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ABSTRACT

Childcare Subsidies and Household Labor Supply*

What would be the aggregate effects of adopting a more generous and universal childcare subsidy program in the U.S.? We answer this question in a life-cycle equilibrium model with heterogeneous married and single households with three key features: (i) joint labor-supply of married households along extensive and intensive margins; (ii) heterogeneity in terms of the presence of children across households; (iii) skill losses of females associated to non participation. We find that subsidies have substantial effects on female labor supply and lead to a large reallocation of hours worked from males to females. Fully subsidized childcare available to all households leads to longrun increases in the participation of married females and total hours worked by about 10.1% and 1.0%, respectively, and to a decline of male hours by 1.5%. There are large differences across households in welfare gains, as a small number of households–poorer households with children–gain significantly while others lose. Welfare gains of newborn households amount to 1.9%.

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1 Introduction

This paper is about the aggregate implications of childcare subsidies. We focus in detail on the evaluation of a hypothetical large-scale program of childcare subsidies for the U.S. economy. We ask: quantitatively, what are the effects of a large expansion of current childcare subsidy programs on labor supply and output? What are the resulting consequences on female skills and the wage gender gap? What are the resulting welfare effects?

Two major reasons motivate our work. First, the findings from the literature on the determinants of labor supply suggest that the availability and cost of childcare is a central determinant of female labor supply. From this perspective and given the underlying large elasticities of female labor supply, subsidizing the provision of childcare services would lead to significant increases in female labor force participation and hours. Moreover, childcare subsidies are expected to have their largest effects on less-skilled females (i.e. those who participate less). Hence, they constitute a-priori an appealing form of transfers without the typical perverse consequences on work incentives. There is, however, a natural trade-off. Expansions of current programs can be concomitant with reductions in the labor supply of males and have to be financed with distortionary taxes. There can be welfare losses as a result.

Second, several high-income countries subsidize the provision of childcare in substantial ways. Sweden for instance, devotes nearly 0.9% of aggregate output to this form of public assistance, while annual public expenditures per child in formal childcare amount to about US$ 6,000 (PPP) in 2008. Several authors, e.g. Rogerson (2007), have attributed the high levels of female labor supply in Scandinavia to the scope and magnitude of childcare subsidies there. In contrast, childcare subsidies in the United States are much smaller. The main childcare subsidy program in the United States, the Child Care Development Fund (CCDF), is minuscule in comparison.[1] Overall, the United States spends less than 0.1% of output in childcare subsidies, and subsidies per child in formal childcare amount to less than US$ 900 in 2008.[2] Despite discussions in policy circles that routinely point out to this policy difference between the U.S. and other rich countries, the consequences for the U.S. economy of an expansion of current childcare subsidies to the aforementioned levels elsewhere are

[1] See section 2 for a detailed description.

[2] Source: OECD Family Database.

largely unexplored. We fill this void in this paper.

We build a life-cycle model populated by heterogeneous single and married individuals. Married households and single females may have children attached to them or not; if children are present, they arrive *early* or *late* in their life cycle. Individuals differ in terms of their labor endowments, which differ both initially and how they evolve over the life cycle. In particular, the labor market productivities of females are *endogenous* and depend on their labor market histories: not working is costly for females since if they do not work their skills depreciate. If a female with children works, married or single, the household has to purchase childcare services. Childcare services depend on the age of the child, and its provision requires only labor services. Married households decide if both or only one member should work, and if so how much, in the presence or absence of (costly) children and available childcare subsidies. This model, when parameterized according to U.S. data, is consistent with observations on female labor participation by skill and over the life cycle, the wage-gender gap by age, and available estimates of the elasticity of female labor-force participation with respect to the cost of childcare.

Childcare subsidies in our model mimic the main U.S. subsidy program (CCDF). Childcare services are subsidized at a given rate, and are means-tested. Hence, two parameters govern subsidization; one of them control the *level* of subsidies given eligibility, and the other controls the *eligibility* into the program. Our policy exercises involve changes in each of these parameters at a time, and in both of them simultaneously. To achieve revenue neutrality, subsidies beyond current levels are financed via an additional, proportional income tax on all households. In this context, changes in the structure of childcare subsidies lead in equilibrium to changes in participation rates, aggregate labor supply and the aggregate tax burden.

We find that an expansion of current subsidy arrangements have rather substantial effects on labor force participation rates and hours worked across steady state equilibria. When childcare subsidies are *universal* (i.e. all households with children qualify for subsidies), subsidizing childcare services at a 50% rate leads to an increase in the participation rate of married females of about 5.8%, and to an increase in aggregate hours of about 0.9%. If subsidies are universal and childcare is *fully* subsidized, participation rates increase by 10.1% and aggregate hours by about 1% across steady states. The effects on married female labor force participation are much higher for less educated females. A universal 100% subsidy on child care increases the labor force participation of married females with less than high school (high school) education by 32.3% (17.6%). As married females, especially ones with less education, work more, the gender gap declines. A universal 100% subsidy generates a 6.3% lower gender wage gap by age 55 for women with high school education.

Concomitantly with the effects on female labor supply described above, childcare subsidies lead to a sizable reallocation of hours worked from males to females. When subsidies are universal and childcare is fully subsidized, hours worked by males drop by 1.5%. Output changes, as a result, are relatively small. In this case, the changes in aggregate output amount to just 0.3% and are *negative* whenever eligibility restrictions are present.

We find that expansions of subsidy arrangements generate diverse welfare effects. Such expansions lead to large welfare *gains* for households who are born into an economy with more generous subsidies. When all households are eligible for a subsidy and childcare is fully subsidized, welfare gains amount to 1.9% of consumption for newborns – households who are 25-29 years old. Moreover, a majority (52.9%) of newborn individuals benefits from the expansion of the subsidy scheme. The welfare gain for a newborn married households with children early (late) in the life cycle amounts to 4.9% (2.2%), while the welfare cost for married households without children is of about 4.8% of consumption. The welfare gains for single mothers with children early (late) in the life cycle are even greater: 10.1% (7.6%). The gains are particularly large for less educated households as child care expenditures constitute a large burden in those cases. Welfare gains for newborns with less than high school education amount to 6.3% while it is only 1.8% for those with more than college education. Interestingly, the highest welfare gains are enjoyed by those with some college education (6.6%), as they are more likely to work and use childcare subsidies than less educated households.

Not surprisingly, households who are older at the time of the policy change experience welfare losses, as they do not benefit from more generous subsidies but have to incur the additional taxes that are needed to finance the expansion of the program. When childcare subsidies are universal and subsidized at 100%, the aggregate welfare cost amounts to about 1.0%. Key for these findings is the simple fact that childcare subsidies benefit relatively few households, and that their costs (i.e. additional taxes) have to be paid by all.

Related Literature This paper is related to several strands of literature. First, it is naturally related to the empirical literature, going back to Heckman (1974), that studies the effects on female labor supply of childcare costs in general, e.g. Hotz and Miller (1988), and childcare subsidies in particular. Blau and Hagy (1998), Tekin (2007) and Baker, Gruber and Milligan (2008) are examples of papers in this group; all find positive and large effects of childcare subsidies on female employment. It is also naturally related to the growing literature that studies macroeconomic models with heterogeneity in two-earner households. Examples of these papers are Chade and Ventura (2002), Greenwood, Guner and Knowles (2003), Olivetti (2006), Kaygusuz (2006, 2010), Hong and Rios-Rull (2007), Heathcote, Violante, Storesletten (2010) , Erosa, Fuster and Restuccia (2010), Guner, Kaygusuz and Ventura (2012-a, 2012-b), Bick and Fuchs-Schundeln (2012), among others.

Finally, our paper is closely related to recent work in macroeconomics that studies the aggregate and cross-sectional effects of childcare costs and subsidies. Attanasio, Low and Sanchez-Marcos (2008), who model female labor supply decisions in a life-cycle model with endogenous human capital accumulation for females, show that the observed declining cost of childcare had a large, positive effect on married female labor supply during recent decades in the United States. Bick (2012) builds a life-cycle model of female labor supply and fertility and shows that an expansion of subsidized childcare in Germany would lead to a positive effect on female labor supply. In his model, universally available child care increases the labor force participation of mothers with young (0-2 years old) children by 14%. Domeij and Klein (2012) approach childcare subsidies from a Ramsey optimal-taxation perspective. They argue that in economy with distortionary taxes on labor supply, tax deductibility of childcare costs can be optimal. In an application of their model to Germany, they find childcare subsidy rates that are welfare improving and are also supported by a majority of households.[3]

Three key features, which we model together in a unified framework, distinguish our work from related papers. First, as in Guner, Kaygusuz and Ventura (2012-a, 2012-b), we allow for

[3]Rendall (2013), following Rogerson (2007), studies an economy with two sectors (final goods and services) with two-earner households. She shows that higher taxes can have positive welfare affects if they are used to finance government transfers of service sector goods that are tied to female work, e.g. child care subsidies. Garcia-Moran (2012) compares the effects of childcare subsidies versus direct cash transfers in an overlapping generations model of marriage, divorce and investment in children. She shows that childcare subsides are more effective than direct cash transfer for improving the well-being of children in poverty.

jointly determined labor-supply decisions of spouses at the *extensive* and *intensive* margins. In particular, we provide a detailed modeling of the labor force participation of married females across heterogenous couples. This matters as a large expansion of current subsidy arrangements would affect married households, and a reallocation of hours worked within married households are possibly substantial for generous subsidies. Second, we carefully take into account the presence of children across married and single households, and the associated childcare costs. In addition, we model the means-tested nature of current subsidy programs, which naturally permits a clean policy analysis of their expansion. Finally, we model the dynamic costs and benefits of participation decisions by allowing the labor market skills of females to depreciate due to childbearing disruptions. Hence, the expansions of subsidy arrangements that we consider capture potential increases in female skills, and corresponding effects on gender wage gaps.

Our paper is organized as follows. Section 2 outlines facts about the Child Care Development Fund program in the United States. Section 3 presents the model environment we study. In section 4, we discuss the parameterization of our model and choice of parameter values. In section 5, we discuss the performance of our model in light of data. Section 6 and 7 present the main findings of the paper for aggregates and welfare. Section 8 discusses key aspects of our results. Finally, section 9 concludes.

2 The Child Care Development Fund (CCDF)

The Child Care Development Fund (CCDF) was created as part of the welfare reform (the Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA) of 1996), and consolidated an array of programs into one.[4] CCDF currently is administered at the Federal level by the Child Care Bureau (CCB), Office of Family Assistance in the Administration for Children and Families (ACF). States, Territories, and Tribes receive grants from the program, and they are responsible for ensuring that these are administered in compliance with Federal statutory and regulatory requirements. As a block grant, States have significant discretion in implementing the program and in determining how funds are used to achieve the overall goals of CCDF.

[4] An excellent overview of the history of childcare subsidy programs in the U.S. as well as the current system can be found in Blau (2003).

The program assists families to obtain childcare so they can work, or participate in training or education. It explicitly targets low-income households. Hence, to qualify for a subsidy, parents must be employed, in training, or in school. States use CCDF funds to assist families with incomes up to 85 percent of state median income (SMI), but can set a lower income eligibility criterion. As of 2011, state income eligibility limits varied from 37% to 83% of SMI; see Lynch (2001). In 1999, the population-weighted average of the income threshold was $25,637 (calculations based on Blau (2000), Table 3, and population estimates from the Census Bureau), which represents 61% of U.S. median household income in 1999. However, only a small fraction of families who qualify actually get the subsidy. According to Administration for Children and Families, for the years 1999 and 2000, it is estimated that the CCDF served 12-15% of eligible children (Blau and Tekin (2007)). In 2010, about 1.7 children (ages 0-13) were served by the CCDF, which is about 5.5% of all children (ages 0-13) in the US.[5]

In general, families that receive the program subsidies are poor, single mothers. In 2010, about half of families had a household income that was less than about $18,000, and only 13% of them had incomes above $27,000. Average income of those receiving subsidy were about $19,000 (about 27% of mean household income in 2010).[6] About 80% of children who receive a childcare subsidy live in a single-mother family. In about 73% of households receiving a subsidy the parents worked, while in about 20% of households, they were in training or education.[7]

Families receiving childcare subsidy from CCDF must make a co-payment. These co-payments increase with parental income. Both the level of co-payments and the benefit reduction rate differ greatly across states. On average co-payments were about 6% of total family income.[8] Given an average income of $19,000 for recipients, this amounts to a co-payment of about $1,140 dollars per year. In 2010, CCDF paid a monthly amount of about $400 per family, or $4800 per year, to care providers (including the co-payment).[9] Hence about 24% of childcare costs ($1,120 out of $4,800) were paid by the families, while the

[5]Source: http://www.acf.hhs.gov/programs/occ/resource/fy-2010-data-tables-final

[6]About 49% of families had incomes that were less than $18310, about 27% has incomes between $18,310 and $27,465, and 13% had incomes that were greater than $27,465. Source: http://archive.acf.hhs.gov/programs/occ/data/ccdf_data/data_fact_sheet.pdf

[7]Source: http://archive.acf.hhs.gov/programs/occ/data/ccdf_data/data_fact_sheet.pdf

[8]Source: http://archive.acf.hhs.gov/programs/occ/data/ccdf_data/data_fact_sheet.pdf

[9]Source: http://www.acf.hhs.gov/programs/occ/resource/fy-2010-data-tables-final

remaining 76% constituted the subsidy.

3 The Economic Environment

We study a stationary overlapping generations economy populated by a continuum of males (m) and a continuum of females (f). Let $j \in \{1, 2, ..., J\}$ denote the age of each individual. Population grows at rate n. For tractability, individuals differ in terms of their marital status: they are born as either single or married, and their marital status does not change over time.

Married households and single females also differ in terms of the number of children attached to them. They can be childless or endowed with two children. These children appear either *early* or *late* in the life-cycle exogenously. Children affect the resources available to households for three periods, and this is mitigated partially or fully by childcare subsidies. Children do not provide any utility.

The life-cycle of agents is split into two parts. Each agent starts life as a worker and at age J_R, individuals retire and collect pension benefits until they die at age J. We assume that married households are comprised by individuals who are of the same age. As a result, members of a married household experience identical life-cycle dynamics.

Each period, working households (married or single) make labor supply, consumption and savings decisions. Children imply a fixed time cost for females. If a female with children, married or single, works, then the household also has to pay childcare costs. Households below an income threshold receive childcare subsidies from the government. Not working for a female is *costly*; if she does not work, she experiences losses of labor efficiency units for next period. Furthermore, if the *female* member of a married household supplies positive amounts of market work, then the household incurs a utility cost.

Heterogeneity and Demographics Individuals differ in terms of their labor efficiency units in two respects. First, at the start of life, each *male* is endowed with an exogenous type z that remains constant over his life cycle. Let $z \in Z$ and $Z \subset R_{++}$ be a finite set. We refer to this type of heterogeneity as the *education* type. Second, within each education type, there is further heterogeneity; some agents with the same education are more productive than others. This additional level of heterogeneity is denoted by ε_z. Let $\varepsilon_z \in E_z$ and $E_z \subset R$ be a finite set. Like z, ε_z is drawn at the start of an agent's life and remains constant over his life cycle.

Average productivity of age-j, type-z agents are denoted by the function $\varpi_m(z,j)$, while the productivity of a age-j, type-z agent with ε_z is given by $\varpi_m(z,j)\varepsilon_z$. Let $\Omega_j(z)$ denote the fraction of age-j, type-z males in male population, with $\sum_{z\in Z}\Omega_j(z)=1$. We assume that ε_z is distributed symmetrically around 1, and let $\Xi_z(\varepsilon_z)$ be the fraction of type ε_z agents such that $\sum_{\varepsilon_z\in E_z}\Xi(\varepsilon_z)\varepsilon_z=1$. Hence, while some type-z agents have productivity levels above the mean along their life-cycle, others have productivity levels below the mean.

As males, each female starts her working life with a particular education type, which is denoted by $x\in X$, where $X\subset R_{++}$ is a finite set. Let $\Phi_j(x)$ denote the fractions of age-j, type-x females in female population, with $\sum_{x\in X}\Phi_j(x)=1$. Again as males, each female is also assigned a particular ε_x value at the start her life. Let $\varepsilon_x\in E_x$ and $E_x\subset R$ be a finite set with $\sum_{\varepsilon_x\in E_x}\Xi(\varepsilon_x)\varepsilon_x=1$.

As women enter and leave the labor market, their labor market productivity levels evolve *endogenously*. Each female starts life with an initial productivity level that depends on her education level, denoted by $h_1=\eta(x)\in H$. After age-1, the next period's productivity level (h') depends on the female's education x, her age, the current level of h and current labor supply (l). We assume that for $j\geq 1$,

$$h'=\mathcal{H}(x,h,l,j).$$

The function $\mathcal{H}$ is increasing in h and x, and non-decreasing in l. It captures the combined effects of a female's education, age and labor supply decisions on her labor market productivity growth. We specify this function in detail in section (4). The labor market productivity for a female with human capital level h, and a productivity realization ε_x, is given by $h\varepsilon_x$.

Let $M_j(x,z)$ denote the fraction of marriages between an age-j, type-x female and an age-j type-z male, and let $\omega_j(z)$ and $\phi_j(x)$ be the fraction of single type-z males and the fraction of single type-x females, respectively. We assume that given their education types, agents are matched randomly according to their ε values. Hence, among $M_j(x,z)$ couples, a fraction $\Xi_z(\varepsilon_z)\Xi_x(\varepsilon_x)$ is formed by $(\varepsilon_x,\varepsilon_z)$-couples.

Then, the following accounting identity must hold

$$\Omega_j(z)=\sum_{x\in X}M_j(x,z)+\omega_j(z). \tag{1}$$

Furthermore, since the marital status does not change, $M_j(x, z) = M(x, z)$ and $\omega_j(z) = \omega(z)$ for all j, which implies $\Omega_j(z) = \Omega(z)$. Similarly, for age-j females, we have

$$\Phi_j(x) = \sum_{z \in Z} M_j(x, z) + \phi_j(x). \tag{2}$$

Since marital status does not change $\phi_j(x) = \phi(x)$ and $\Phi_j(x) = \Phi(x)$ for all j

We assume that each cohort is $1 + n$ bigger than the previous one. These demographic patterns are stationary so that age j agents are a fraction μ_j of the population at any point in time. The weights are normalized to add up to one, and obey the recursion, $\mu_{j+1} = \mu_j/(1+n)$.

Children Children are assigned exogenously to married couples and single females at the start of life, depending on the education of parents. Each married couple and single female can be of three types: *early* child bearers, *late* child bearers, and those *without* any children. Early and late child bearers have *two* children for three periods. Early child bearers have these children in ages $j = 1, 2, 3$ while late child bearers have children attached to them in ages $j = 2, 3, 4$. We assume that childbearing status of married couples and singles females differs only with respect to their education types.

Childcare Costs We assume that if a female with children works, married or single, then the household has to pay for childcare costs. Childcare costs depend on the age of the child (s). For a female with children of age $s \in \{1, 2, 3\}$, the household needs to purchase $d(s)$ units of (childcare) labor services for their two children. Since the competitive price of childcare services is the wage rate w, the total cost of childcare services for two children equals $wd(s)$.

Utility Cost of Joint Work We assume that at the start of their lives married households draw a $q \in Q$, where $Q \subset R_{++}$ is a finite set. These values of q represent the *utility costs* of joint market work for married couples. For a given household, the initial draw of utility cost depends on the education of the husband. Let $\zeta(q|z)$ denote the probability that the cost of joint work is q, with $\sum_{q \in Q} \zeta(q|z) = 1$.

Preferences The momentary utility function for a single female is given by

$$U_f^S(c, l, k_y) = \log(c) - \varphi(l + k_y \varkappa)^{1+\frac{1}{\gamma}},$$

where c is consumption, l is time devoted to market work, φ is the parameter for the disutility of leisure, $\varkappa$ is fixed time cost having two age-1 (young) children for a female, and γ is the intertemporal elasticity of labor supply. Here $k_y = 0$ stands for the absence of age-1 (young) children in the household, whereas $k_y = 1$ stands for young children being present. Since a single male does not have any children, his utility function is simply given by

$$U_m^S(c, l) = \log(c) - \varphi(l)^{1+\frac{1}{\gamma}}.$$

Married households maximize the sum of their members utilities. We assume that when the female member of a married household works, the household incurs a utility cost q. Then, the utility function for a married female is given by

$$U_f^M(c, l_f, q, k_y) = \log(c) - \varphi(l_f + k_y\varkappa)^{1+\frac{1}{\gamma}} - \frac{1}{2}\chi\{l_f\}q,$$

while the one for a married male reads as

$$U_m^M(c, l_m, l_f, q) = \log(c) - \varphi l_m^{1+\frac{1}{\gamma}} - \frac{1}{2}\chi\{l_f\}q,$$

where $\chi\{.\}$ denote the indicator function. Note that consumption is a public good within the household. Note also that the parameter $\gamma > 0$, the intertemporal elasticity of labor supply, and φ, the weight on disutility of work, are independent of gender and marital status.

Production and Markets There is an aggregate firm that operates a constant returns to scale technology. The firm rents capital and labor services from households at the rate R and w, respectively. Using K units of capital and L_g units of labor, firms produce $F(K, L_g) = K^\alpha L_g^{1-\alpha}$ units of consumption (investment) goods. We assume that capital depreciates at rate δ_k. Households save in the form of a risk-free asset that pays the competitive rate of return $r = R - \delta_k$.

3.1 Government

The government taxes labor and capital income, and uses these tax collections to pay for government consumption and childcare subsidies. It also collects payroll taxes and pays for social security transfers.

Childcare Subsidies Each household, married or single, with total income level below $\widehat{I}$ and with a working mother receives a subsidy of θ percent for childcare payments. As a result, effective childcare expenditures for a household with two children of age s is given by $wd(s)(1-\theta)$, if the household qualifies, and $wd(s)$ otherwise.

Incomes, Taxation and Social Security Income for tax purposes, I, is defined as total labor and capital income. Let a stand for household's assets. Then, for a single male worker, taxable income equals $I = ra + w\varpi_m(z,j)\varepsilon_z l_m$, while for a single female worker, it reads as $I = ra + wh\varepsilon_x l_f$. For a married working household, taxable income equals $I = ra + w\varpi_m(z,j)1 + \varepsilon_z l_m + wh\varepsilon_x l_f$. We assume that social security benefits are not taxed, so income for tax purposes is simply given by ra for retired households. The total income tax liabilities of married and single households are affected by the presence of children in the household, and are represented by tax functions $T^M(I,k)$ and $T^S(I,k)$, respectively, where $k=0$ stands for the absence of children in the household, whereas $k=1$ stands for children of any age being present. These functions are continuous in I, increasing and convex. This representation captures the actual variation in tax liabilities associated to the presence of children in households.

There is a (flat) payroll tax that taxes individual labor incomes, represented by τ_p, to fund social-security transfers. Moreover, each household pays an additional flat capital income tax for the returns from his/her asset holdings, denoted by τ_k. We assume that the social security system has to balance its budget every period.

Retired households have access to social security benefits. We assume that social security benefits depend on agents' education types, i.e. initially more productive agents receive larger social security benefits. This allows us to capture in a parsimonious way the positive relation between lifetime earnings and social security transfers, as well as the intra-cohort redistribution built into the system. Let $p^S_f(x)$, $p^S_m(z)$, and $p^M(x,z)$ indicate the level of social security benefits for a single female of type x, a single male of type z and a married retired household of type (x,z), respectively. Hence, retired households pre-tax resources are simply $a + ra + p^S_f(x)$ and $a + ra + p^S_m(z)$ for singles, and $a + ra + p^M(x,z)$ for married ones.

3.2 Decision Problem

We now present the decision problem for different types of agents in the recursive language. For single males, the individual state is (a, z, ε_z, j). For single females, the individual state is given by $(a, h, x, \varepsilon_x, b, j)$. For married couples, the state is given by $(a, h, x, z, \varepsilon_x, \varepsilon_z, q, b, j)$. Note that the dependency of taxes on the presence of children in the household (k) is summarized by age (j) and childbearing status (b): (i) $k = 1$ if $b = \{1, 2\}$ and $j = \{b, b+1, b+2\}$, and (ii) $k = 0$ if $b = 2$ and $j = 1$, or $b = \{1, 2\}$ for all $j > b + 2$, or $b = 0$ for all j. Similarly, the presence of age-1 (young) children (k_y) depends on b and j.

The Problem of a Single Male Household Consider now the problem of a single male worker of type (a, z, ε_z, j). A single worker of type-(a, z, ε_z, j) decides how much to work and how much to save. His problem is given by

$$V_m^S(a, z, \varepsilon_z, j) = \max_{a',l} \{U_m^S(c, l) + \beta V_m^S(a', z, \varepsilon_z, j + 1)\} \tag{3}$$

subject to

$$c + a' = \begin{cases} a(1 + r(1 - \tau_k)) + w\varpi_m(z, j)\varepsilon_z l(1 - \tau_p) \\ -T^S(I, 0) \quad \text{if } j < J_R \\ \\ a(1 + r(1 - \tau_k)) + p_m^S(z) - T^S(ra), \text{ otherwise} \end{cases},$$

and

$$l \geq 0,\ a' \geq 0 \text{ (with strict equality if } \ j = J),$$

where

$$I = w\varpi_m(z, j)\varepsilon_z l + ra$$

The Problem of a Single Female Household In contrast to a single male, a single female's decisions also depends on her current human capital h and her child bearing status b. Hence, given her current state, $(a, x, \varepsilon_x, h, b, j)$, the problem of a single female is

$$V_f^S(a, h, x, \varepsilon_x, b, j) = \max_{a',l} \{U_f^S(c, l, k_y) + \beta V_f^S(a', h', x, \varepsilon_x, b, j + 1)\},$$

subject to

(i) <u>With kids:</u> if $b = \{1, 2\}$, $j \in \{b, b + 1, b + 2\}$, then $k = 1$, and

$$c + a' = \begin{cases} a(1 + r(1 - \tau_k)) + wh\varepsilon_x l(1 - \tau_p) - T^S(T, 1) \\ -wd(j + 1 - b)(1 - \theta)\chi(l) \text{ if } I \leq \widehat{I} \\ \\ a(1 + r(1 - \tau_k)) + wh\varepsilon_x l(1 - \tau_p) - T^S(I, 1) \\ -wd(j + 1 - b)\chi(l), \text{ otherwise} \end{cases},$$

where $I = wh\varepsilon_x l + ra$. Furthermore, if $b = j$, then $k_y = 1$.

(ii) Without kids but not retired: if $b = 0$, or $b = \{1, 2\}$ and $b + 2 < j < J_R$, or $b = 2$ and $j = 1$, then $k = 0$ and

$$c + a' = a(1 + r(1 - \tau_k)) + wh\varepsilon_x l(1 - \tau_p) - T^S(wh\varepsilon_x l + ra, 0)$$

(ii) Retired: if $j \geq J_R$, $k = 0$ and

$$c + a' = a(1 + r(1 - \tau_k)) + p_f^S(x) - T^S(ra, 0).$$

In addition,

$$h' = \mathcal{H}(x, h, l, j),$$

$$l \geq 0,\ a' \geq 0 \text{ (with strict equality if } j = J)$$

Note how the cost of children depends on the age of children. Consider a single female whose income is low enough to qualify for the subsidy. If $b = 1$, the household has children at ages 1, 2 and 3, then $wd(j + 1 - b)(1 - \theta)$ denote cost for ages 1, 2 and 3 with $j = \{1, 2, 3\}$ if she receives the subsidy θ. If $b = 2$, the household has children at ages 2, 3 and 4, then $wd(j + 1 - b)(1 - \theta)$ denotes the cost for children of ages 1, 2 and 3 with $j = \{2, 3, 4\}$ again assuming that she receives the subsidy θ. A female only incurs the time cost of children if her kids are 1 year old, and this happens if $b = j = 1$ or $b = j = 2$.

The Problem of Married Households Like singles, married couples decide how much to consume, how much to save, and how much to work. They also decide whether the female member of the household should work. Their problem is given by

$$\begin{aligned} V^M(a, h, x, z, \varepsilon_x, \varepsilon_z, q, b, j) &= \max_{a',\, l_f,\, l_m} \{[U_f^M(c, l_f, q, k_y) + U_m^M(c, l_m, l_f, q)] \\ &+ \beta V^M(a', h', x, z, \varepsilon_x, \varepsilon_z, q, b, j + 1)\}, \end{aligned}$$

subject to

(i) With kids: if $b = \{1, 2\}$, $j \in \{b, b+1, b+2\}$, then $k = 1$ and

$$c + a' = \begin{cases} a(1 + r(1 - \tau_k)) + w(\varpi_m(z, j)\varepsilon_z l_m + h\varepsilon_x l_f)(1 - \tau_p) \\ -T^M(I, 1) - wd(j + 1 - b)(1 - \theta)\chi(l_f) \text{ if } I \leq \widehat{I} \\ \\ a(1 + r(1 - \tau_k)) + w(\varpi_m(z, j)\varepsilon_z l_m + h\varepsilon_x l_f)(1 - \tau_p) \\ -T^M(I, 1) - wd(j + 1 - b)\chi(l_f), \text{ otherwise} \end{cases},$$

where $I = w\varpi_m(z, j)\varepsilon_z l_m + wh\varepsilon_x l_f + ra$. Furthermore, if $b = j$, then $k_y = 1$.

(ii) Without kids but not retired: if $b = 0$, or $b = \{1, 2\}$ and $b + 2 < j < J_R$, or $b = 2$, $j = 1$, then $k = 0$ and

$$\begin{aligned} c + a' &= a(1 + r(1 - \tau_k)) + w(\varpi_m(z, j)\varepsilon_z l_m + h\varepsilon_x l_f)(1 - \tau_p) \\ &- T^M(w\varpi_m(z, j)\varepsilon_z l_m + wh\varepsilon_x l_f + ra, 0) \end{aligned}$$

(ii) Retired: if $j \geq J_R$, then $k = 0$ and

$$c + a' = a(1 + r(1 - \tau_k)) + p^M(x, z) - T^M(ra, 0).$$

In addition,

$$h' = \mathcal{H}(x, h, l_f, j)$$

$$l_m \geq 0,\ l_f \geq 0, a' \geq 0 \text{ (with strict equality if } j = J)$$

3.3 Stationary Equilibrium

The aggregate state of this economy consists of distribution of households over their types, asset and human capital levels. In particular, let the function $\psi_j^M(a, h, x, z, \varepsilon_x, \varepsilon_z, q, b)$ denote the number of married individuals of age j with assets a, female human capital h, when the female is of type (x, ε_x), the male is of type (z, ε_z), the household faces a utility cost q of joint work, and is of child bearing type b. The function $\psi_{f,j}^S(a, h, x, \varepsilon_x, h, b)$, for single females, is defined similarly. Finally, the function $\psi_{m,j}^S(a, z, \varepsilon_z)$, for single males, is defined over asset levels and the male type. As we mentioned earlier, we restrict x, z, and q to take values from finite sets and b is finite by construction. In contrast, household assets, a, and female human capital levels, h, are continuous decisions. We denote by $A = [0, \overline{a}]$ and $H = [0, \overline{h}]$ the sets of possible assets and female human capital levels.

By construction, $M(x, z)$, the number married households of type (x, z), must satisfy for all ages

$$M(x, z) = \sum_{q,b,\varepsilon_x,\varepsilon_z} \int_{A\times H} \psi_j^M(a, h, x, z, \varepsilon_x, \varepsilon_z, q, b) dhda.$$

Similarly, the fraction of single females and males must be consistent with the corresponding measures $\psi_{f,j}^S$ and $\psi_{m,j}^S$. For all ages,

$$\phi(x) = \sum_{b,\varepsilon_x} \int_{A\times H} \psi_{f,j}^S(a, h, x, \varepsilon_x, b) dhda,$$

and

$$\omega(z) = \sum_{\varepsilon_z} \int_A \psi_{m,j}^S(a, z, \varepsilon_z) da.$$

We now sketch the elements of a stationary equilibrium for our economy. In equilibrium, factor markets clear. Aggregate capital (K) and aggregate labor (L) are given by

$$\begin{aligned} K &= \sum_j \mu_j [\sum_{x,z,q,b,\varepsilon_x,\varepsilon_z} \int_{A\times H} a\psi_j^M(a, h, x, z, \varepsilon_x, \varepsilon_z, q, b) dhda + \sum_{z,\varepsilon_z} \int_A a\psi_{m,j}^S(a, z, \varepsilon_z) da \quad (4) \\ &+ \sum_{x,b,\varepsilon_x} \int_{A\times H} a\psi_{f,j}^S(a, h, x, \varepsilon_x, b) dhda] \end{aligned}$$

and

$$\begin{aligned} L &= \sum_j \mu_j [\sum_{x,z,q,b,\varepsilon_x,\varepsilon_z} \int_{A\times H} (h\varepsilon_x l_f^M(a, h, x, z, \varepsilon_x, \varepsilon_z, q, b, j) \\ &\quad + \varpi_m(z, j))\varepsilon_z l_m^M(a, h, x, z, \varepsilon_x, \varepsilon_z, q, b, j))\psi_j^M(a, h, x, z, \varepsilon_x, \varepsilon_z, q, b) dhda \quad (5) \\ &+ \sum_{z,\varepsilon_z} \int_A \varpi_m(z, j)\varepsilon_z l_m^S(a, z, \varepsilon_z, j)\psi_m^S(a, z, \varepsilon_z) da \quad (6) \\ &\quad + \sum_{x,b,\varepsilon_x} \int_{A\times H} h\varepsilon_x l_f^S(a, h, x, b, j)\psi_{f,j}^S(a, x, b) dhda] \quad (7) \end{aligned}$$

Furthermore, labor used in the production of goods, L_g, equals

$$L_g = L - [\sum_{x,z,q,\varepsilon_x,\varepsilon_z} \sum_{b=1,2} \sum_{j=b,b+2} \mu_j \int_{A \times H} \chi\{l_f^M\} d(j+1-b) \psi_j^M(a,h,x,z,\varepsilon_x,\varepsilon_z,q,b) dhda$$

$$+ \sum_{x,\varepsilon_x} \sum_{b=1,2} \sum_{j=b,b+2} \mu_j \int_{A \times H} \chi\{l_f^S\} d(j+1-b) \psi_{f,j}^S(a,h,x,\varepsilon_x,b) dhda], \quad (8)$$

where the term in brackets is the quantity of labor used in childcare services.

Factor prices are competitive so $w = F_2(K, L_g)$, $R = F_1(K, L_g)$, and $r = R - \delta_k$.

Finally, total taxes must cover government expenditures G and the total government spending on child care subsidy program C; i.e.

$$G + C = \sum_j \mu_j [\sum_{x,z,\varepsilon_x,\varepsilon_z,q,b} \int_{A \times H} T^M(.) \psi_j^M(a,h,x,z,\varepsilon_x,\varepsilon_z,q,b) dhda + \sum_z \int_A T^S(.) \psi_{m,j}^S(a,z,\varepsilon_z) da$$

$$+ \sum_{x,b} \int_{A \times H} T^S(.) \psi_{f,j}^S(a,h,x,\varepsilon_x,b) dhda] + \tau_k r K, \quad (9)$$

where the total government expenditure on child care subsidies is given by

$$C = \theta \sum_{x,z,q,\varepsilon_x,\varepsilon_z} \sum_{b=1,2} \sum_{j=b,b+2} \mu_j \int_{A \times H} \chi(I \leq \widehat{I}) \chi\{l_f^M\} d(j+1-b) \psi_j^M(a,h,x,z,\varepsilon_x,\varepsilon_z,q,b) dhda$$

$$+ \theta \sum_{x,\varepsilon_x} \sum_{b=1,2} \sum_{j=b,b+2} \mu_j \int_{A \times H} \chi(I \leq \widehat{I}) \chi\{l_f^S\} d(j+1-b) \psi_{f,j}^S(a,h,x,\varepsilon_x,b) dhda], \quad (10)$$

where $\chi(I \leq \widehat{I})$ indicates whether a household qualifies for a subsidy.

4 Parameter Values

We now proceed to assign parameter values to the endowment, preference, and technology parameters of our benchmark economy. To this end, we use aggregate as well as cross-sectional and demographic data from multiple sources. As a first step in this process, we start by defining the length of a period to be 5 years.[10]

Endowments Agents start their life at age 25 as workers and work for forty years, corresponding to ages 25 to 64. The first model period ($j = 1$) corresponds to ages 25-29, while the first model period of retirement ($j = J_R$) corresponds to ages 65-69. After working

[10]Details of the mapping of model to data for taxation and social security are relegated to the Data Appendix.

8 periods, agents retire at age 65 and live until age 80 ($J = 11$). The population grows at the annual rate of 1.1%, the average values for the U.S. economy between 1960-2000.

There are 5 education types of males. Each type corresponds to an educational attainment level: *less than high school* (hs-), *high school* (hs), *some college* (sc), *college* (col) and *post-college* (col+) education. We use data from the 2008 CPS March Supplement to calculate age-efficiency profiles for each male type. Within an education group, efficiency levels correspond to mean weekly wage rates, which we construct using annual wage and salary income and weeks worked. We normalize wages by the mean weekly wages for all males and females between ages 25 and 64.[11] Figure A1 in the data appendix shows the second degree polynomials that we fit to the raw wage data. In our quantitative exercises, we calibrate the male efficiency units, $\varpi_m(z, j)$, using these fitted values.

There are also 5 education types for females. Table A1 in data appendix reports the initial (ages 25-29) efficiency levels for females together with the initial male efficiency levels and the corresponding gender wage gap. We use the initial efficiency levels for females to calibrate their initial human capital levels, $h_1 = \eta(x)$. After ages 25-29, the human capital level of females evolves endogenously according to

$$h' = \mathcal{H}(x, h, l, j) = \exp\left[\ln h + \alpha_j^x \chi(l) - \delta(1 - \chi(l))\right]. \tag{11}$$

We calibrate the values for α_j^x and δ as follows: First, we choose δ such that annual wage loss associated to non-participation is 2%, a figure calculated by Mincer and Ofek (1982). Then, we select α_j^x so that if a female of a particular type works in every period, her wage profile has exactly the same shape as a male of the same type. This procedure takes the initial gender differences as given, and assumes that the wage growth rate for a female who works full time will be the same as for a male worker; hence, it sets α_j^x values equal to the growth rates of male wages at each age. Table A2 shows the calibrated values for α_j^x.

We assume that the variables capturing residual heterogeneity within educational types, ε_x and ε_z, take two values: $\varepsilon_z \in E_z = \{\varepsilon, -\varepsilon\}$ and $\varepsilon_x \in E_x = \{\varepsilon, -\varepsilon\}$. Furthermore, we set $\Xi_z(\varepsilon) = \Xi_x(-\varepsilon) = \Xi_z(\varepsilon) = \Xi_x(-\varepsilon) = 0.5$. This leaves us with one parameter (ε) to calibrate. We set this parameter so that, in conjunction with heterogeneity in education types, the

[11] We include in the sample the civilian adult population who worked as full time workers last year, and exclude those who are self-employed or unpaid workers or make less than half of the minimum wage. Our sample restrictions are standard in the literature and follow Katz and Murphy (1992).

model reproduces the variance of log-wages for males in our first age group. Using estimates in Heathcote, Storesletten and Violante (2004), we calculate a value of about 0.227 for this statistic. Matching this value requires $\varepsilon = 0.395$ (39.5%).

Demographics We determine the distribution of individuals by productivity types for each gender, i.e. $\Omega(z)$ and $\Phi(x)$, using data from the 2008 U.S. Census. For this purpose, we consider all household heads or spouses who are between ages 30 and 39 and for each gender calculate the fraction of population in each education cell. For the same age group, we also construct $M(x, z)$, the distribution of married working couples, as shown in Table A3. Given the fractions of individuals in each education group, $\Phi(x)$ and $\Omega(z)$, and the fractions of married households, $M(x, z)$, in the data, we calculate the implied fractions of single households, $\omega(z)$ and $\phi(x)$, from accounting identities (5) and (6) in the article. The resulting values are reported in Table A4 about 74% of households in the benchmark economy consists of married households, while the rest (about 26%) are single. Since we assume that the distribution of individuals by marital status is independent of age, we use the 30-39 age group for our calibration purposes. This age group captures the marital status of recent cohorts during their prime-working years, while being at the same time representative of older age groups.

Children In the model each single female and each married couple belong to one of three groups: *childless*, *early child bearer* and *late child bearer*. The early child bearers have two children at ages 1, 2 and 3, corresponding to ages 25-29, 30-34 and 35-39, while late child bearers have their two children at ages 2, 3, and 4, corresponding to ages 30-34, 35-39, 40-44. This particular structure captures two features of the data from the 2008 CPS June supplement.[12] First, conditional on having a child, married couples tend to have about two children.[13] Second, these two births occur within a short time interval, mainly between ages 25 and 29 for households with low education and between ages 30 and 34 for households with high education.

For singles, we use data from the 2008 CPS June supplement and calculate the fraction of 40 to 44 years old single (never married or divorced) females with zero live births. This

[12]The CPS June Supplement provides data on the total number of live births and the age at last birth for females, which are not available in the U.S. Census.

[13]In Section 8, we allow for fertility differences by type (education) of households.

provides us with a measure of lifetime childlessness. Then we calculate the fraction of all single women above age 25 with a total number of two live births who were below age 30 at their last birth. This fraction gives us those who are early child bearers, and the remaining fraction of assigned as late child bearers. The resulting distribution is shown in Table A5.

We follow a similar procedure for married couples, combining data from the CPS June Supplement and the U.S. Census. For childlessness, we use the larger sample from the U.S. Census.[14] The Census does not provide data on total number of live births but the total number of children in the household is available. Therefore, as a measure of childlessness we use the fraction of married couples between ages 35-39 who have no children at home.[15] Then, using the CPS June supplement we look at all couples above age 25 in which the female had a total of two live births and was below age 30 at her last birth. This gives us the fraction of couples who are early child bearers, with the remaining married couples labeled as the late ones. Table A6 shows the resulting distributions.

Childcare Costs We use the U.S. Bureau of Census data from the Survey of Income and Program Participation (SIPP) to calibrate childcare costs we use.[16] The total yearly cost for employed mothers, who have children between 0 and 5 and who make childcare payments, was about \$6,414.5 in 2005. This is about 10% of average household income in 2005, which we take as the total child care cost of two children. The Census estimate of total childcare costs for children between 5 and 14 is about \$4,851, which amounts to about 7.7% of average household income in 2005. We set $d(1) = d_1$ and $d(2) = d(3) = d_2$ and select d_1 and d_2 so that families with childcare expenditures spend about 10% and 7.7% of average household income for young (0-5) and older (5-14) children, respectively.[17]

Childcare Subsidies We assume that the childcare subsidies in the model economy reflect the childcare subsidies provided by the Children Child Care and Development Fund (CCDF)

[14]The CPS June Supplement is not particularly useful for the calculation of childlessness in married couples. The sample size is too small for some married household types for the calculation of the fraction of married females, aged 40-44, with no live births.

[15]Since we use children at home as a proxy for childlessness, we use age 35-39 rather than 40-44. Using ages 40-44 generates more childlessness among less educated people. This is counterfactual, and simply results from the fact that less educated people are more likely to have kids younger, and hence these kids are less likely to be at home when their parents are between ages 40-44.

[16]See Table 6 in http://www.census.gov/population/www/socdemo/child/tables-2006.html

[17]In Section 6, we allow for differential child care costs by education and let more educated household spend more on child care.

in the US. In 2010, abut 1.7 million children (ages 0-13) were served by CCDF. This is about 5.5% of all children (ages 0-13) in the US. In 2010, average household income of households that received childcare subsidy was about $19,000. About 74% of families who receive childcare subsidies from CCDF made co-payments were about 6% of family income. If we take $19,000 as average income of subsidy receivers, this amounts to a co-payment of 1,140 dollars per year. In 2010, the average monthly payment for childcare providers (including the co-payment by the families) was about $400 per month or $4,800 a year. Hence about 24% of total payments $(1,140/4,800)$ came from family, while the remaining 76% was a subsidy. In our calibration we simply set $\theta = 0.75$ and set $\widehat{I}$ such that the poorest 5.5% of families with children receive a subsidy from the government. This procedure set $\widehat{I}$ at about 21% of mean household income in the benchmark economy.

Preferences and Technology There are three utility functions parameters to be determined: the intertemporal elasticity of labor supply (γ), the parameter governing the disutility of market work (φ), and fixed time cost of young children ($\varkappa$). We set γ to 0.4. This value is contained in the range of recent estimates by Domeij and Floden (2006, Table 5). Given γ, we select the parameter φ to reproduce average market hours per worker observed in the data, about 40.1% of available time in 2008.[18] We set $\varkappa = 0.076$ to match the labor force participation of married females with young, 0 to 5 years old, children. From the 2008 U.S. Census, we calculate the labor force participation of females between ages 25 to 39 who have two children and whose oldest child is less than 5 as 62.2%. We select the fixed cost such that the labor force participation of married females with children less than 5 years (i.e. early child bearers between ages 25 and 29 and late child bearers between ages 30 and 34), has the same value. Finally, we choose the discount factor β, so that the steady-state capital to output ratio matches the value in the data consistent with our choice of the technology parameters (2.93 in annual terms).

Utility costs associated to joint work allows to capture the *residual* heterogeneity among couples, beyond heterogeneity in endowments and childbearing status, that is needed to account for the observed heterogeneity in participation choices. We assume that the utility cost

[18]The numbers are for people between ages 25 and 54 and are based on data from the Census. We find mean yearly hours worked by all males and females by multiplying usual hours worked in a week and number of weeks worked. We assume that each person has an available time of 5000 hours per year. Our target for hours corresponds to 2005 hours in the year 2003.

parameter of joint participation is distributed according to a (flexible) gamma distribution, with parameters k_z and θ_z. Thus, conditional on the husband's type z,

$$q \sim \zeta(q|z) \equiv q^{k_z - 1} \frac{\exp(-q/\theta_z)}{\Gamma(k_z)\theta_z^{k_z}},$$

where $\Gamma(.)$ is the Gamma function, which we approximate on a discrete grid. This procedure allows us to exploit the information contained in the *differences* in the labor force participation of married females as their own wage rate differ with education (for a given husband type). In this way we control the slope of the distribution of utility costs, which is potentially key in assessing the effects of changing incentives for labor force participation.

Using Census data, we calculate that the employment-population ratio of married females between ages 25 and 54, for each of the educational categories defined earlier.[19] Table A7 shows the resulting distribution of the labor force participation of married females by the productivities of husbands and wives for married households. The aggregate labor force participation for this group is 72.2%, and it increases from 61.8% for the lowest education group to 81.9% for the highest. Our strategy is then to select the two parameters governing the gamma distribution, for every husband type, so as to reproduce each of the rows (five entries) in Table A7 as closely as possible. This process requires estimating 10 parameters (i.e. a pair (θ, k) for each husband educational category).

Finally, we specify the production function as Cobb-Douglas, and calibrate the capital share and the depreciation rate using a notion of capital that includes fixed private capital, land, inventories and consumer durables. For the period 1960-2000, the resulting capital to output ratio averages 2.93 at the annual level. The capital share equals 0.343 and the (annual) depreciation rate amounts to 0.055.[20]

5 The Benchmark Economy

Table 1 summarizes our parameter choices. Table 2 illustrates the performance of the model in terms of data. We briefly comment below on how the model performs in terms of variables that are pertinent for the main questions of this paper.

[19]We consider all individuals who are *not* in armed forces.

[20]We estimate the capital share and the capital to output ratio following the standard methodology; see Cooley and Prescott (1995). The data for capital and land are from Bureau of Economic Analysis (Fixed Asset Account Tables) and Bureau of Labor Statistics (Multifactor Productivity Program Data).

As Table 2 shows, the model reproduces quite well the facts for labor-force participation rates. The table shows that in the model, participation rates for married females by skill rise from about 51.8% for less than high school females, to about 80.6% for those with more than college education. In the data, participation rates rise from 46.4% to 81.9%, respectively. Likewise, as the data indicates, the model generates the large differences in participation rates – not directly targeted – by the presence of children.

Figures 1 and 2 show model's performance for other two statistics that are not directly targeted in the calibration. As Figure 1 illustrates, the model does an excellent job capturing the life-cycle pattern of married female labor force participation. There is a slight decrease in married female labor force participation between ages 25-30 to 30-35, both in the data and the model economy, reflecting the effect of children on married female labor supply. Between ages 25 to 55, the labor force participation has the typical hump-shape. Overall, this conformity of model with data in terms of participation rates is important as childcare subsidies are expected to have substantial effects on this variable.

Figure 2 shows the gender wage gap in the model and data, defined as the ratio of female hourly wages to male hourly wages. By construction, our calibration matches the gender gap at first model period, ages 25-30. Afterwards, the gender wage gap evolve endogenously as married females decide whether to work or not and their wages change accordingly. In particular, as a female decide not to participate in the labor market to save on child care costs and to avoid the utility cost associated with joint work, their human capital depreciates and the gender wage gap grows with age. While the gender wage gap is about 85% for ages 25-30, it increases to 70% by ages 50-55.

Our model economy is also in close conformity with estimates of the elasticity of labor force participation with respect to changes in the cost of childcare – a natural statistic given the aim of the paper. There is a wide array of estimates for this elasticity that suggest large responses in terms of female labor-force participation associated to childcare subsidies. Blau and Currie (2006) survey multiple studies, and argue for a range of elasticity estimates between -0.1 and -0.2. Our model implies an elasticity within this range: -0.15. In addition and in consistency with the evidence surveyed by these authors, our model also implies that poorer households and those with young children respond more to changes in the price of childcare than their counterparts.

6 Findings: The Expansion of Childcare Subsidies

We report in this section the steady-state effects of our quantitative experiments. Our experiments are conducted under the assumption of a small-open economy, where the rate of return on capital and thus, the wage rate, are unchanged across steady states. Changes in the subsidy scheme are revenue neutral, and are financed via a proportional flat-rate income tax, applied to all households. The regular income tax system, the payroll tax, and the additional capital income tax do *not* change with respect to the benchmark economy.

We conduct exercises via changes in eligibility into the subsidy scheme (i.e. changing $\widehat{I}$) and/or via variation in the subsidy rate (i.e. changing θ). Given the benchmark values of $\widehat{I}$, 21% of mean household income, and θ, 75%, we consider eligibility levels of 50% and 100% of mean household income and when all households with children are eligible (i.e. $\widehat{I}$ arbitrarily large), and subsidy rates of 50%, 75% and 100%. Results are in Tables 3, 4 and 5.

Relaxing Eligibility Relaxing *eligibility* constraints has substantial consequences on certain aggregates. Under the benchmark subsidy rate (75%), increasing the threshold $\widehat{I}$ from the benchmark value (21% of mean household income) to 50% and 100% of mean household income and then to an arbitrarily large value so that all households are eligible increases the participation rate of married females by 2.3%, 6.2% and 8.3%, respectively. Concomitant with the effects on female labor supply, the labor supply of males reacts *negatively* to the expansion of the subsidies. For instance, when all households are eligible and the subsidy rate is at the benchmark value of 75%, hours worked by men drop by 1.2%.

The effects on aggregate work hours are negligible at a threshold of about one-half mean household income, but become positive when the threshold equals mean household income, and amount to about 1% when all households are eligible. Changes in output across steady states are *negative* for low levels of the two lowest levels of eligibility, but become slightly positive when all households are eligible.[21] In understanding these findings is worth keeping in mind that, upon an expansion in the scope of childcare subsidies, (i) the long-run tax rate increases to pay for them, (ii) married households reallocate labor from males to females,

[21]The measure of output that we report pertains to output for consumption and investment, and does *not* include the value of childcare services.

and (iii) females with children working prior to the expansion of subsidies choose to reduce their hours. In addition, in some households, labor supply and intertemporal asset choices adjust in order to have access to the subsidies (i.e. not to lose them). Given the relatively small magnitude of additional tax rates, which amount 1.3% when all households are eligible, the second and third effects appear of quantitative importance. Childcare subsidies act as a positive income effect on married males and some households, which in turn leads to a reduction in their labor supply. This naturally explains why, despite the large changes in participation rates and hours of married females, total hours worked and output react much less, and even in negative ways.

Changing Subsidy Rates The effects driven by changes in the subsidy rate for given levels of eligibility are also substantial, and in line with the effects associated to relaxing eligibility. For instance, for an eligibility level of mean household income, subsidy rates of 50%, 75% and 100% imply changes in participation rates of 4.0%, 6.2% and 7.6%, respectively, relative to the benchmark case. Similarly, when subsidies are universal, increasing the subsidy rate from 50% to 100% implies an increase in participation rates of about 4.3%. In this latter case, total hours worked are essentially *constant* despite the doubling of the subsidy rate. This reflects the consequences of childcare subsidies mentioned earlier: the reallocation of hours from males to females in some households, and the reduction of hours worked by females with children who worked in the benchmark economy.

Summing up, the changes induced by the large-scale subsidy program that we consider on female labor supply are rather large. Placing our findings in some perspective, in related work and using this framework (Guner et al, 2012-a), we found that fully replacing the income tax schedule by a proportional income tax leads to steady-state changes in participation rates of about 5.1% in an open economy. As Table 3 demonstrates, this about *half* of the effect that we find when all households are eligible and childcare subsidies are fully subsidized. Unlike the case of a tax reform, however, these effects are mitigated by the reallocation of hours from males to females in married households and by the overall reduction in hours worked by females along the intensive margin. As a result, the overall effects on aggregate hours and output are relative minor.

The Aggregate Magnitude of Subsidies Tables 3 and 4 show that expanding the scope of the subsidy program leads to rather large changes in its size. In the benchmark economy, childcare subsidies are minuscule and amount to 0.08% of output (very close to the actual size of nearly 0.1% of GDP). But as eligibility changes – or the subsidy rate increases – the size of the subsidy program increases sharply and becomes of macroeconomic significance. When the threshold level is at one mean income, the subsidy program can cost up to 1.2% of output; when all households are eligible, the program can amount to about 1.6% of output, requiring a tax rate on all incomes of 1.8% to support it. As the child care subsidy program becomes more generous, the characteristics of households that receive any subsidy change as well. In the benchmark economy all recipients are single mothers (about 80% of them are single mothers in the data) and their average income is about 19% of mean household income (it is about 27% in the data). When all household are eligible for a 100% subsidy, only 19.5% of recipients are single mothers and the average household income of recipients is higher than the mean household income in the economy.

Who Increases Participation? Table 6 shows changes in labor force participation of married females relative to the benchmark economy, for women with different education levels and by child-bearing status. The table also shows that the effects of more generous subsidies on women with different education levels is not uniform. Not surprisingly, changes are greater for women with less education, with percentage changes that monotonically decline as the level of education increases. In the extreme case when all households are eligible and the subsidy rate is 100%, women with less than high school education increase their participation rate by about 32%, whereas the increase for those with more than college education is of about 3.6%. Childcare costs constitute a significant fraction of household income for households with less skilled women and as a result, these households benefit the most from the subsidy. Furthermore, their labor force participation is lower to start with (Table A7) and therefore, there is ample room for them to increase their participation.

Similar findings hold for married women according to child-bearing status. Women with children arriving earlier in their life cycle increase their participation rates *more* than those with children late. This is not surprising and in line with the previous discussion. Women in households with early childbearing are disproportionately less skilled, whereas the opposite is true for women in households with late childbearing.

Effects on the Wage-Gender Gap A key feature of our model economy is that human capital levels for females and as a result, the gender wage gap, is endogenous. As generous subsidies lead to greater labor force participation by married females, they reduce the loses of human capital due to labor market disruptions caused by childbearing. Thus, more generous subsidies lower the gender gap. Figure 3 shows how the gender gap changes along the life cycle for the case of a childcare subsidy of 100% when all households are eligible, for the special groups of women with high school (HS) and some college education (SC). As Figure 3 shows, those with higher education experience lower gender gaps, both in the benchmark economy as well as with more generous subsidies, as they are more likely to participate in the labor market. As a result, their human capital depreciates less. For both groups (indeed for all education groups), the gender gap increases along the life-cycle as women stay out of labor force (due to childbearing and associated costs), and their human capital depreciates. Finally, a more generous subsidy has a positive and non-trivial effect on the gender gap. By age 55, more generous subsidies lower the gender gap for women with high school (some college) education by about 6.3% (4.4%) points.

7 Welfare

We now turn our attention to the implied welfare effects associated to the expansion of childcare subsidies. For these purposes, we compute the transitional dynamics between steady states implied by the policy change under consideration, when the policy change is unanticipated at, say, $t = t_0$. Our notion of welfare is standard; we calculate consumption compensations, or the common, percentage change in consumption in all future dates that leaves a household indifferent between the status quo and the new transitional path. We balance the budget in each period via the additional flat-rate income tax applied to all households.

Newborn Households We first discuss in detail who wins and who loses with the introduction of childcare subsidies. We summarize key results in Table 6, where we focus on newborn households at the date of the policy change, taking into account transitional dynamics between steady states. The table shows findings for single females and married households, where for the former group we separate findings by childbearing status and by educational type. For married households, we show welfare effects by childbearing status only, by aggregating across the educational types of spouses.[22] The table also shows the welfare effects for *all* newborn households at $t = t_0$.

Overall, our findings in Table 6 show that newborn households, as a group, experience substantial welfare gains associated to the expansion of childcare subsidies. These gains range from 0.5% when the subsidy rate is 50% and only those with incomes below mean household income are eligible, to 1.9% when all households are eligible at a 100% subsidy rate. The welfare effects on different types of households, however, are not uniform. Single females who have children early in the life cycle gain more than those who tend to have their children late. This naturally follows from the fact that the early childbearing group contains a disproportionate fraction of less skilled females. Hence, childcare subsidies are highly valuable for these females and thus, their expansion leads to higher welfare gains. Conversely, the expansion of childcare subsidies leads to welfare losses for single females with no children. As single men, they obtain no benefits from the expansion of the subsidy scheme. This pattern is also repeated for married households according to childcare status. With a universal subsidy, the welfare gain for a newborn married households with children early (late) in the life cycle amounts to 4.9% (2.2%), while the welfare cost for married households without children is of about 4.8% of consumption. The welfare gains for single mothers with children early (late) in the life cycle are even greater: 10.1% (7.6%). The gains are particularly large for less educated households as child care expenditures constitute a large burden in those cases. Welfare gains for newborns with less than high school education amount to 6.3% while it is only 1.8% for those with more than college education. Interestingly, the highest welfare gains are enjoyed with those with some college education (6.6%), as they are more likely to work and use childcare subsidies than less educated households.

In Table 7, we show disaggregated findings for married households by skill types for the case of universal subsidies at a 100% subsidy rate. As the table demonstrates, married households in the upper-left corner of the table gain, and substantially so. This is in line with our discussion so far, as these households are comprised by members with low or middle skills. The table also shows that for a fixed male type, increasing the female type tends to lead to a mild hump-shaped profile of welfare gains; i.e. those with middle skills gain most.

[22]For simplicity of exposition, we do not show results for single men, who uniformly *lose* with the introduction of the chilcare subsidy policies.

This follows as females with middle skills participate more than their low-skill counterparts to begin with. In addition, and in contrast with females with higher skill types, childcare expenditures constitute a significant expense for them. Conversely, for a fixed female type, increasing the male type leads to a generic decline in welfare gains. This is not surprising: as the male type increases, (i) households benefit less and less from an expansion of subsidies to cover childcare expenditures (a fixed amount) and, (ii) the incentives for the labor-market participation of females decline.

It is worth mentioning that the expansion of the subsidies can lead to welfare losses amongst less skilled females in certain cases. What accounts for this? Consider the case of a low subsidy rate at 50%. Single females with less than HS education see no direct benefit from the expansion in eligibility as most of them already qualified for subsidies in the benchmark economy. However, the subsidy rate is *lower* than in the benchmark economy and thus, they lose from the policy change. As their educational type increases, gains increase and then diminish as childcare expenditures become less important. Hence, when the subsidy rate is at 100% (above the benchmark value), welfare gains are always positive and decline monotonically with the educational type.

All Together Now We now turn our attention to the welfare consequences on all households alive at date $t = t_0$. The top panel of Table 8 shows the welfare consequences (consumption compensation) for households of different age groups (across all educational types, childbearing and marital status), as well as for *all* households alive as a group. The results show *sharp* differences between groups in terms of the welfare impact of childcare subsidies. Younger households as a group win whereas older households lose. For instance, in the extreme case when all households are eligible and childcare is fully subsidized, the consumption compensation decreases monotonically from 1.9% for newborns (aged 25-29), to -2.4% for those aged 50-54. Furthermore, this asymmetry in welfare gains is magnified as childcare subsidies become more generous, either by expanding eligibility or by increasing subsidy rates.

These results are naturally driven by the fact that at the time of the policy change, younger households are net beneficiaries as childcare expenditures are concentrated at young ages. As age groups become older, childcare expenditures become less important for those alive at the date of the introduction of the policy, while higher taxes affect all households.

Hence, welfare gains become lower with the group age and eventually become negative.

Aggregate welfare gains in Table 8 are *negative*. This is not surprising given the fact that only few households at $t = t_0$ benefit from the policy change – less than 16%. The results in the table also indicate that newborn individuals strictly prefer to be born in a steady state with childcare subsidies, and that the gains are substantial, of up to 1.9% of consumption. However, as we discussed above, within the narrowly defined group of newborns, there are naturally winners and losers. As Table 8 shows, a central finding is that there are subsidy schemes for which a majority of newborn individuals benefit from the policy change; when subsidies are universal at a 100% subsidy rate, about 53% of newborns benefit from the introduction of childcare subsidies.

8 Discussion and Robustness

We now attempt to place our findings in perspective and provide robustness checks. To this end, we provide below some calculations to highlight the importance of aspects of the data and our environment that are key for our results. We quantify the role of endogenous female skills and the importance of the reallocation of labor hours from men to females within married couples for our findings. We also investigate the extent to which aspects of the data that we abstracted from in the benchmark model are important for our analysis. In particular, we investigate the role of (i) differences in the number of children per household, and (ii) heterogeneity in childcare expenditures across households. For ease of exposition, in all cases we report results for the case of universal subsidies under a 100% subsidy rate.

8.1 How Important is the Endogeneity of Female Skills?

A novel aspect our analysis is the explicit consideration of the depreciation of female skills due to non participation. How important is this channel quantitatively? To answer this question, we shut down the endogenous skill channel, and study the expansion of child care subsidies in an economy in which each married female type has exogenously the *same* skill profile that she had in the benchmark economy. Hence, her skills do not change if she chooses to change her participation decision in response to the policy change.

We summarize our findings in Table 9. Without the endogenous changes in skills, the labor supply by married females increases less than it does in the baseline experiments. With a 100% subsidy, the participation rate of married females increases by 8.3% for the case of exogenous skills, whereas it increases by about 10.1% when the endogenous skill channel is operative. The increase in total hours is of about 0.5%, whereas the increase is of about 1% in the baseline policy experiment. Hence, nearly one fifth of the increase in married female labor force participation, and about half of the changes in total hours, are associated to the concomitant changes of females skills. Overall, with lower labor supply responses in response to the expansion of childcare subsidies, aggregate output shows a *decline* across steady states, rather than an increase as in the baseline experiments.

8.2 How Important is the Reallocation of Hours Within Couples?

As we have discussed earlier, child care subsidies generate a reallocation of hours worked in married couples, from males to females. This reallocation is arguably important: males are on average more skilled than females and in our baseline experiments, per-worker hours of males drop by about 1.5% under universal subsidies at a 100% rate.

In order to quantify the importance of these reallocation, we compute stationary equilibria when we expand childcare subsidies while keeping the labor supply decisions of married males at their benchmark values. Table 9 shows the results under universal subsidies at a 100% rate. With labor supply decisions of married males fixed, households find optimal *not* to increase married female labor supply as much as they do in the benchmark economy. As a result, their labor force participation and hours increase less with more generous childcare subsidies than in our baseline experiments. The participation rate increases by about 8.6% in this case, versus an increase of about 10.1% in the baseline experiment. Given that the labor supply of males is fixed and that they are on average more skilled than females, total output increases much more with the expansion of subsidies. Now the increase in output amounts to about 1.6% – it is just 0.3% in the baseline experiments.

We conclude that the reallocation of hours within married couples in response to the expansion of subsidies is an important mechanism underlying our findings. Quantitatively, the ability of households to substitute work hours from men to women is central for the aggregate implications of such expansion.

8.3 The Role of Fertility Differences

In the benchmark economy, we assume that conditional on having children, each household has two of them. In this section, we relax this assumption and allow for differential fertility. Table A8 shows how lifetime fertility, conditional on having a child, differs by the education for single and married households.[23] The differences in fertility are non trivial. For instance, Table A8 shows that single females with more than college education have about 1.6 children on average, while their counterparts with less than high school education have 2.7 children. Equivalent fertility differences are present for married couples, albeit they tend to be smaller in magnitude.

To evaluate the role of fertility differences, we proceed as follows. Let $k(x)$ and $k(x, z)$ denote the number of children that a single female of type-x and a married couple of type (x, z) have. Then, the total cost of child care for a single female and married couple household with age-s children is given by $wk(x)d(s)\chi(l)$ and $wk(x, z)d(s)\chi(l)$, respectively. Our calibration strategy is to find, given $k(x)$ and $k(x, z)$, $d(s)$ values so that on aggregate households spend about 10% and 7.7% of average household income on young and old children, as they did the benchmark economy.[24]

Tables 10 and 11 show the aggregate and welfare effects of an expansion of child care subsidies in this economy. We note first that the effects on married female labor force participation and output are very close to what we obtain in the benchmark economy. This results from two opposing effects. On the one hand, less educated females, who have more children, receive larger subsidies and their labor supply is more sensitive to the cost of childcare. Hence, their response is stronger than in the baseline exercises, as the table shows. On the other hand, the opposite is true for more educated females, who now have lower fertility and as a result receive less childcare subsides. Second, welfare gains from more generous subsidies are now higher for less educated females, who have more children, and are lower for more educated females, who have less children. On aggregate, newborns still gain from childcare subsidies; welfare gains amount to 1.6%, which are similar to the gains

[23]The table shows children ever born for single and married females of different types. We use the 2008 CPS June Supplement that provides detailed fertility statistics. As a measure of completed fertility, the children ever born by ages 40-44 are reported.

[24]The economy with fertility differences is recalibrated to match the targets in Table 2. The resulting $d(1)$ and $d(2)$ values are 0.029 and 0.022, respectively. As these are per child expenditures, they are lower than values reported in Table 1.

in the baseline experiments.

We conclude that the effects on aggregates are quite similar to those in the baseline experiments. Differences in fertility, however, *magnify* the asymmetries in terms of participation responses and welfare that we found earlier.

8.4 The Role of Heterogeneity in Childcare Expenditures

In the benchmark economy we assume that different households, independent of their education levels, face the same child care costs. We now allow for differences in child care costs, as more educated households spend more on child care than less educated households in the data, possibly reflecting differences in childcare quality. Table A9 shows how child care expenditures differ by education of females in single female and married couple households. Given data limitations, we condition married couples' child care expenditure only on wives' education.[25] The table shows non-trivial heterogeneity in expenditures. We note that for children under age 5, a single female with more than college education spends almost twice as much than a single female with less than high school education. Similar figures hold for couples in which both members have more than college education.

Let $d(s, x)$ and $d(s, x, z)$ be the childcare costs for a single female of type-x and a married couple of type-(x, z), respectively. Then, the total cost of child care for a single female and married couple household with age-s children is given by $wd(s, x)\chi(l)$ and $wd(s, x, z)\chi(l)$, respectively. Our strategy is to choose $d(s, x_1)$ for a single female with less than high school education and set all other child care costs according to Table A9 to ensure on average households spend again about 10% and 7.7% of average household income on young and old children.[26] The results, shown in Tables 10 and 11, are conceptually the opposite of what we get from differences in fertility. While on average married female labor force participation goes up by about 10% point as in benchmark calibration, now less educated females, who spend less on child care react *less* to more generous child care subsidies while more educated females who spend more react more. More educated households now gain more from more

[25] Table A9 reports average weekly child care expenditures for households between ages 25-44. The data comes from the 2004 SIPP Panel, Wave 4, 4th reference month (January 2005 to April 2005). All the income and demographics were extracted from the core files, while the data related to childcare expenditure comes from the Childcare Topical Module. We restrict the sample to households in which mothers are employed in all months.

[26] The economy with child care cost differences is also recalibrated to match the targets in Table 2. The resulting $d(1, x_1)$ and $d(2, x_1)$ values are 0.04 and 0.036, respectively.

generous subsidies as they are the ones who spend more on child care. On average, newborn households gain slightly more than they did in the benchmark economy; their welfare gain is 2.0% (versus 1.9%) with a 100% subsidy.

As in the previous case, we conclude that the effects on aggregates are similar to those in the baseline experiments. In this case, differences in childcare expenditures *reduce* the asymmetries in terms of participation responses and welfare that we found in the baseline experiments.

9 Concluding Remarks

We evaluate the macroeconomic implications of childcare subsidies in a life-cycle model with heterogeneous married and single households, costly childbearing and with an extensive margin in labor supply for married females. We find that an expansion of current subsidy arrangements can have substantial effects on observables such as participation rates and hours worked across steady state equilibria. When childcare subsidies are universal, subsidizing childcare services at a 50% rate leads to an increase in the participation rate of married females of about 5.8%, and to an increase in aggregate hours of about 0.9%. When access to childcare subsidies is universal at a 100% rate, participation rates increase by 10.1% and aggregate hours by 1%. However, subsidies lead to a large reallocation of hours worked from males to females; when subsidies are universal and fully subsidized, hours worked by males drop by 1.5%. Output changes, as a result, are small and of about 0.3%. Indeed, when the reallocation of hours worked from males to females in married households is shut down, output changes are much larger across steady states – about 1.6% – reassuring the finding that the reallocation of hours of work within households is of quantitative importance.

We find large asymmetries in terms of welfare. On the one hand, childcare subsidies lead to subtantial gains for some households and for newborn households as a group, at the date when the childcare subsidy scheme is expanded. In addition, we find that there are subsidy schemes that are supported by a majority of individuals at birth. On the other hand, we find that childcare subsidies do *not* lead to welfare gains under an utilitarian welfare criterion, taking into account transitions between steady states. Key for these findings is the simple fact that childcare subsidies benefit relatively few households, and that costs (i.e. additional taxes) have to be paid by all.

Our benchmark analysis abstracts from fertility differences across households, as well as possible differences in child care quality that different households might choose. When we introduce these extensions into our model, the basic message remains the same: child care subsidies have rather substantial and similar effects on married female labor force participation, their consequences on aggregate output are small, and there are large differences in welfare gains across newborn households.

We close the paper by commenting on issues related to childcare subsidies that would be worthwhile exploring in the future. First, we note that child care subsidies, by altering how much time and resources children receive from their parents, are likely to affect the outcomes of children in the future. In this regard, the available evidence is mixed. Baker, Gruber and Milligan (2008) and Herbst and Tekin (2010) document that child care subsidies can worsen outcomes for children, while Griffen (2012) estimates small but positive effects on children's cognitive skills. Second, we note that we abstract from income risk that households face and as a result, do not capture possible welfare gains that child care subsidies can generate by making household labor supply more flexible. Blundell, Pistaferri and Saporta-Eksten (2012) show that female labor supply plays an important role in insuring households against labor market shocks. Hence, childcare subsidies can improve welfare by facilitating changes in labor supply in response to shocks. We leave this and other extensions for future research.

Table 1: Parameter Values

Parameter	Value	Comments
Population Growth Rate (n)	1.1	U.S. Data
Discount Factor (β)	0.971	Calibrated - matches K/Y
Intertemporal Elasticity (Labor Supply) (γ)	0.4	Literature estimates.
Disutility of Market Work (φ)	8.03	Calibrated - matches hours per worker
Time cost of Children ($\varkappa$)	0.076	Calibrated – matches LFP of married females with young children
Childcare costs for young children (d_1)	0.064	Calibrated - matches childcare expenditure for young (0-5) children
Childcare costs for young children (d_2)	0.049	Calibrated - matches childcare expenditure for old (5-14) children
Childcare subsidy (θ)	75%	U.S. Data
Income threshold ($\widehat{I}$) (as a % of mean household income)	21%	Calibrated
Dep. of human capital, females (δ)	0.02	Literature estimates
Growth of human capital, females (α_j^x)	-	Calibrated
Within group heterogeneity (ε)	0.388	Calibrated
Capital Share (α)	0.343	Calibrated
Depreciation Rate (δ_k)	0.055	Calibrated
Payroll Tax Rate (τ_p)	0.086	U.S. Data
Social Security Income ($p_m^S(z_1)$) (lowest type single male, as a % of average household income)	17%	Calibrated — balances social security budget
Capital Income Tax Rate (τ_k)	0.097	Calibrated - matches corporate tax collections
Distribution of utility costs $\zeta(.\|z)$ (Gamma Distribution)	–	Calibrated - matches LFP by education conditional on husband's type

Note: Entries show parameter values together with a brief explanation on how they are selected – see text for details.

Table 2: Model and Data

Statistic	Data	Model
Capital Output Ratio	2.93	2.94
Labor Hours Per-Worker	0.40	0.40
LFP of Married Females with Young Children (%)	62.6	61.6
Variance of Log Wages (ages 25-29)	0.227	0.227
Households with Children Receiving Subsidy (%)	5.5	6.1
Participation rate of Married Females (%), 25-54	72.2	70.8
Less than High School (<HS)	46.4	51.8
High School (HS)	68.8	65.2
Some College (SC)	74.0	73.7
College (COL)	74.9	76.3
More than College (COL+)	81.9	80.6
Total	72.2	70.8
With Children	68.3	65.2
Without Children	85.9	81.7

Note: Entries summarize the performance of the benchmark model in terms of empirical targets and key aspects of data. Total participation rates, with children and without children are not explicitly targeted.

Table 3: Childcare Experiments

	$\widehat{I}= 0.5I$			$\widehat{I}= I$			All		
	50%	75%	100%	50%	75%	100%	50%	75%	100%
Married Fem. LFP	1.4	2.3	2.9	4.0	6.2	7.6	5.8	8.3	10.1
Total Hours	0.1	0.0	-0.2	0.5	0.5	0.3	0.9	1.1	1.0
Total Hours (MF)	1.1	1.6	1.7	3.0	4.5	5.1	4.7	6.5	7.6
Hours per worker (f)	-0.5	-1.3	-2.1	-1.0	-2.1	-2.8	-1.0	-2.1	-2.6
Hours per worker (m)	-0.2	-0.5	-1.0	-0.7	-1.2	-1.7	-0.7	-1.2	-1.5
Output	-0.3	-0.6	-0.9	-0.3	-0.7	-1.2	0.4	0.3	0.3
Tax Rate	0.2	0.4	0.6	0.6	1.0	1.4	0.8	1.3	1.8

Note: Entries show effects across steady states on selected variables driven by the expansion of the childcare subsidy system. The values for "Tax Rate" correspond the values that are necessary to achieve revenue neutrality. See text for details.

Table 4: Childcare Experiments

	Benchmark	$\widehat{I} = I$		All Eligible	
		50%	100%	50%	100%
Households Receiving Subsidy (%)	5.7	63.1	68.5	100	100
Income of Recipients (% Household Income)	18.9	64.5	68.3	104.1	104.7
Single Mothers Recipients (% total)	100	30.8	28.4	19.5	19.5
Childcare Subsidies (% GDP)	0.08	0.56	1.16	0.82	1.64

Note: Entries show effects across steady states on selected variables driven by the expansion of the subsidy system. See text for details.

Table 5: Effects on Participation by Type

	$\widehat{I} = I$		All	
	50%	100%	50%	100%
Education				
< HS	12.0	29.9	12.8	32.3
HS	9.6	16.0	11.4	17.6
SC	4.2	7.6	5.9	9.6
COL	1.3	2.6	3.4	5.9
COL+	0.2	0.9	2.0	3.6
Child Bearing Status				
Early	6.7	12.6	8.7	15.3
Late	2.2	4.3	4.3	7.2

Note: Entries show effects across steady states on the participation rates of married females of different types driven by the expansion of the subsidy system. See text for details.

Table 6: Welfare Effects (Newborns)

	$\widehat{I}$=I		All	
	50%	100%	50%	100%
Single F				
No Children	-0.8	-1.9	-1.1	-2.4
Early	2.6	10.7	2.2	10.1
Late	2.1	8.2	1.8	7.6
< HS	-3.0	6.8	-3.3	6.3
HS	0.1	6.7	-0.2	6.2
SC	2.4	7.1	2.0	6.6
COL	1.3	3.2	0.9	2.6
COL+	1.3	2.4	1.0	1.8
Married				
No Children	-1.6	-3.7	-2.3	-4.8
Early	2.1	4.8	2.1	4.9
Late	0.6	1.8	0.8	2.2
All Newborns	0.5	1.6	0.5	1.9

Note: Entries show the welfare effects (consumption compensation) driven by the expansion of the subsidy system, for newborns of different marital status, by educational types and childbearing status. Calculations take into account transitions between steady states.

Table 7: Welfare Effects
(Newborn Married Households, Universal Subsidies, 100% Subsidy Rate)

	Females				
Males	<HS	HS	SC	COL	COL+
<HS	1.6	5.0	6.7	6.8	6.1
HS	2.7	4.8	6.2	5.7	5.6
SC	3.0	3.9	4.6	4.0	3.5
COL	0.0	0.7	1.1	0.8	0.7
COL+	-2.9	-2.1	-1.8	-1.3	-1.2

Note: Entries show the welfare effects (consumption compensation) driven by the expansion of the subsidy system for newborns married households. Calculations take into account transitions between steady states.

Table 8: Welfare Effects

	$\widehat{I}$=I		All	
	50%	100%	50%	100%
Age				
25-29	0.5	1.6	0.6	1.9
30-34	0.1	0.4	0.3	1.0
35-39	-0.6	-1.3	-0.5	-0.9
40-44	-1.1	-2.5	-1.3	-2.9
45-49	-1.2	-2.7	-1.6	-3.4
50-54	-1.0	-2.3	-1.4	-2.9
All	-0.5	-0.9	-0.6	-1.0
(%) Winners	10.1	11.5	15.1	15.9
Steady States:				
Newborns	0.5	1.6	0.5	1.9
(%) Winners	35.6	40.4	47.0	52.9

Note: Entries show the welfare effects (consumption compensation) driven by the expansion of the subsidy system, for different age groups and in the aggregate, as well as the aggregate percentage of winners. The entries in the top panel show results taking into account the transition between steady states. The entries in the bottom panel show the corresponding results across steady states.

Table 9: The Role of Endogenous Margins
(Universal Subsidies, 100% Subsidy Rate)

	Baseline Results	Fixed Female Skills	Fixed Male Labor Supply
Married Fem. LFP	10.1	8.3	8.6
Total Hours	1.0	0.5	1.3
Total Hours (MF)	7.6	5.2	5.7
Hours per worker (f)	-2.6	-3.4	-2.6
Output	0.3	-1.1	1.6
Tax Rate	1.8	2.4	1.6
Effects on Participation:			
By Education			
< HS	32.3	27.2	27.1
HS	17.6	15.5	14.5
SC	9.6	8.4	8.7
COL	5.9	4.3	4.8
COL+	3.6	2.3	2.8
By Child Bearing Status			
Early	15.3	12.6	13.4
Late	7.2	6.2	5.7

Note: Entries show effects across steady states on selected variables driven by the expansion of the childcare subsidy system in economies in which human capital accumulation by married females and labor supply decisions by males are fixed at their benchmark values. The results pertain to the case where all households are eligible and full subsidization of childcare expenditures. See text for details.

Table 10: The Role of Fertility and Expenditure Differences
(Universal Subsidies, 100% Subsidy Rate)

	Baseline Results	Fertility Differences	Expenditure Differences
Married Fem. LFP	10.1	9.8	9.8
Total Hours	1.0	1.0	0.9
Total Hours (MF)	7.6	7.3	7.1
Hours per worker (f)	-2.6	-2.6	-2.6
Output	0.3	0.1	0.4
Tax Rate	1.8	1.8	1.7
Effects on Participation:			
By Education			
< HS	32.3	33.5	22.2
HS	17.6	18.5	16.2
SC	9.6	9.5	9.0
COL	5.9	4.8	6.8
COL+	3.6	2.6	5.3
By Child Bearing Status			
Early	15.3	14.9	14.1
Late	7.2	7.0	7.6

Note: Entries show effects across steady states on selected variables driven by the expansion of the childcare subsidy system in economies in which fertility differences or childcare expenditures differences by household types are taken into account in line with data. The results pertain to the case where all households are eligible and full subsidization of childcare expenditures. See text for details.

Table 11: Welfare Effects Across Groups
(Newborns, Universal Subsidies, 100% Subsidy Rate)

	Baseline Results	Fertility Differences	Expenditure Differences
Single F			
No Children	-2.4	-2.5	-2.3
Early	10.1	10.0	11.7
Late	7.6	7.0	9.0
< HS	6.3	14.0	4.3
HS	6.2	6.0	4.7
SC	6.6	5.7	7.5
COL	2.6	1.7	4.9
COL+	1.8	0.5	3.8
Married			
No Children	-4.8	-5.0	-4.7
Early	4.9	4.5	5.3
Late	2.2	1.8	2.5
All	1.9	1.6	2.0

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Data Appendix

We describe below the mapping of the model to data for taxation and social security, and present the tables mentioned in section 4.

Income Taxes To construct income tax functions for married and single individuals, we use our estimates contained in Guner et al (2012-c) of *effective tax rates* as a function of reported income, marital status and children. The underlying data is tax-return, micro-data from Internal Revenue Service for the year 2000 (Statistics of Income Public Use Tax File). For married households, the estimated tax functions correspond to the legal category *married filing jointly*. For singles without children, tax functions correspond to the legal category of *single* households; for singles with children, tax functions correspond to the legal category *head of household*.[27] To estimate the tax functions for a household with children, married or not, the sample is restricted to households in which there are two dependent children for tax purposes.

In Guner et al (2012-c) we posit

$$t(\tilde{y}) = \eta_1 + \eta_2 \log(\tilde{y}),$$

where t is the average tax rate, and the variable $\tilde{y}$ stands for multiples of mean household income in the data. That is, a value of $\tilde{y}$ equal to 2.0 implies an average tax rate corresponding to an actual level of income that is twice the magnitude of mean household income in the data. Given these estimates, we impose these tax functions in our model using the model counterpart of $\tilde{y}$ and mean income. That is, total tax liabilities amount to $t(\tilde{y}) \times \tilde{y} \times$ *mean household income*.

Estimates for η_1 and η_2 are contained in Table A10 for different tax functions we use in our quantitative analysis. Figure A2 displays estimated average and marginal tax rates for different multiples of household income for married and single households with two children. Our estimates imply that a married household at around mean income faces an average tax rate of about 7.3% and marginal tax rate of 14.0%. As a comparison, a single household

[27] We use the 'head of household' category for singles with children, since in practice it is clearly advantageous for most unmarried individuals with dependent children to file under this category. For instance, the standard deduction is larger than for the 'single' category, and a larger portion of income is subject to lower marginal tax rates.

at the half of mean income faces average and marginal tax rates that are 2.9% and 5.7%, respectively. At twice the mean income level, the average and marginal rates for a married household amount to 11.9% and 18.6%, respectively, while a single household at the mean income level has an average tax rate of 4.8% and a marginal tax rate of 7.6%.

Social Security and Capital Taxation We calculate $\tau_p = 0.086$, as the average value of the social security contributions as a fraction of aggregate labor income for 1990-2000 period.[28] Using the 2008 U.S. Census we calculate total Social Security benefits for all single and married households.[29] Tables A11 and A12 show Social Security benefits, normalized by the level corresponding to single males of the lowest type. Given τ_p, the value of the benefit for a single retired male of the lowest type, $p_m^S(x_1)$, is chosen to balance the budget for the social security system. The implied value of $p_m^S(x_1)$ for the benchmark economy is about 18.1% of the average household income in the economy.

We use τ_k to proxy the U.S. corporate income tax. We estimate this tax rate as the one that reproduces the observed level of tax collections out of corporate income taxes after the major reforms of 1986. such tax collections averaged about 1.92% of GDP for 1987-2000 period. Using the technology parameters we calibrate in conjunction with our notion of output (business GDP), we obtain $\tau_k = 0.097$.

[28]The contributions considered are those from the Old Age, Survivors and DI programs. The Data comes from the Social Security Bulletin, Annual Statistical Supplement, 2005, Tables 4.A.3.

[29]Social Security income is all pre-tax income from Social Security pensions, survivors benefits, or permanent disability insurance. Since Social Security payments are reduced for those with earnings, we restrict our sample to those above age 70. For married couples we sum the social security payments of husbands and wives.

Table A1: Initial Productivity Levels, by Type and Gender

	males (z)	females (x)	x/z
< HS	0.511	0.426	0.813
HS	0.668	0.542	0.811
SC	0.728	0.639	0.878
COL	1.039	0.809	0.779
COL+	1.287	1.065	0.828

Note: Entries are the productivity levels of males and females, ages 25-29, using 2008 data from the CPS March Supplement. These levels are constructed as weekly wages for each type –see text for details.

Table A2: Labor Market Productivity Process for Females (α_J^x)

	Types				
Age	<HS	HS	SC	COL	COL+
25-29	0.038	0.114	0.194	0.213	0.254
30-34	0.041	0.086	0.125	0.140	0.157
35-39	0.042	0.063	0.077	0.091	0.095
40-44	0.044	0.044	0.038	0.053	0.048
45-49	0.045	0.027	0.003	0.020	0.007
50-54	0.046	0.012	-0.031	-0.010	-0.033
55-60	0.047	-0.003	-0.069	-0.042	-0.078

Note: Entries are the parameters α_j^x for the process governing labor efficiency units of females over the life cycle – see equation (11). These parameters are the growth rates of male wages.

Table A3: Distribution of Married Working Households by Type

	Females				
Males	<HS	HS	SC	COL	COL+
< HS	5.77	2.35	2.65	.047	0.12
HS	0.19	7.21	7.80	2.31	0.70
SC	1.49	5.34	16.85	6.82	2.38
COL	0.29	1.27	5.41	11.18	4.83
COL+	0.06	0.36	1.54	5.01	5.87

Note: Entries show the fraction of marriages out of the total married pool, by wife and husband educational categories. The data used is from the 2008 U.S. Census, ages 30-39. Entries add up to 100. –see text for details.

Table A4: Fraction of Agents by Type, Gender and Marital Status

	Males			Females		
	All	Married	Singles	All	Married	Singles
< HS	11.72	8.41	3.31	9.77	7.03	2.74
HS	20.30	14.75	5.54	16.98	12.21	4.77
SC	33.37	24.29	9.08	35.48	25.31	10.17
COL	22.51	17.10	5.41	24.17	19.06	5.11
COL+	12.12	9.49	2.63	13.6	10.27	3.33

Note: Entries show the fraction of individuals in each educational category, by marital status, constructed under the assumption of a stationary population structure –see text for details.

Table A5: Childbearing Status, Single Females

	Childless	Early	Late
< HS	27.72	62.04	10.24
HS	26.68	59.95	13.37
SC	32.39	53.38	14.23
COL	53.75	30.50	15.75
COL+	56.17	23.06	20.77

Note: Entries show the distribution of childbearing among single females, using data from the CPS-June supplement. See text for details.

Table A6: Childbearing Status, Married Couples

	Childless					Early					
	Females						Females				
Male	<HS	HS	SC	COL	COL+	male	<HS	HS	SC	COL	COL+
< HS	6.75	8.23	8.60	13.37	15.51	< HS	74.92	67.55	62.64	46.31	18.61
HS	9.04	10.60	8.76	14.76	12.66	HS	70.03	63.33	60.10	43.39	40.98
SC	6.82	10.52	9.53	12.66	13.08	SC	72.49	58.36	60.93	41.10	32.37
COL	3.52	9.36	10.35	11.57	11.24	COL	43.39	56.99	43.17	32.55	21.36
COL+	5.90	10.57	9.55	9.45	13.28	COL+	46.42	52.85	36.36	30.57	15.52

Note: Entries show the distribution of childbearing among married couples. For childlessness, data used is from the U.S. Census. For early childbearing, the data used is from the CPS-June supplement. Values for late childbearing can be obtained residually for each cell. See text for details.

Table A7: Labor Force Participation of Married Females, 25-54

	Females				
Males	<HS	HS	SC	COL	COL+
< HS	44.0	64.8	71.3	76.9	79.2
HS	49.4	70.8	77.2	85.1	90.6
SC	51.7	69.9	75.8	83.5	90.4
COL	47.1	64.0	68.6	73.0	82.9
COL+	42.8	55.4	60.6	62.7	76.7
Total	46.4	68.8	73.9	74.9	81.9

Note: Each entry shows the labor force participation of married females ages 25 to 54, calculated from the 2008 U.S. Census. The outer row shows the weighted average for a fixed male or female type.

Table A8: Fertility Differences

Singles		Married Females					
		Male	<HS	HS	SC	COL	COL+
< HS	2.72	< HS	2.74	2.52	2.27	1.97	2.08
HS	2.19	HS	2.73	2.27	2.15	2.10	1.97
SC	2.00	SC	2.68	2.27	2.23	2.07	1.89
COL	1.84	COL	3.01	2.34	2.27	1.97	1.87
COL+	1.65	COL+	2.22	2.26	2.43	2.18	1.90

Note: Entries show, conditional on having children, the total number of children different types of households have by age 40-44. The authors' calculations from the 2008 CPS-June supplement. See text for details.

Table A9: Child Care Cost Differences by Education

	Young Children			Older Children	
	Single	Married		Single	Married
< HS	1	1.12	< HS	1	0.84
HS	1.20	1.41	HS	1.29	1.27
SC	1.58	1.22	SC	1.57	1.62
COL	1.58	1.55	COL	2.83	1.79
COL+	2.14	1.82	COL+	1.94	2.07

Note: Entries show child care costs for young (0-4 years old) and older (5-14 years old) children, relative to a single female household with less than high school education, for different households. The authors' calculations from SIPP. See text for details.

Table A10: Tax Functions

Estimates	Married (no children)	Married (two children)	Single (no children)	Single (two children)
η_1	0.096	0.073	0.121	0.048
η_2	0.054	0.067	0.035	0.028
St. Errors				
η_1	0.000	0.000	0.000	0.001
η_2	0.000	0.000	0.000	0.001

Note: Entries show the parameter estimates for the postulated tax function. These result from regressing effective average tax rates against household income, using 2000 micro data from the U.S. Internal Revenue Service. For singles with two children, the data used pertains to the 'Head of Household' category – see text for details.

Table A11: Social Security Benefits, Singles

	Males	Females
< HS	1	0.858
HS	1.126	0.999
SC	1.184	1.050
COL	1.274	1.063
COL+	1.282	1.122

Note: Entries show Social Security benefits, normalized by the mean Social Security income of the lowest type male, using data from the 2008 U.S. Census. See text for details.

Table A12: Social Security Benefits, Married Couples

	Females				
Males	<HS	HS	SC	COL	COL+
< HS	1.708	1.873	1.904	1.890	1.911
HS	1.870	1.989	2.042	2.065	2.095
SC	1.887	2.018	2.040	2.101	2.249
COL	1.912	2.140	2.196	2.224	2.321
COL+	2.091	2.149	2.234	2.300	2.365

Note: Entries show the Social Security income, normalized by the Social Security income of the single lowest type male, using data from the 2008 U.S. Census. See text for details.

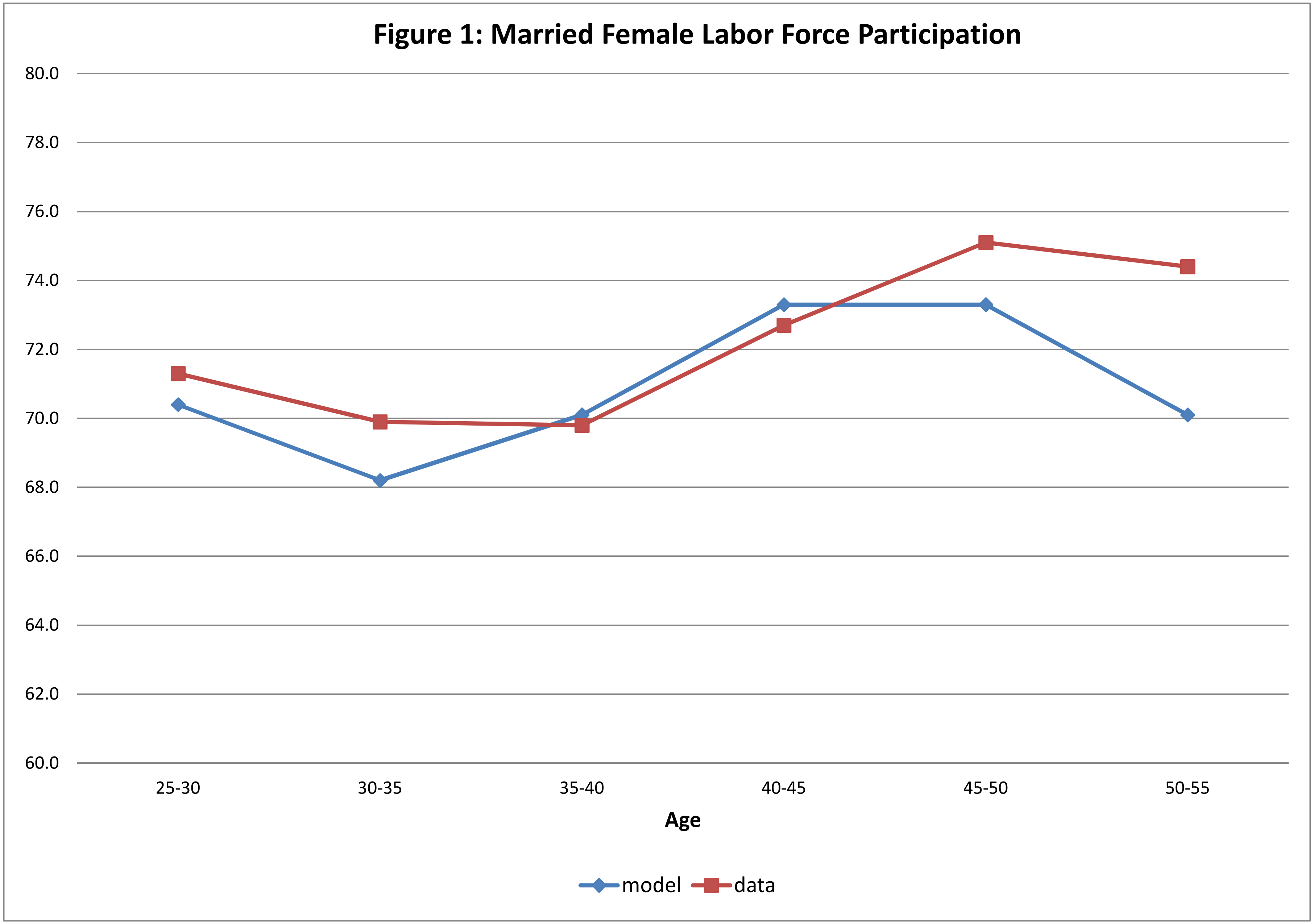
Figure 1: Married Female Labor Force Participation
80.0
78.0
76.0
74.0
72.0
70.0
68.0
66.0
64.0
62.0
60.0
25-30
30-35
35-40
40-45
45-50
50-55
Age
model
data

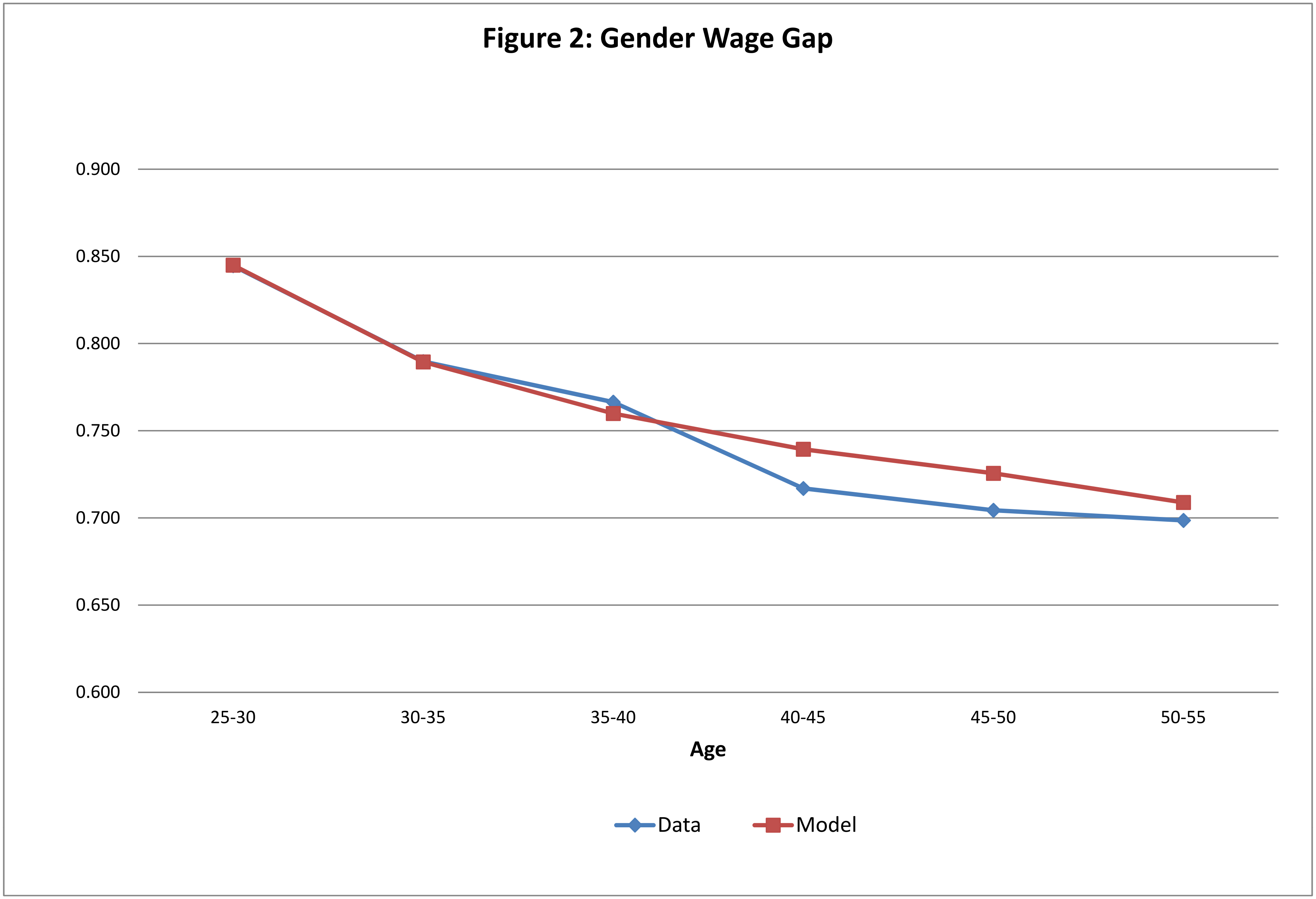
Figure 2: Gender Wage Gap
0.900
0.850
0.800
0.750
0.700
0.650
0.600
25-30
30-35
35-40
40-45
45-50
50-55
Age
Data
Model

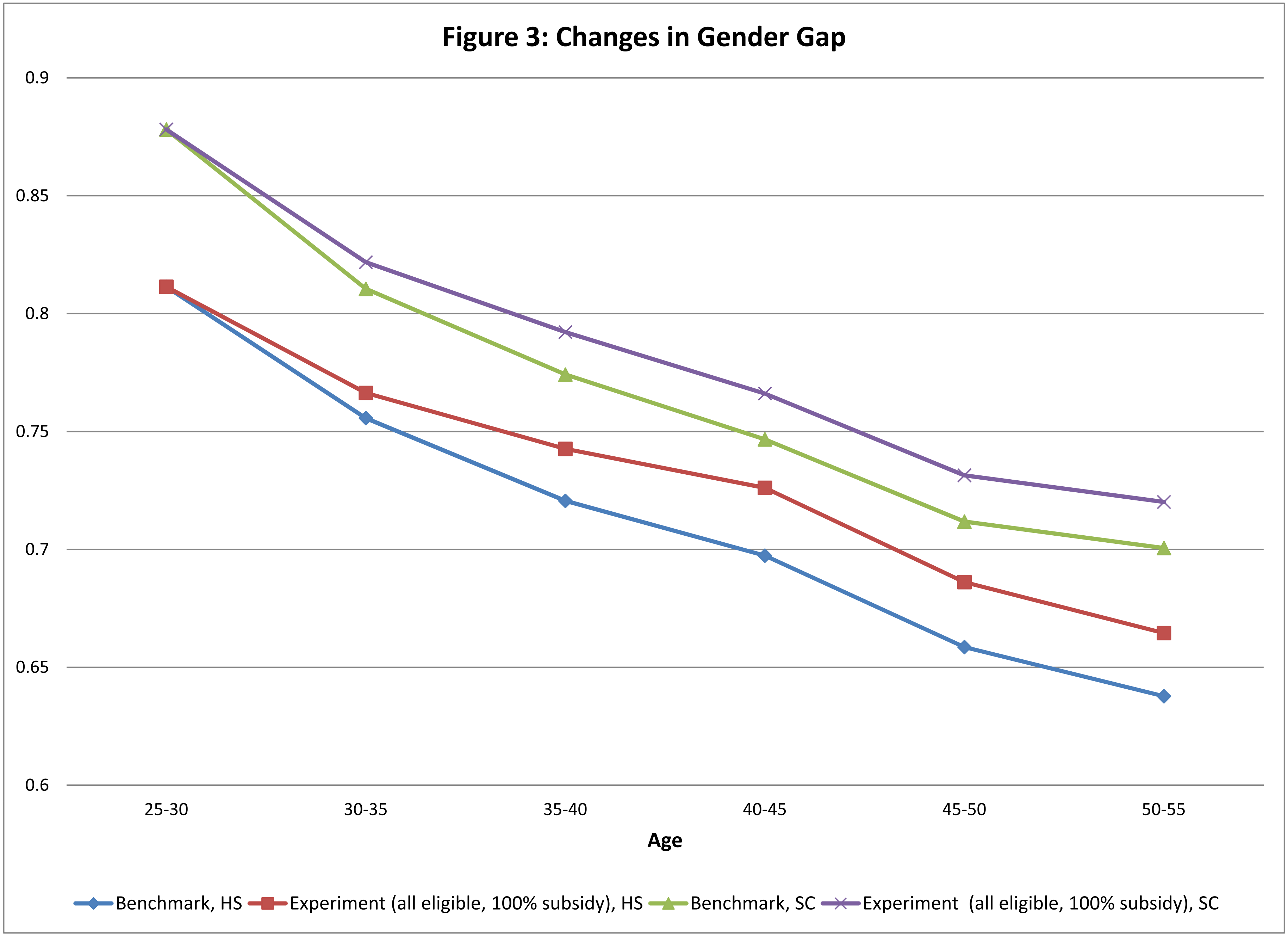

Figure 3: Changes in Gender Gap
0.9
0.85
0.8
0.75
0.7
0.65
0.6
25-30
30-35
35-40
40-45
45-50
50-55
Age
Benchmark, HS
Experiment (all eligible, 100% subsidy), HS
Benchmark, SC
Experiment (all eligible, 100% subsidy), SC

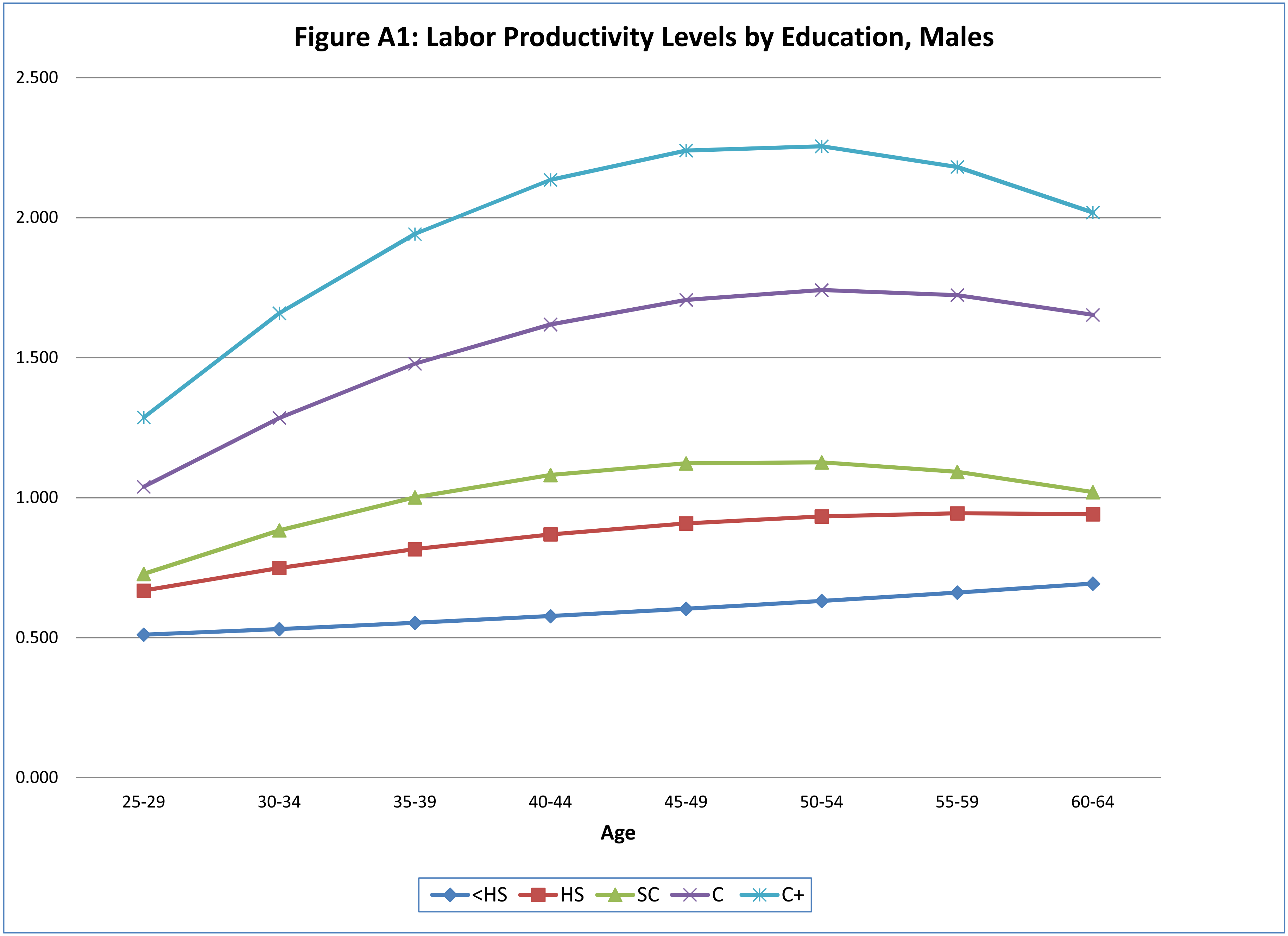
Figure A1: Labor Productivity Levels by Education, Males
2.500
2.000
1.500
1.000
0.500
0.000
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
Age
<HS
HS
SC
C
C+

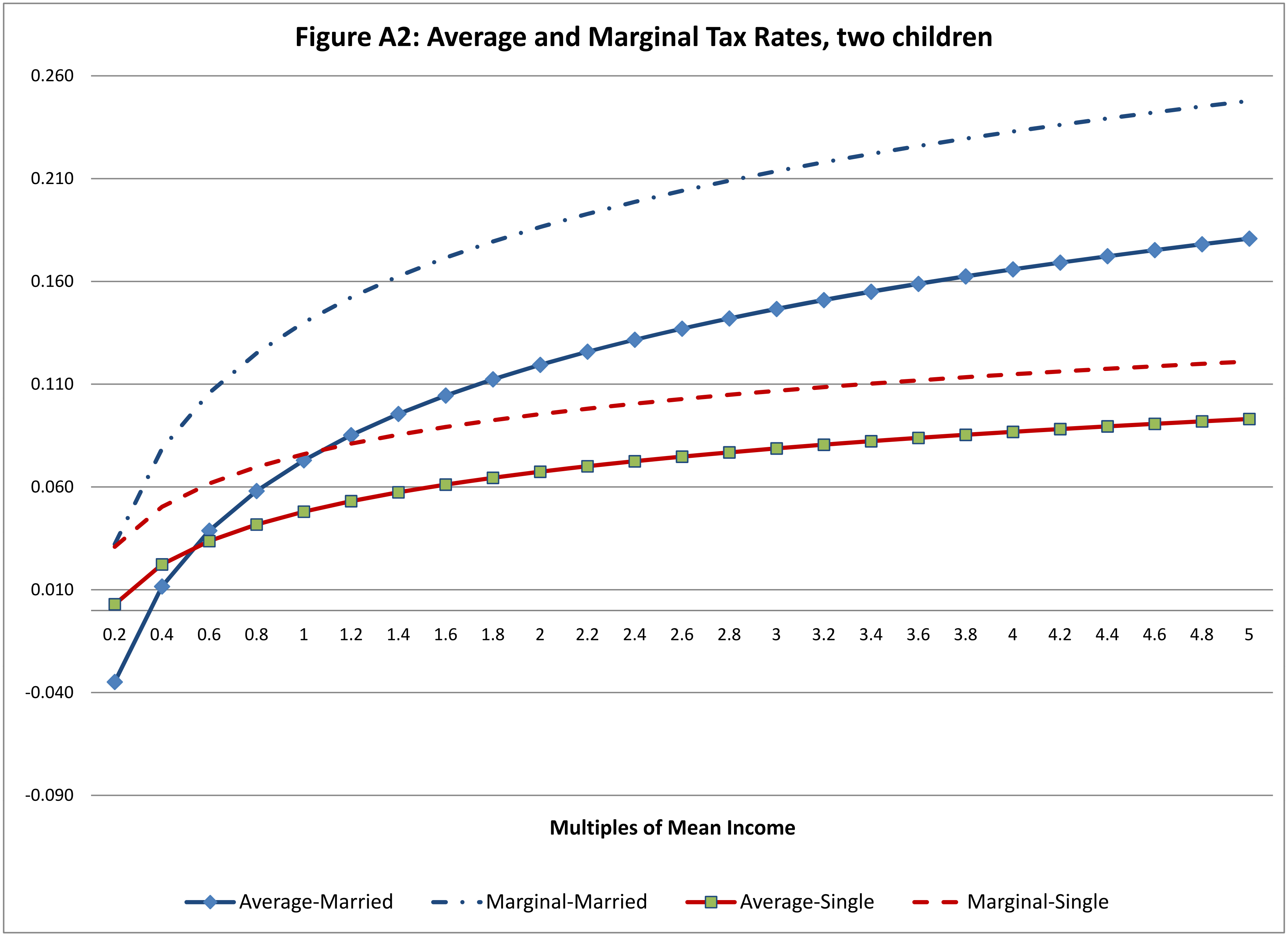
Figure A2: Average and Marginal Tax Rates, two children
0.260
0.210
0.160
0.110
0.060
0.010
-0.040
-0.090
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
2.4
2.6
2.8
3
3.2
3.4
3.6
3.8
4
4.2
4.4
4.6
4.8
5
Multiples of Mean Income
Average-Married
Marginal-Married
Average-Single
Marginal-Single