but even low-income single-earner households receive a 5–6% bonus. In line with our previous discussion, these observed marriage bonuses makes matches between partners with unequal earnings potential more attractive, and also incentivize married couples to increase the degree of intra-household specialization.

Second, as in our example, U.S. secondary earners face high tax rates, even on their first dollar of earnings, generating potentially substantial disincentives to work. To illustrate this, we proxy primary and secondary earner status by gender in Figure 2a, and plot two variables as a function of the husband's earnings. The first is the predicted average tax rate (ATR) on a married woman's first $\$15,000$ of income, which exceeds 40% for a significant share of U.S. secondary earners.[3] The second variable is the share of married women who do not work. Figure 2a shows a striking positive relationship between these two variables. Whenever the tax rate increases, due to placement along the tax and EITC schedules, the fraction of married women who do not work also increases. Moreover, the differences in women's non-employment rates by husband's earnings are quantitatively large, ranging from 20% to 55%.

Finally, Figure 2b analyzes the same variables in Canada – which has an individual tax system – for

[3] Note that this is much higher than the approximately 0% rate on the first 15k of an individually taxed worker. As in our previous example, we calculate the secondary earner's ATR under the simplifying assumption that primary earners (here, husbands) work mostly a fixed number of hours, and that secondary earners adjust labor supply based on their after-tax wages and shocks to the household.

comparison. We omit graphing the ATR on the first $\$15,000$ since it is similar for all secondary earners under the individual system. Two features of the Canadian female employment patterns stand out: first, women's non-employment as a function of husband's earnings varies much less, from around 20% to 30%. Second, in Canada, there is no distinctive relationship between the labor force participation of married women and the husband's earnings. This evidence is consistent with the idea that the U.S. system introduces disincentives for secondary earners to work, by taxing even relatively low earnings at a high rate.

Our evidence suggests that a switch to individual taxation could have positive welfare effects on secondary earners by reducing their marginal and average tax rates. However, they also indicate the gains from such a change would be unequally distributed. Figure 3a Due to assortative matching (cite papers finding assortative matching), potential secondary earners in low- or medium-income households will on average have lower earnings potential than those in high-income families. Those secondary earners and their households would thus benefit less from their entry into the labor force, yet they would lose the marriage bonuses generated by the joint system.

that single-earner households will

How those gains are distributed will depend on three factors: how a change to the tax system affects sorting; how

It also indicates that the gains would be unequally distributed.

4 Tax Reforms and Labor Supply Behavior

The evidence provided in the previous section indicates that the choice of a tax system has potentially significant effects on individual and family decisions. To evaluate these effects, we will structurally estimate a model of household decisions and use it to evaluate the performance of different taxation systems. For the policy evaluations 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 are tax reforms (Keane (2011)). In this paper, we will use the changes generated by the tax reform that took place in the U.S. in 2003, known as the Jobs and Growth Tax Relief Reconciliation Act of 2003 (the Bush tax cuts). We now describe the variation produced by the Bush tax cuts, which will be used later in the paper to construct the moments used to identify the model parameters affecting time

allocation decisions.[4].

Figure 5 reports the tax schedule for a married couple without dependents before and after the Bush tax cuts. It documents that almost all households with total income greater than $\$57,000$ experienced reductions in marginal tax rates and that the cuts were particularly large for family with total income between $\$57,000$ and $\$70,000$. Other types of married households enjoyed similar rate declines. To estimate the effects of these cuts on individual labor supply decisions, we employ two datasets: the Panel Studies of Income Dynamics (PSID) and the Current Population Survey (CPS) March supplement. The PSID has the advantage of being a panel. By exploiting this feature, we can analyze 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. Using the CPS we can overcome this limitation at the cost of relying on repeated cross-section, which forces us to study only the responses of married women.

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 individual's optimal labor supply after the reform. To isolate the first part, we compute the tax rate before and after the reform using in both cases the husband's 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 and time fixed effects, and control variables.

Formally, we estimate the following fixed effect regression:

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

where y_{it} is either the logarithm of work hours in period t or an indicator for whether the married woman works in that period, α_i is a household fixed effect, γ_t is a time 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, $post_t$ is an indicator for being in a post-reform year, 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.

[4]In the appendix, we ouline the labor supply effects of the other two major tax reforms that took place in the U.S. in the past four decades: the Tax Reform Act of 1986 (the Reagan tax cuts) and the 1993 EITC expansion as part of Omnimus Budget Reconciliation Act (OBRA)

The results, reported in Table 2, indicate that married women responded to the Bush tax cuts by significantly increasing their labor force participation. We find a 10 percentage points increase in the marginal tax rate is associated with an reduction in labor force participation of 3.13 percentage points. Our results also indicate that married women with young children responded the most, with an increase in labor force participation of 5.42 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. Because of this, we can only consider individuals that worked before the response and, thus, only estimate their intensive margin response. Also, the meaning of the coefficient on the change in marginal taxes is 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 hours of work for the three groups, which should be expected as the majority works full time.

CPS. Given the small sample size of the PSID, we cannot use it to study the individual responses by income and education as they are imprecisely estimated. For married women, we can address this issues by switching to the CPS.

As the CPS is a repeated cross section, we cannot follow the approached used with the PSID. For married women, however, we can determine their average response by constructing income bins for their husband's income and 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 bin after the reform. By keeping the income bin constant, we can approximate the approach used with the PSID.

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:

$$y_{it} = \sum_k \alpha_k inc_k + \sum_k \pi_k inc_k \cdot post_t + \beta_2 X_{it} + \gamma_t + \varepsilon_{it} \tag{1}$$

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.

Given the large sample size, in Figure 4a we can first document graphically which married women were affected the most by the Bush tax cuts. Only women with husbands earning between $\$55,000$ and $\$85,000$ experienced large declines in marginal tax rates. Correspondingly, Figure 4b provides evidence that exclusively women in that subgroup responded by significantly increasing their labor force participation.

The results obtained by estimating equation (1) are described in Table 4. In the last column, we report the change in marginal tax for different husband's income quintiles and document that all income quintiles above $\$50K$ experience a substantial cut in marginal tax rates, with the the quintile $\$60-70K$ experiencing the largest cut at 8.3 percentage points. We find that only married women that experienced the largest tax cut responded by significantly changing their labor force participation, with an increase of 4 percentage points. The results are therefore consistent with the graphical evidence. We then divide the sample in married women with and without college degree and find that both have significant responses, but married women with a college degree are more responsive to the tax cuts. Consistently with the PSID results, we also find that married women with young children are affected the most by the cuts in marginal tax rates, with increases in labor force participation that, at 6 percentage points, are about twice as as large as the changes for married women without children. We have also estimated the effect of the tax reform on hours of work of married women and, as with the PSID, we find no significant change in this variables.

The labor supply responses just documented will be used to construct the moments targeted to estimate the parameters governing the individual responses to tax changes.

5 Model

An essential ingredient in the evaluation of the long-term effects of tax reforms is a model sufficiently realistic that can account for the main patterns in the data. To this end, we develop a model with the following features. The model is dynamic to asses the long-terms impact of tax reforms. There are three dynamic aspects: (i) individuals accumulated or lose human capital depending on their intensive and extensive labor supply decisions; (ii) they save or borrow financial resources; (iii) if married, they optimally vary over time the intra-household allocation of time and financial resources and optimaly choose whether to divorce, depending on the individual outside options, which are affected by human capital and savings.

A good is produced within the household (quality of the household environment and of children)

using as inputs time of the family members and market inputs. This model component is important as the evidence given in the previous section indicates that individual taxation provides incentives for secondary earners to increase labor supply at the expenses of time devoted to household production. Given the significant amount of time that people allocate to home production and childcare – on average 25 and 12 hours per week by women and men – if this trade-off is ignored, the policy evaluations will tend to overestimate the welfare effects of individual taxation.

To account for the fact that individuals are generally taxed using different rules depending on their marital status, we model the decision about whom and whether to marry and whether to divorce. To allow for the changes in individual outside options produced by changes in tax regimes to affect choices and to produce a realistic fraction of married and divorced individuals, we consider an intertemporal model in which married couples make efficient decisions with no commitment. These model features enable us also to capture potential long-run effects on marriage, divorce, and matching patterns.

5.1 Timing

People enter adult life with or without a college degree. Their adult life is divided into a working and a retirement stage. During their working stage, each person makes decisions about labor supply, time spent on household production, consumption, savings, marriage, and divorce. People who enter a period in this stage as single meet a potential spouse and chooses whether to marry. If instead they enter the period as married, they choose whether to divorce. At the end of the working life, people enter the retirement stage in which they only choose consumption and savings.

5.2 Preferences and Technology

Preferences. Individual i has preferences over private consumption c^i, leisure l^i, and a home-produced good Q. If i is married, the preferences depend also on the marriage quality θ. They are characterized by following utility function if married:

$$u\left(c^i, l^i, Q, \theta\right) = \frac{\left(c^i\right)^{1-\sigma_c}}{1-\sigma_c} + \gamma_l \frac{\left(l^i\right)^{1-\sigma_l}}{1-\sigma_l} + \gamma_Q^i \log Q + \theta,$$

where we allow the relative taste for public consumption to vary across households depending on whether they have children. Single individuals have the same utility function, except that θ is set to zero.

Match quality follows the random walk $\theta_t = \theta_{t-1} + z_t$, where z_t is drawn from a normal distribution

with mean 0 and variance σ_z. 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 they enter the working stage of their life with or without a college degree. The degree has three types of returns. It endows graduates with better wage processes; it makes the time invested in the home-good Q more productive; and it increases the probability of matching with other college graduates in the marriage market. 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 gender j, individual i's wage process takes a standard form that depends on a quadratic term in experience e_{it}, an idiosyncratic shock $\varepsilon_{i,t}$, and ability through an individual fixed effect a_i. Specifically,

$$\ln w_{it} = a_i + \beta_0^{g,j} + \beta_1^{g,j} e_{it} + \beta_2^{g,j} e_{it}^2 + \varepsilon_{it}, \tag{2}$$

where $\varepsilon_{it} \sim N(0, \sigma_\varepsilon^{ig})$, g is high school or college, and $a_i \sim N(0, \sigma_a^{g,j})$.

Human capital, in the form of labor market experience, evolves according to the following 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 $0 \leq \lambda \leq 1$. If someone does not work in the period, the person's experience declines by $0 \leq \delta \leq 1$. Thus, the variable experience in the wage process (2) can be characterized using the following equation:

$$e^i = e_{FT}^i + \lambda e_{PT}^i - \delta e_{NT}^i,$$

where e_{FT}^i and e_{PT}^i are years of experience accumulated in full-time and part-time jobs, and e_{NT}^i are years spent outside the labor force. The wage process can then be written as follows:

$$\ln w^{g,j} = a^i + \beta_0^{g,j} + \beta_1^{g,j} \left(e_{FT}^i + \lambda e_{PT}^i + \delta e_{NT}^i\right) + \beta_2^{g,j} \left(e_{FT}^i + \lambda e_{PT}^i + \delta e_{NT}^i\right)^2 + \epsilon^{g,i},$$

or equivalently,

$$\begin{aligned} \ln w^{g,j} = {} & a^i + \beta_0^{g,j} + \beta_1^{g,j} e_{FT}^i + \psi_1^{g,j} e_{PT}^i + \psi_2^{g,j} e_{NT}^i + \beta_2^{g,j} \left(e_{FT}^i\right)^2 + \psi_3^{g,j} \left(e_{PT}^i\right)^2 + \psi_4^{g,j} \left(e_{NT}^i\right)^2 \\ & + \psi_5^{g,j} e_{FT}^i e_{PT}^i + \psi_6^{g,j} e_{FT}^i e_{NT}^i + \psi_7^{g,j} e_{PT}^i e_{NT}^i + \epsilon^{g,i}, \end{aligned} \tag{3}$$

where $\psi_1^{g,j} = \beta_1^{g,j}\lambda$, $\psi_2^{g,j} = \beta_1^{g,j}\delta$, $\psi_3^{g,j} = \beta_2^{g,j}\lambda^2$, $\psi_4^{g,j} = \beta_2^{g,j}\delta^2$, $\psi_5^{g,j} = 2\beta_2^{g,j}\lambda$, $\psi_6^{g,j} = 2\beta_2^{g,j}\delta$, and $\psi_7^{g,j} = 2\beta_2^{g,j}\lambda\delta$.

Taxes. The tax schedule is allowed to vary with the tax system and the marital status of an individual. We 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 $w_t h_t$. The taxes levied on a married couple are described by $\tau^m(w_t^1 h_t^1, w_t^2 h_t^2)$, with the first spouse's earnings equal to $w_t^1 h_t^1$ and the second spouse's to $w_t^2 h_t^2$.

The functions τ^s and τ^m are 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 changes introduced by the Bush tax cuts. To solve the model, we have to make assumptions on the beliefs people have on future 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 assumptions: people have perfect foresight; or people believe that there will be no major reform. We adopt the second assumption, even if it introduces complexity in the model, because it is more realistic.

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 generally have smaller effects on individual choices and welfare in places with a well-developed food-stamp program. Moreover, economists have argued that the kinks and non-convexities created by the social security system have substantial effects on individual decisions and, hence, on the impact of tax reforms (Saez (2010)). To account for the interactions between the social security and taxation schemes, we model the U.S. social security system by allowing the tax schedules $\tau^s(w_t h_t)$ and $\tau^m(w_t^1 h_t^1, w_t^2 h_t^2)$ to depend on (i) Social Security Income taxes (SSI), (ii) Medicare taxes, (iii) the Earned Income Tax Credit, (iv) the Child Tax Credit, (v) the Child and Dependent Care Credit, and (vi) the Supplemental Nutrition Assistance Program (SNAP) (food stamps).

Household Production Function. The home-produced good Q is produced using as inputs the time spent by each household member on household production, d^i, and market goods, m. We assume that the corresponding production function has three main features. It allows for substitutability between time and market goods. This feature is essential to match the following two related observed patterns. Women with a college degree have higher labor force participation and hours of work than women with less education. Men with higher earnings potential are more likely to marry women with a college degree. Without market good m or without a significant degree of substitutability between

time and goods, our model would not be able to simultaneously generate both patterns. As a second characteristic, to account for the evidence provided in Guryan, Hurst, and Kearney (2008), in our production function, the productivity of time depends on the number of the children, on whether they are of pre-school age ($age < 6$), and on whether the parents have a college degree. Lastly, for couples, we allow the productivity of time to vary between women and men.

For couples, the three characteristics are incorporate in the following constant elasticity of substitution (CES) production function:

$$Q = f\left(d^1, d^2, m\right) = \left(\eta^{g,n} \cdot (\alpha^1 \cdot (d^1)^{\upsilon} + \alpha^2 \cdot (d^2)^{\upsilon})^{\frac{\tau}{\upsilon}} + (1 - \eta^{g,n}) \cdot m^{\tau}\right)^{\frac{1}{\tau}},$$

where α^i varies only by gender; $\eta^{g,n}$ varies both by education and by child status: (i) no children, (ii) children < 6, and (iii) only children 6 or older. The parameter τ measures the degree of substitutability between time and market goods; υ describes the substitutanility between the time of the two spouses; η represents the share of time employed in the production of Q relative to market goods; and α^1 and α^2 capture differences in the productivity of time between women and men.

For singles, the production function becomes:

$$Q = f\left(d^1, m\right) = \left(\eta^{g,n} \cdot (\alpha^1 d^1)^{\tau} + (1 - \eta^{g,n}) \cdot m^{\tau}\right)^{\frac{1}{\tau}}.$$

The sum of the time devoted to household production, 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 probit function that depends on their marital status, education, age, and current number of children. Individuals can therefore affect the number of children they have, albeit in a simple way, by delaying marriage.

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 frictions. 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 they have lower marriage rates.

5.3 Decisions

Single's Decisions. If individual i enters period t as single and decides to remain single, this person chooses labor supply, the time and goods used in household production, private consumption, and savings that solve 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 the period. The single-agent problem can then be written as follows:

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

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

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

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

Couples' Decisions. If two individuals enter period t as married and decide to stay married, 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 individual i's value function if this person enters period t as married and $V_t^{dm,i}$ the value function if the couple decides to stay married. Then, the two individuals choose labor supply, household production time and goods, private consumption, and savings as the solution to the following problem:

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

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

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

where the change in number of 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 of the couple's problem. Then, person's i value function if this individual decides to stay married takes the following form:

$$V_t^{dm,i}\left(b_{t+1}, e_{t+1}^1, e_{t+1}^2, n_{t+1}, a^1, a^2\right) = u^i(c_t^{i*}, l_t^{i*}, Q_t^*, f_t^{i*}, \theta_t) + \beta E_t\left[V_t^{em,i}\left(b_{t+1}^*, e_{t+1}^1, e_{t+1}^2, n_{t+1}, a^1, a^2\right)\right].$$

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 and the potential spouse choose to marry if the value of being married is larger than the value of staying single for both of them, i.e.

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

These inequalities are also known as participation constraints (Kocherlakota (1996), Mazzocco (2007), Marcet and Marimon (2011), Bronson (2015), and Chiappori and Mazzocco (2017)).

The participation constraints determine also whether it is optimal for a married couple to divorce, remain married maintaining the current allocation of resources, or renegotiate it by changing the Pareto weights used to solve the couple's problem. Consider two individuals who enter period t as married 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 satisfied for both spouses, it is optimal for them to remain married at the current optimal allocation of resources. 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.

6 Heuristic Arguments for Identification and Moments Selection

In this section, we provide heuristic arguments describing the variation in the data that enables us to identify the parameters of the model. With the exception of the curvature of the sub-utility for consumption σ_c and the discount factor β, we estimate all the model's parameters using the data described in Section 2. The parameter σ_c is set equal to 1.5 based on Blundell, Browning, and Meghir (1994) and Attanasio and Weber (1995), and the parameter β is set equal to 0.98 following Attanasio, Low, and Sánchez-Marcos (2008).

Wage and Experience Parameters: $\beta_0^{g,i}$, β_1^g, β_2^g, σ_ϵ^g, σ_a^g, λ, δ

Identification. Given the model assumptions, the parameters $\beta_0^{g,i} - \beta_2^g$, the parameters $\psi_1 - \psi_7$, and the fixed-effects of the wage processes (3) can be consistently estimated using ordinary least squared (OLS) if years in full-time and part-time jobs and years without a job are observed. They are therefore identified. Using the fixed-effects, $\beta_0^{g,i} - \beta_2^g$, and $\psi_0 - \psi_7$, we can also consistently estimate and, hence, identify the standard deviation of the distribution of ability (the fixed effect), σ_a^g, and of the error terms, σ_ϵ^g. The parameters governing the accumulation of human capital can then be identified by noting that $\lambda = \frac{\psi_2}{\psi_1}$ and $\delta = \frac{\psi_3}{\psi_1}$.

Estimation. These parameters are estimated separately using the PSID. We employ a two-stage procedure that controls for selection into working, which is applied separately to each gender-education group. The selection equation is estimated using a Probit specification that includes the following variables: non-labor income, dummies for whether someone is married, never married, widowed, separated, or divorced, a dummy for whether the household includes a child younger than 6, dummies for number of children, a dummy for a black head of households, year-fixed effects, and the expected average tax rate on own income. For married women, we also include the marginal tax rate based on the husband's income. The excluded variables are the dummy for children younger than 6 and the tax variables.

Production Function Parameters: η, τ, υ, α_1, α_2

Identification. For singles, the parameter τ determines the degree of sustitutability between time and market inputs in the household production function in response to wage changes. As the degree of substitutability is an increasing function of τ, this parameter can be identified by the elasticity of the ratio of the two inputs with respect to changes in individual wages. For couples, the parameter

υ characterizes the substitutability between the primary and secondary earners' time in household production when their relative wages change. Thus, it can be identified by the elasticity of the ratio of the two time inputs to the relative wages of primary and secondary earners.

The share parameter η takes six different values depending on education (high school or college) and child status (no children, children younger than 6, children of age 6 or older). We only discuss the identification of one of the six parameters. The argument for the identification of the other five parameters follows directly. Given the substitution parameter τ, $1-\eta$ determines the fraction of resources used in household production that a single individual allocates to market inputs relative to time inputs. η can therefore be identified by the amount of market inputs used in household production by singles divided by the sum of market inputs and time inputs valued at the individual's wage.

We allow women's time inputs to have a different productivity (α_1) from men's productivity (α_2). Given our production function, we can normalize one of the two parameters without loss of generality. We can identify the other productivity parameters by the difference between single men and women in the ratio of market inputs to the sum of the value of market and time inputs.

Estimation. The production function parameters are estimation using the Simulated Method of Moments (SMM) by targeting the following moments: the average changes in $\frac{d}{m}$ in response to the Bush tax cuts (τ); the average changes in $\frac{d^1}{d^2}$ in response to the Bush tax cuts (υ);[5] the average expenditure for singles with different education and child status on market goods m divided by the same average plus the average time spent on household production evaluated at the individual's wage (η); the difference between single women and men for the previous moment (α_1).

Preference Parameters: $\sigma_l,\ \gamma_l,\ \gamma_Q$

Identification. In our model, the Frish leisure elasticity of single individuals is equal to $-\frac{1}{\sigma_l}$. The power parameters on leisure can therefore be identified by the changes in leisure by singles in response to expected changes in their wages or, equivalently, changes that keep the marginal utility of wealth constant. The parameters γ_l measures the the taste for leisure relative for the taste for private consumption. It can therefore be identified by the average ratio of leisure to private consumption for single individuals. Analogously, γ_Q captures the relative taste for public consumption relative to leisure. Thus, we can identify this parameters by the average ratio of consumption to the value of inputs used on household production.

[5] Our model parameters affects all the targeted moments. We associate specific parameters to specific moments to highlight which moments are affected the most.

Estimation. These parameters are estimation using the SMM by targeting the following moments: the average changes in married women's labor force participation generated by the Bush tax reform, conditional on having or not having children, as measured in the CPS (σ_l); the average ratio of private consumption to leisure for single women, as observed in the PSID (γ_l); the average ratio between average private consumption and average expenditure on market good inputs for single women, as observed in the PSID (γ_Q).

Fertility Process

Identification. In our model, the probability of a birth is a function of discrete variables. If births and the corresponding discrete variables are observed, then there is only one conditional probability function for births that is consistent with the data. The fertility process is therefore identified.

Estimation. The probability of a birth conditional on marital status, education, age, and presence of children is estimated non-parametrically using PSID data and a bin estimator.

Marriage, Divorce, and Meeting Parameters: μ_θ, σ_θ, σ_z, K_d, π_{HS}, π_C, $\rho_{g=g_s}$, $\rho_{g\neq g_s}$

Identification. The parameters of the initial match quality μ_θ and σ_θ affect the probability of marriage for a couple with given education, as higher μ_θ and lower σ_θ increase it. We can therefore identify these two parameters by means of the probability of marriage conditional on the couple's education. Given the couple's education, the probability of divorce is an increasing function of the standard deviation of the subsequent match quality shocks σ_z and a declining function of the cost of divorce K_d. Thus, we can identify σ_z and K_d using the probability of divorce for couples with a college degree and couples with high school or less. Lastly, the probability that an individual with education g marries a potential spouse with the same education $g_s = g$ increases with the probability that two individuals with such education meet π_g. Consequently, we can identify the parameters π_{HS} and π_C using the probabilities that a person with high school or college education marries a person with the same education. The correlation between the ability of two *married individuals* with the same education is an increasing function of $\rho_{g=g_s}$: the correlation between the ability two individuals with the same education that *just met and have to decide whether to marry.*[6] Using data on wages for married individuals we can identify the first correlation and then use it to identify the parameter $\rho_{g=g_s}$. The same argument applies to $\rho_{g\neq g_s}$.

[6] These two parameters differ because of selection into marriage.

Estimation. We normalize the standard deviations σ_θ and σ_z to 1. The probability of drawing a spouse is normalized to be equal to 1 at any age since it cannot be separately identified from μ_θ without data on meetings before marriage. The other parameters are estimated using the SMM by targeting the following moments: the marriage probabilities by education (μ_θ); the divorce probabilities by education (K_d); the shares of married couples with spouses that have the same education for different education levels (π_{HS} and π_C; the correlation between the individual fixed effects estimated for the wage process for married couples with identical education ($\rho_{g=g_s}$); the correlation between fixed effects for married couples with different education ($\rho_{g\neq g_s}$).

Full Set of Moments Used in the SMM: (i) changes in labor force participation of married women generated by the Bush tax cut by quantile the husband's income; (ii) the same moments for married women with children younger than 6; (iii) married women's labor force participation and hours worked by education (high school and college), child status (no children, with children younger than 6, without children younger than 6), and quartile of husband's income; married men's labor force participation and hours worked by education (high school and college) and child status (no children, with children younger than 6, without children younger than 6); (iv) single individuals labor force participation and hours worked by gender, education, and child status; (iv) labor force participation by age group (20-25, 26-54, 56-64), gender, and education; (v) hours invested in household production by gender, education, marital status, and child status (no children, with children younger than 6, without children younger than 6); for married women we also condition on work status (no work, part-time, full-time); (vi) expenditure on market inputs used in household production by marital status, child status (no children, with children younger than 6, without children younger than 6), and work status (no work, part-time, full-time);[7]; (vii) share married and share divorced by age group (22-26, 27-36, 37-50, above 50) and education; (viii) share of individuals with high school or college education married to individual with the education.

7 Results

7.1 Parameter Estimates

The parameter estimates are reported in Tables 5-7. We discuss the estimates most relevant for the policy evaluations performed in later sections. The estimated value of σ_l implies a Frish leisure elas-

[7]Market input expenditure is composed of expenditure on children, housekeeping, meals, and additional daycare expenditure above the minimum required when both parents work.

ticity of 0.35 for both men and women. By setting the elasticity for the time allocated to household production to zero, we can compute the corresponding upper bound for the implied Frish labor elasticity. As on average men have a leisure to labor-hours ratio of around 1, their upper bound is 0.35, which is consistent with the low estimates obtained in the labor literature (Keane (2011)). Women's leisure to labor-hours ratio is on average larger at around 1.5, which implies a larger upper bound at 0.53.

Families with young children value public consumption Q more ($\gamma_Q = 13.28$) than those with older kids ($\gamma_Q = 5.90$) or without children ($\gamma_Q = 4.43$). These sizable differences imply correspondingly large variation in the resources allocated to home production, with families with young children experiencing the largest reductions in leisure, as they shift both time and financial resources toward the public good, Q. Men and women with children under age six allocate about 11 fewer hours weekly to leisure – both in the data and in the model simulations – as compared to childless individuals (Table 9); similarly, those with older children devote about six fewer hours weekly to leisure. Families with children thus have the highest propensity to work, either in the market or within the household, and this is observed systematically across sex, education, and spousal income in Table 9. These differences in leisure time by family type are an order of magnitude greater than differences by gender ($0.5 - 1.8$ hours).

Next, we consider the estimated production function parameters for the home good, Q. The CES substitution parameters, $\tau = 0.38$ and $\upsilon = 0.40$, are sizable and positive, indicating that there is substantial substitutability both between the time inputs of husband and wife, as well as between time and market inputs to home production. However, these inputs are far from perfect substitutes, which would require them to equal one, consistent with the findings in Calvo, Lindenlaub, and Reynoso (2021). Lastly, we estimate that the weight of women's hours in home production is slightly higher than men's (1.1, compared to 0.9).

The estimates of the marriage market parameters indicate substantial sorting on income that is not captured by sorting on education alone. While single individuals are more likely to draw a potential spouse with the same education (with probability 0.75), we estimate additionally a strong positive correlation between individual fixed effects, even conditioning on education. The correlation is similar for potential partners with the same completed education (0.44) and for partners with different degrees (0.46).

Finally, the wage parameters have the expected sign and size, with experience increasing wages at a declining rate, and with higher estimated returns for educated workers. Women's returns (linear terms of 0.047 and 0.069 for high school and college, respectively) are lower than those of men (0.050

and 0.079), in line with evidence that women select into occupations with flatter wage profiles Goldin (2014). Human capital depreciates rapidly for all groups, with each year-long absence reducing the FTE stock of experience by approximately one year.[8] Women experience fewer penalties for part-time work, consistent with Goldin (2014) and Bronson (2015): college women accumulate 0.63 years of full-time equivalent experience for each year of part-time work, while college men accumulate only 0.43 years. Part-time accumulation rates are significantly lower for high school women and men (0.317 and −0.098), in line with evidence from Blundell et al. (2016), on low returns to part-time work among those without a college degree.

7.2 Model Fit

Main Moments. With the estimated parameters we match well the most relevant moments, which are reported in Table 8. 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: for high school women 0.64 in the simulations vs 0.66 in the data. College women work slightly more both in the model (0.79) than in the data (0.83).

The match of the production function moments is also reasonable good. We account well for the degree of intra-household specialization. We only 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.

Income Distributions and Matching. Our main goal is to evaluate the effects of changes in the taxation system. The response to these changes strongly depend on the income distributions of women and men with different education and on how they match in the marriage market for two

[8] This is comparable to estimates of long-run wage loss penalties of around 5 to 10% due to firm separations from mass lay-offs. See a recent overview by Bertheau et al. (2022).

related reasons. First, men's income affects married women's labor supply through the tax rates they pay on their earnings and the income effect it generates. Second, most of the tax reforms we evaluate are revenue neutral, but they produce changes in the distribution of the tax burden in the population, which depend on the underlying income distributions and matching patterns. It is therefore essential that we match well these aspects of the U.S. data.

In Figure 6, we report the actual and simulated income distribution for men by education. The corresponding distributions for women are described in Figure 7. Our model fits all of them well, with higher densities at low income levels for low-education individuals, but lower densities at larger income levels. This is a noteworthy achievement, as we do not match them directly in our estimation.

We provide evidence on the ability of our model to fit the matching patterns in the marriage market by reporting the relationship between a husband's earnings and the wife's education and labor supply choices. In Figure 8, we report the share of women employed be education as a function of husband's earnings. We achieve a good overall fit and we able to match the decline in the share employed as the husband's earning increases. In Figures 9 (college) and 10 (high school or less), we describe the same variable, but we also condition on the presence of children young. We can account for the fact that women work less when young children are present, for both education groups. Figure 11 documents the excellent fit of the share of women with a college degree as a function of the husband's earnings. As education is a strong predictor of earnings potential, our model can therefore account for marital sorting based on potential earnings of the spouse.

Lifecycle Labor Supply and Responses to the Bush Tax Cuts. In Figure 12, we document the ability of our model to replicate the labor supply decisions over the life-cycle by gender and education. 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 labor hours in the middle of their working life due to fertility events. But low-education women experience the decrease earlier, as they have children at younger ages. Third, the dip in labor supply generated by fertility is larger for college women. For men, we match the main pattern observed in the data: college men work longer hours for most of their working life.

In Table 10, we test the ability of our model to generate the labor force participation responses to the Bush tax cuts observed in the CPS. We can replicate them well by child status and education of women. This result gives us some confidence that our model can properly evaluate the main effects

of the responses to tax reforms.

8 Tax Reforms

We now use the estimated model to achieve the main objective of the paper: the evaluation of potential tax reforms. We consider four alternatives to the the current U.S. joint system: (i) the current U.S. joint system with optimal tax rates; (ii) the optimal individual tax system; (iii) a general optimal joint system that allows for an arbitrary dependence between the tax rates of spouses; and (iv) the optimal joint U.S. system with deductions for secondary earners. We assess the performance of each system on two dimensions: (i) the change in total welfare and (ii) the change in inequality. We finally document the effect of dynamics and assortative matching on our policy findings.

8.1 Optimal Tax Rates

The Setup. For each alternative tax system, we derive the optimal tax rates by maximizing a measure of welfare in the economy, conditional on the constraint that the raised tax revenues must be greater than or equal to the tax revenues currently collected by the U.S. government. To be consistent with current practices, the government can condition the tax rates only on individual incomes, which are observed. As one of our goals is to compare the performance of four alternative tax schemes to the current system, the optimal tax rates are computed for the seven tax brackets adopted in the U.S. in 2012. As in the U.S. the brackets for singles are approximately equal to the tax brackets for married households, we use the latter and divide them by two to obtain the brackets for singles. Thus, for singles they are $\$0k - \$4.5k,\ \$4.5k - \$10.75k,\ \$10.75k - \$31k,\ \$31k - \$57.25k,\ \$57.25k - \$85.5k,\ \$85.5k - \$149k,\ > \$149k$. For couples, the endpoints of each bracket are multiplied by 2.

Given the dynamic nature of our model, we can construct the welfare measure in different ways depending on the weight we assign to value functions of different generations. We adopt a welfare function that assigns the same weight to all generations, as it better approximate the objective function of a democratic government. To limit the computational complexity of the problem, we consider the five generations that are of age 20, 30, 40, 50, and 60 at the time of the reform.[9]

Specifically, let $V^a(S, t_r)$ be the value function of an individual of age $a = 20, 30, 40, 50, 60$, with state variables S at the time of the reform t_r. Denote with $f^a(S, t_r)$ the distribution of state variables

[9] An alternative way of computing the welfare function is to assign all the weight to individuals that enter the economy at the time of the reform. It has the benefit of capturing effects for the longer term. But it ignores the impact on older generation, which would make the reform difficult to implement in a democratic system.

for generation a at t_r. Then, conditional on a taxation system, the optimal tax rates $\tau = [\tau_1, \ldots, \tau_n]$ solve the following problem:[10]

$$\max_{\tau} \sum_{a=20,30,40,50,60} \int_S V^a(S, t_r)\, df^a(S, t_r).$$

Solution Methods for the Alternative Systems. The maximization problem can be solved using standard techniques for the the U.S. joint system with and without deducations and for the individual system. In these cases, we follow current practices in the U.S. and other countries by allowing for only one optimal marginal tax rate τ_j within each bracket. We can then use standard search methods.

It is more complicated to find the optimal tax rates for the general joint system, first defined in Kleven, Kreiner, and Saez (2009). In this system, the total taxes of a married couple depend freely on the individual incomes of the two spouses, as it allows for a general dependence of the tax rate of one on the income of the other. We approximate this general schedule following the approach used in Gayle and Shephard (2019). Specifically, we allow for different optimal rates for single and married households. For single households, we adopt the approach used for the other taxation systems by allowing for one marginal tax rate for each bracket. For married couples, we assume that both spouses have the same tax brackets characterized by the end points $n_1, \ldots, n_N$, which form the grid of $(N+1) \times (N+1)$ points illustrated in Figure 13. We also assume that the grid is symmetric, i.e $\tau_{i,j} = \tau_{j,i}$, and to be consistent with the other tax systems, that along each side of the squares forming the grid the marginal tax rate is constant. To each point of the grid we assign the marginal tax rate $\tau_{i,j}$ that applies to the part of the couple's total income that corresponds to that point in the grid. We need to take a stand on which spouse's income is taxed first. We assume that the primary earner's income is taxed first followed by the secondary earner. For example, in Figure 13 the total taxes paid by a couple with total incomes equal to $57.25k + 10.75k$ are computed by applying the rate $\tau_{2,1}$ to $4.5k$, $\tau_{3,1}$ to $10.75k - 4.5k$, $\tau_{4,1}$ to $31k - 10.75k$, $\tau_{5,1}$ to $57.25k - 31k$, $\tau_{5,2}$ to $57.25k + 4.5k - 57.25k$, and $\tau_{5,3}$ to $57.25k + 10.75k - 57.25k + 4.5k$.[11]

Starting from the lowest grid point and moving upward, we can then compute the total taxes paid by a married couple with income that corresponds to each point of the grid. We can then approximate

[10] It is straightforward to adopt a transformation of our linear welfare function to increase the degree of inequality aversion, following Mirrlees (1971), Blundell and Shephard (2012), and Gayle and Shephard (2019). This generalization would favor the general joint system, as it will be clear from our results.

[11] The assumption that the primary earner's income is taxed first is only needed to work with marginal tax rates that apply only within bracket and, hence, to make the rates for the general joint system comparable with the rates of the other system. One can eliminate this assumption by working with tax rates that apply to total income at each point of the grid and not the the residual part that belong to the grid. In this case, the tax rates for the joint system have a different meaning.

the entire tax schedule in a flexible way by dividing each square of the tax grid in an upper and lower triangle and by computing the total taxes paid by a couple with income that corresponds to a given point in the triangle using the endpoints of the triangle and barycentric coordinates. The marginal tax rates at each point of the grid $\tau_{i,j}$ and the tax rates for singles are the decision variables in the maximization problem. To apply the approximation method that uses the barycentric coordinates, we need to have an upper bound for the individual income of the two spouses. We choose it to be equal to twice the starting point of the highest bracket ($\$298k = 2 \times \$149k$). With the seven brackets used in the U.S., we therefore have $8 \times (8+1)/2$ decision variable for couples and 7 decision variables for singles. We assume that individuals and couples with zero income pay zero taxes as marginal tax rates cannot be negative, which reduces the number of decision variable by 2. We therefore end up with $8 \times (8+1)/2 - 1 + 7 - 1 = 41$ decision variables. To find the optimal solution we use the augmented Lagrangian method to account for the constraint that total revenue must be greater than or equal to the revenue collected currently by the U.S. The method is implemented by using first a simulated annealing search algorithm to find a good starting point and then a Nealder-Mead algorithm.

8.2 Results

We evaluate each optimal taxation system based on two measures: (i) the total welfare they generate and (ii) the change in distribution of welfare (change in inequality). We report the welfare distribution as a function of unobserved ability, education, and gender, as in our model they are constant across taxation systems . We compute the changes in welfare as the average willingness to pay for a tax reform by individuals in each cell ability-education-gender.

Table 11 contains the current U.S. tax rates, the optimal tax rates for the four alternative systems, and the corresponding percentage changes in total welfare. Figure 15 describes the changes in distribution of welfare relative to the existing U.S. joint system by ability.

Optimal Standard Joint vs Current Standard Joint

Rates and Welfare. The first two columns compare the rates currently adopted by the U.S. (first column) with the optimal rates in the same standard joint system (second column). The rates are quite similar with the exception of the very bottom and top brackets. We find that total welfare in the economy would increase with additional redistribution of resources from households at the very top to households at the bottom of the income distribution. The political hurdle of increasing tax rates for wealthy households may explain why the U.S. government does not impose the more progressive tax

schedule of Table 11. The rates differences are, however, small and this is reflected in a low willingness to pay by households for a reform that would switch to the optimal rates. We estimate that they are willing to give up 0.82% of their annual income.

Change in Distribution of Welfare. The red line in Figure 14 describes the changes in distribution of welfare as a function of individual ability for different education and gender groups. Women with low education and men with low education and ability are the ones that benefit the most from the changes in tax rates. Under the new rates, most women with low education experience higher annual incomes when working. The same argument applies to low-education men with low ability. Moreover, due to assortative matching, married secondary earners with low education can reduce their labor force participation and labor supply, as lower tax rates at the bottom of the income distribution for primary earners increase annual income for these households. All other individuals experience either small welfare gains or losses as a result of the higher tax rates at the top of the income distribution.

General Insights. One limitation of the joint system with income splitting is it can achieve only a limited degree of redistribution, as higher rates for top brackets apply to both primary and secondary earners. As secondary earners tend to have high labor supply elasticities, they respond to significant increases in rates by reducing their labor force participation and labor supply. The red lines in Figures 17, 18, and 19 confirm this insight. Even with the limited increases in tax rates for the top brackets, most high education women reduce their labor force participation and labor supply and increase the time invested in household production. These responses limit the ability of governments to increase tax revenue and, thus, redistribute resources in a standard joint system.

Optimal Individual vs Current Standard Joint

Rates and Welfare. The optimal rates under the individual system are significantly different from the rates under the joint system, with substantially more redistribution from the top of the earnings distribution to the bottom. Every bracket below \$57.25k benefit from lower tax rates, with the \$4.5k-\$10.75k and \$31k-\$57.25k brackets experiencing the steepest declines (8 and 11 percentage points). These declines are funded with significant increases in the tax rates for the top three brackets (8, 14, and 15 percentage points).

Individual taxation can achieve higher levels of redistribution because it decouples the tax rates of primary and secondary earners in married households. The government can therefore increase the tax rates of high-earnings primary earners without creating disincentives to work for secondary earners. The more extensive redistribution produces a larger increase in welfare. Individuals are willing to pay

on average 0.93% of their annual income for this reform.

Change in Distribution of Welfare. It is surprising, nevertheless, that the substantial increase in redistribution generates just a modest rise in willingness to pay of 0.1%. The reason behind this finding is that this reform has different effects depending on ability and gender, as shown by the blue lines in Figure 14. The group benefiting the most is the one that has the highest welfare before the reform: college men. They all attain large welfare gains, except at the very top of the income distribution. College women are at the opposite end, with large welfare loses for all of them. Somewhere in between, we find low-education women and men. The individuals in this group have the lowest level of welfare before the reform – low-ability – either experience a reduction in welfare (women) or insignificant change (men). Other low-ability individuals enjoy welfare increases that are a small fraction of the gains experienced by college men. All this leads to an increase in inequality and the low increase in average willingness to pay.

General Insights.

The negative or limited effect of the reform on low-ability individuals can be explain by the two main changes produced by a shift to individual taxation: the lower tax rates for low- and medium- income earners and the removal of marriage bonuses. As Figure 16 highlights, low-ability, low-education women and men have low participation rates even under individual taxation. Thus, most of them do not benefit from the lower tax rates. Yet, if married, they lose the marriage bonuses provided by the joint system.

The welfare decline for college women has a different explanation. Due to assortative matching, they are generally married to college men, who have high earnings, on average higher earning potential than their spouse, and lower productivity in household production. Under joint taxation, it is therefore optimal for these couple to choose high degrees of intra-household specialization, with the wife spending less time in the labor market. With the switch to individual taxation, the high degree of specialization is no longer optimal and women, who are typically secondary earners, increase their labor force participation (Figure 16) and reduce the time invested in household production (Figure 19). This increases the couple's resources – explaining the higher welfare for college men – but it has two negative welfare effects for women. It reduces the wives' leisure (Figure 21), as the increase in labor supply outweighs the decline in hours in household production. It lowers the amount of public good produced by the couple (Figure 22). For college women the increase in private consumption is not sufficiently large to offset the decline in leisure and public consumption.

The previous discussion emphasizes the value of dividing the population in groups based on ability,

education, and gender. Had we studies the population as a whole (Figure 15), we would have reached a different conclusion: individual taxation has positive and similar effects on all ability levels. This would hide the finding that the most vulnerable part of the population – low-ability, low-education individuals and secondary earners – suffer welfare loses. Our results also underscore the importance of accounting for the time spent on household production by family members when evaluating a taxation system. Individual taxation has the indisputable effect of increasing labor supply of individuals with sufficiently high ability (Figures 17 and 18) and, thus, the amount of resources available to them. At the same time, it affects the allocation of time to different activities and the production of public goods in complicated ways. Without properly accounting for them, one is bound to overestimate the positive effects of this system.

Optimal General Joint vs Current Standard Joint

Rates and Welfare. Columns 6-9 of Table 11 report the optimal tax rates for married individuals with spouses with low, medium-low, medium-high, and high income, and column 10 outlines the optimal rates for singles. This system is significantly more flexible than the standard joint and individual systems, as it can select tax rates that account for a larger set of labor supply elasticities and target the subpopulation with the lowest ones. By doing this, it can achieve high levels of redistribution without large adverse effects on individuals with low earning potential. This is attained by adopting rates for married households with low or medium-low total income that are lower than in the current joint (highlighted in blue), and by offsetting the decline in tax revenues with sharp increases in rates for earners with medium and high income married to spouses with medium and high income, as these individuals have typically lower elasticities. With these rates, the economy reaches the highest level of welfare, as households are willing to pay on average 2.11% of their annual income for this reform.

Change in Distribution of Welfare. The distribution of welfare by gender and education and overall (green lines in Figures 14 and Figure 15) highlights the main strengths of the general joint system. Its ability to target in flexible ways earners with different labor supply elasticities, enables governments to achieve higher levels of welfare while reducing inequality. Indeed, all groups experience on average welfare gains, including individuals at the bottom of the ability distribution, who enjoy the largest increases, and secondary earners.

General Insights. The shift to general joint system generates changes in labor force participation (Figure 17), labor supply (Figure 18), and time invested in household production (Figure 19) that are similar, albeit smaller, to the changes produced by individual taxation: most individuals increase the

time spent in the labor market and reduce household production time. There is, however, an important difference between the two reforms. With the general joint system, most people are able to compensate for the decline in household production time with significant increases in market inputs (Figure 20). Consequently, public consumption increases for almost all ability-education-groups. This is not the case for the individual system, as the increase in market inputs is outweighed by the reduction in household production time, producing a drop in public consumption for most families.

The different outcome is explained by the higher flexibility of the general system, which can be used to target with tax increases the earners with lower labor supply elasticities. As a results, more resources are available to redistribute across the ability-education-gender distribution, and take-home income increases more than under individual taxation for almost all families (Figure 28).

The individual and general joint systems differ also on the generated marriage bonuses: the difference for married individuals between take-home income under the evaluated system and take-home income if they are taxed as singles. Under general joint, marriage bonuses are even larger than under the current joint system (Figure 29). But, as expected, with individual taxation the marriage bonuses decline at all ability levels, with larger reductions for low ability tax-payers. This explains the higher welfare at the lower end of the ability distribution under general joint. The larger bonuses also generate higher marriage rates (Figure 25), which further increase welfare across the ability distribution, as married individuals benefit from intra-household specialization. The general joint system has also the effect of reducing divorce rates (Figure 25), but the changes are similar to the ones produced by individual taxation.

Seconday Earners Deducations vs Current Standard Joint

Rates and Welfare. The main concern with the general joint system is that it may be difficult to implement in practice because of its complexity. To address this issue, we have tried to approximate its flexibility using alternative system. We found that the best alternative is a standard joint system with the addition of a \$20k deduction for secondary earners. The corresponding optimal tax rates are reported in the fifth column of Table 11. With the simple introduction of the deduction, the economy can attain higher levels of redistribution compared with the standard joint system. As secondary earners do not pay taxes up to \$20k, this system can increase tax rates at the top of the earning distribution (>\$85k), without the concern of a decline in the labor force participation of secondary earners and, thus, tax revenue. Welfare improves by less than with the general joint system, as people are willing to pay on average 1.15% of their annual income vs the 2.11% with the general joint. But

this improvement is the highest among all other systems.

Change in Distribution of Welfare and General Insights. Similarly to the general joint system, individuals with low ability experience significant welfare gains (Figure 14), indicating that the most vulnerable part of the population can be helped with the simple inclusion of a deduction. Almost everyone else experience similar welfare gains for the same reasons they enjoyed them with the general joint. Labor force participation, market inputs, public consumption, and marriage rates are higher on average for most men and women of different ability and education levels. These changes raise individual welfare despite of a decline in leisure and private consumption. Thus, if the general joint system is not an option for feasibility or political reasons, the inclusion of a secondary earners deduction in the standard joint system is the second best alternative.

The Significance of Dynamics

The tax reforms highlight the importance of accounting for some aspects of individual decisions, such as household production and the time and market inputs employed in it, marriage, and differences in ability and education. But it is difficult to asses the role of dynamics. Here, we provide evidence on its effects.

Insurance Against Consumption Risk. The dynamic dimension of our model enables us to evaluate the ability of different taxation systems to insure individuals against consumption shocks. In Figure 32, we report the changes in the standard deviation of individual private consumption, which we use as a measure of consumption risk, relative to the current taxation system. The general joint system offers the best insurance against consumption risk across ability, education, and gender. Low-education women attain a similar level of insurance under the general joint system as with the current joint system. But all other groups experience lower consumption risk under general joint, with gains that are particularly large for medium and high ability individuals ability individuals. Individual taxation has mixed effects, as it increases the consumption risk of low-education women and men and it reduces it for high ability individuals. Thus, the general joint system outperforms individual taxation even in terms of consumption insurance. The joint system with deductions approximate the insurance results of the general joint system, except for low-education women who endure an increase in risk.

Dynamics and Optimal Tax Rates. We then run an experiment to evaluate the effect of dynamics on the optimal tax rates. We diminish the effect of dynamics by reducing by 10% the coefficients on the experience variables in the wage processes. At the same time, to focus just on the

change in the slope of human capital accumulation, we increase the constants in the wage processes by an amount that keeps average wages for each gender and education constant.[12] We then re-derive the optimal tax rates. We study only the general joint system as it outperforms all others.

The results are reported in Table 12. It is noteworthy that if we just reduce the rate of accumulation of human capital without deriving the new optimal tax rates, tax revenues decline by 1.4%, as individuals are move from high to medium brackets, and from medium to low brackets. To adjust for this change, the general joint system reduces the speed at which the tax rates increase with income. The top brackets experience declines in tax rates of 2-5 percentage points (marked in blue), while the tax rates for medium earnings increase by 2-3 percentage points (marked in red).

This simple experiment underlines the importance of accounting for human capital accumulation when assessing tax reforms. Without it, earnings inequality is underestimated, with resulting tax rates that are too low at the top and too high for medium earner.

The Significance of Assortative Matching

A second feature that distinguishes our paper is matching of spouses based on unobserved ability. To evaluate its importance for our findings, we run a second experiment where we reduce the correlation between the ability draws of potential spouses by an amount that diminishes the correlation in ability between married individuals – assortative matching – by half.[13] We then re-compute the optimal tax rates for the general joint system.

The results reported in Table 13 indicate that assortative matching and dynamics have similar effects on the optimal tax schedule. With less assortative matching, married couples are shifted from higher to lower brackets. The optimal response is a decline in tax rates for couples with high earners (marked in blue) and an increase for couples that earn incomes in the middle of the distribution. Without assortative matching, the tax schedule is therefore not sufficiently progressive.

9 Conclusions

The objective of the paper is to evaluate the effect of different taxation systems welfare and inequality. 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

[12] We have experimented with larger declines in the experience coefficients. In those cases, the simulated moments are quite far from the actual moments, making the analysis less appealing.

[13] The two correlations differ because of selection into marriage.

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. The model accounts for the main features of the U.S. taxation and welfare systems. Using the estimated model we evaluate four tax reforms: the adoption of tax rates that maximize welfare in the joint system currently used in the U.S.; a shift to an optimal individual taxation system; a switch to a joint system that allows for flexible dependence between the tax rates of an individual and the spouse's income; the introduction of secondary earners deductions in the current joint system. Our findings indicate that the general joint system generates the highest level of welfare, as it can achieve a significant redistribution of resources from the top to the bottom of the earnings distribution, without introducing significant disincentives to work for secondary earners. It also reduces welfare inequality. The standard joint system with secondary-earner deductions is the second best choice, as it can approximate the effects of the general joint schedule.

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	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 1: Effects on Outcomes: Joint vs. Individual Taxation

	All Women		Women with Young Children		Women without Young Children	
	LFP	Hours	LFP	Hours	LFP	Hours
1986 Reform	-0.175*	-0.001	-0.278*	0.001	-0.121	-0.001
	[0.101]	[0.001]	[0.167]	[0.003]	[0.109]	[0.002]
1993 Reform	-0.197	0.001	-0.240	-0.008	-0.164	0.007
	[0.141]	[0.004]	[0.237]	[0.007]	[0.158]	[0.006]
2003 Reform	-0.313**	-0.001	-0.542**	-0.001	-0.227	-0.002
	[0.159]	[0.003]	[.303]	[0.004]	[0.175]	[0.003]

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

	Married Men	Single Men	Single Women
1986 Reform	0.044	-0.012	-0.220*
	[0.077]	[0.237]	[0.126]
1993 Reform	0.018	0.593	-1.187***
	[0.191]	[0.417]	[0.483]
2003 Reform	0.022	0.505	0.213
	[0.114]	[0.621]	[0.225]

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

	(1) All	(2) HS	(3) Col	(4) W/Child <6	(5) No Yng. Ch.	(6) Tax Change
Post x 45,000	0.00323	0.00642	-0.00308	0.00685	0.00302	-0.0109
	(0.00725)	(0.00949)	(0.0111)	(0.0141)	(0.00842)	
Post x 55,000	0.000893	0.00415	-0.00408	-0.00146	0.00111	-3.693
	(0.00882)	(0.0122)	(0.0126)	(0.0179)	(0.0101)	
Post x 65,000	0.0390***	0.0300*	0.0438***	0.0599***	0.0315***	-8.339
	(0.0107)	(0.0157)	(0.0141)	(0.0212)	(0.0122)	
Post x 75,000	0.00723	-0.0251	0.0375**	0.00993	0.00748	-3.408
	(0.0136)	(0.0208)	(0.0176)	(0.0279)	(0.0153)	
Post x 85,000	0.0186	0.0311	0.00281	0.0140	0.0192	-1.768
	(0.0131)	(0.0205)	(0.0167)	(0.0256)	(0.0151)	
Post x 95,000	-0.0176	0.0130	-0.0388	-0.0740*	-0.00363	-2.087
	(0.0212)	(0.0353)	(0.0264)	(0.0418)	(0.0244)	
Observations	136296	94658	41638	40389	95907	136296
Adjusted R^2	0.736	0.704	0.795	0.683	0.757	

Standard errors in parentheses
Source: CPS
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Secondary Earner Employment After Reform, by Decile of Primary Earner Income Table

Parameter	Description:	Value	Std. Error
σ_c	Private consumption power parameter, fixed	1.50	
σ_l	Leisure power parameter	2.85	(0.04)
Utility parameters, private consumption relative to			
	Leisure, γ_l	1.97	(0.04)
	Public consumption without kids present, γ_Q^i	4.43	(0.08)
	Public consumption if kids present (ages 6+ only), γ_Q^i	5.90	(0.18)
	Public consumption if kids under age 6 present, γ_Q^i	13.28	(0.24)
Home good production function parameters			
η	Time share parameter, no kids (high school)	0.33	(0.01)
η	Time share parameter, kids age 6+ (high school)	0.45	(0.01)
η	Time share parameter, kids under age 6 (high school)	0.24	(0.01)
η	Time share parameter, no kids (college)	0.47	(0.01)
η	Time share parameter, kids age 6+ (College)	0.57	(0.01)
η	Time share parameter, kids under age 6 (College)	0.42	(0.01)
τ	Substitution parameter, home hours vs. market Good	0.38	(0.01)
υ	Substitution parameter, wife's vs husband's home hours	0.40	(0.01)
α^1	Productivity of home hours, women:	1.10	(0.02)
α^2	Productivity of home hours, men:	0.90	(0.02)

Table 5: Estimates I: Preference and Production Function Parameters

Description:	Value	Std. Error
Cost of divorce, high school	5.49	(0.11)
Cost of divorce, college	11.52	(0.20)
Mean Initial Match Quality	-0.40	(0.01)
Variance Match Quality, Normalized	1.0	-
Decline in mean of initial match quality with age:	0.14	(0.01)
Probability of drawing a potential match, Normalized	1.0	-
Probability of drawing a partner with the same education	0.75	(0.02)
Corr. between the individual FEs of potential partners, if same education	0.46	(0.01)
Corr. between the individual FEs of potential partners, if different education	0.44	(0.01)

Table 6: Estimates II: Match Quality and Marriage Market Parameters

Description:	Women	Men
Constant:		
High School	2.085	2.229
College	2.340	2.539
Experience:		
High School	0.047	0.050
College	0.069	0.079
Experience Squared:		
High School	-0.0009	-0.0009
College	-0.0014	-0.0016
Part-time Experience Accumulation:		
High School	0.317	-0.098
College	0.630	0.433
No-time Experience Depreciation:		
High School	-0.937	-1.131
College	-1.585	-1.020
Standard Deviation of Wage Shocks:		
High School	0.370	0.373
College	0.387	0.433
Standard Deviation of Fixed Effects:		
High School	0.415	0.414
College	0.475	0.459

Table 7: Estimates III: Wage Process Parameters

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 8: Summary Statistics, Data and Model Simulation

	No Children		Children 6+		Children <6	
	Data	Model	Data	Model	Data	Model
All	66.1	66.4	59.3	59.9	55.2	56.6
Men	65.9	65.9	58.9	58.6	54.3	55.6
Women	66.4	66.9	59.8	61.2	56.1	57.7
High School	66.9	67.3	60.2	60.9	56.6	58.2
College	64.4	64.4	57.3	57.4	51.9	53.0
Married Women,						
By Quartile of Husband's Income						
First Quartile	64.5	65.3	59.9	60.5	56.9	57.6
Second Quartile	63.8	64.6	60.7	62.1	56.0	56.3
Third Quartile	65.0	66.3	59.0	60.4	54.5	55.7
Fourth Quartile	66.0	67.2	61.8	62.3	55.2	56.2

Table 9: Weekly Time Spent on Leisure: Data and Model Simulation

Employment Changes:	Model	Data
By Child Status:		
Women with children under age 6:	0.0547	0.0599
Women without children under age 6:	0.0297	0.0315
By Education:		
College-educated women:	0.0461	0.0438
High school or less:	0.0269	0.0300
HS+Low-type (model), HS drop-out (data):	-0.0051	-0.0075

Table 10: Bush Tax Cut and Women's Employment (Husbands' Earning $60-70k)

Brackets	Curr. Joint	Joint*	Individual*	Deduction*	General Joint*				
					Spouse's Earnings				Singles
					<10.75	10.75-57.25	57.25-149	>149	
0-4.5k	0.0	0.0	0.0	0.0	0.04	0.14	0.35	0.42	0.0
4.5-10.75k	0.11	0.0	0.03	0.0	0.06	0.15	0.38	0.42	0.20
10.75-31k	0.19	0.23	0.18	0.24	0.07	0.24	0.39	0.44	0.20
31-57.25k	0.30	0.32	0.19	0.33	0.21	0.25	0.40	0.45	0.25
57.25-85.5k	0.33	0.34	0.41	0.34	0.33	0.36	0.44	0.46	0.43
85.5-149k	0.38	0.39	0.52	0.49	0.41	0.43	0.47	0.50	0.49
>149k	0.40	0.47	0.55	0.65	0.42	0.45	0.48	0.51	0.49
Ann. Cons. Equiv.		0.82%	0.93%	1.15%	2.11%				

Table 11: Optimal Tax Rates in Different Taxation Systems

Brackets	General Joint* 10% Lower Human Capital Accumulation				
	Spouse's Earnings				Singles
	<10.75	10.75-57.25	57.25-149	>149	
0-4.5k	0.03	0.10	0.36	0.42	0.0
4.5-10.75k	0.05	0.16	0.41	0.42	0.24
10.75-31k	0.08	0.25	0.41	0.43	0.22
31-57.25k	0.18	0.25	0.42	0.44	0.25
57.25-85.5k	0.35	0.39	0.44	0.44	0.45
85.5-149k	0.42	0.44	0.45	0.45	0.48
>149k	0.42	0.43	0.45	0.46	0.48
% Change in Tax Revenues before Re-optimization					-1.4%
Brackets	General Joint*				
	Spouse's Earnings				Singles
	<10.75	10.75-57.25	57.25-149	>149	
0-4.5k	0.04	0.14	0.35	0.42	0.0
4.5-10.75k	0.06	0.15	0.38	0.42	0.20
10.75-31k	0.07	0.24	0.39	0.44	0.20
31-57.25k	0.21	0.25	0.40	0.45	0.25
57.25-85.5k	0.33	0.36	0.44	0.46	0.43
85.5-149k	0.41	0.43	0.47	0.50	0.49
>149k	0.42	0.45	0.48	0.51	0.49

Table 12: Optimal General Joint with 10% Percent Lower Human Capital Accumulation with Constant Average Wages

Brackets	General Joint* 50% Lower Assortative Matching				
	Spouse's Earnings				Singles
	<10.75	10.75-57.25	57.25-149	>149	
0-4.5k	0.03	0.14	0.35	0.39	0.0
4.5-10.75k	0.05	0.15	0.37	0.39	0.23
10.75-31k	0.07	0.27	0.38	0.39	0.20
31-57.25k	0.23	0.27	0.40	0.40	0.25
57.25-85.5k	0.34	0.39	0.41	0.41	0.44
85.5-149k	0.38	0.39	0.41	0.44	0.47
>149k	0.39	0.40	0.42	0.45	0.47
% Change in Tax Revenues before Re-optimization					-0.5%
Brackets	General Joint*				
	Spouse's Earnings				Singles
	<10.75	10.75-57.25	57.25-149	>149	
0-4.5k	0.04	0.14	0.35	0.42	0.0
4.5-10.75k	0.06	0.15	0.38	0.42	0.20
10.75-31k	0.07	0.24	0.39	0.44	0.20
31-57.25k	0.21	0.25	0.40	0.45	0.25
57.25-85.5k	0.33	0.36	0.44	0.46	0.43
85.5-149k	0.41	0.43	0.47	0.50	0.49
>149k	0.42	0.45	0.48	0.51	0.49

Table 13: Optimal General Joint with 50% Lower Assortative Matching

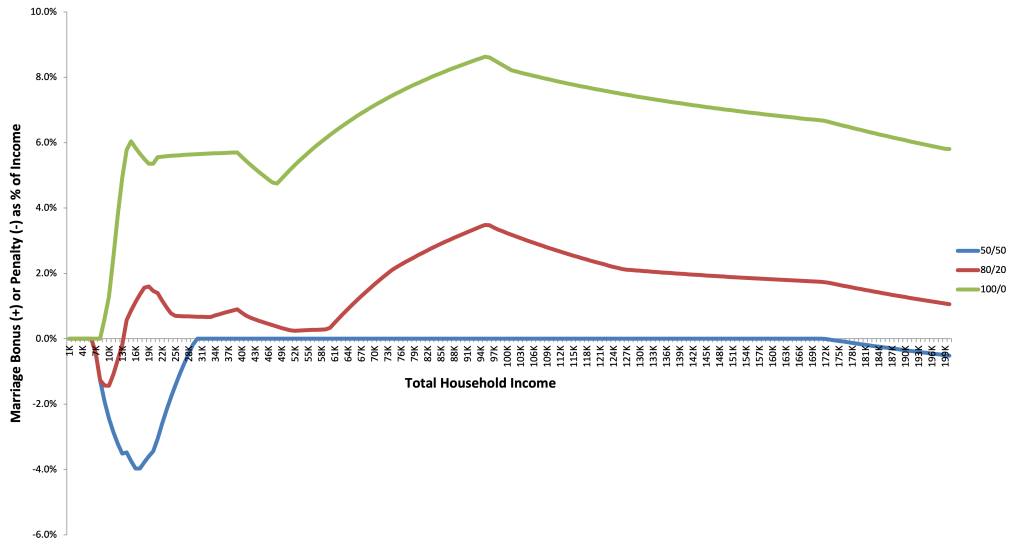
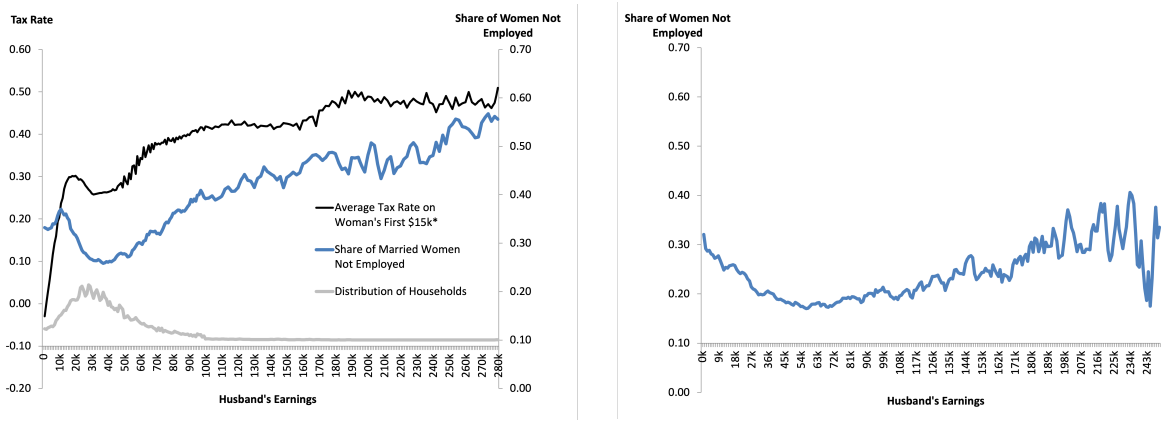


Figure 1: U.S. Tax Schedule: Marriage Bonuses and Penalties, 2015

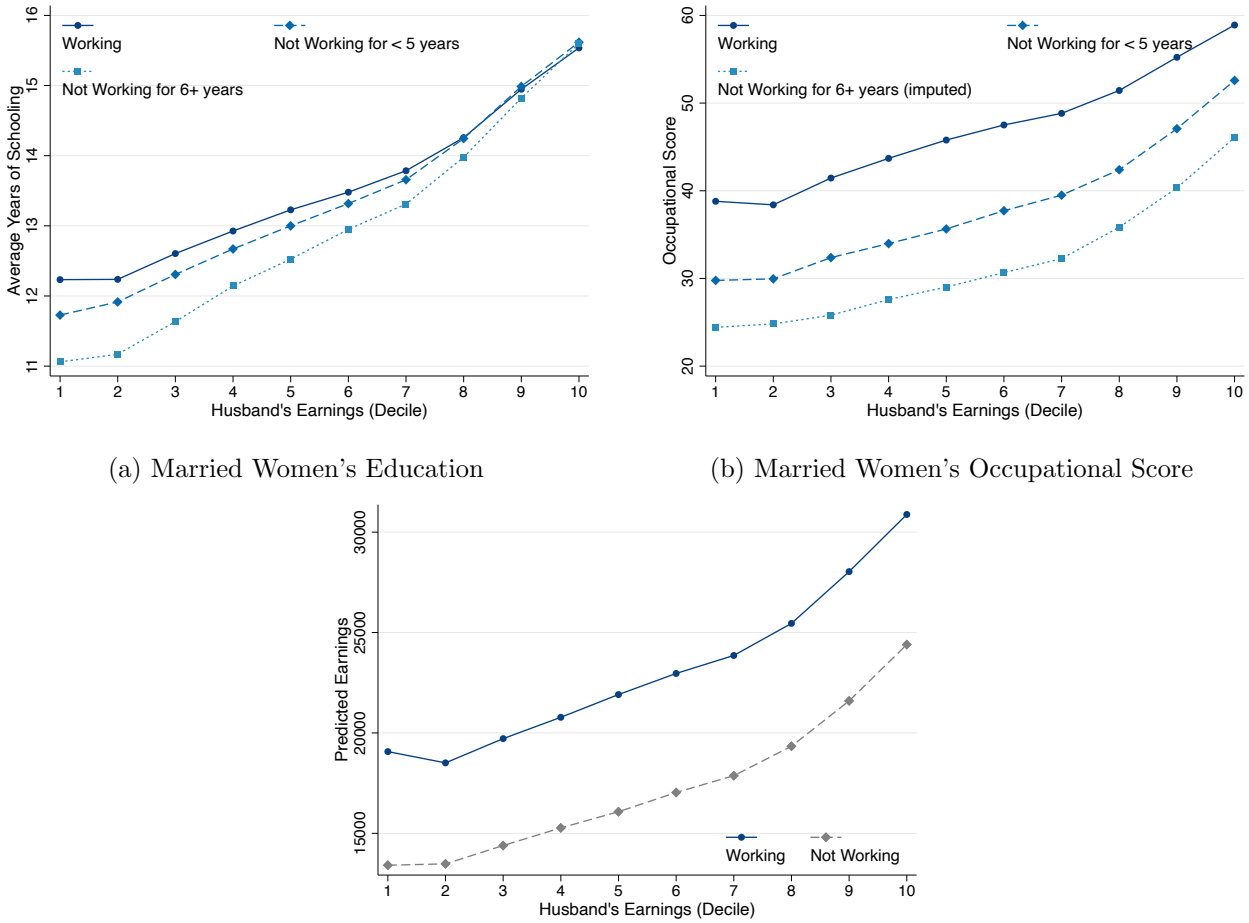


(a) Women's Non-Employment, US

(b) Women's Non-Employment, Canada

Figure 2: Women's Non-employment and Tax Rates, Comparison Between US and Canada

Notes: In the computation of the average tax rate, we include federal income taxes, FICA, state taxes weighted by population, the Earned Income Tax Credit and the Child Tax Credit. The EITC helps explain the steep increase in the average tax rate at very low levels of income and the subsequent decline for households with income between $\$20,000$ and $\$40,000$.



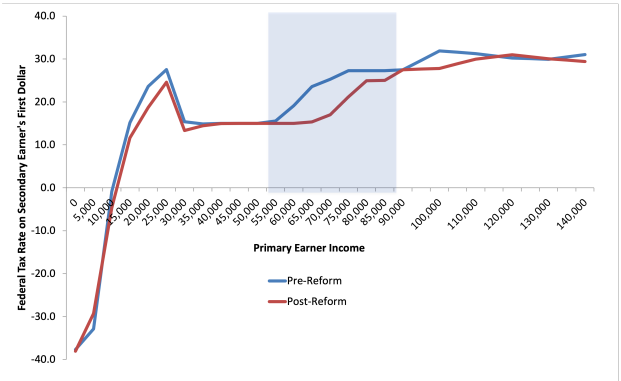
(a) Married Women's Education

(b) Married Women's Occupational Score

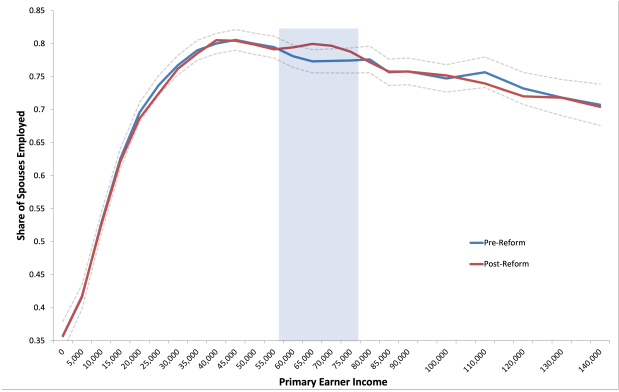
(c) Married Women's Potential Earnings

Figure 3: Married Women's Earnings Potential, by Work Status

Notes: The figures graph three different measures of women's earnings potential, by their employment status and decile of their husband's earnings. The sample includes all couples in which the husband is prime age (25 to 54) and has positive income. Occupational score (in Panel (b)) is available in the IPUMS Census for all individuals who are currently in the labor force or who worked in the last 5 years. For women who have been out of the labor force for more than five years, we impute their occupational score by assigning to them the median score of married women with the same education. The score captures a person's percentile rank in the earnings distribution, based on the median earned income in their occupation. Finally, in Panel (c), we predict potential earnings for all women, working or not, using coefficients from a regression of log earned income on occupational score, and on a set of indicator variables for age and years of education. As before, occupation score is imputed for women who are out of the labor force for more than five years. Source: IPUMS USA, 2000-2007.



(a) Marginal Tax Rate for Married Women



(b) Labor Force Participation Married Women

Figure 4: Effect of Bush Tax Cuts on Married Women

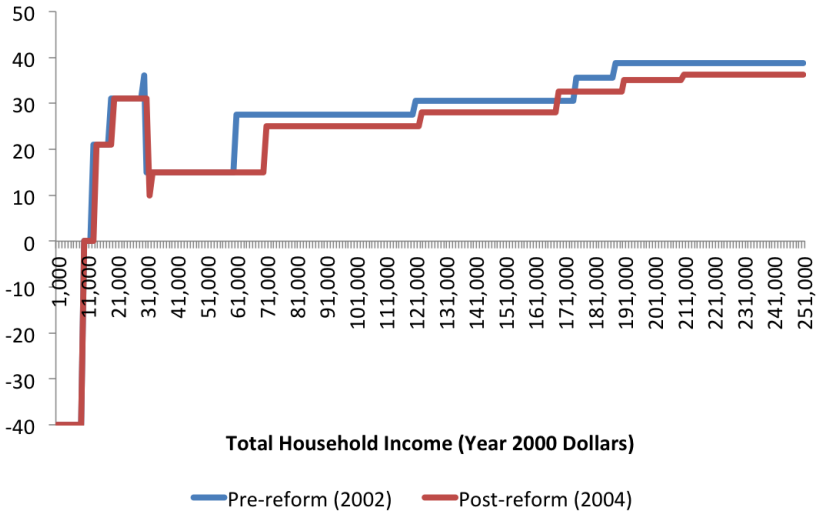


Figure 5: 2003 Bush Tax Reform

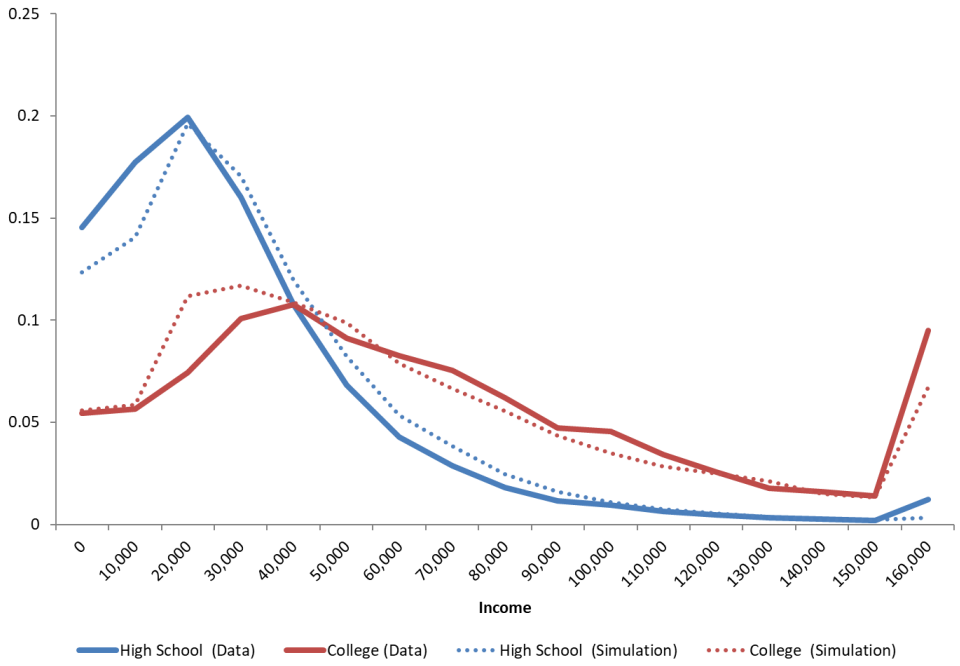


Figure 6: Income Distribution of Men By Education (Ages 25-54)

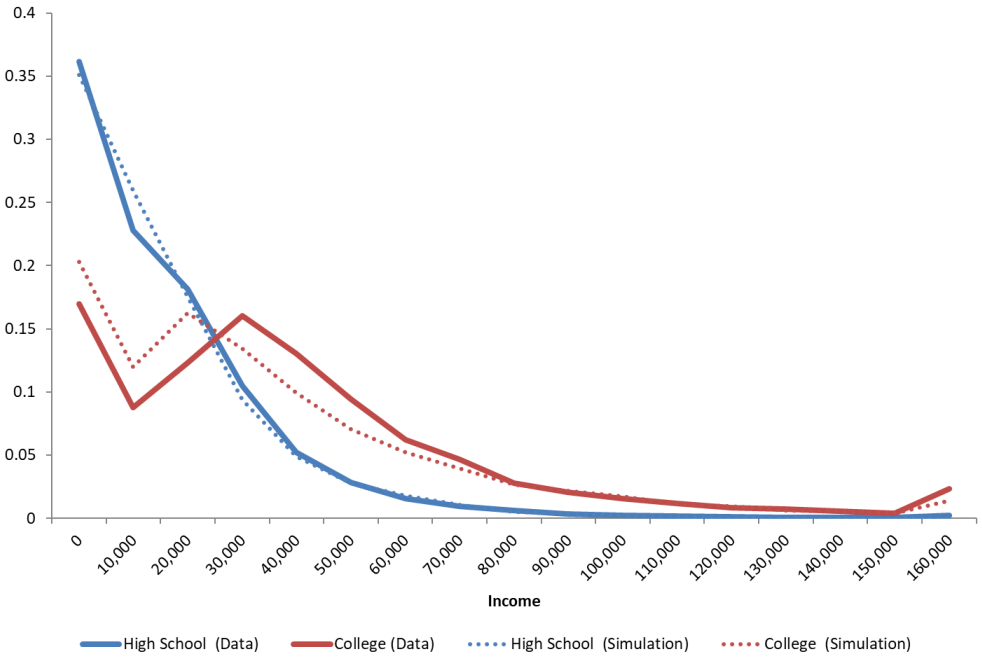


Figure 7: Income Distribution of Women (Ages 25-54)

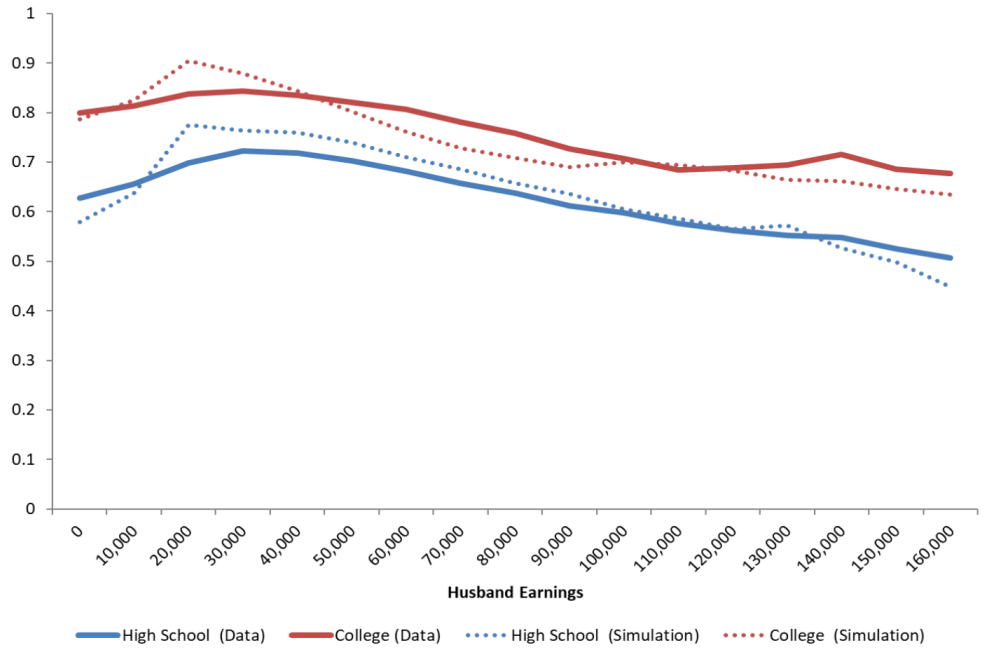


Figure 8: Share of Women Employed By Husband's Earnings and Education

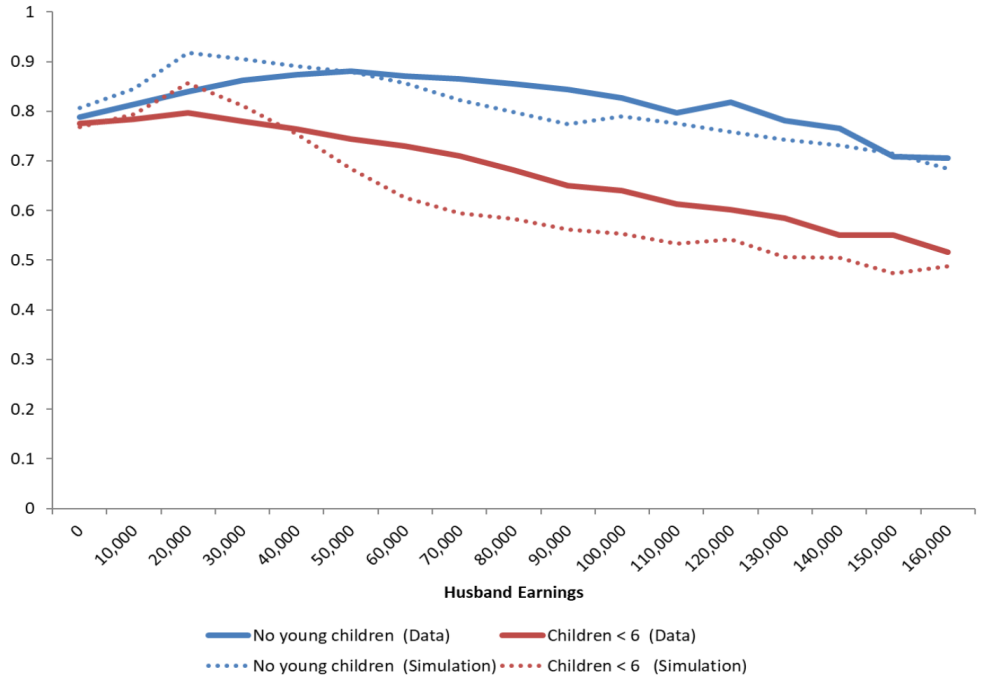


Figure 9: Share of College Women Employed By Husband's Earnings and Young Children

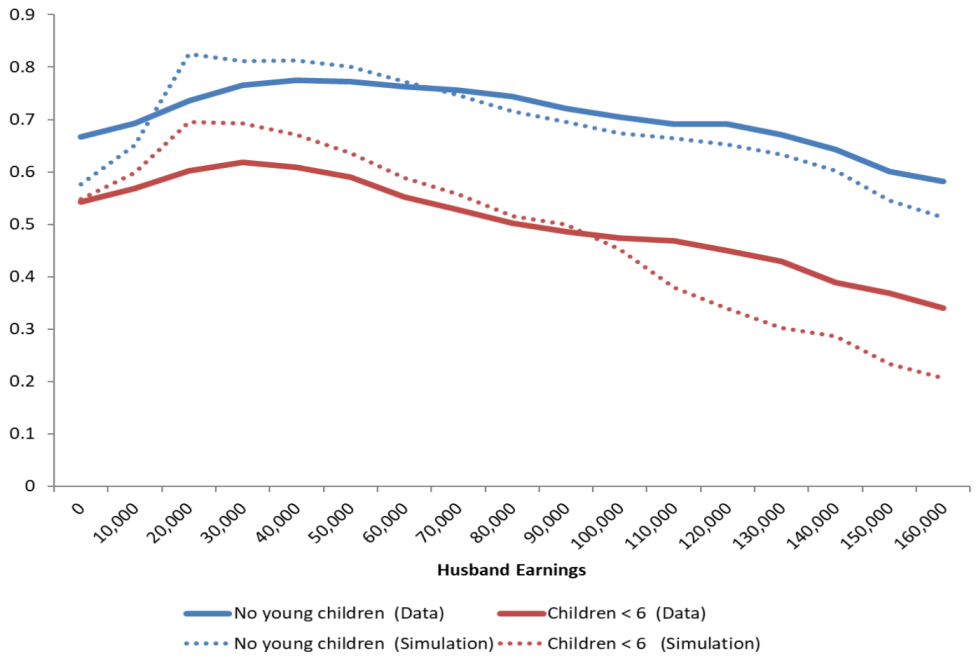


Figure 10: Share of High School Women Employed By Husband's Earnings and Young Children

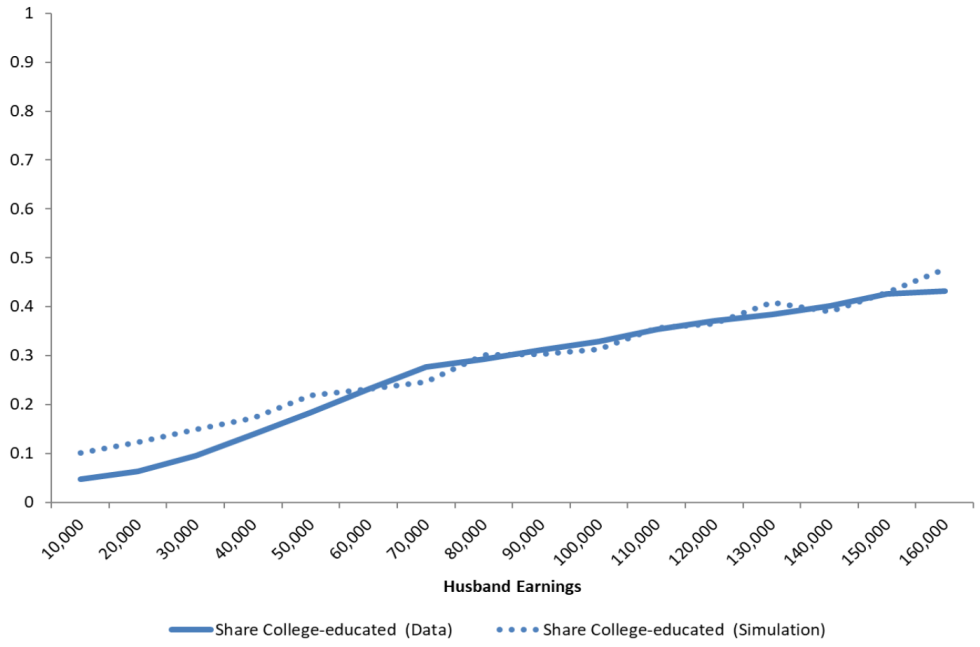


Figure 11: Share of Women With College Education, By Husband's Earnings

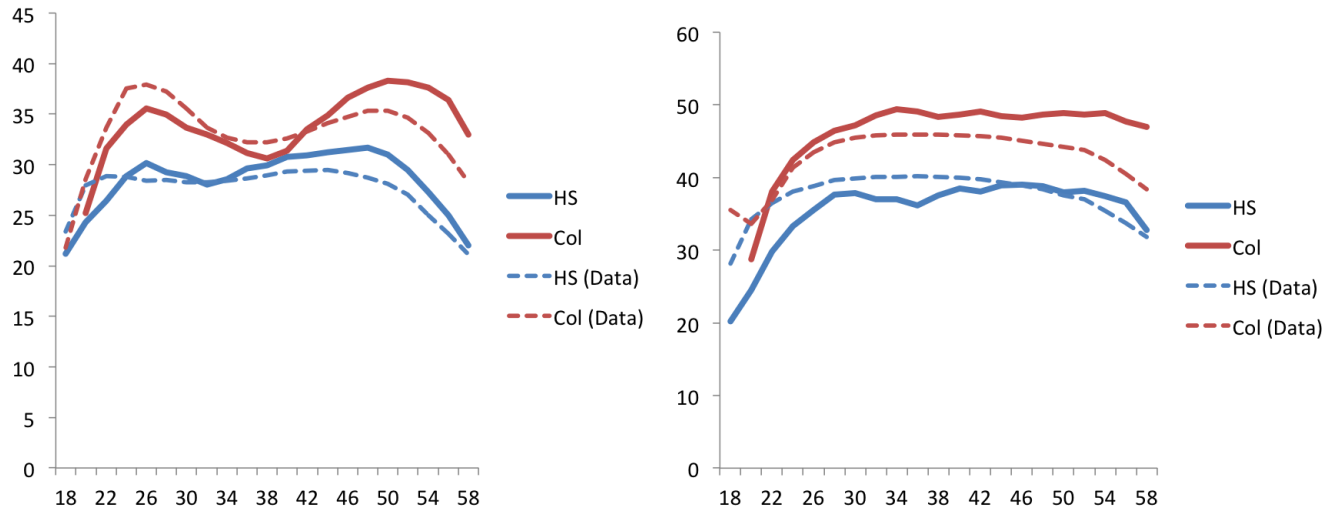


Figure 12: Weekly Hours Worked, Model and Data

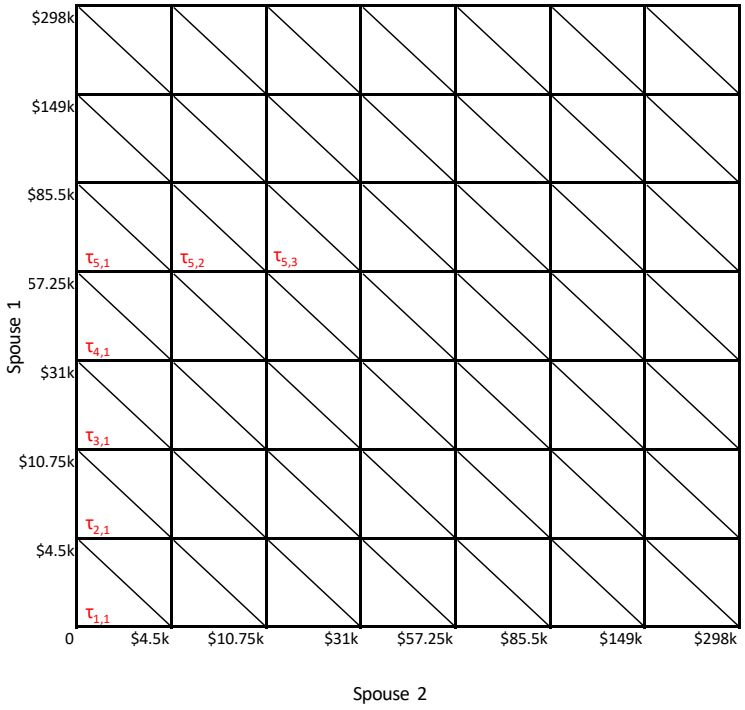


Figure 13: Grid for the General Joint System

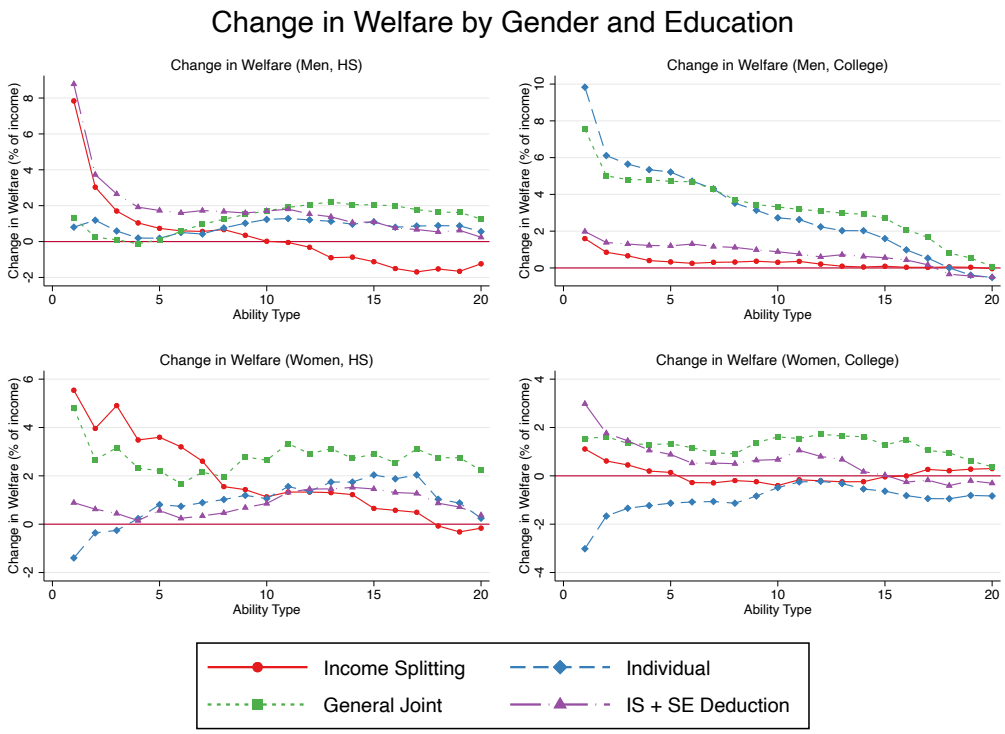


Figure 14: Percent Changes in Welfare over Ability, Education, and Gender by Tax System

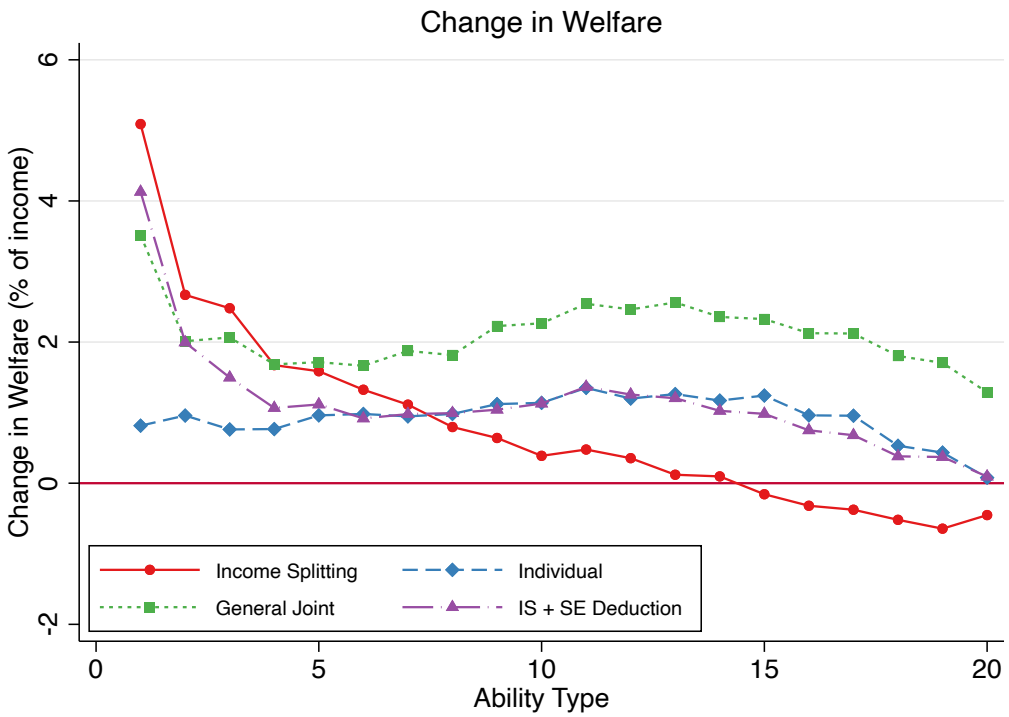


Figure 15: Percent Changes in Welfare over Ability by Tax System

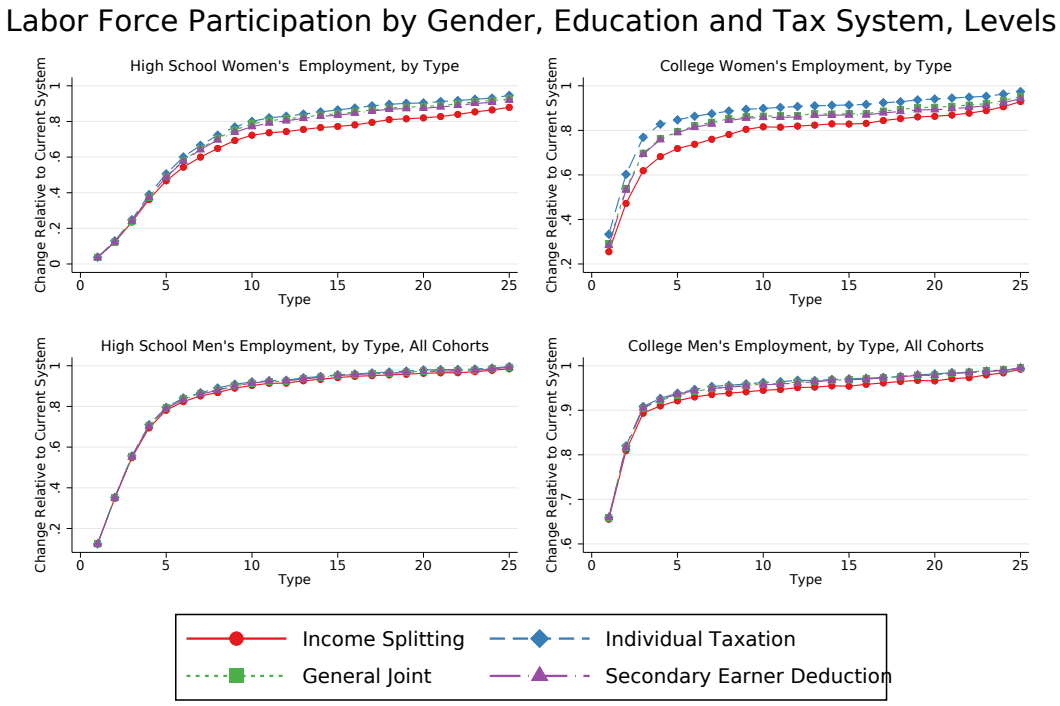
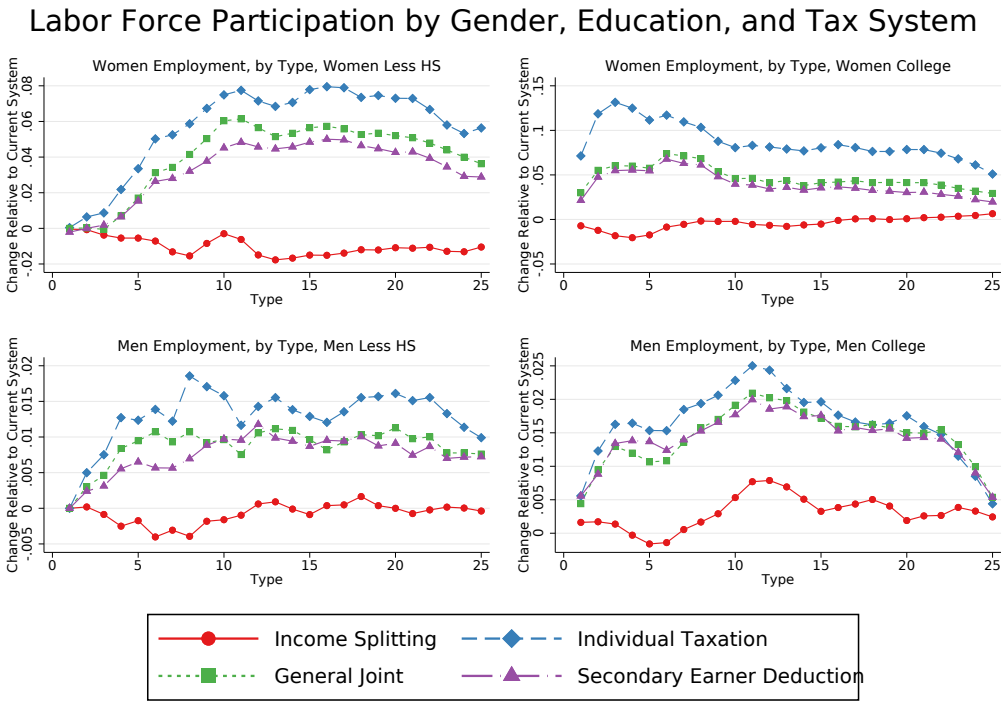
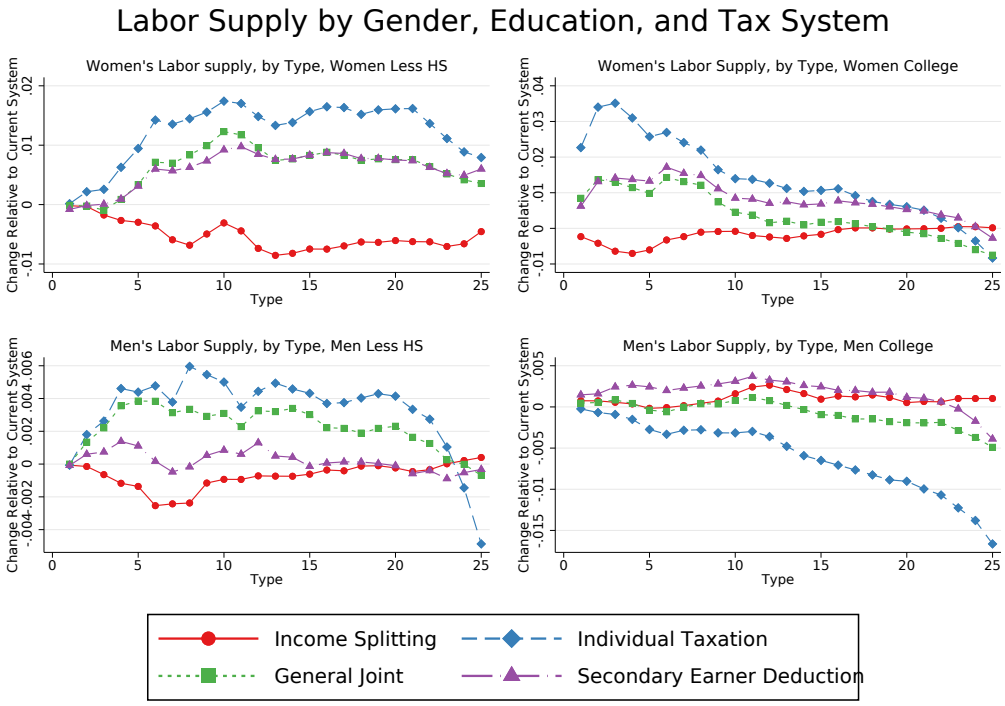


Figure 16: Labor Force Participation over Ability by Education, Gender, and Tax System



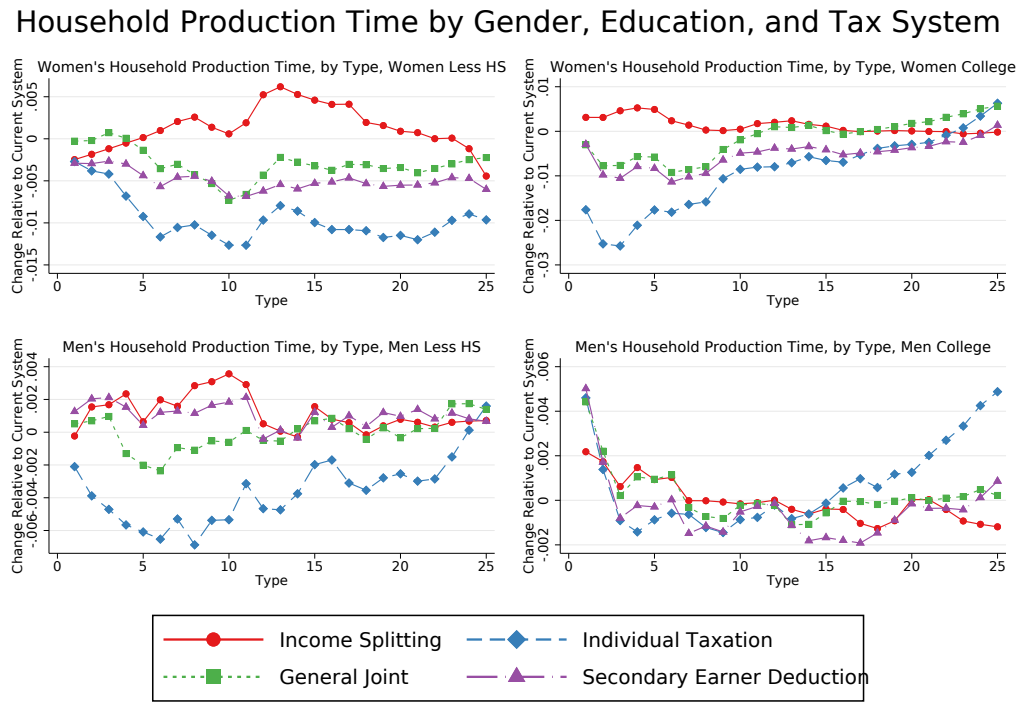
Notes: Moving averages.

Figure 17: Changes in Labor Force Participation over Ability by Education, Gender, and Tax System



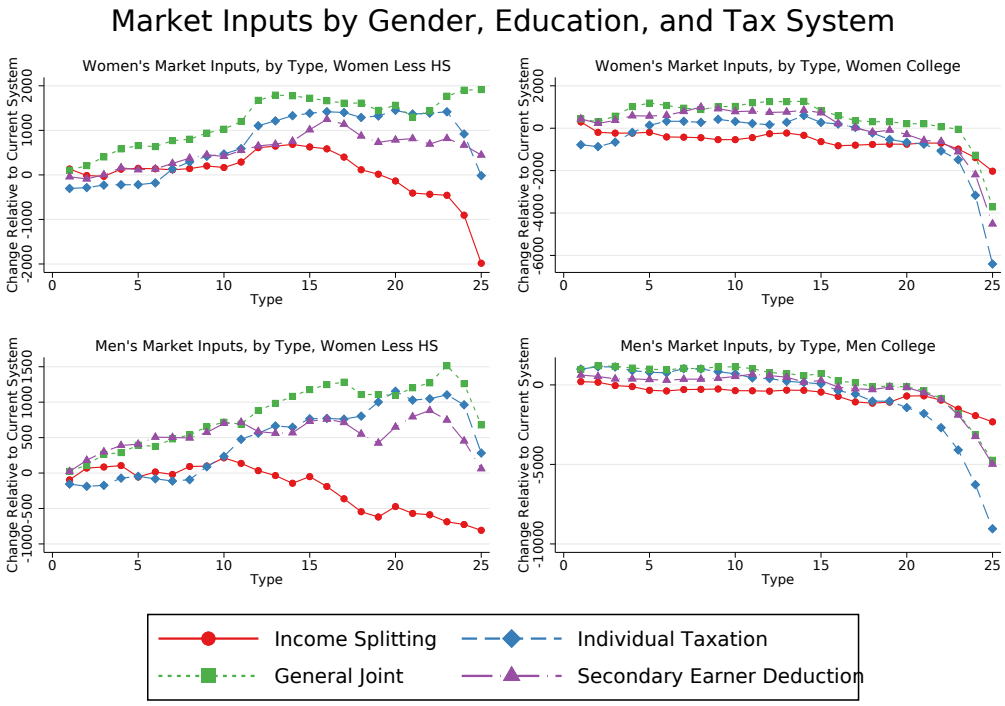
Notes: Moving averages.

Figure 18: Changes in Labor Supply over Ability by Education, Gender, and Tax System



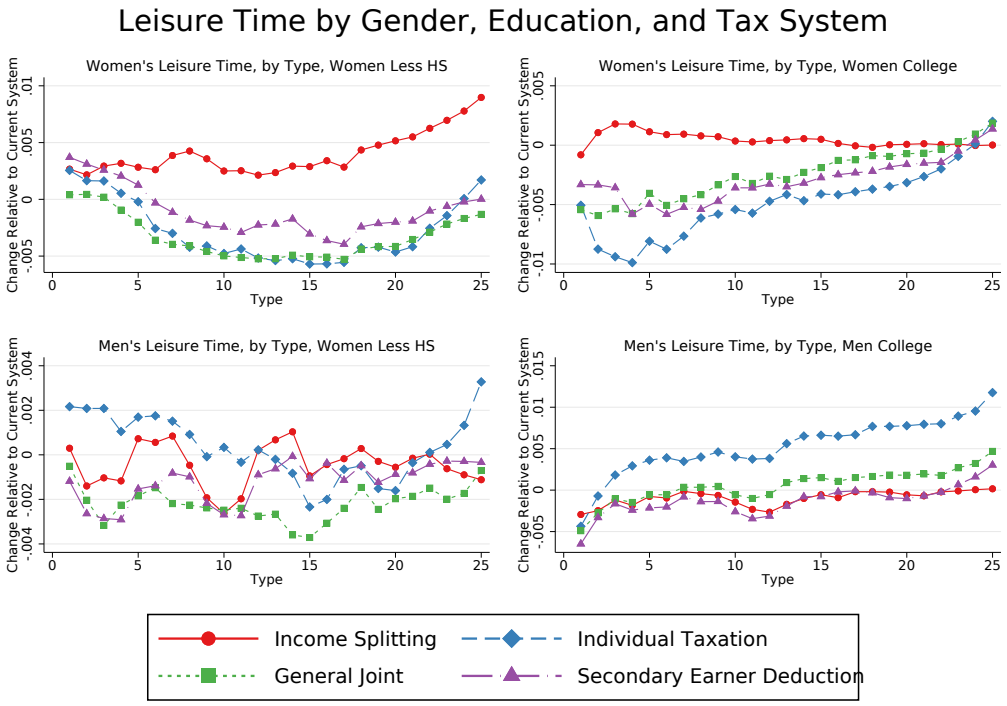
Notes: Moving averages.

Figure 19: Changes in Household Production Time over Ability by Education, Gender, and Tax System



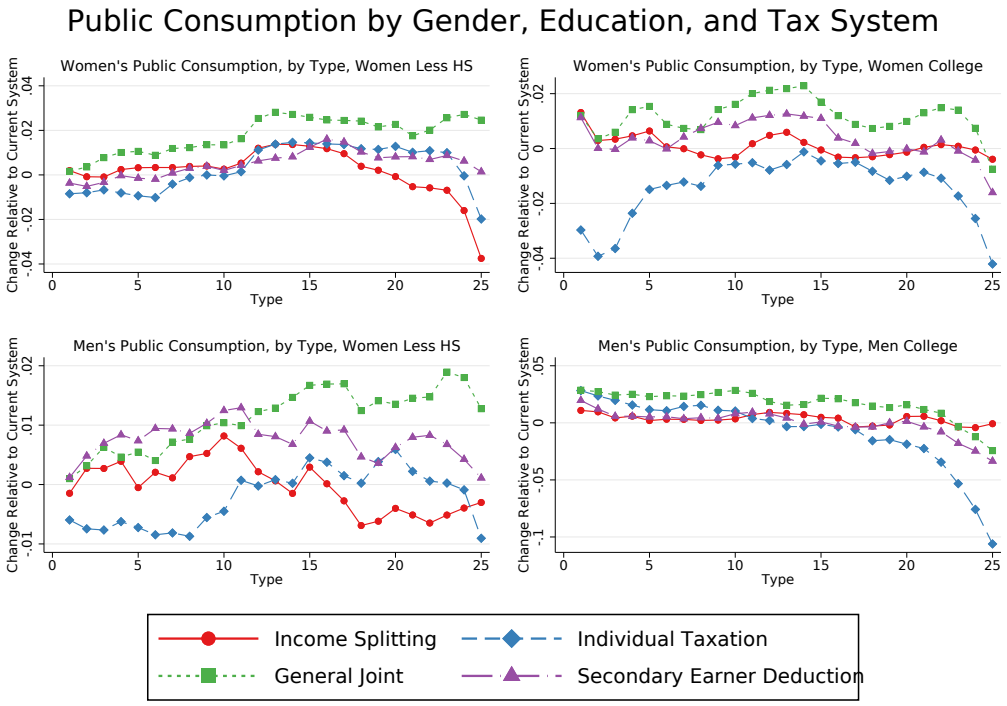
Notes: Moving averages.

Figure 20: Changes in Market Inputs by Tax System



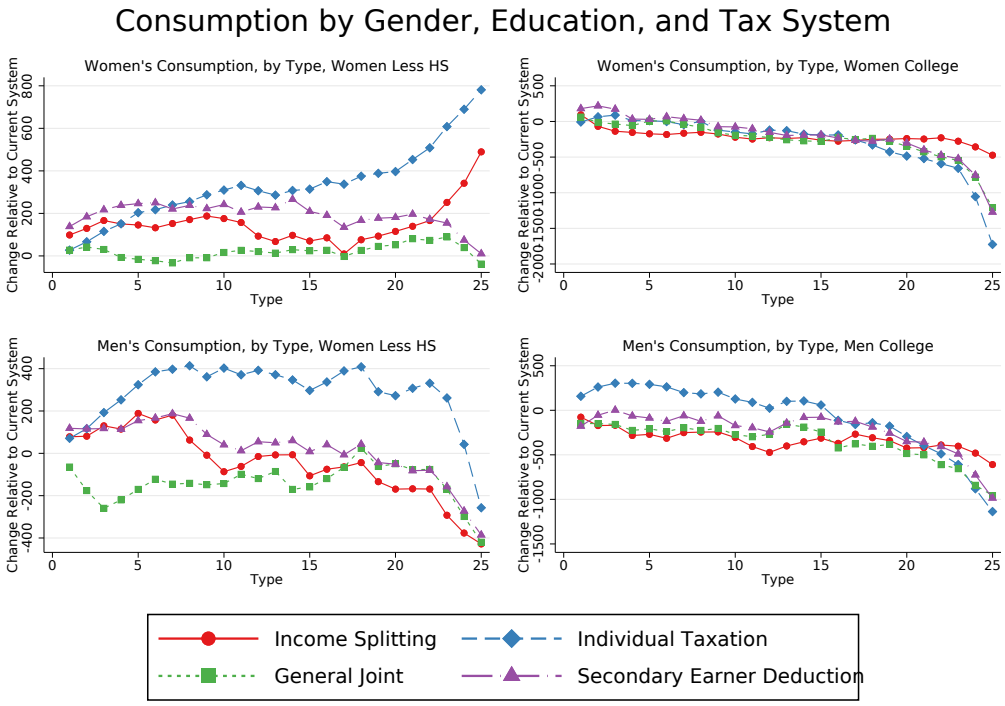
Notes: Moving averages.

Figure 21: Changes in Leisure over Ability by Education, Gender, and Tax System



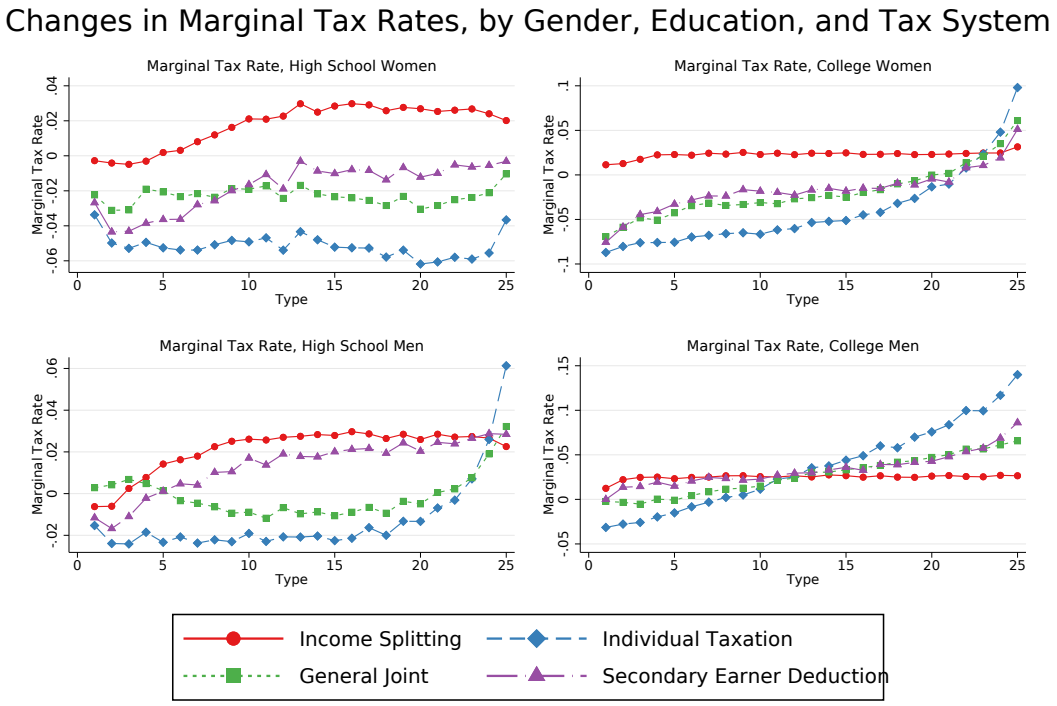
Notes: Moving averages.

Figure 22: Changes in Public Consumption over Ability by Education, Gender, and Tax System



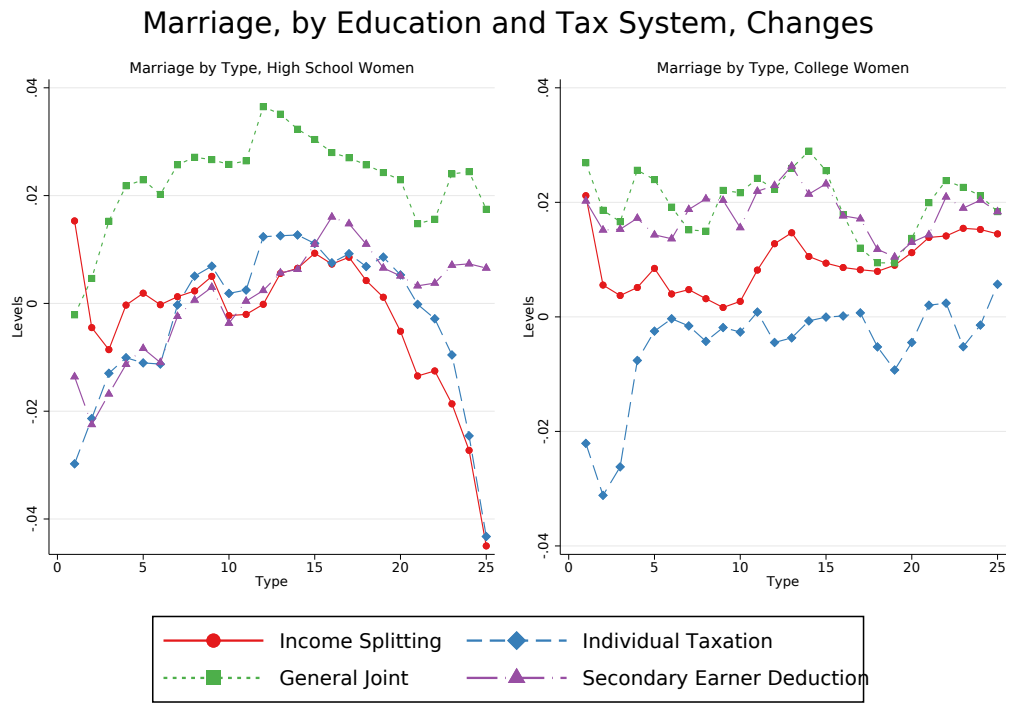
Notes: Moving averages.

Figure 23: Changes in Consumption over Ability by Education, Gender, and Tax System



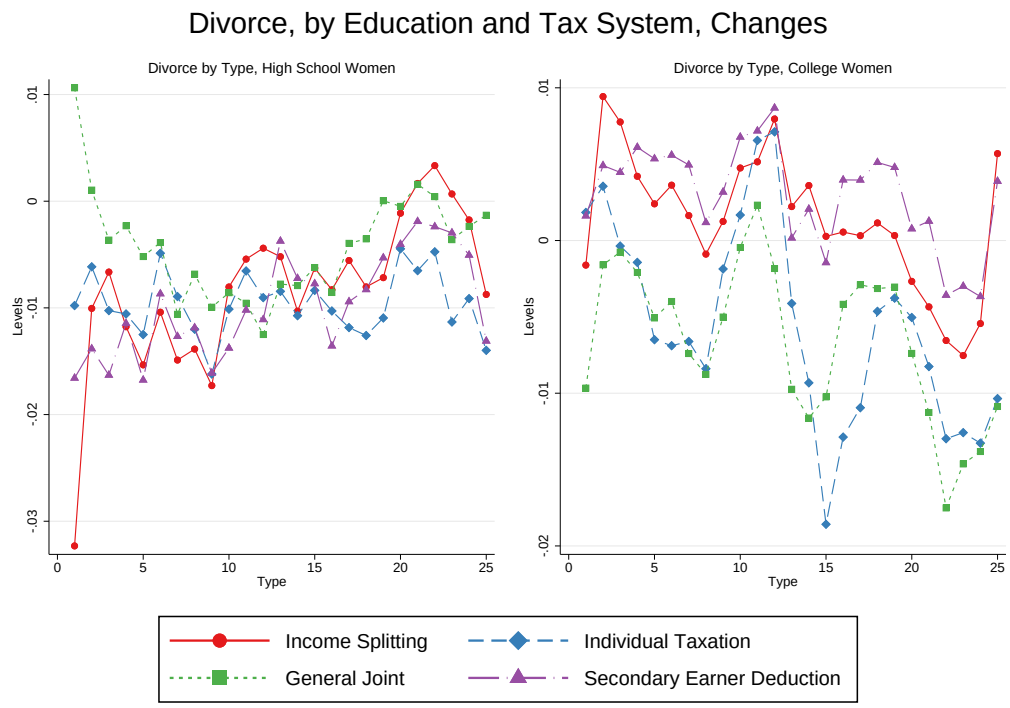
Notes: All households.

Figure 24: Changes in Marginal Tax Rates by Gender, Education and Tax System



Notes: Moving averages.

Figure 25: Changes in Marriage Rates by Tax System



Notes: Moving averages.

Figure 26: Changes in Divorce Rates by Tax System

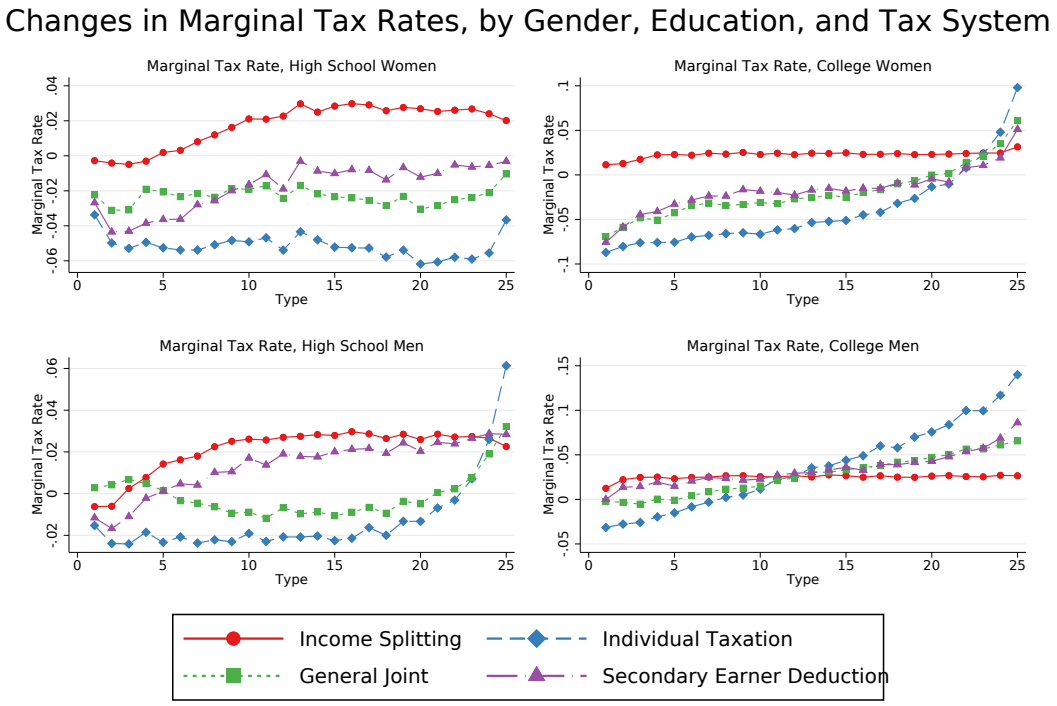
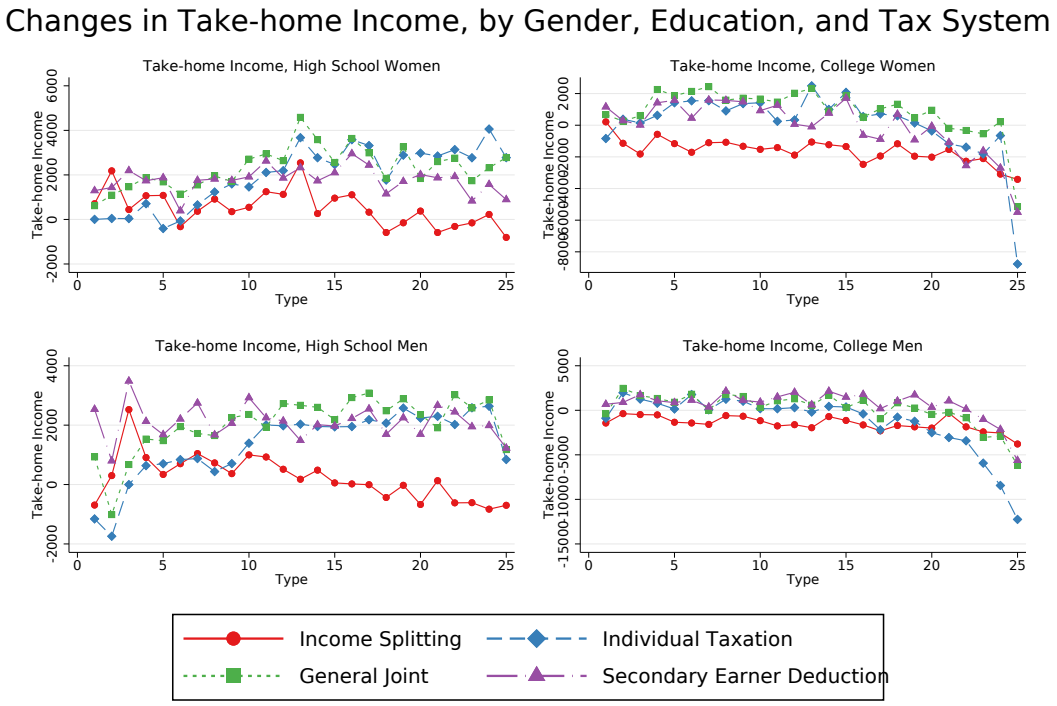
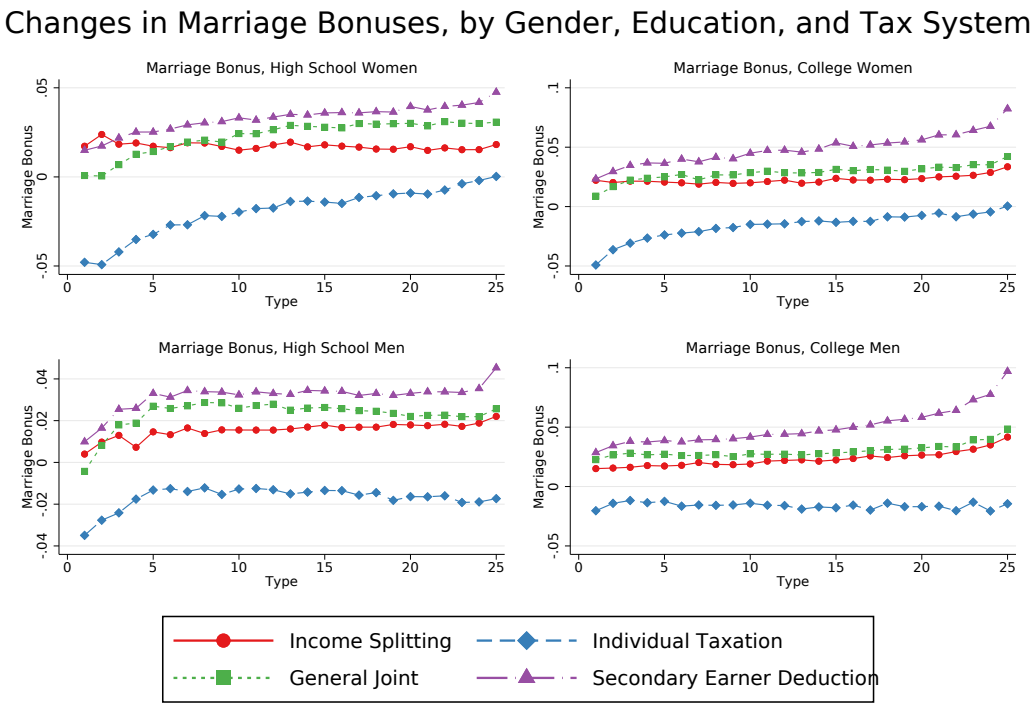


Figure 27: Changes in Marginal Tax Rates by Gender, Education, Age, and Tax System



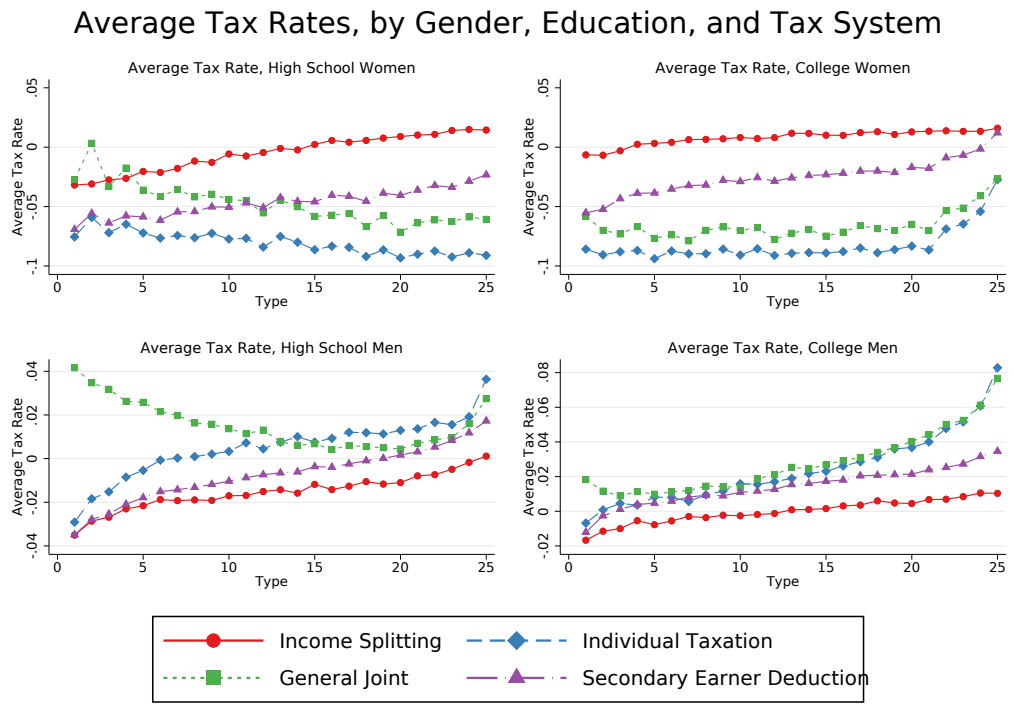
Notes: All households.

Figure 28: Changes in Take-home Income by Gender, Education, and Tax System



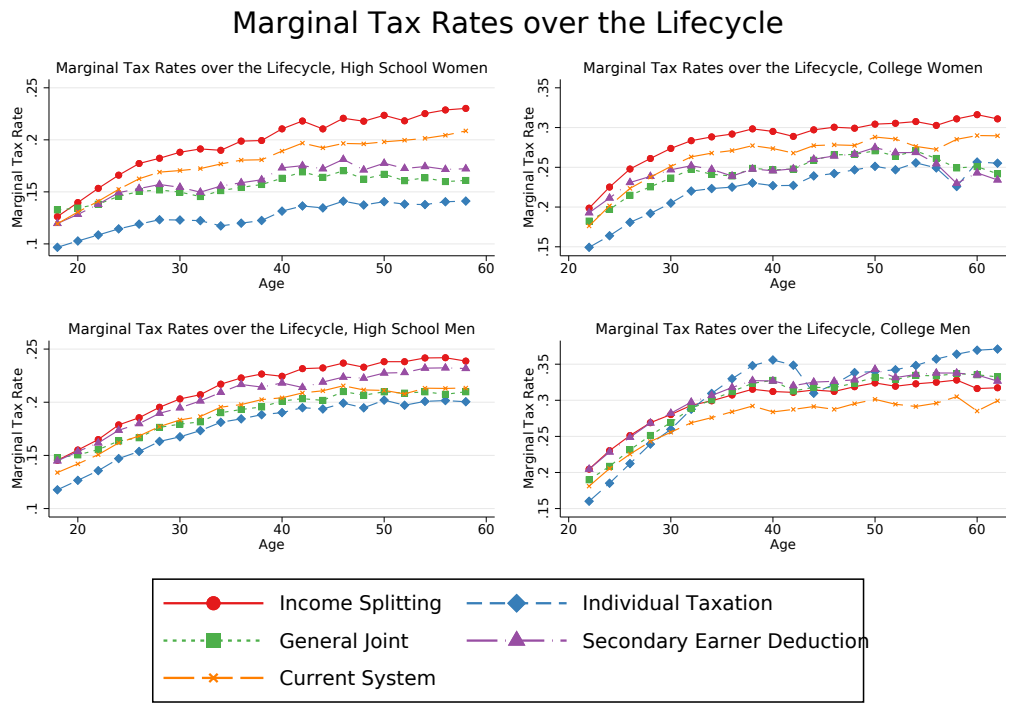
Notes: All households.

Figure 29: Changes in Marriage Bonuses by Gender, Education, and Tax System



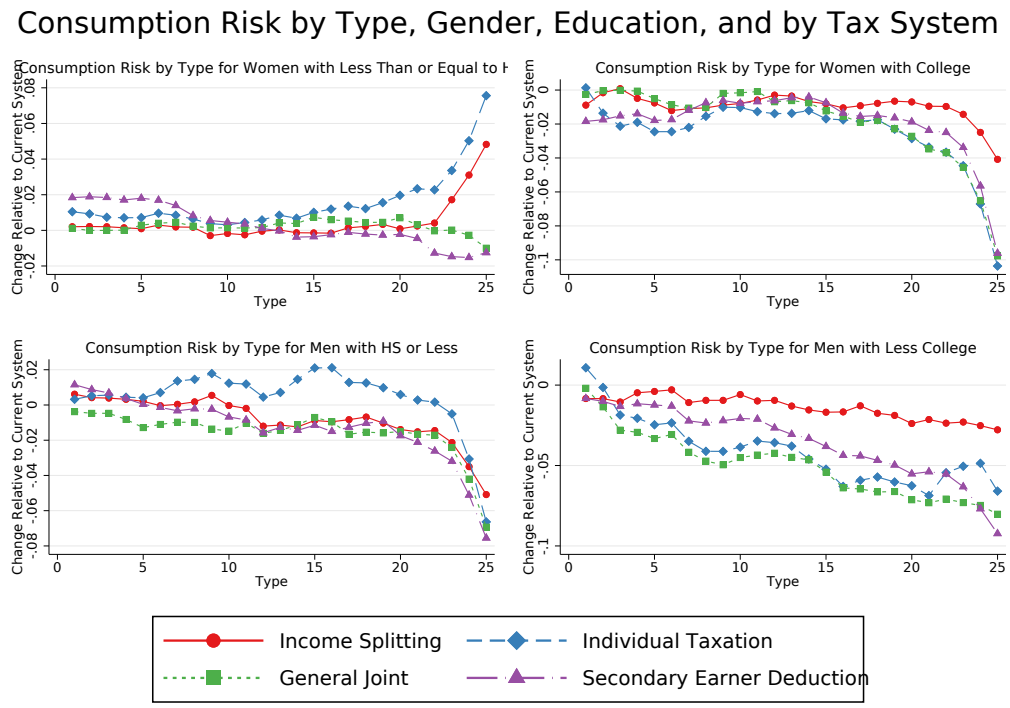
Notes: All households.

Figure 30: Changes in Average Tax Rates by Gender, Education, Age, and Tax System



Notes: All households.

Figure 31: Marginal Tax Rates by Gender, Education, Age, and Tax System



Notes: Moving averages.

Figure 32: Changes in Consumption Risk by Gender, Education, Age, and Tax System