Childcare Subsidies and Household Labor Supply

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Abstract

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 discipline our model with U.S. observations on the cost of childcare in the presence of existing childcare subsidy programs, as well as with data on gender and skill premia and the labor force participation of married females across skill groups. Our findings indicate that childcare subsidies have substantial effects on female labor supply, and lead to a large reallocation of hours worked, from males to females. Childcare subsidies available to all households lead to long-run increases in total hours worked and labor force participation of married females of about 1.0% and and 10.1%, respectively, and to a decline of male hours of 1.5%. Expansions of current subsidy arrangements are *not* preferred by a majority of households and lead to aggregate welfare losses.

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1 Introduction

This paper is about the macroeconomic 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 arrangements on labor supply and output? What are the resulting consequences on female human capital accumulation 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.[1] 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 tradeoff. Expansions of current arrangements 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 have attributed the high levels of female labor supply in Scandinavia to the scope and magnitude of childcare subsidies there.[2] 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.[3] 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.[4] 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 largely unexplored.

[1] See for instance Attanasio, Low and Sanchez Marcos (2008), Blau (2003) and Tekin (2007), among many others.

[2] For instance, see Rogerson (2007).

[3] See section 2 for a detailed description.

[4] Source: OECD Family Database.

We fill this void in this paper.

We study a dynamic, equilibrium framework with ingredients that are key to the issues at hand. Three of them are central. First, as in Guner, Kaygusuz and Ventura (2012-a, 2012-b), 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 males and females in different households are expected to react differently. 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 arrangements, 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 wage-gender gaps .

We build a life-cycle model populated by heterogeneous single and married agents. 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 human capital depreciates. Married households decide if both or only one members should work, in the presence or absence of (costly) children and the structure of the tax system and childcare subsidies.

There are two types of costs associated to labor force participation in our setup. 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. In addition, if children are young (less than 5 years old), they impose a time cost on the mother regardless on whether she works or not.

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. 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. Given their cost and indirect equilibrium effects, they can have significant welfare consequences.

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 there are *no* eligibility requirements (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 instead there are no eligibility requirements and childcare is *fully* subsidized, participation rates increase by 10.1% and aggregate hours by about 1% across steady states. However, subsidies lead to a large reallocation of hours worked from males to females; when there are no eligibility requirements and childcare is fully subsidized, hours worked by males drop by 1.7%. Output changes, as a result, are relatively small.

We find that expansions of subsidy arrangements do *not* lead to aggregate welfare gains under an utilitarian welfare criterion, taking into account transitions between steady states. In addition, we also find that such expansions are not supported by a majority of households, and that they are consistent with substantial welfare gains *and* losses for different groups. When all households are eligible and childcare is fully subsidized, the aggregate welfare cost amounts to about 1.0%. 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. 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.

Relevant Literature This paper is related to three strands of literature. First, it is naturally related to the empirical literature that studies the effects of childcare prices in general, and childcare subsidies in particular, on female labor supply. Blau and Tekin (2007), Tekin (2007) and Hebst (2010) are examples of papers in this group; all find positive and large effectS of childcare subsidies on female employment.

Second, it is related to recent papers in macroeconomics that study 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, show that 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 childcare subsidies in Germany would lead to a positive effect on female labor supply. Domeij and Klein (2012) approach childcare subsidies from an optimal taxation perspective. They argue that in economy with distortionary taxes on labour, tax deductibility of childcare costs can be welfare improving. 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. 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.

Finally, our paper is related to the growing literature that studies the effects of policies using macroeconomic models with heterogeneity in two-earner households. Examples of these papers are Chade and Ventura (2002), Greenwood, Guner and Knowles (2003), Erosa, Fuster and Restuccia (2010), Kaygusuz (2006, 2010) and Guner et al (2012-a, 2012-b), among others.

1.1 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.[5] 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.

The program assists families to obtain childcare so they can work, or participate in training or education. It explicitly targets low-income households. Hence, t o 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] 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).

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 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.

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 7% of total family income. Given an average income of $19,000 for recipients, this amounts to a co-payment of about $1,120 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). Hence about 23.3% of childcare costs ($1,120 out of $4,800) were paid by the families, while the remaining 76.7% constituted the subsidy.

2 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. Married households and single females can be childless or endowed with two children. These children appear either *early* or *late* in the life-cycle exogenously, and affect the resources available to households for three periods. 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 (education) 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 type 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 zero 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 $j \geq 1$,

$$h' = G(x, h, l, j)$$

all $h \in H$. The function G 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 (3). 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 a 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 $r = R - \delta_k$.

2.1 Government

The government taxes labor and capital income, and uses these tax collections to pay for government consumption 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 Let a stand for household's assets. Then, the total pre-tax resources of a single working male of age j and a single female worker of age j without any children are given by $a+ra+w\varpi_m(z,j)\varepsilon_z l_m$ and $a+ra+wh\varepsilon_x l_f$, respectively. For a single female worker with children, they amount to $a+ra+wh\varepsilon_z l-wd(s)(1-\theta)\chi\{l_f\}$, if she receives the childcare subsidy. The pre-tax total resources for a married working couple with children are given by $a+ra+w\varpi_m(z,j)\varepsilon_z l_m+wh\varepsilon_x l_f-wd(s)(1-\theta)\chi\{l_f\}$ (if the household receives the childcare subsidy) while they are $a+ra+w\varpi_m(z,j)\varepsilon_z l_m+wh\varepsilon_x l_f$ for those without children.

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 $p_f^S(x)$, $p_m^S(z)$, 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 $a+ra+p_f^S(x)$ and $a+ra+p_m^S(z)$ for singles, and $a+ra+p^M(x,z)$ for married ones.

Income for tax purposes, I, is defined as total labor and capital income. Hence, for a single male worker, it 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.

2.2 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

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

In addition,

$$h' = G(x, h, l, j),$$

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

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

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

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,

$$h'=G(x,h,l_f,j)$$

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

2.3 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

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

In stationary equilibrium, factor markets clear. Aggregate capital (K) and aggregate labor (L) are given by

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

and

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

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

$$\begin{aligned}L_g &= L-[\sum_{x,z,q,\varepsilon_x,\varepsilon_z}\sum_{b=1,2}\sum_{j=b,b+2}\mu_j\int_{A\times H}\chi\{l_f^M\}d(j+1-b)\psi_j^M(a,h,x,z,\varepsilon_x,\varepsilon_z,q,b)dhda \\ &+ \sum_{x,\varepsilon_x}\sum_{b=1,2}\sum_{j=b,b+2}\mu_j\int_{A\times H}\chi\{l_f^S\}d(j+1-b)\psi_{f,j}^S(a,h,x,\varepsilon_x,b)dhda],\end{aligned} \quad (8)$$

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

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

3 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.

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 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 U.S. Census 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.[6] Figure 1 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 female. Table 1 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

$$h' = G(x, h, l, j) = \exp\left[\ln h + \alpha_j^x \chi(l) - \delta(1 - \chi(l))\right]. \tag{9}$$

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

[6] 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).

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 2 shows the calibrated values for α_j^x.

We assume 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 $\Xi_z(\varepsilon) = \Xi_x(-\varepsilon) = \Xi_z(\varepsilon) = \Xi_x(-\varepsilon)$. This leaves us with one parameter (ε) to calibrate. We set this parameter so that, in conjunction with heterogeneity in education types, the 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%).

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 3. 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 4 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.[7] First, conditional on having a child, married couples tend to have two children. 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

[7]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.

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 Tables 5.

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.[8] 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.[9] 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 6 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.[10] 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 estimates of total childcare costs for children between 5 and 14 is about \$4851, 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.

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) 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 household

[8]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.

[9]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.

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

that received childcare subsidy was about \$19,000.[11] About 70% of families who receive childcare subsidies from CCDF made co-payments were about 7% of family income. If we take 19,000 as average income of subsidy receivers, this amounts to a co-payment of 1,120 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 23.3% of total payments (1120/4800) came from family, while the remaining 76.7% 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.

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.*[12] 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.*

[11]According to Administration for Children and Families (2012), 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.

[12]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.

Estimates for η_1 and η_2 are contained in Table 7 for different tax functions we use in our quantitative analysis. Figure 2 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 7.9% and marginal tax rate of 15.5%. As a comparison, a single household at the half of mean income faces average and marginal tax rates that are 3.3% and 11.5%, respectively. At twice the mean income level, the average and marginal rates for a married household amount to 13.2% and 20.8%, respectively, while a single household at the mean income level has an average tax rate of 9% and a marginal tax rate of 17.2%.

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.[13] Using the 2008 U.S. Census we calculate total Social Security benefits for all single and married households.[14] Tables 8 and 9 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 $\tau_k = 0.097$.

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).[15] Given γ, we select the parameter φ to reproduce average market hours per worker observed in the

[13]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.

[14]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.

[15]Heathcote, Storesletten and Violante (2009) estimate a very close value, 0.38. Rupert, Rogerson and Wright (2000) provide estimates within a similar range in the presence of a home production margin.

data, about 40.1% of available time in 2008.[16] We set $\varkappa = 0.132$ 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).

We assume that the utility cost parameter 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). This way we control the slope of the distribution of utility costs, which is potentially important in assessing the effects of tax changes on 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.[17] Table 10 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 (4 entries) in Table 9 as closely as possible. This process requires estimating 8parameters (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

[16]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.

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

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.[18]

Table 11 summarizes our parameter choices. Table 12 illustrates the performance of the model in terms of data.

4 Findings: The Expansion of Childcare Subsidies

We report in this section on 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 financed via a proportional flat-rate income tax, applied to all households. The regular income tax system, the 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 (θ). Given the benchmark values of $\widehat{I}$ and θ, 21% of mean household income and 75%, respectively, we consider eligibility levels of 50%, 100% 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 13, 14 and 15.

Relaxing Eligibility Relaxing *eligibility* constrains has substantial consequences on certain aggregates. Under the benchmark subsidy rate (75%), increasing the threshold $\widehat{I}$ from the benchmark value (21%) to the case when all households are eligible, increases the participation rate of married females by 2.3%, 6.2% and 8.3%, respectively. These changes contribute to changes in aggregate work hours, that 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.[19]

It is important to note that 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

[18]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).

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

by men drop by 1.2%. 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, and (ii) married households reallocate labor from males to females. 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, (ii) appears of quantitative importance. Childcare subsidies act as a positive income effect on married males, 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. For instance, for an eligibility level of one mean household income, subsidy rates of 50%, 75% and 100% imply changes in participation rates of 4.0%, 6.2% and 7.6%. Overall, the changes induced by the large-scale subsidy program that we consider on female labor supply are rather large. In related work and using this framework (Guner et al, 2012-a), we found that fully replacing the income tax schedule by a flat-rate proportional income tax leads to steady-state changes in participation rates of about 5.1% in an open economy. As Table 13 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, subsidies lead to a large *reallocation* of hours worked in two-earner households and thus, to minor effects on total hours worked and output.

The Aggregate Magnitude of Subsidies Tables 13 and 14 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.

Who Increases Participation? Table 15 shows changes 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 12) 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-a and 3-b 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 group), 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.

5 Welfare Effects

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.

The top panel of Table 16 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 at $t = t_0$. The results show *sharp* differences between groups in terms of the welfare impact of chilcare 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 those 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 as the time of the policy change, younger households are net beneficiaries as childbearing expenditures are concentrated at young ages. As age groups become older, childbearing 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.

A key result in Table 15 is that aggregate welfare gains are *negative*. This is not surprising given the fact that only few households at $t = t_0$ benefit from the policy change – less than 15%. The results in the table also indicate that newborn households 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, within the narrowly defined group of newborns, there are naturally winners and losers. As the table shows, central finding is the absence of a majority of households supporting childcare subsidies. At most, only about 48% of households benefit from the introduction of childcare subsidies.

Winners and Losers We now discuss in detail who wins and who loses with the introduction of childcare subsidies. We summarize key results in Table 17, where we focus on newborn households at the date of the policy change and taking into account transitional dynamics between 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.[20]

We start by noting that newborn single females are, as a group, better off with the introduction of the subsidies. 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.

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.

6 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 there are *no* eligibility requirements (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 instead there are no eligibility requirements and childcare is *fully* subsidized, 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 there are no eligibility requirements and childcare is fully subsidized, hours worked by

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

males drop by 1.7%. Output changes, as a result, are small.

In terms of welfare, we find that childcare subsidies do *not* lead to welfare gains under an utilitarian welfare criterion, taking into account transitions between steady states. In addition, we also find that such expansions are not supported by a majority of households, and that they lead to a substantial redistribution of welfare among groups. 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.

Table 1: 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 2: Labor Market Productivity Process for Females (%)

Types	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 (9). These parameters are the growth rates of male wages.

Table 3: Distribution of Married Working Households by Type

Males	Females 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 4: 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 5: 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 6: 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 7: Tax Functions

Estimates	Married (no children)	Married (two children)	Single (no children)	Single (two children)
η_1	0.1028	0.0789	0.1392	0.090
η_2	0.0582	0.0763	0.0481	0.0819
St. Errors				
η_1	0.0002	0.0003	0.0003	0.0011
η_2	0.0002	0.0003	0.0003	0.0020

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 det

Table 8: 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 9: 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.

Table 10: 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 11: Parameter Values

Parameter	Value	Comments
Population Growth Rate (n)	1.1	U.S. Data
Discount Factor (β)	0.972	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 ($\varkappa$)	0.132	Calibrated – matches LFP of married females with young children
Childcare costs for young children (d_1)	0.064	Calibrated - matches childcare expenditure for young (0-4) children
Childcare costs for young children (d_2)	0.049	Calibrated - matches childcare expenditure for old (5-14) children
Childcare subdiy (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)	0.395	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)	18.1%	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 12: 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	46.4	51.8
High School	68.8	65.2
Some College	74.0	73.7
College	74.9	76.3
More than College	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 13: 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	7.0	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 budget balance. See text for details.

Table 14: 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 Receipients (% 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 15: 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 16: 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	-1.1	-2.4
All	-0.5	-0.9	-0.6	-1.0
(%) Winners	9.9	11.4	13.9	14.8
Steady States:				
Newborns	0.5	1.6	0.5	1.9
(%) Winners	33.4	38.2	42.2	48.3

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 17: Welfare Effects Across Groups: 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	-1.7	-2.3	-4.8
Early	2.1	4.8	2.1	4.9
Late	0.6	1.8	0.8	2.2

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.

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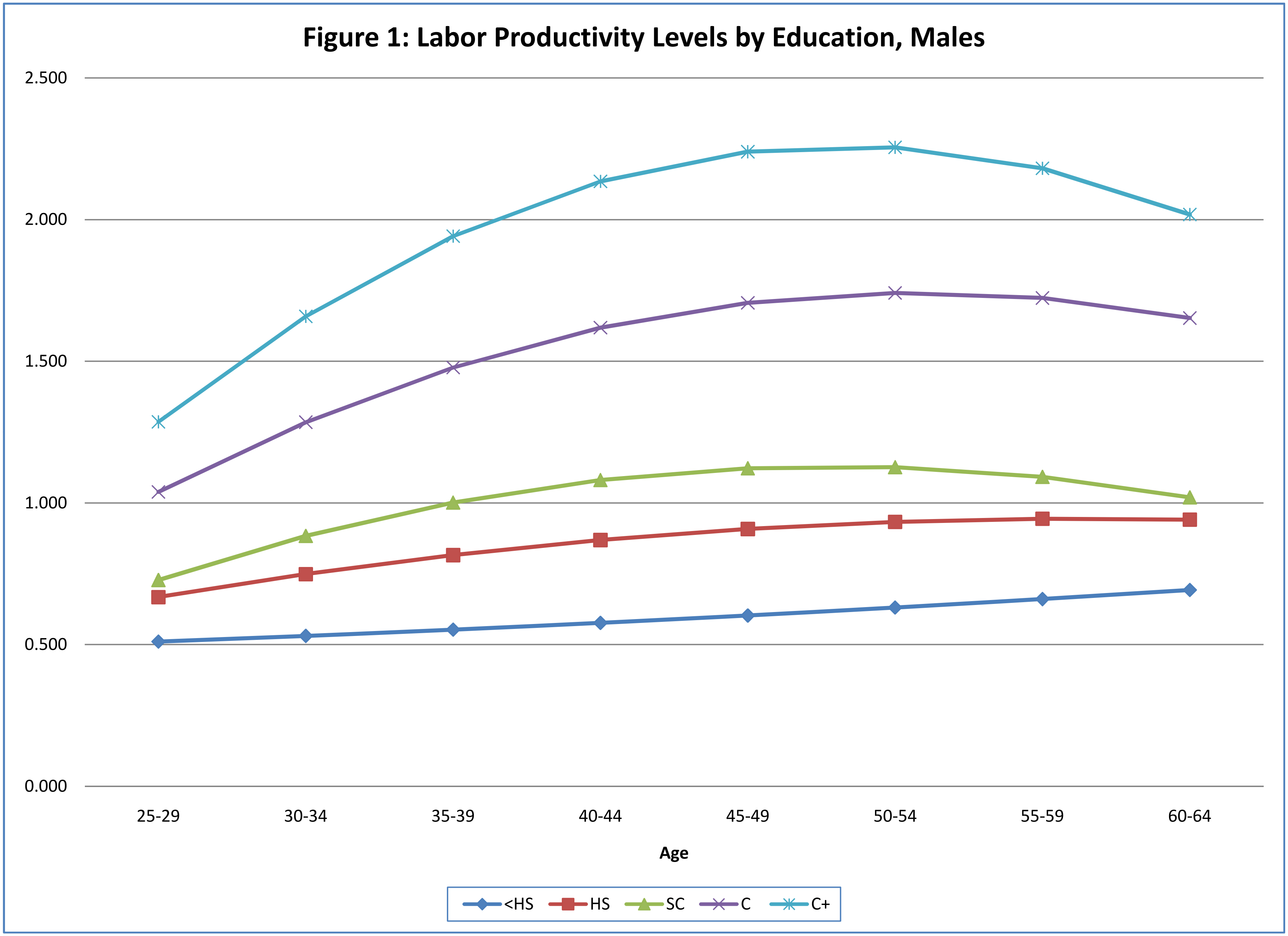
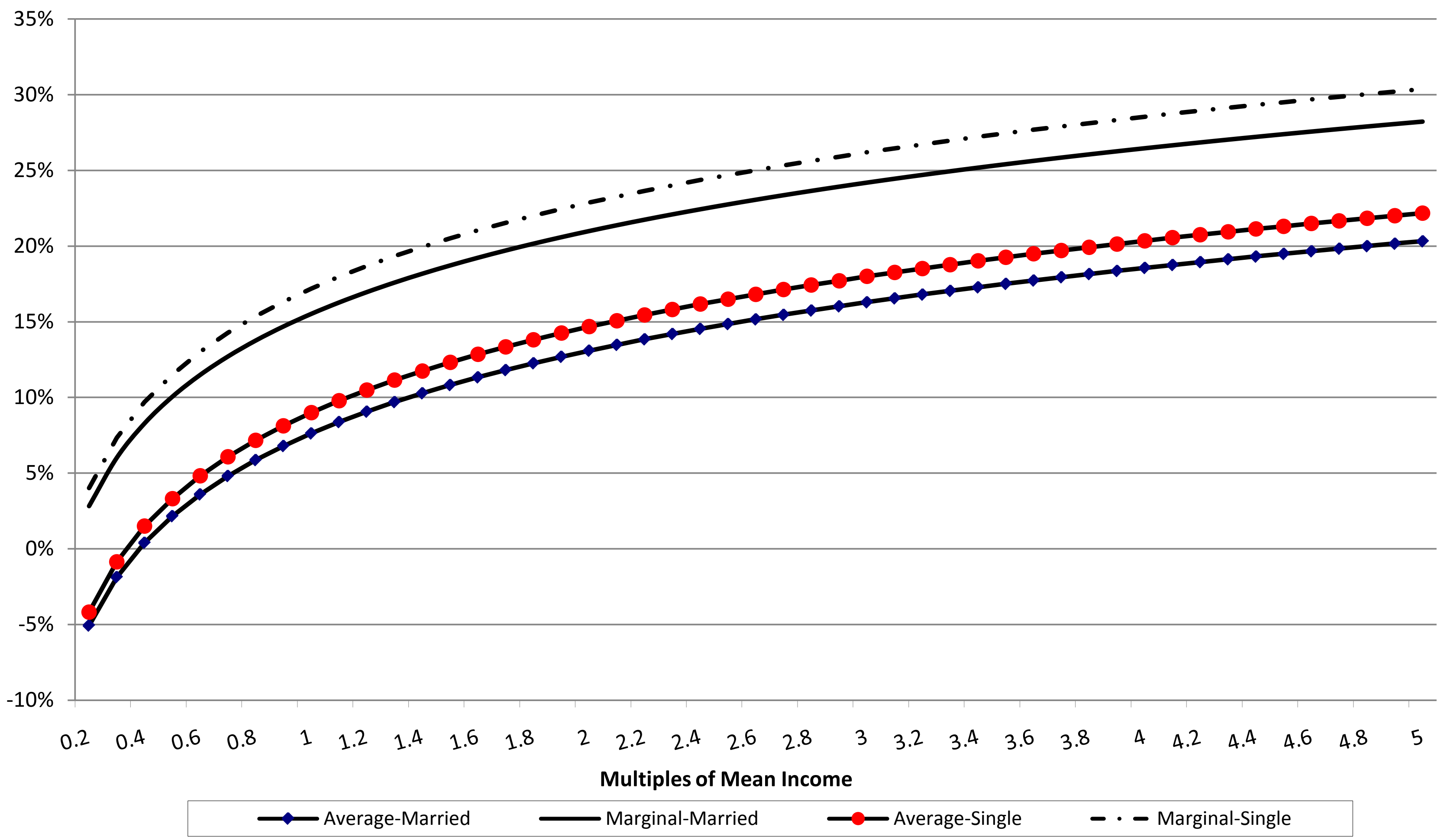


Figure 1: Labor Productivity Levels by Education, Males
2.500
2.000
1.500
1.000
0.500
0.000
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
Age
<HS
HS
SC
C
C+

Figure 2: Average and Marginal Tax Rates, 2 Children



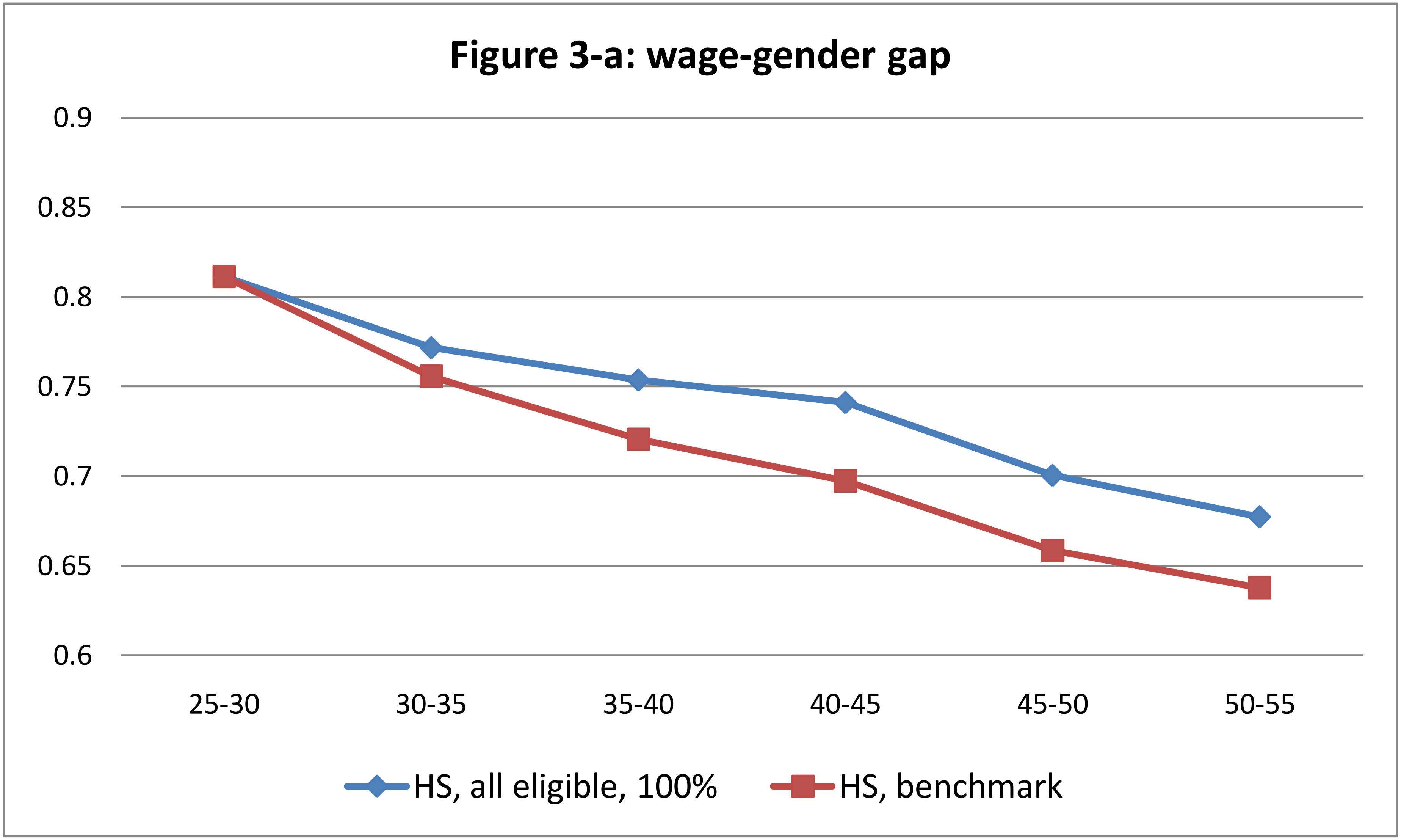


Figure 3-a: wage-gender gap
0.9
0.85
0.8
0.75
0.7
0.65
0.6
25-30
30-35
35-40
40-45
45-50
50-55
HS, all eligible, 100%
HS, benchmark

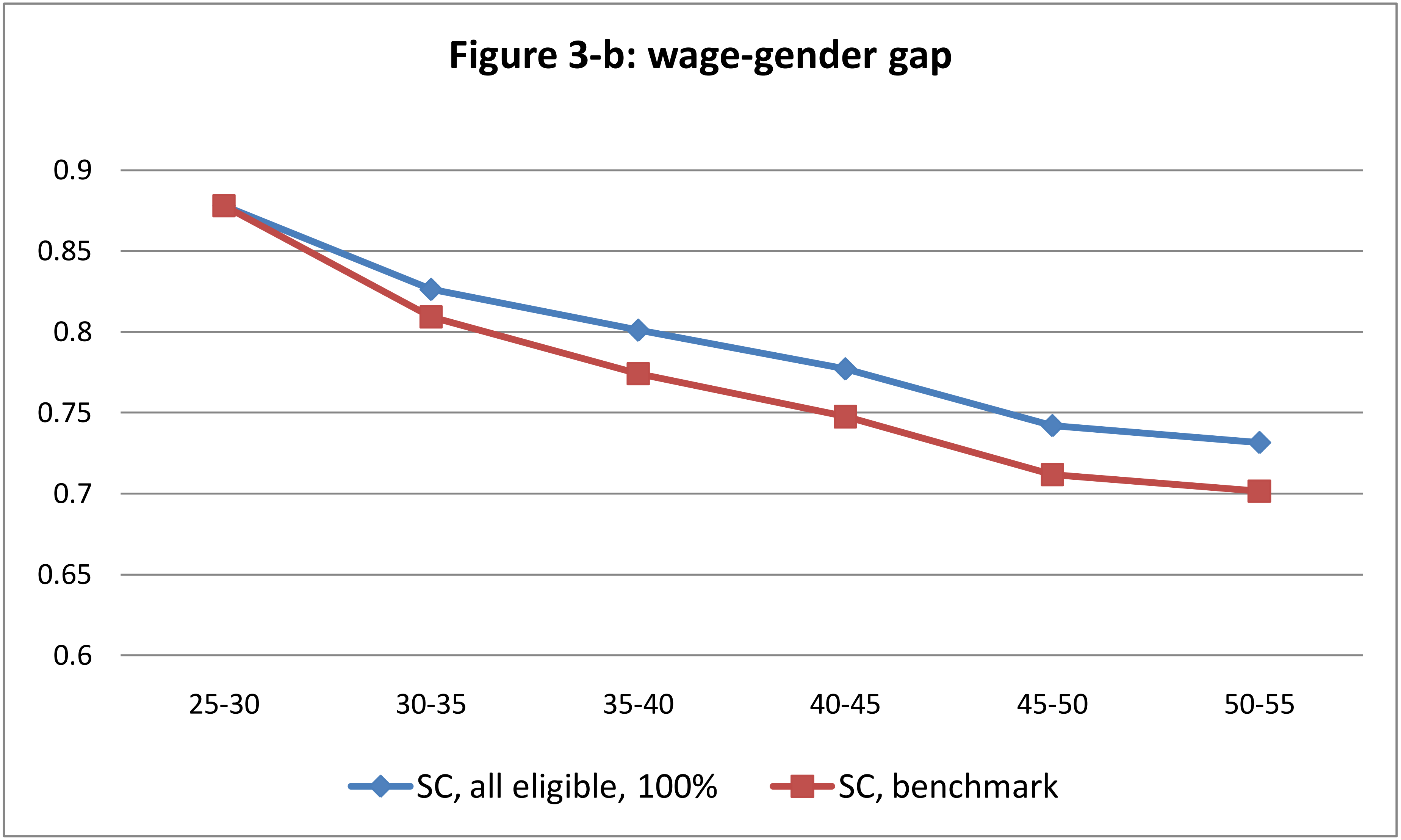


Figure 3-b: wage-gender gap
0.9
0.85
0.8
0.75
0.7
0.65
0.6
25-30
30-35
35-40
40-45
45-50
50-55
SC, all eligible, 100%
SC, benchmark