

# Taxing Families: The Impact of Child-related Transfers on Maternal Labor Supply

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## Abstract

Childbirth causes persistent gender differences in labor force participation and the difference in employment rates of married women with and without pre-school children varies substantially across countries. To what extent can child-related transfers account for this differential? To answer this question, I develop an overlapping generations model of joint labor supply, in which female human capital evolves endogenously and a fraction of households has access to informal child-care. I calibrate the model to the US and Denmark, two countries in which the gap in employment rates of women with and without pre-school children differs in sign and magnitude: the gap is 13.2% in the US and -3.7% in Denmark. After taking the labor income tax treatment of married couples and variation in out-of-pocket child-care costs into account, I find that child-related transfers are key to explaining the positive gap in the US and the negative gap in Denmark.

**Keywords:** Maternal Labor Supply, Family Transfers, Taxation

**JEL Codes:** E62, H31, J12, J22

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# 1 Introduction

Despite increasing female educational attainment, the convergence in gender differences in earnings and labor force participation has stagnated in recent years. Recent literature attributes these remaining gender differences to the effect of childbirth on the labor market trajectories of women relative to men (Goldin et al. (2017), Kleven et al. (2017)). Across OECD countries, the employment rate of married mothers with young children is on average 15% lower than the employment rate of married women without children (OECD, 2016).<sup>1</sup> I refer to this difference as the *maternal participation gap*. The size of the maternal participation gap varies significantly across countries. For example, the participation rate of women with pre-school children is 13.2% lower in the US relative to women without children. In Denmark, on the other hand, the participation rate of mothers is 3.7% higher relative to childless women, resulting in a negative maternal participation gap. This paper explores the following two questions quantitatively: 1. What are the key factors that account for the size of the maternal participation gap in a given country? 2. Can these factors explain the variation in the size of the maternal gap across countries? To answer both questions, I focus on the US and Denmark. The maternal participation gap in the US is representative of the gap observed in many Western European countries, such as Austria, France, Ireland, and Luxembourg. Denmark, in contrast, displays the lowest maternal participation gap across all OECD countries.

Important differences in the tax system and the design of child-related transfers in the US and Denmark motivate the analysis. The tax and transfer systems in both countries differ along three dimensions that are of first-order importance for the labor supply decision of households with children.<sup>2</sup> First, the US taxes the labor income of both spouses jointly, while Danish labor income is taxed at the individual level. Next, child-related transfers are much more generous in Denmark relative to the US. I define child-related transfers as all government transfers to households with young children, including child tax credits, childcare subsidies, subsidies for lone parents and supplementary transfers to low income families with children. Denmark spends 3.1% of its GDP on child-related transfers, while the US spends 1.5% of its GDP on these policies. Finally, out-of-pocket childcare costs are about 25% lower in Denmark.

This paper argues, first, that child-related transfers are the key determinant for the maternal participation gap in the US and in Denmark. Child-related transfers increase the maternal participation gap in the US, while they reduce the gap in Denmark. The country-specific design of child-related transfers introduces important differences in the effective tax rates that households with and without children face and these differences

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<sup>1</sup>At the same time, employment rates of men with and without children in the household are comparable.

<sup>2</sup>Another strand of literature emphasizes cultural values as a key factor to explain variations in maternal participation rates across countries and across time. Examples of these papers are Fogli and Veldkamp (2011), Fernández (2013), and Giavazzi et al. (2013).

are driving the result. Second, the availability of informal care determines the elasticity of maternal labor supply with respect to policy reforms. A larger informal care market implies that mothers are less responsive to policy reforms that reduce the cost of childcare.

I develop an overlapping generations model of joint household labor supply, in which a fraction of households has access to informal childcare. The model economy is populated by married and single households. Households either have two children or no children. If households have children, they arrive early or late in the lifecycle. Parents do not derive utility from children, but having children consumes additional households resources. During child rearing periods, single and married females have to purchase childcare services if they choose to work. A fraction of households in the economy that have access to informal care and do not incur out-of-pocket childcare expenses, even if both parents work. Male and female individuals start their life at working-age and differ in terms of their initial education. Female labor productivity evolves endogenously over the lifecycle. In the model, both spouses choose consumption, labor supply and savings.

I choose the US economy as my benchmark and calibrate it to the Danish data by adjusting the model economy along specific dimensions. The calibration uses US macroeconomic and microeconomic data, as well as country-specific data on labor income taxes and child-related transfers from the OECD. Holding preferences fixed, I predict the labor supply behavior of married women with and without children in Denmark by re-calibrating the following four key features of the economy: First, taxes and transfers that impact all households are modified. This includes consumption, capital, and labor income taxes, social security transfers, and old-age benefits. In addition, child-related transfers and out-of-pocket childcare costs are adjusted to match Danish data. Third, female human capital growth rates conditional on education are estimated from the data and passed into the model to account for differences in the evolution of female labor productivity over the lifecycle in Denmark. Finally, I adjust the size of the informal care market to match the fraction of households that use informal care in the data. Using this set up, I analyze the two questions posed at the beginning of this paper.

*1. What Accounts for the Size of the Maternal Participation Gap?* Child-related transfers are key for explaining the size of the maternal participation gap in both countries. The benchmark economy predicts a participation gap of 14.1% for the US, which is in line with the data. Excluding child-related transfers from the economy generates a participation gap of -1.7% instead. The results for Denmark are similar: The participation gap in the benchmark economy is -4.7%, which closely matches the Danish data. The economy without child-related transfers generates a small and positive participation gap of 0.5%. It is worth noting that introducing child-related transfers into the economy

increases the maternal participation gap in the US and reduces the gap in Denmark. Hence, transfers to families with children are of first-order importance to generate a maternal participation gap that corresponds to the data both in sign and magnitude.

This finding is due to the fact that child-related transfers introduce important differences in the effective tax rates that households with and without children face. [Holter et al. \(2017\)](#) summarize these differences by estimating non-linear tax functions for a set of OECD countries. They show that families with children on average face lower levels of labor income taxes and higher tax progressivity. Their estimates for the US and Denmark imply that the effective tax rate for households with 2 children is 13% below the effective tax rate of households without children. At the same time, the tax progressivity is 10% higher for families with children in both countries. In addition, the gap between effective tax rates for households with and without children is particularly large for low-income families. The effect of child-related transfers on the labor supply of households thus varies in the cross-section.

*2. What Accounts for the Variation in the Maternal Participation Gap Across Countries?*  
The size of the informal care market is crucial for explaining the gap across countries because it determines the elasticity of maternal labor supply. To arrive at this conclusion, I conduct the following two-step policy experiment. I take the US economy as benchmark, including the size of the informal care market, and introduce an individual labor income taxation system as currently in place in Denmark. The maternal participation gap declines by nearly half from 14.1% to 8.7%. Next, I adjust child-related transfers and out-of-pocket childcare costs to match the Danish data. The second step of the policy experiment has very little effect on the participation gap: The gap merely declines from 8.7% to 8.4%. After introducing child-related transfers into the economy in step 2, the participation gap shrinks to -1.7%, which is close to the gap that we observe in the Danish data. Hence, repeating the experiment for the US, but conditioning on the smaller size of the Danish informal care market, increases the elasticity of maternal labor supply.

The fact that the elasticity of maternal labor supply depends on the availability of informal care is supported by empirical evidence. [Bettendorf et al. \(2015\)](#) and [Givord and Marbot \(2015\)](#) find that take-up rates of formal childcare exceed the increase in maternal labor supply in response to policy reforms that reduce the price of formal childcare. The allocation of time between formal and informal childcare is thus an important decision margin that needs to be considered when analyzing family policy reforms in a structural framework. For example, [Guner et al. \(2017\)](#) develop a structural model of joint household labor supply with informal care and conclude that a universal childcare subsidy of 75% in the US would increase maternal participation by 8.8%. This finding might overstate the actual effect of the policy on maternal labor supply if certain mothers merely switch from informal to formal care without adjusting their labor force

participation status.

This paper contributes to several distinct strands of literature. First, this study is motivated by an extensive empirical literature going back to Heckman (1974) that studies the effects of childcare costs on maternal labor supply (Hotz and Miller (1988), Schöne (2004), Baker et al. (2008)).<sup>3</sup> Blau and Currie (2006) provide an overview of these studies and report a wide range of maternal labor supply elasticities across countries: The reported estimates vary between 0.06 and -3.60. This paper attempts to reconcile these findings by providing a structural framework that allows to decompose the effect of country-specific and institutional factors on maternal labor supply. The elasticity of maternal labor supply is likely to be affected by current wage levels, female participation rates, the tax code, and the generosity of the social security system. These cross-country differences pose a challenge to many empirical studies as they introduce identification problems. The majority of empirical studies thus shifted the focus to quasi-experimental methods that exploit exogenous variations in childcare prices as a result of policy reforms.<sup>4</sup> Even in the presence of a clean identification strategy, most authors carefully interpret their estimates in the country-specific context (Cascio et al. (2015)). A structural framework like the one presented in this paper can be used to reconcile the variation in empirical labor supply elasticity estimates across countries.

A second contribution is that this paper demonstrates the importance of informal childcare for determining the elasticity of maternal labor supply. The substitutability of formal and informal care is an important margin to understand the effect of policy reforms on maternal labor supply and most structural models do not consider this margin. One paper that introduces informal care giving as an endogenous choice into a structural framework is Barczyk and Kredler (2017). They focus on care for the elderly. Empirical studies support the notion that a reduction in the cost of formal childcare leads to large substitutions of informal for formal care and not necessarily to an increase in maternal labor supply. Havnes and Mogstad (2011) study a large-scale expansion of subsidized childcare in Sweden in the 1970s. They conclude that this policy increased maternal employment by merely 0.06% and crowded out existing informal care arrangements. More recently, Bettendorf et al. (2015) study the introduction of the Law in Childcare in 2005 in the Netherlands that lead to a reduction in the cost of formal childcare. They find that the share of parents using formal care among pre-school children increased by 19% for 0 to 3 year olds and 32% for children between 3 and 6 years of age, while the maternal employment rate only increased by 2.3%. Givord and Marbot (2015) draw similar conclusions from a 2004 reform in France, where an

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<sup>3</sup>The strong correlation between childcare costs and maternal labor supply has led to the general conclusion that affordable childcare is the main driving force for the cross-country differences in maternal employment (Havnes and Mogstad; 2011).

<sup>4</sup>See for example, Sánchez-Mangas and Sánchez-Marcos (2008), Azmat and González (2010), Bettendorf et al. (2015), Cascio et al. (2015), Geyer et al. (2015), Givord and Marbot (2015), Nollenberger and Rodríguez-Planas (2015), for recent empirical evidence.

expansion of childcare subsidies increased maternal employment by only 1.1%.

A third contribution is that this paper uses the actual nonlinear tax and subsidy systems rather than average marginal tax rates as model inputs to predict maternal labor force participation. [Bick and Fuchs-Schündeln \(2017\)](#) show that linear tax functions introduce a correlation between male and female hours worked that is much larger than in the data and that differences in hours worked between the US and Europe are overstated by 57% using a model with linear tax functions. Nonlinearities in the tax code, that is, the difference in effective tax rates between households with and without children, are even more pronounced when analyzing the household labor supply problem of families with small children. Child-related transfers are typically conditional on household income and/or parental labor force status and thus lead to heterogeneous maternal labor supply incentives in the cross-section of households. The model presented in this paper can account for these differences as it takes into account the full nonlinearity of the tax and transfer schemes in the US and Denmark.

This paper builds on [Guner et al. \(2017\)](#) and is also related to [Bick and Fuchs-Schündeln \(2017\)](#). [Guner et al. \(2017\)](#) develop a model of joint household labor supply for the US economy and analyze the effect of policy reforms, such as an expansion in childcare subsidies and child tax credits, on labor supply and family welfare. The key difference is, this paper uses actual tax data from the OECD to identify effective tax rates for different household types, thus taking the full non-linearity of the tax code into account. In addition, the model set up can be easily extended to other OECD countries and lends itself for further cross-country studies. The way taxes are introduced into the model is based on [Bick and Fuchs-Schündeln \(2017\)](#), who systematically implement country-specific non-linear income tax codes for married household types. In contrast to [Bick and Fuchs-Schündeln \(2017\)](#), who abstract from the presence of children, this paper explicitly models the decision problem for households with and without children.

This work is part of a growing body of literature on the joint labor supply decision problem of married couples from a macroeconomic perspective. In this strand of literature, the decision to be a single or dual-earner household is endogenous ([Greenwood et al. \(2003\)](#), [Hong and Ríos-Rull \(2007\)](#), and [Heathcote et al. \(2010\)](#) among others). [Chade and Ventura \(2002\)](#), [Kaygusuz \(2010\)](#), [Guner et al. \(2012\)](#), [Chakraborty et al. \(2015\)](#), [Bick and Fuchs-Schündeln \(2017\)](#), [Duval-Hernández et al. \(2017\)](#) and [Holter et al. \(2017\)](#) explore to what extent the labor supply decision of the second earner depends on the income tax code and the social security system. A related strand of macroeconomic research has explored the effects of childcare costs and childcare subsidies, both in the aggregate ([Rogerson \(2007\)](#), [Attanasio et al. \(2008\)](#) and [Domeij and Klein \(2013\)](#)) and across household types ([Erosa et al. \(2010\)](#), [Bick \(2015\)](#) and [Guner et al. \(2017\)](#)).

The remainder of the paper proceeds as follows. Section 2 presents a stylized household decision problem that can rationalize cross-country variation in the maternal par-

ticipation gap. In Section 3 gives an overview of important data facts that are used to discipline the quantitative model in section 4. Section 5 describes the model calibration in detail. Section 6 presents the benchmark economy, while Section 7 performs policy experiments to address the two questions raised at the beginning of this paper. Concluding remarks and directions for future research are given in section 8.

## 2 Maternal Participation Gap

Figure 1 summarizes the cross-country variation in the maternal participation gap in the data. The gap is defined as the difference in the average employment rate of married females with children less than 6 years of age and married females without children. The participation gap varies significantly across European countries and the US. It is virtually non-existent in Denmark and Sweden and largest in Germany, the UK and Ireland. While the gap is relatively small in Southern European countries, it is worth noting that the employment rates for females without children are particularly low in this region as well. In fact, the maternal participation rates in Greece and Italy are among the lowest in the sample.

A stylized version of the household labor supply problem can rationalize the cross-country variation in the maternal participation gap observed in the data. The goal is to derive an expression that helps to summarize how the main components that generate differences in employment rates for married women with and without children enter the theoretical model. In addition, the exercise highlights how these model components vary across countries, which will be important for the quantitative exercise.

For simplicity, assume that male labor supply is fixed,  $\bar{l}_m$ . This fairly strong assumption will be relaxed in the quantitative model. In addition, the problem also abstracts from savings and households simply choose consumption and female labor supply for the time being. Households derive utility from consumption  $c$  and incur disutility from labor  $l_i$ , where  $i \in \{f, m\}$ . Married couples face an additional utility cost from joint work,  $q$ . This utility cost can be interpreted as the loss in utility from two working spouses that are unable to spend time together or forgone home production. Having children is costly and households do not derive any utility from raising children. This implies that in this model setup having children only affects the household budget constraint. Finally, consumption is a public good within the household and total household utility is defined as the sum of individual utilities. The household decision problem is given by:

$$\begin{aligned} \max_{\{c, l_f\}} \quad & 2 \log c - \phi \bar{l}_m^\chi - \phi l_f^\chi - q \mathbb{I}(l_f > 0) \\ \text{s.t.} \quad & (1 + \tau_c)c = (1 + s_k)y_{hh}^v - \bar{w}k\psi \mathbb{I}(l_f > 0) \mathbb{I}(g = 0) \end{aligned}$$



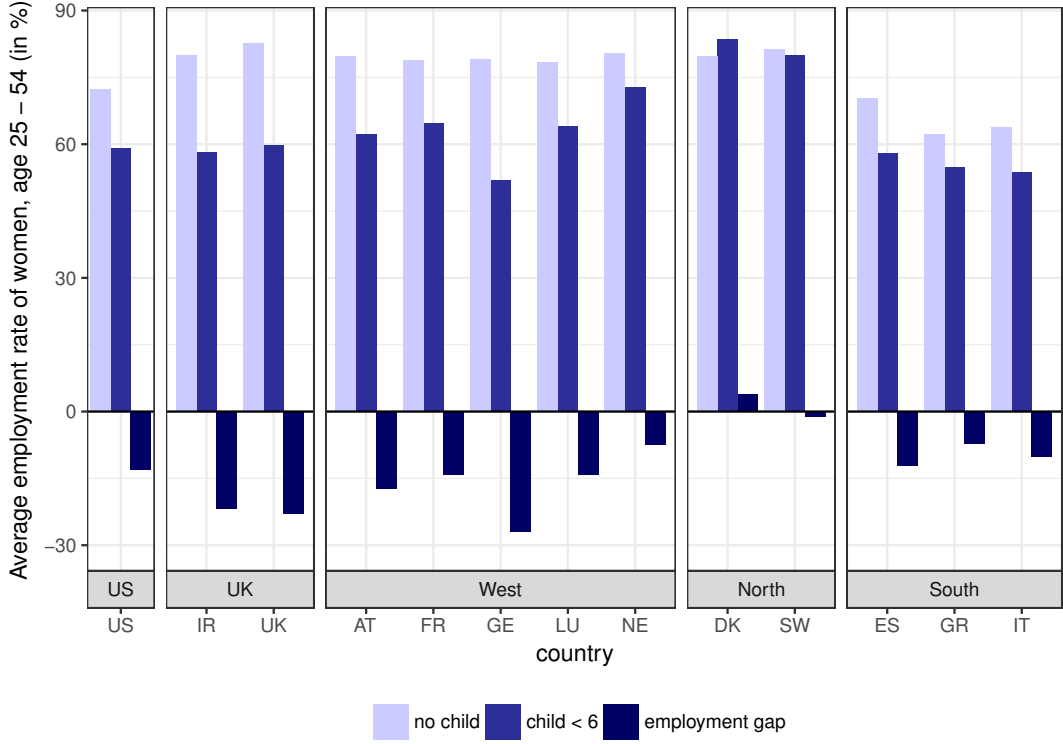


Figure 1: Female employment rates, 2005-2007

*Notes:* Data for the US comes from the Current Population Survey (CPS), while employment rates for European countries are based on the European Labor Force Survey (ELFS). Due to the limited sample size in the ELFS, data from 2005 to 2007 are pooled. The sample is restricted to married females between the age of 25 to 54.

where  $y_{hh}^v$  is the after tax household income. Following Benabou (2002), the after tax household income can be expressed as

$$y_{hh}^v = \begin{cases} 2(1 - \delta) \left( \frac{w_m l_m + w_f l_f}{2} \right)^{1-\xi} & \text{if } v = \text{joint taxation} \\ (1 - \delta)(w_m l_m)^{1-\xi} + (1 - \delta)(w_f l_f)^{1-\xi} & \text{if } v = \text{separate taxation} \end{cases}$$

where  $\xi$  is the degree of progressivity embedded in the tax code. In the case of full progressivity, i.e.  $\xi = 1$ , the after-tax income for every household is identical. If  $\xi = 0$ ,  $\delta$  represents the average tax rate.  $k$  is an indicator that takes the value of 1 if a child is present in the household and 0 if not. If  $k = 0$ , all highlighted variables drop out of the budget constraint and it collapses to a standard version of the joint household labor supply problem. If children are present, there are two additional factors that affect the household labor supply decision through the budget constraint: (1) Households have to pay for childcare if the female is working  $\psi \mathbb{I}(l_f > 0)$ , which is modeled as a fraction of the average income in the economy. If parents have access to informal care provided by grandparents,  $g > 0$ , the indicator function  $\mathbb{I}(g > 0)$  takes the value



of zero, implying that the household does not face formal childcare costs. (2) Second, families with children receive child-related transfers  $s_k$  that effectively increase the after-tax household income. If couples have access to informal care, child-related transfers are the only variation between the decision problem between a married couple with and without children.

In this simple set up, married women without children ( $k = 0$ ) enter the labor force if

$$u(c, l_f | k) \Big|_{l_f > 0} - u(c, l_f | k) \Big|_{l_f = 0} \geq 0.$$

Define the pre-tax labor income of a 2-earner household as  $Y_{hh,2} = w_m l_m + w_f l_f$  and let  $Y_{hh,1} = w_m l_m$  be the pre-tax income of a single earner household. Then, a married woman without children enters the labor force if

$$\underbrace{\left( \frac{Y_{hh,2}}{Y_{hh,1}} \right)^{1-\xi}}_{\text{Participation Gain}} \geq \underbrace{\exp\{\phi l_f^\chi + q\}}_{\text{Participation Cost}}$$

where the gain from entering the labor force is the additional after-tax labor income earned by the wife, which depends on  $\xi$ , the progressivity of the tax code. The cost of entering the labor force is the disutility of labor and the cost of joint work. As long as the additional after-tax household income exceeds the utility costs, a married woman chooses to work. The gain from entering the labor force for a married woman with children is the additional after-tax household income, and therefore identical to the participation gain for a woman without children.

$$\underbrace{\left( \frac{Y_{hh,2}}{Y_{hh,1}} \right)^{1-\xi}}_{\text{Participation Gain}} \geq \underbrace{\exp\{\phi l_f^\chi + q\} + \overbrace{\left( \frac{1}{1+s_k} \right) \frac{\bar{\omega} \psi \mathbb{I}(g)}{y_{hh,1}^v}}^{\text{Effective Relative Childcare Costs}}}_{\text{Participation Cost}}$$

The out-of-pocket cost of childcare relative to the after-tax income of a single earner household reflects the degree to which the budget constraint of a household is tightened due to the presence of children. The maternal participation gap arises if the costs of participating for mothers is different from the cost of participating for married women without children. This is the case if

$$\begin{aligned} u(c, l_f | k = 0) \Big|_{l_f > 0} - u(c, l_f | k = 1) \Big|_{l_f > 0} &\neq 0 \\ \Leftrightarrow \underbrace{\left( \frac{1}{1+s_k} \right) \frac{\bar{\omega} \psi \mathbb{I}(g)}{y_{hh,1}^v}}_{\text{Effective Relative Childcare Cost}} &\neq 0 \end{aligned}$$

Hence, the maternal participation gap arises due to (1) out-of-pocket childcare costs  $\psi$ , (2) access to informal care provided by grandparents  $\mathbb{I}(g)$ , and (3) child-related transfers  $s_k$ . All these costs effectively tighten the budget constraint of households with small children relative to households without children and make participation for mothers more costly.

It is easy to see that these factors also contribute to the cross-country variation in the participation gap. In addition, net household income of a single earner household,  $y_{hh,1}^v$ , which is a function of the country-specific labor income tax code, contributes to the variation in the effective relative childcare costs (ERCC):

$$ERCC^{\text{joint}} = \left( \frac{1}{1 + s_k} \right) \frac{\bar{\omega}\psi\mathbb{I}(g)}{2(1 - \delta)\left(\frac{w_m l_m}{2}\right)^{1-\zeta}}$$

$$ERCC^{\text{separate}} = \left( \frac{1}{1 + s_k} \right) \frac{\bar{\omega}\psi\mathbb{I}(g)}{(1 - \delta)(w_m l_m)^{1-\zeta}}$$

Notice, that in a world where labor income is taxed at a flat rate, i.e.  $\zeta = 0$ , the effective relative childcare costs do not differ across the two taxation systems, all else equal. In this case, the participation gain  $\left(\frac{Y_{hh,2}}{Y_{hh,1}}\right)^{1-\zeta}$  is also identical.

### 3 Stylized Facts

This section presents data on the factors that drive a wedge between the decision problem of households with and without children. These data moments are also used to discipline the quantitative model in section 5.

#### 3.1 Out-of-pocket Childcare Costs

Out-of-pocket childcare costs are defined as the unsubsidized rates for purchasing childcare conditional on child age. The concept of out-of-pocket childcare costs that parents incur fundamentally differ between the US and Denmark. In Denmark, day-care rates are based on the actual operating costs per child and the Danish government caps the maximum payable price for parents at 30% of operating costs<sup>5</sup>. The OECD reports the average cost for providing full-time daycare to a child between the age of 0 to 5 was DKK 40,049 (USD 6,686). This corresponds to 12.7% of the average Danish labor income in 2004. In contrast, childcare in the US is not provided by the public sector, but primarily through a private market in which rates are determined by supply and demand. In the US, full-time center-based childcare was USD 7,916 for 0-2 year-olds and USD 6,616 for 3-5 year-olds, which corresponds to 21.5% and 18.0% of the average US labor income in 2004.

<sup>5</sup>The government pays the difference in operating costs and fees paid by parents directly to childcare providers. Thus, the costs presented below are based on the average fees that parents pay

While the rates for full-time center based childcare are striking between both countries, it is worth noting that differences in the average expenses per household for childcare are less extreme. This could be due to the fact that more children in the US spent fewer hours in center-based care (less than full-time) and more households use informal care. The table below summarizes the average expenditure for childcare in 2004 for the US and Denmark for different age groups of children.

Table 1: Out-of-pocket Childcare Costs

	US		Denmark	
	US\$	% of AW	US\$	% of AW
0-2 years	3,674	0.100	4,457	0.084
3-5 years	2,829	0.077	3,173	0.060

*Notes:* Data for the US average expenditures for childcare per household comes from the 2004 Survey of Income and Program Participation (SIPP) and the average childcare expenditures for Denmark are documented by the OECD Wages and Benefits module.

### 3.2 Informal Childcare

Informal childcare is defined as unpaid care, usually provided by a grandparent of the child or by other relatives, friends or neighbors. It excludes any care that is paid for regardless of who is providing the paid-for care. Table 2 summarizes the fraction of children that are in informal care.

Table 2: Fraction of Children in Informal Care

	Fraction in informal care		Avg. hours per week	
	0-2 years	3-5 years	0-2 years	3-5 years
Ireland	16.36	14.16	21.84	14.40
UK	33.84	39.12	15.67	13.56
Austria	31.54	43.99	10.17	8.20
France	17.36	19.26	16.33	10.07
Luxembourg	24.47	28.25	14.01	11.64
Netherlands	56.11	47.97	11.56	7.15
Denmark	0.00	0.00	--	--
Sweden	0.27	0.42	--	--
Greece	55.45	39.98	29.44	22.50
Italy	36.27	38.79	19.72	13.83
Spain	15.37	7.43	26.86	12.92

### 3.3 Child-related Transfers

The US and Denmark differ widely in the types of family policies that are used to support families with children. In general, two types of policies can be distinguished:

child benefits and childcare subsidies. Child benefits that are lump-sum or means-tested and paid out to every family that has a child. The benefit amount usually declines with child age. The second type of benefit are childcare subsidies that are used to lower the cost of childcare for families with children.

Table 3: Child-related Transfers

A. Child Benefits	
USA	Denmark
1. <i>Child Tax Credit (CTC)</i> - non-refundable - means-tested  2. <i>Earned Income Tax Credit (EITC)</i> - refundable - means-tested - conditional on employment status	<i>Family Benefit</i> - lump-sum - non-taxable
B. Childcare Subsidies	
USA	Denmark
1. <i>Child and Dependent Care Credit (CDCC)</i> - conditional on employment status - means-tested  2. <i>Childcare Development Fund (CCDF)</i> - conditional on employment status - means-tested	<i>Childcare Subsidies (CCD)</i> - means-tested

*Notes:* Both countries additionally subsidize poor families through social assistance and housing benefits. These subsidies are means-tested and conditional on the number of children in the household. They pay higher subsidies to households with children relative to households without children conditional on household income. The US

Denmark subsidizes families with children lump-sum transfers for every child below the age of 17. Lump-sum transfers are higher for younger children. In 2004, the Danish government paid USD 2,204 (DKK 13,204 or 4.2% of mean labor income) to every child between the age of 0-2, USD 1,992 (DKK 11,932 or 3.8% of mean labor income) for children aged 3-6 and USD 1,567 (DKK 9,388 or 3.0% of mean labor income) for children 7-17 years of age. Childcare expenses for households that earned below USD 20,852 (DKK 124,901 or 39.5% of mean labor income) received a 100% subsidy. The subsidy linearly declines with income and households earning USD 64,675 or more (DKK 387,401 or 122% of mean labor income) are not eligible for childcare subsidies. However, out-of-pocket expenses are capped at 30% of the average operating expenses for daycare by law.

The tax and transfer system in the US used to subsidize families with children is far more complex compared to the Danish system. The key differences between the two

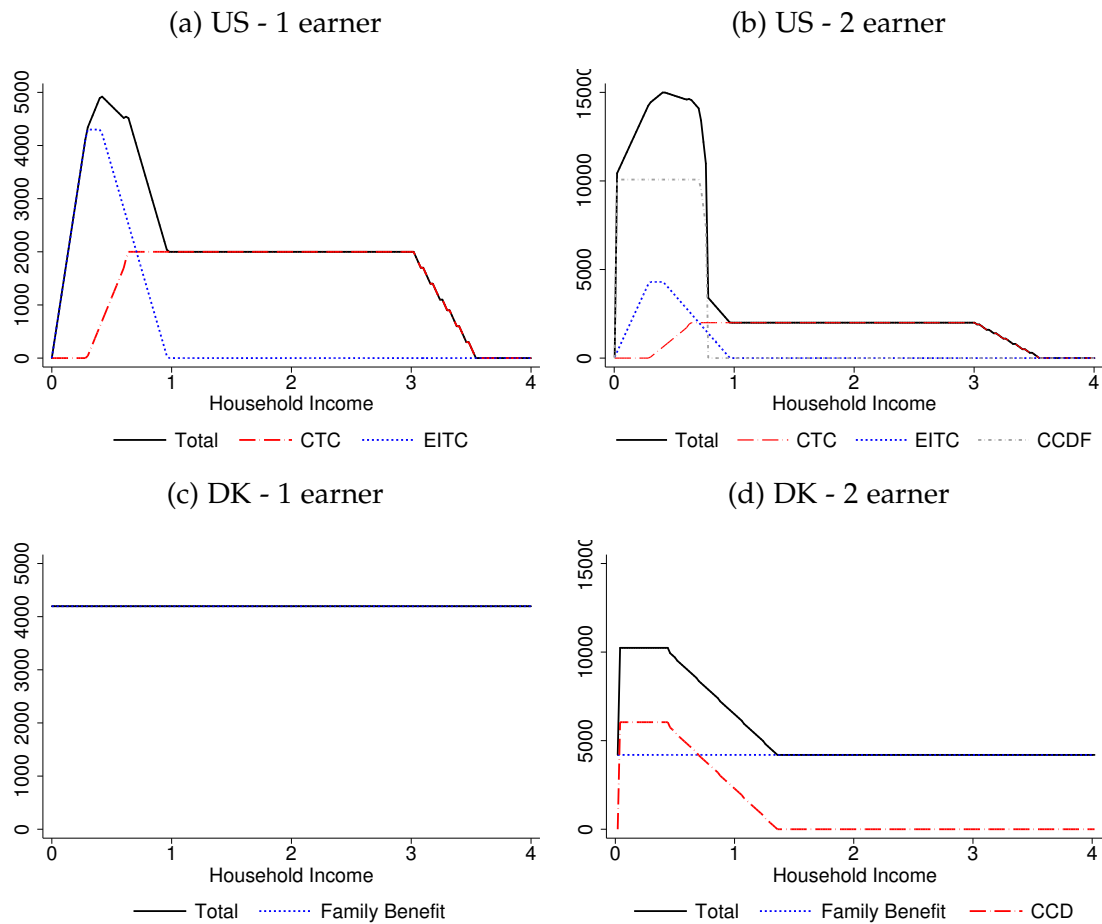


Figure 2: Child-related Transfers to Families with 2 Children

*Notes:* All benefits are shown in 2004 USD for married households with 2 children aged 2 and 4 years. Benefits are calculated using the OECD Taxes and Wages Module. In case of a 1-earner household, it is assumed that children are cared for by the non-working spouse and thus do not incur childcare expenses. Hence, 1-earner households are not eligible for programs that reduce the cost of formal childcare.

systems are that the US does not pay any lump-sum transfers and all US programs are means-tested. Family benefits are paid through the Child Tax Credit (CTC). The tax credit is non-refundable, meaning that poor households that do not pay sufficient taxes do not benefit from this policy. In addition, families are subsidized through the Earned Income Tax Credit (EITC). Both tax credits are initially increasing in income (phase-in range), pay the maximum benefit for a certain income bracket (flat range) and eventually decline with income (phase-out range). The Child Tax Credit pays a maximum benefit of USD 1,000 per child. In 2004, the CTC phases in for household incomes of USD 10,750 and above (0.29% of mean labor income). For married couples in 2004, the maximum benefit is paid up to an income of USD 110,000 (300% of mean labor income). In 2004, the EITC phase-in range was between USD 0 and USD 10,750 for married couples with 2 children, which corresponds to 0.29% of mean labor income. The maximum

benefit of USD 4,300 was paid out until family income reaches the maximum threshold of USD 15,040 (or 40.3% of mean labor income), and phases out thereafter.

Figure 2 summarizes the benefits paid to 1-earner and 2-earner families in Denmark and the US as a function of household labor income normalized by mean labor earnings in each country in 2004. It is easy to see that the country-specific design of child-related transfers introduces important non-linearities, especially at the low end of the income distribution. In addition, these programs have specific phase-in, and phase-out ranges, which correspond to a wage subsidy and a wage tax, respectively (Guldi and Schmidt; 2017). The predicted effects on the intensive and extensive margin of household labor supply are quite different for each range. In other words, the income and substitution effect dominate at different ranges of the total benefit function.

Another way of looking at the problem is to compare the effective tax rates that households with and without children face. Figure 3 summarizes the effective tax rates for households at different points in the income distribution. The effective tax rate is defined as the percentage between gross and net household income. Here, childcare benefits and costs are counted in household net income. In countries with very high childcare costs and no childcare benefits, it can thus be the case that households with children face a higher effective tax rates than households without children conditional on income, such as in Ireland and the UK (see Figure 10).

The graphs below show effective tax rates for various household types that are defined according to male labor earnings. Low income households are defined as households in which men earn 1/4 or 1/2 of mean labor income. Medium income households are households in which the men earns 3/4 of mean labor income or mean labor income. Finally, high income households are defined as households with 3/2 or twice the mean labor income for men. Keeping male labor income fixed, the figure displays the evolution of the effective tax rates as the female increases her labor income from zero to twice the mean labor income in 2004. Tax rates are displayed separately for households with 2 children and without children to demonstrate the effect of child-related transfers on the effective tax rates that households with the same total labor income face.

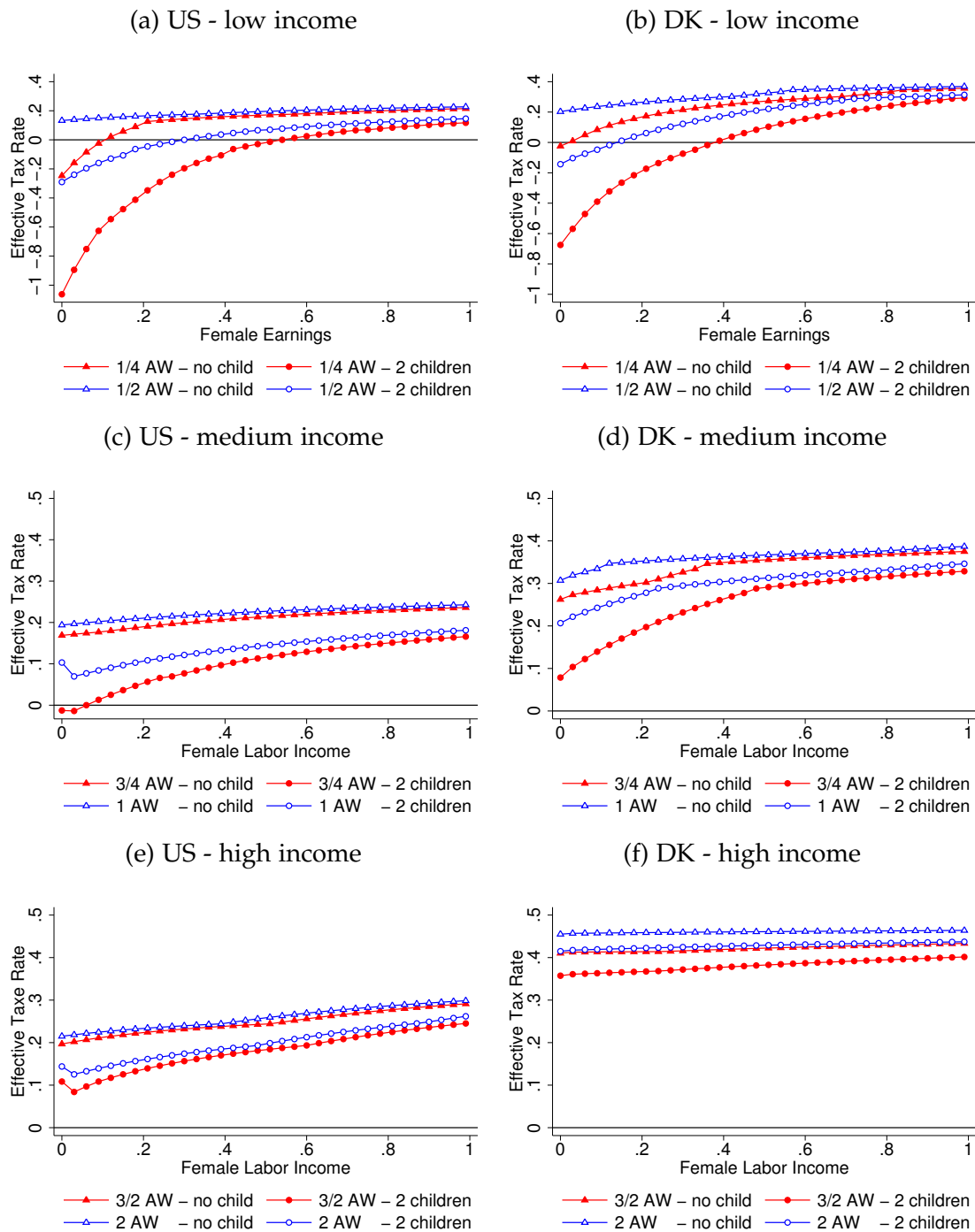


Figure 3: Differences in effective tax rates for married couples with and without children

*Notes:* Effective tax rates are calculated for married households with 2 children, 2 and 4 years of age. The effective tax rate is defined as the percentage difference between gross labor income and net labor income after taxes and subsidies. Rates are calculated using the OECD Taxes and Wages Module. In case of a 1-earner household (female labor income is zero), it is assumed that children are cared for by the non-working spouse. Since 1-earner households do not incur childcare expenses, they are not eligible for childcare subsidies.



## 4 Model

This section develops an overlapping generations economy of joint household labor supply, in which female human capital evolves endogenously and a fraction of households in the economy have access to informal care. The model is used to study to what extent differences in labor income taxes, child-related transfers, out-of-pocket childcare costs and access to informal care contribute to the cross-country variation in the maternal participation gap. The model is similar to [Guner et al. \(2017\)](#). The key difference from their paper is the way in which non-linear labor income tax functions and the non-linear transfer functions are implemented.

### 4.1 Firms

Firms hire capital  $K$  and labor  $L_y$  on perfectly competitive factor markets to transform it into a single output good according to the Cobb-Douglas production technology given by

$$Y \equiv F(K, L) = AK^\alpha L_y^{1-\alpha} \quad (1)$$

Capital depreciates at rate  $\delta_a$ . Total labor services,  $L$ , are divided into labor available for the production of consumption goods,  $L_y$ , and labor used to provide childcare services,  $L_c$ , such that  $L = L_y + L_c$ . Households can purchase a risk-free asset that pays a competitive rate of return given by  $r = R - \delta_a$ .

### 4.2 Households

The economy is populated by a continuum of males  $m$  and females  $f$  and  $j \in \{1, 2, \dots, J\}$  denotes the age of individuals. The population grows at a constant rate  $n$ . Hence, the fraction of agents of the population at age  $j$  is given by  $\mu_{j+1} = \frac{\mu_j}{1+n}$ . Individuals begin their life at working-age in period 1, retire after period  $J_R$ , and die at the end of period  $J$ . Individuals are either born single or married and marital status is constant throughout the lifetime. In addition, both individuals in a married household are assumed to have the same age.

**Labor Productivity** Individuals are endowed with a certain level of education at the start of their life. These exogenous education types are given by  $z \in Z$  for males and  $x \in X$  for females and both sets  $X$  and  $Z$  are finite. Male productivity evolves exogenously over the lifetime, conditional on the initial level of education, such that the age-specific labor productivity of a male with education level  $z$  in period  $j$  is given by  $\omega_m(z, j)$ . Female education types map into an initial human capital level,  $h_1 = \eta(x)$  at the start of period 1. Female human capital evolves endogenously thereafter. Female

productivity in the next period is described by  $\Lambda$  and depends on her initial education type  $x$ , current period human capital  $h$  and current period labor supply  $l_f$ , as well as age  $j$ .  $\Lambda$  is increasing in the female education  $x$  and current period human capital  $h$  and non-decreasing in labor supply  $l_f$ :

$$h' = H(x, h, l_f, j) \quad \forall h \in H. \quad (2)$$

The distributions of agents by household type, by education and by spouse education for married couples are stationary. First, let  $M_j(z)$  be the distribution of all males in the economy of education type  $z$  at age  $j$ . Further,  $F_j(x)$  define the distribution of all females by education type and age  $j$ . Since marital status is invariant over the lifecycle, the following identities have to be satisfied:

$$M_j(z) = \sum_{z \in Z} \Omega_j(z, x) + \Pi_j(z) \quad (3)$$

$$F_j(x) = \sum_{x \in X} \Omega_j(z, x) + \Lambda_j(x) \quad (4)$$

$\Omega_j(z, x)$  is the distribution of females of education type  $x$  married to a male of education type  $z$ . The distribution of singles by education type is given by  $\Pi_j(z)$  for males and  $\Lambda_j(x)$  for females. Since marital status does not change over the lifecycle, it has to be that the distribution of married couples,  $\Omega_j(z, x) = \Omega(z, x)$ , and single males,  $\Pi_j(z) = \Pi(z)$ , is constant across all ages  $j$ , which implies that the distribution of all males is stationary:  $M_j(z) = M(z)$ . In addition, for single females,  $\Lambda_j(x) = \Lambda(x) \forall j$ , which implies that  $F_j(x) = F(x)$  for all periods  $j$ .

**Children** Household either have no children or 2 children attached to them. If a household is born with children, these children arrive either early (period 1) or late (period 2) in the life cycle. This gives rise to three childbearing types: households *without children*, *early childbearers* and *late childbearers*. The childbearing type for each household is indexed by  $b = \{0, 1, 2\}$ , respectively. Children stay in the household for three model periods, that is, *early childbearers* raise children in period 1, 2 and 3, while *late childbearers* nurture in period 2, 3 and 4. The age of children is indicated by  $s = \{1, 2, 3\}$ .

**Cost of Childcare** A fraction of households has access to informal care

$$\mathbb{I}(g) = \begin{cases} 0 & \text{if } g = 1 \\ 1 & \text{otherwise} \end{cases} \quad (5)$$

This function takes the value of zero if  $g = 1$ , that is, if households have access to informal care provided by grandparents, they do not incur any childcare costs. In the

absence of informal care, a working mother, single or married, has to purchase formal childcare. The cost of care,  $\phi_s$ , varies with child age  $s$  and is modeled as a fraction of the average earnings in the economy. Notice that the fraction of income spent on childcare is independent of maternal education or household income. Empirically, we observe that mother with higher education spend a larger fraction of household income on childcare for every child. At the same time, lower educated households spend less on childcare per child, but tend to have more children. These two effects counteract each other in the model, such that the childcare expenses are modeled as a constant fraction of the average earnings.

**Utility Cost from Joint Work** Married couples face an additional utility cost from joint work,  $q \in Q$  where  $Q$  is a finite set. Couples draw this cost at the beginning of their lives and it remains constant throughout the lifetime. The initial draw of  $q$  is conditional on the education type of the husband,  $z$ . Let  $p(q|z)$  be the probability that the cost of joint work amounts to  $q$ , with  $\sum_{q \in Q} p(q|z) = 1$ .

**Preferences** Individuals derive utility from consumption  $c$  and dislike market work  $l_n$ ,  $n = \{m, f\}$ . Utility is additively separable and the momentary utility function for a single male or single female household reads

$$u_n^S(c, l_n) = \log c - \phi l_n^\chi \quad n = \{f, m\} \quad (6)$$

Married couples maximize the summed utility of individual household members. Consumption is a public good within the household. The weight and curvature of the disutility of labor is identical for all individuals, independent of gender and marital status.

$$u^M(c, l_m, l_f, q) = 2 \log c - \phi l_m^\chi - \phi l_f^\chi - q \mathbb{I}(l_f > 0) \quad (7)$$

The utility cost  $q$  captures a utility loss due to joint work of both spouses, which could originate from inconvenience for scheduling joint work, forgone home production or spending less family time with children (as in Cho and Rogerson (1988)).

### 4.3 Government

The government taxes labor income and levies a flat tax on capital income and collects tax receipts from payroll taxes. It uses these tax receipts to subsidize families with small children through transfers and childcare subsidies, to pay old-age benefits to retirees and to finance government consumption.

**Income Taxation and Child-related Transfers** The taxable income is defined as the

sum of labor income and capital income. For a working-age single male household, taxable income equals  $I_m^S = w\omega(z, j)l_m + ra$  and  $I_f^S = wh_x l_f + ra$  for working-age single females. Taxable income for working-age couples is given by  $I^M = w\omega(z, j)l_m + wh_x l_f + ra$ . All workers, in addition, pay payroll taxes on their individual labor income.

The total tax liability for the different households types is also contingent on the presence of children. The government subsidizes households through tax credits and childcare subsidies, conditional on household income and labor force status. There are two types of tax credits in the economy. The first type is only contingent on the presence of a child in the household, i.e.  $k = 1$ . The second type of tax credit is additionally contingent on total household income. This type of tax credit fully reduces the household's tax liability of total income  $I$  is below a threshold  $\bar{I}$  and phases out at a constant rate if  $I > \bar{I}$ . This tax credit fully phases out if  $I > \hat{I}$ .

The tax functions  $t^S(I_m^S, k)$ ,  $t^S(I_f^S, k)$ , and  $t^M(I^M, k)$  summarize the income tax code in the economy, as well as the child-related tax credits and childcare subsidies. They can be interpreted as the *effective income tax rate* households face. This general representation of the labor income tax code encompasses both individual and joint taxation regimes.

**Old-age Benefits** Old-age benefits are not taxed by the government, and thus taxable income for retirees is simply capital income defined as  $I^R = (1 + r)a$ . Old-age benefits depend on the innate education type of the individuals, which helps to capture the positive correlation between lifetime earnings and the size of old-age benefits.  $p_f^S(x)$ ,  $p_m^S(z)$  and  $p^M(x, z)$  define the level of old-age benefits for single females, single males and married couples, respectively, conditional on initial education levels.

#### 4.4 Household Problem in Recursive Form

This section lays out the decision problem for married and single households in recursive form. The state space for single males is given by  $\{a, z, j\}$  and for single females by  $\{a, x, h, b, g, j\}$ . For married couples, the state space is given by  $\{a, z, x, h, b, q, g, j\}$ . Notice that  $b = 0$  for all households without children. Single male households never have children attached to them.

**Single Males** The decision problem of a single male household essentially can be decomposed in the two periods only: working age,  $j < J_R$ , and retirement,  $j \geq J_R$ . Single males choose consumption and savings in every period according to

$$V_m^S(a, z, j) = \max_{a', l_m} \{u_m^S(c, l_m) + \beta V_m^S(a', z', j + 1)\} \quad (8)$$

subject to

$$(1 + \tau_c)c + a' = \begin{cases} (w\omega_m(z, j)l_m + ra)(1 - t^S(I_m^S, 0)) + a(1 + r(1 - \tau_a)) & \text{if } j < J_R \\ a(1 + r(1 - \tau_k)) + p^S(z) & \text{if } j \geq J_R \end{cases}$$

and

$$l \geq 0, \quad a' \geq 0 \quad \text{and} \quad I_m^S = w\omega_m(z, j)l_m + ra.$$

**Single Females** In contrast to single males, single females can be born with children attached to their household.  $k = 1$  indicates the presence of a child in a given period. Moreover, if females have children they can be early ( $b = 1$ ) or late childbearers ( $b = 2$ ). If they are early childbearers  $k = 1$  during ages  $j = \{1, 2, 3\}$ , while  $k = 1$  during ages  $j = \{2, 3, 4\}$  for late childbearers.  $\mathbb{I}(g)$  indicates whether mothers have access to informal care. If mothers do not have access to informal care from grandparents,  $\mathbb{I}(g = 1) = 0$  and no childcare costs are incurred. The cost for formal care varies with child age  $i = \{1, 2, 3\}$ . Female human capital evolves endogeneously. Hence, the state space for females is characterized not only by their innate education level  $x$ , but also current period human capital  $h$ .

To simplify notation, let  $\mathbf{s}_f^S \equiv (x, b, g)$  be the vector of exogenous state variables for single females. If  $g = 1$ , females have access to informal care provided by grandparents and do not pay for formal care. They choose consumption and savings as given by

$$V_f^S(a, h, \mathbf{s}_f^S, j) = \max_{a', l_f} \{u_f^S(c, l_f) + \beta V_f^S(a', h', \mathbf{s}_f^S, j + 1)\} \quad (9)$$

subject to

$$(1 + \tau_c)c + a' = \begin{cases} (wh_x l_f + ra)(1 - t^S(I_f^S, k)) + a(1 + r(1 - \tau_a)) \\ -\omega\psi_i \mathbb{I}(l_f > 0) \mathbb{I}(g = 0) & \text{if } j < J_R \text{ and } k = 1 \\ (wh_x l_f + ra)(1 - t^S(I_f^S, k)) + a(1 + r(1 - \tau_a)) & \text{if } j < J_R \text{ and } k = 0 \\ a(1 + r(1 - \tau_k)) + p^S(x) & \text{if } j \geq J_R \end{cases}$$

and

$$l \geq 0, \quad a' \geq 0 \quad \text{and} \quad I_f^S = wh_x l_f + ra.$$

**Married Couples** Both spouses maximize the sum of the individual utilities of both spouses. Consumption is a public good. Similar to female singles, married couples can be of all childbearing types, i.e.  $b = \{0, 1, 2\}$ . Let  $\mathbf{s}^M$  be the state space of exogenous state variables for married couples:  $\mathbf{s}^M \equiv (z, x, q, b, g)$ . Couples maximize household utility by choosing consumption, labor supply and savings according to

$$V^M(a, h, \mathbf{s}^M, j) = \max_{a', l_f, l_m} \{u^M(c, l_m, l_f, q) + \beta V^M(a', h', \mathbf{s}^M, j+1)\} \quad (10)$$

subject to

$$(1 + \tau_c)c + a' = \begin{cases} (w\omega(z, j)l_m + wh_x l_f + ra)(1 - t^M(I^M, k)) \\ + a(1 + r(1 - \tau_k)) - \omega\psi_i \mathbb{I}(l_f > 0) \mathbb{I}(g = 0) & \text{if } j < J_R \text{ and } k = 1 \\ (w\omega(z, j)l_m + wh_x l_f + ra)(1 - t^M(I^M, k)) \\ + a(1 + r(1 - \tau_k)) & \text{if } j < J_R \text{ and } k = 0 \\ a(1 + r(1 - \tau_k)) + p^M(x, z) & \text{if } j \geq J_R \end{cases}$$

$$l \geq 0, \quad a' \geq 0 \quad \text{and} \quad I^M = w\omega(z, j)l_m + wh_x l_f + ra.$$

## 5 Calibration

This section describes the calibration of model parameters. The model is used to assess what accounts for the variation in the maternal participation gap across countries. Thus the calibration proceeds in 2 steps. First, the model is calibrated to match data moments from 2004 U.S. data. More specifically, parameter values are assigned to endowments, preferences, technology, childcare costs, and policy parameters related to tax and transfer functions. Next, the parameters related to childcare costs, government policies, and female human capital are adjusted to match data moments for Denmark.

**Endowments** Individuals start their life at age 25, work for 40 years, retire at age 65, and die with certainty at age 80. One model period corresponds to five years, which implies that every individual lives for 11 periods. The first model period corresponds to ages 25-29 ( $j = 1$ ) and the begin of retirement corresponds to ages 65-69 ( $j = J_R$ ). Population growth is set to 1.1% per annum, which is the average population growth rate for the U.S. economy between 1960-2000.

Males and females can be one of four education types: high school (*hs*), some college

(*sc*), college (*col*), more than college (*col+*). Age-efficiency profiles are constructed by computing average weekly wages using annual wages and salary income divided by the number of weeks worked. The data to compute age-efficiency profiles comes from the March Supplement of the 2000 Current Population Survey (CPS) for the US and the Survey of Income and Living Conditions (SILC) for Denmark. Wages are normalized by the average wages for all males and females of age between 25 and 64. The sample is restricted to follow [Katz and Murphy \(1992\)](#). First, the sample is restricted to the civilian population who work full-time. Excluded are self-employed and unpaid workers. In the US data, workers who make less than half the minimum wage are excluded. Figure x shows the labor productivity profiles for males and females, fitted to the data using second degree polynomials. The fitted values are used to calibrate the labor-efficiency units for males  $\omega(z, j)$ .

Initial labor-efficiency levels for females in period 1 are pinned down following the same procedures as for males. Table C1 in the Appendix shows the initial efficiency levels for males and females and the corresponding gender wage gap. The initial gender differences are about 10% smaller for both low and high educated females in Denmark. The evolution of female human capital after period 1 follows [Attanasio et al. \(2008\)](#) and is determined by

$$h' = H(x, h, l_f, j) = \exp \left[ \ln h + \alpha_j^x \mathbb{I}(l_f > 0) - \delta_x (1 - \mathbb{I}(l_f > 0)) \right] \quad (11)$$

Human capital depreciation is estimated conditional on female education using the Panel Study of Income Dynamics (PSID) data following [Mincer and Ofek \(1982\)](#). Due to the small sample size, female education types are collapsed into two skill groups.  $\delta_1$  is set to 2.2% for skilled females with *col* and *col+* education and  $\delta_2$  is set to 0.9% for less skilled females with *hs* and *sc* education. The data suggest that the human capital of skilled females depreciates more than twice as fast in a given year if females interrupt their labor force participation.  $\alpha_j^x$  is selected in such a way that the wage profile of females who participate in every period has the same shape as the one for males of the same education type  $x$ . This implies that  $\alpha_j^x$  are effectively set to the values of growth rates for males wages at age  $j$ . The same procedure is applied using data from the SILC for Denmark. Table C2 shows the values for all  $\alpha_j^x$ . Due to the small sample size of the SILC, I pool data between 2004 and 2010 for Denmark to estimate  $\alpha_j^x$  and only distinguish two education types: low educated women (*hs* and *sc*) and high educated women (*col* and *col+*).

**Demographics**  $F(x)$  and  $M(x)$  are the stationary distributions of females and males by innate education type. The distributions are estimated using U.S. data from the 2004 Census and are based off of all household heads and spouses belonging to age group 30-39. This age group is selected to capture the distributions of individuals across



productivity types during their prime-age working years. In addition, the fraction of females and males for each education cell is computed using the same sample. Approximately 26% of households are single and 74% of households are married. Using the data for married households, the distribution of married households by male and female education,  $\Omega(z, x)$ , is constructed. Table C3 summarizes the distributions.

The ELFS data for Denmark reveals that the fraction of married couples in the age group 30-30 is only 53.01%. However, the cohabitation rate in Denmark is significant. When accounting for cohabitation, the number of couples increases to 73.5%, which is surprisingly close to the distribution of married and singles in the US. I hence keep the distributions of singles and married couples constant across both countries.

**Children** There are three childbearing types in the model: *childless*, *early childbearer* and *late childbearer*. Every single female and every married couple can be one of the three childbearing types, while single males are always childless. Early childbearers have two children at ages 25-29, 30-34, and 35-39, which corresponds to model periods 1, 2 and 3. In contrast, late childbearers have children during model periods 2, 3 and 4, corresponding to ages 30-34, 35-39, and 40-44. In the U.S. data from the 2004 June Supplement, conditional on having a child married couples have on average two children and these births occur within a relatively short time period, between ages 25-29 for low educated households and 30-34 for high educated households. For single households the fraction of 40-44 year old women who were never married or divorced and never had children determine the measure of women who never have children in the model ( $b = 0$ ). Next, the fraction of females 25 and older with their last birth between the ages of 25 and 29 gives the fraction of early childbearers ( $b = 1$ ). Finally, females 25 and older with their last birth between the ages of 30 and 34 determine the fraction of old childbearers ( $b = 2$ ). The distribution of single females by childbearing type is given in Appendix B.3. For married couples, the same procedure is used. The data is supplemented using U.S. Census data to calculate the fraction of childless married couples with childless wives aged 40-44.<sup>6</sup> The Census only provides information on the total number of children in the household, not the total number of birth. Thus, the fraction of married couples aged 35-39 with no children in the household are used as a measure for childless married couples. The CPS June Supplement is used to calculate the fraction of couples above 25 who have a child early (age 25-29) or late (30-34) in the lifecycle. Appendix B.4 shows the distributions. For Denmark, the measure of childless couples is computed for

**Out-of-pocket Childcare Costs** In the US, out-of-pocket childcare costs paid by parents for full-time formal center-based care vary substantially. While some families may

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<sup>6</sup>The fraction of childless married females is too small in the CPS June Supplement.

pay 100% of costs, others may have fully subsidized care, while others may have partially subsidized care. Eligibility for child care subsidies is based on state-determined criteria for family income and work requirements and these requirements vary widely by state. The OECD Tax Benefit Model assumes cost and eligibility criteria as observed in Michigan. In 2004, a full-time center-based daycare spot was \$7,916 for a child less than three years of age and \$6,616 for children in the age group 3-5 years. Using data from the Survey of Income and Program Participation (SIPP), families spend on average 10% of their income on childcare for children below the age of 6 and around 7.7% for school-age children.

In Denmark, the maximum payable price for public day care is calculated as a proportion of the average expenses for all day care facilities of a given type in the municipality. The proportion that parents pay can be at a maximum of 30%. The OECD Tax Benefit Model assumes public day care center fees before subsidies of DKK 26,700 (\$4,463) for children 0-2 years of age and DKK 19,000 (\$3,176.21) for children 3-5. This corresponds to 8.4% of the average Danish income in 2004 for children below the age of 3 and to 6% for children age 3-6.

**Informal Care** Data on the fraction of households that use informal care as their primary care arrangement for children comes from the Survey of Income Program Participation (SIPP) for the US and from the SILC for Denmark. In the US data, more educated mothers spend more on childcare than less educated mothers, which potentially reflects differences in childcare quality. At the same time, more educated mothers have fewer children. These two effects counteract each other in the model and almost cancel out perfectly.<sup>7</sup> I thus abstract from modeling variation of childcare cost by maternal education and variation in the number of children by maternal education type. In 2004, about 24% of US families use informal care (i.e. care provided by grandparents) as their primary care arrangement for children under the age of 6, while the fraction in Denmark is significantly lower with 9.5%.

**Capital and Consumption Taxes** Consumption tax rates and capital tax rates are provided by [McDaniel \(2012\)](#), who calculates consumption and capital tax rates from NIPA data. The advantage over these tax rates over simple value added tax rates is that they capture excise taxes, and exemptions from value added taxes, among others. The difference between consumption and capital taxes between the US and Denmark are large. While the consumption tax in the US is about 7.5%, the same tax is more than four times as large with 31% in Denmark.

**Non-linear Labor Income Taxes** The tax functions for singles and married couples

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<sup>7</sup>[Guner et al. \(2017\)](#) introduce both channels into the model and do not find that it significantly affects their conclusions, even in the cross-section.

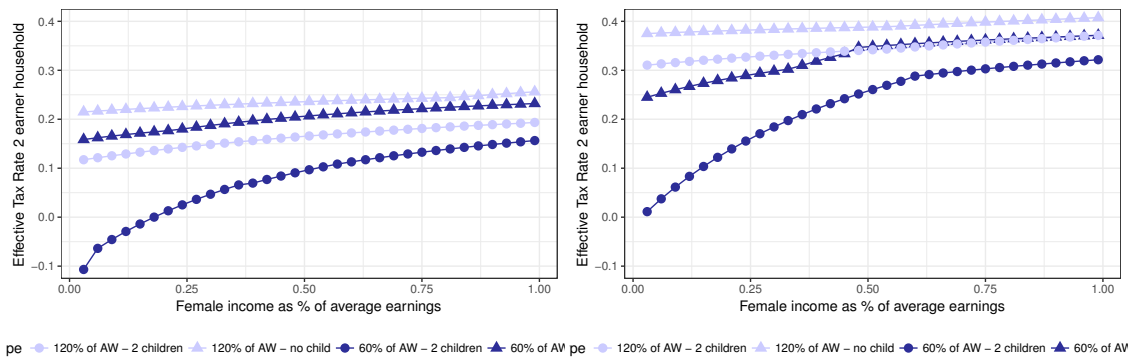
without children,  $t^S(I,0)$  and  $t^M(I,0)$ , are approximated using the OECD Tax Benefit model, which is comparable to the NBER TaxSim module for the US. The OECD Tax Benefit model calculates labor income taxes according to the statutory labor income tax code, and includes employees' social security contributions and benefits, conditional on the number of children, child age, and marital status. The OECD model calculates the household net income for any combination of male and female earnings for married couples. It takes standard deductions, such as basic allowances, allowances for children, deduction of social security contributions into account. In addition, since 2004 the tax deductibility of childcare expenses is included. The model abstracts from individual non-standard deductions, such as mortgage payment deductions and deductions for expenses on household helpers.

Using the module, I compute the effective tax rate for a single household with earnings between 0 and 6 times the average wage in the economy using an equally spaced grid of 251 grid points. For married couples, I construct a 2 dimensional grid. One dimension captures the labor income of married women, the other dimensions captures earnings of a married man. The combination of both incomes gives the effective tax rate that the couples faces. Female labor income varies between 0 to 6 times the average wage in the economy and is approximated on 251 grid points. Male earnings vary between 0 and 9 times the average wage in the economy and 151 grid points are used to capture earnings for males. This gives a total of 37,901 combinations of husbands' and wives' labor income. I then use two-dimensional interpolation to find the effective tax rate that a model household faces given the individual earnings faces.

**Child-related Transfers** The presence of children in the household is indicated by  $k = 1$ . The functions  $t^S(I,1)$  and  $t^M(I,1)$  approximate the effective tax rates for families with children. The tax grids are computed under the assumption that every household has two children of ages 2 and 4 attached to it. To compute the effective tax rates for households with young children, I take advantage of the special 2004 OECD Taxing Wages module, that implements the tax deductibility of childcare expenses in addition to benefits, such as child tax credits and lone-parent benefits, across countries.

The OECD Tax Benefit model computes the relevant transfers and tax credits conditional on statutory eligibility criteria. For example, childcare expenses in the US are only tax deductible if the mother is working and programs such as the Childcare Development Fund (CCDF) or the Child and Dependent Care Credit (CDCC) are means-tested. Child benefits in Denmark, on the other hand, are universal.

Figure 5 summarizes the effective tax rates for households with and without children conditional on two male earnings levels. The  $x$ -axis plots wives' labor income between 0 and 100% of the average wage in the economy at a given level of husband earnings. The dark blue line plots the effective tax rates for low income families in



(a) USA

(b) Denmark

Figure 4: Effective Tax Rates from the OECD Tax Benefit Model

which the husband earns 60% of the average wage in the economy and the light blue line plots the effective tax rates faced by families in which the husband earns 120% of the average wage.

Across both countries, two patterns emerge: First, at all income levels, families with young children face lower effective tax rates. This is mainly due to policies, such as child tax credits that vary with income level, but are only conditional on the presence of a child within the family. Second, non-linearities in the tax code are more pronounced among low-income families, and in particular with young children. This is due to the fact low-income families are usually subject to means-tested programs that include special benefits or tax credits for families with young children. [include graph for singles and lone-parents.]

Childcare cost in Denmark are subsidized. For low-income families fees are subsidized up to 100%. The extent of the subsidy diminishes as income increases. There are also special discount rates for single-parents and for siblings. Childcare fees are not tax deductible and subsidized day-care is available to all households with young children. Local authorities finance nurseries, kindergartens, other day-care institutions and pre-school classes from block grants allocated to them by the State. A so called care guarantee has been introduced by many authorities guaranteeing a subsidized day-care place for the child from when the child is 26 weeks until school age. Parents pay a maximum of 25% of the budgeted gross operating expenditure for day-care services. There is no charge for day-care if the personal income (i.e. gross income net of general social security contributions) is below DKK 156 301. From DKK 156 301 to DKK 159 765 the payment is 5% of the full rate. From that income level, the payment is linearly increased until the full price is paid at a personal income of DKK 485 499.

Child care services are primarily provided through a market-based system at rates determined by market forces. Rates vary substantially based on region, state, age of child, and type of child care setting. The Child Care and Development Fund (CCDF) is

the government child care subsidy program, which provides subsidies to low-income working families to offset the cost of purchasing child care, while maintaining the parental choice afforded by the market system. CCDF is a federal block grant program, providing funds directly to states, territories and tribes to operate a child care subsidy program designed to meet local needs. States have broad flexibility in determining eligibility guidelines (up to a maximum of 85% of state median income, set to 37% in Michigan in 2010), reimbursement rates, and co-payment amounts, as well as the scope and quality of services. In Michigan, subsidies provided through the CCDF vary with family income, size of the family and age of the child in care. The (non-refundable) Child and Dependent Care Credit (CDCC) provides assistance to working taxpayers. A maximum of 35% of childcare costs (after CCDF and subject to a ceiling) can be claimed. Child care fees are tax deductible through the CDCC. The tax credit is non-refundable, so families that do not pay taxes do not benefit from the credit.

**Preferences** Following [Kaygusuz \(2010\)](#), [Guner et al. \(2012\)](#) and [Guner et al. \(2017\)](#),  $\chi$ , the elasticity of labor supply, is set to 0.4. This is consistent with survey estimates (see [Blundell and MaCurdy \(1999\)](#), [Domeij and Flodén \(2006\)](#), and [Keane \(2011\)](#) for a discussion of these estimates). Given  $\chi$ , I select the weight on the disutility of labor,  $\phi = 5.71$ , to match average hours worked per worker in the data, which is 44%. Average hours worked are calculated using a sample of all employed and unemployed individuals between the age of 25 to 64 in the CPS data. I assume that individuals work at most 80 hours per week. The discount factor  $\beta$  is set to 0.973 annually, such that the capital-to-output ratio is 2.93, which is consistent with US data.

The utility cost from joint work for married couples is calibrated using the method developed in [Kaygusuz \(2010\)](#), which was later applied in [Guner et al. \(2012\)](#), [Guner et al. \(2017\)](#) and [Bick and Fuchs-Schündeln \(2017\)](#). At the beginning of their life-cycle, married couples draw a utility cost parameter conditional on the husband's initial education type  $z$ . The utility cost parameter  $q_z$  is drawn from a flexible gamma distribution with shape parameter  $k_z$  and scale parameter  $\theta_z$  and  $\Gamma(\cdot)$  is the Gamma function :

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

$z$ ,  $k_z$  and  $\theta_z$  are selected in such a way that the labor force participation rates of a married female with education type  $x$  married to a male of education type  $z$  is matched as closely as possible in the US data. This implies that for each couple of type  $(z, x)$ , there is a  $q_z^*$  that makes the a married women indifferent between working and not working. This optimal  $q_z^*$  will be higher for women with higher education who can earn higher returns to market work. Hence, married women with higher education will have a higher participation rate conditional on husband's education, a pattern that

is consistent with the data. Appendix ?? summarized the parameters governing the distributions of utility costs.

	USA			
m/f	hs	sc	col	col+
hs	48.7	66.5	71.2	78.8
sc	52.6	72.8	77.4	85.1
col	54.4	70.8	75.7	84.2
col+	52.6	67.9	70.8	75.6
Total	50.4	70.7	74.2	78.3

Table 4: Labor force participation of married females, age 25-54

Using 2004 CPS data, I calculate the employment-to-population ratio based on individuals in the civilian labor force (i.e. excluding armed forces). Table 4 displays the resulting distributions. The aggregate participation rate for married females aged 25-54 is 72.3%, ranging from 50.4% for the lowest education type to 78.3% for the highest education type.

**Technology** The capital share  $\alpha$  of the Cobb -Douglas production function and the capital depreciation rate  $\delta_a$  are calibrated using a notion of capital that includes fixed private capital, land, inventories, and consumer durables. The capital-to-output ratio for the period 1960-2000 is on average 2.93 annually. The capital share is set to 0.343 and the annual depreciation rate to 0.055.

**Summary** Table 5 summarizes the parameter choices for the benchmark economy. While the previous sections laid out as detailed as possible which parameters were chosen from exogenous estimates, the following parameters were chosen to match specific targets. First, the discount factor  $\beta$  is chosen to match the capital-to-output ratio in the model. Next disutility of market work,  $\gamma$ , is chosen to match average hours worked in the model. Finally, the utility cost from joint work for married couples is  $p(q|z)$  is chosen such that the participation rates for married females conditional on their own education type and their husbands' education type is matched.

Parameter		Value US	Adj. for DK	Target
A. Preferences				
Discount factor	$\beta$	0.973	–	Capital-to-output ratio
Intertemporal elasticity	$\gamma$	0.400	–	Literature estimates [0.2, 0.4]
Disutility of market work	$\phi$	5.710	–	Average hours worked
Joint utility cost	$p(q z)$		–	Female LFP by education
B. Technology				
Capital share	$\alpha$	0.342	–	Guner et al. (2012)
Depreciation rate	$\delta_k$	0.055	–	Guner et al. (2012)
C. Female Human Capital				
Depreciation female COL+	$\delta_1$	0.020	–	PSID data
Depreciation female less COL	$\delta_2$	0.009	–	PSID data
Growth female HC	$\alpha_j^x$			CPS and SILC data (see App.)
D. Childcare Costs				
Childcare cost young	$\psi_1$	0.100	0.084	Childcare exp. for 0-5 yr olds
Childcare cost old	$\psi_2$	0.077	0.060	Childcare exp. for 6-15 yr olds
E. Government				
Capital income tax	$\tau_k$	0.236	0.408	McDaniel (2012)
Consumption tax	$\tau_c$	0.075	0.310	McDaniel (2012)
Income tax schedule	$t^M(I, k)$			OECD Tax Benefit Model
	$t^S(I, k)$			OECD Tax Benefit Model
Old-Age-Benefits	$b^M(x, z)$			CPS and SILC data (see App.)
	$b^S(x)$			CPS and SILC data (see App.)
	$b^S(x)$			CPS and SILC data (see App.)

Table 5: Calibration of Benchmark Economy

## 6 Benchmark Economy

This section compares the results of the benchmark economy to the data. The model is calibrated to the US economy. As shown in panel A and B in table 5, preference and technology parameters are set to the same values for the Danish economy. In addition, the parameters governing human capital depreciation for low and high skilled females,  $\delta_1$  and  $\delta_2$ , are estimated from the PSID data. These depreciation parameters are not adjusted in the Danish economy due to a lack of panel data for Denmark in the SILC.

The following key parameters of the model are adjusted for the Danish economy. First, the growth rate of female human capital,  $\alpha_j^x$ , is adjusted. Due to data limitations in the SILC, only two education groups can be distinguished for Denmark: high skilled (*col* and *col+*) and low skilled (*hs* and *sc*) women. Next, the out-of-pocket childcare costs (Panel D) are adjusted to levels that are observed in the data and correspond to the assumptions made by the OECD in the Tax Benefit simulation model. Finally, all functions and parameters that govern taxes households pay to the government and the benefits they receive from the government are modified to match the Danish tax system: capital taxes, consumption taxes, labor income tax functions and old-age benefits. Labor income taxes functions differ for married and single household and whether they have children and not. Old-age benefits are conditional on marital status and education.



	USA		Denmark	
	Data	Model	Data	Model
$K/Y$	2.93	2.94	3.20	3.06
Avg. hours	0.44	0.43	0.35	0.30
LFP married	72.30	73.10	79.80	74.20
LFP mothers	59.10	59.00	83.70	78.90
LFP <sub>gap</sub>	13.20	14.10	-3.90	-4.70

Table 6: Results for the Benchmark Economy

At the aggregate level, the model matches the capital-to-output ratio and the average hours worked in the US economy quite well, which are moments targeted by the calibration. In addition, the labor force participation of all married women aged 25-54 is 73.1% in the model and 72.3% in the data, a moment targeted by calibrating the joint utility cost for married couples. The model almost perfectly matches the maternal participation rate, which is 59% in the model and 59.1% in the data. The resulting maternal participation gap for the US is 14.1% in the model compared to 13.2% in the data.

It is worth noting that maternal participation rate and the resulting participating gap is not a targeted moment. In [Guner et al. \(2012\)](#) and [Guner et al. \(2017\)](#), the time cost for rearing children is chosen such that the model matches the maternal participation gap in the data. In contrast, the model economy presented here abstracts from time costs for females with children. Thus, the difference between participation rates of women with and without children is only driven by differences in the household budget constraint.

The key feature to generate the participation gap endogenously is to introduce the actual tax and transfer system, including child-related transfers and all social benefits. This notion is supported by the fact that the time cost in [Guner et al. \(2017\)](#) is 85% lower than in the simpler model version in [Guner et al. \(2012\)](#). The key difference between both studies is that the later model version specifically models means-tested programs in the US (such as TANF, CCDF and CCDC) that give additional child tax credits to low income families or allow low-income families to deduct childcare expenses from their taxable income. These policies are absent from [Guner et al. \(2012\)](#), and the model has a hard time matching the maternal participation gap without exogeneously imposing a fixed time cost. As pointed out by [Bick and Fuchs-Schündeln \(2017\)](#), capturing the full non-linearities introduced by these policies is crucial in matching the labor force participation of married women. The benchmark results demonstrate that this point can be extended to married women with and without pre-school children.

For Denmark, the model matches the capital-to-output ratio and average hours worked quite closely, even though these moments are not targeted. Average hours are about 14% lower in the model than in the data. Similarly, the participation rates of

married women in general and married women with small children are both about 5% lower than in the data. This finding is consistent with [Bick and Fuchs-Schündeln \(2017\)](#). They note that Denmark is an outlier in their sample of OECD countries. They attribute the fact that the model does not perform as well for Denmark to the fact that it features the highest average tax rate in Scandinavia, thereby providing a huge disincentive to work. The model matches the maternal participation gap quite closely, it is -3.9% in the data and -4.7% in the model. The negative gap is mainly due to the underlying age composition of both groups. The statistics for married women with young children is comprised of younger women who have children either between the ages 25-29 or ages 30-34. Those periods are also periods during which the growth in human capital is the largest. Hence, in countries with very generous policies that alleviate the cost of child-rearing for women, the labor force participation of mothers tends to be very high.

## 7 Policy Experiments

### 7.1 Decomposing the Maternal Participation Gap

This section revisits the first question raised at the beginning of the paper: *What accounts for the maternal participation gap?* To explore this question from the perspective of a structural model, I first remove all model features that affect households, and in particular women, with and without children differently. The three key features removed from the model are the cost of childcare  $\psi = 0$ , access to informal care  $g = 0$ , and child-related transfers,  $s_k = 0$ . For simplicity, I denote the model that treats families with and without children identically when determining the effective tax rate as  $s_k = 0$ . In the quantitative model, this implies that the tax functions  $t^M(I, 0)$  and  $t^S(I, 0)$  are applied to families with young children. The three model features are then successively added back to the model. This gives rise to 4 model versions:

- (1) No child-related differences:  $\{\psi, g, s_k\} = 0$

There are no model differences between households with and without children, which implies that the budget constraint for married couples with and without children is identical. The same holds for the budget constraint of single households with and without children.

- (2) Childcare-cost-economy:  $\{\psi > 0, g = 0, s_k = 0\}$

Mothers who work have to purchase formal childcare. No working mother has access to informal care and no child-related transfers are paid.

- (3) Informal-care-economy:  $\{\psi > 0, g > 0, s_k = 0\}$

In this economy, working mothers have to pay out-of-pocket childcare costs, but a fraction of them has access to informal care.

(4) Benchmark economy:  $\{\psi > 0, g > 0, s_k > 0\}$

This calibration accounts for the benchmark economy, in which households receive child-related transfers, a fraction of families has access to informal childcare, and working mothers without access to informal care face out-of-pocket childcare expenses.

	Data	(1) $\{\psi, g, s_k\} = 0$	(2) $\psi > 0$	(3) $g > 0$	(4) $s_k > 0$
USA					
LFP <sub>gap</sub>	13.20	-6.60	4.30	-1.70	14.10
Denmark					
LFP <sub>gap</sub>	-3.70	-0.60	2.30	0.50	-4.60

Table 7: Decomposition

Table 7 summarizes the results from the decomposition exercise and reports the maternal participation gap that arises endogenously in each of the model versions, both for the model calibrated to the US and to Denmark.

In the no child-related differences economy (1), households with children do not face any additional costs due to the presence of young children. The negative participation gap arises in both economies due to the different demographic composition of both groups. In the model, mothers have young children during model period 1 and 2. The labor force participation rate of married women is computed as the average rate between ages 25-54, which corresponds to model period 1-6. Notice that the average participation rate of married women without children in model period 1 and 2 still differs from the participation rate of mothers due to differences in the distribution of education types across childbearing groups (see Appendix).

The participation gap is larger in the US relative to Denmark, suggesting that the gains in female human capital early in the life cycle are more pronounced. Indeed, the data suggests that the growth rate in human capital for Danish women is non-decreasing up until retirement, while US women reach a peak in their human capital at age 50-54, and human capital declines afterwards. This notion is supported by [Gupta and Smith \(2002\)](#), who show that the effect of children on the wage gap of mothers disappears when controlling for unobserved heterogeneity. Danish mothers appear to lose human capital during child-rearing periods, however, this does not have long-term effects on the earnings potential of mothers. In a recent paper, [Kleven et al. \(2017\)](#) point out, however, that the persistence in gender difference in earnings in Denmark can be fully attributed to the effect of children on the wage.

Model economy (2) introduces out-of-pocket childcare costs for working mothers,  $\psi > 0$ . The effect of the participation gap is homogeneous across both countries. The participation gap increases substantially in both countries. The effect of out-of-pocket

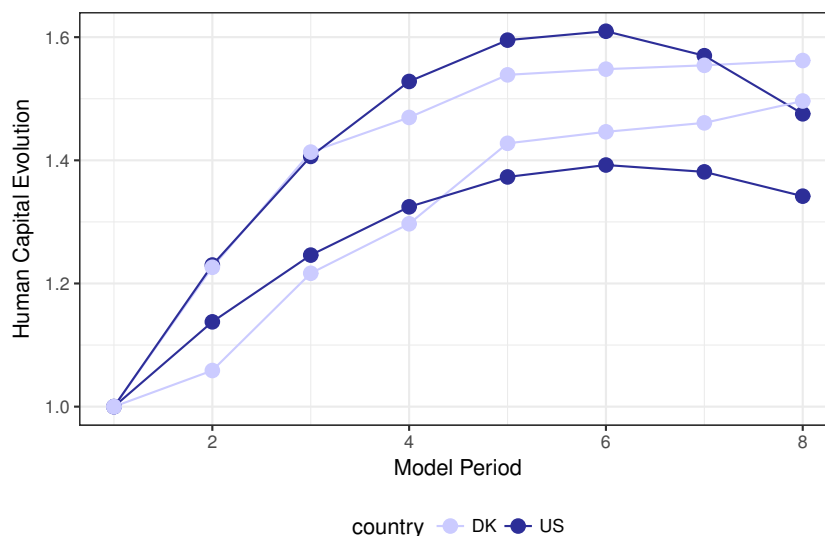


Figure 5: Human Capital Evolution of a low and high skilled full-time working woman

childcare costs in the US is significantly larger, which can be attributed to the fact that these costs are about 25% larger in the US.

The strong increase in the maternal participation gap due to the introduction of out-of-pocket childcare costs in (2) is largely alleviated by allowing a fraction of households in the economy to have access to informal care,  $g > 0$  as in (3). Informal care relaxes the household budget constraint as working mothers do not face out-of-pocket childcare cost. The effect of informal care on maternal participation is larger in the US since a greater fraction of households in the US rely on informal care as their primary care arrangement. It is crucial to note, however, that the maternal participation gap cannot be matched even qualitatively, if only out-of-pocket childcare costs and informal care arrangements are considered.

Model version (4) is the benchmark economy and taxes households with young children according to the statutory labor income tax code, i.e. it accounts for child tax credits and the tax deductibility of childcare costs:  $s_k > 0$ . The model now generates a maternal participation gap that is positive in the US and negative in Denmark. This finding deserves further discussion. Figure 6 plots the effective tax rates for households as females increase their earnings and conditional on male earnings for the US and Denmark. Low income for males is defined as 1.2 times the average earnings in the economy, middle income is defined as 1.8 times average earnings and high income as 3 times the average earnings.

In a joint taxation system like the US, the effective tax rate for the household increases as females increase their earnings. The increase of the effective tax rate due to the second earner working becomes less strong for high income households. In Den-

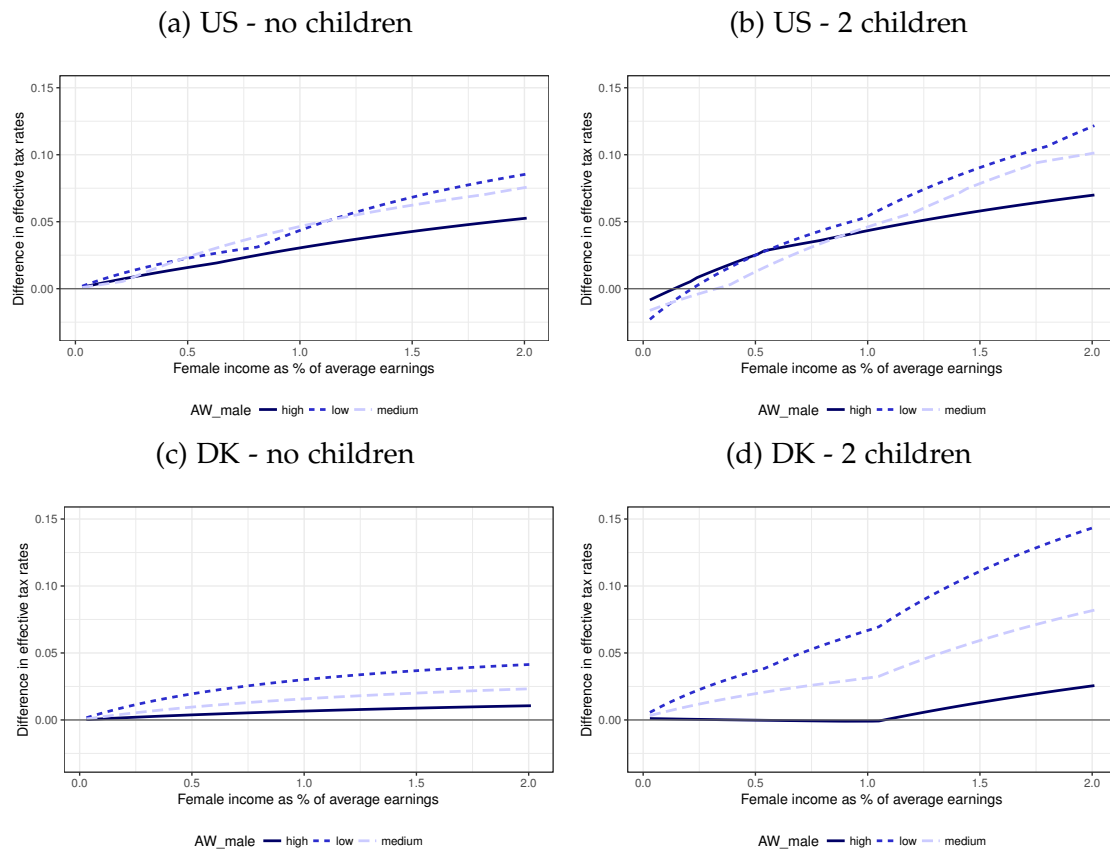


Figure 6: Differences in effective tax rates relative to a 1-earner household

mark, this pattern is much less pronounced due to the individual taxation system. For families with children in the US, the effective tax rates is initially lower for a 2-earner household relative to a 1-earner household. However, as females further increase their earnings, the effective tax rates rises and the increase is almost homogeneous across male earning types. In Denmark, the effective tax rates increases most for low income households. A rise in female earnings implies that households become ineligible for social benefits and thus the effective tax increase is most pronounced for low income households. For high income households, that is, households that do not qualify for social benefits, the effective tax rate does not differ increase until females earn at least the average earnings in the economy. Thus, the disincentive embedded in the tax code is lower for females in Denmark, in particular for households that do not receive social benefits.

Table 8 shows that the adjustment in the participation rates of women for the cross-section on the US. The adjustment in aggregate maternal participation rate due to the introduction of child-related transfers stems mainly from low skilled mothers. These transfers reduce the effective tax rates for households with young children the most for low income households. These results underline the highly non-linear effect of these child-related transfer programs. They also imply that any type of family policy reform

USA				
m/f	LFP( $s_k = 0$ ) - LFP( $s_k > 0$ )			
	HS	SC	COL	COL+
HS	-19.0	-16.0	-4.0	0.0
SC	-5.0	-7.0	-2.0	-1.0
COL	-9.0	-2.0	1.0	1.0
COL+	-1.0	1.0	1.0	0.0

Table 8: Adjustment in participation rates, model (3) vs. (4)

will affect mothers differently, depending on their skill type. Notice that this exercise is a pure decomposition and there are no implications for the effects on family welfare in each model regime.

## 7.2 Cross-Country Variation in the Maternal Participation Gap

### 7.2.1 The Design of Child-related Transfers in the US and Denmark

To what extent is the finding that child-related transfers decrease the participation gap in Denmark, but increase the gap in the US driven by joint vs. separate taxation? To explore this angle further, I conduct the following experiment: I keep the US tax rates as given for families without children and use simulated tax rates for families with children. The simulated tax rates capture the difference in the effective tax rates for households with and without children as in the Danish tax code. The impact of child-related transfers on the effective tax rates of households with and without pre-school children is summarized in Figure 7.

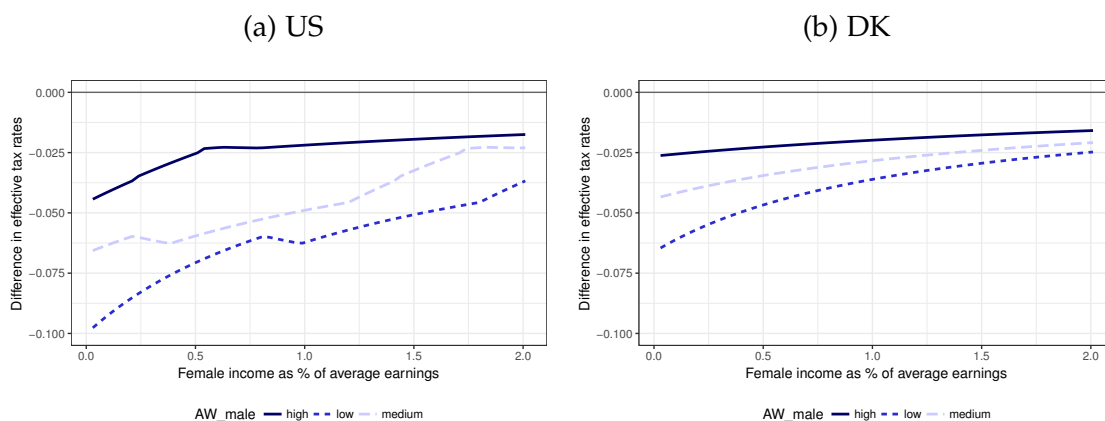


Figure 7: Differences in effective tax rates for married couples with and without children

The tax data shows that child-related transfers as designed in Denmark introduce much smaller differences in the tax rates of families with and without children com-

pared to the US tax code. In addition, the tax differences between households with and without children are decreasing with family income. Child-related transfers in the US introduce large distortionary tax differences, in particular for low income households with children. I capture the effect of an introduction of Danish child-related in the US economy by keeping the average tax rates and tax progressivity of the US tax code fixed. Thus, households without children face identical tax rates relative to the benchmark economy. The simulated effective tax rates for households with children capture the difference in tax rates of families with and without children as in the Danish tax code (see Figure 3b). Table 9 summarizes the effect of an introduction of Danish child-related transfers into the US economy. The design of Danish-transfers closes the participation gap by 2/3 from 14.1% to 4.9%. This suggests that the larger participation gap in the US economy is mainly due to the specific design of US family policies and cannot merely be attributed to the fact that the US is a joint taxation country in which the 2-earner faces a higher marginal tax rate than in Denmark.

USA			
	Data	Benchmark	DK transfers
LFP <sub>married</sub>	72.30	73.10	77.30
LFP <sub>mothers</sub>	59.10	59.00	72.40
LFP <sub>gap</sub>	13.20	14.10	4.90

Table 9: US economy with Danish child-related transfers

### 7.2.2 Informal Care and the Elasticity of Maternal Labor Supply

To explore to what extent maternal labor supply responds to policy reforms, I conduct a second thought experiment. I take the US benchmark economy and successively replace the following three features of the economy. First, I introduce the statutory labor income tax code of Denmark into the economy. This implies that households are now taxed at the individual level instead of jointly. Hence, the female participation decision only affects her individual tax rate, the marginal tax rate faced by the spouse remains unaffected. This effect should theoretically increase the labor force participation rate of married women. At the same time, Denmark's tax code implies higher average taxes on labor income and it is more progressive than the US economy. [Holter et al. \(2017\)](#) derive an index of tax progressivity for a set of OECD countries. They find that Denmark has one of the most progressive tax system with an index of 1.88 relative to the US with an index of 1.

Would an introduction of the Danish individual tax system and child-related transfers close the participation gap of the US economy? Table 10 summarizes the responses of maternal employment rates in the US economy to both policy changes. Surprisingly,

	Informal Care	$y_{hh}^{DK}$	$(1 + s_k^{DK})y_{hh}^{DK}$
LFP <sub>married</sub>	$g^{US}$	71.90	73.50
LFP <sub>mothers</sub>		63.00	65.10
LFP <sub>gap</sub>		8.90	8.40
LFP <sub>married</sub>	$g^{DK}$	70.10	72.80
LFP <sub>mothers</sub>		50.80	73.40
LFP <sub>gap</sub>		19.30	-1.60

Table 10: Maternal labor supply and the size of the informal care market

conditional on the large informal care market in the US, an introduction of an individual taxation system and less distortionary child-related transfers closes the participation gap by less than half. The same policy change, however, yields a gap of -1.6% that is similar to the Danish data when the small informal care market that is observed in Denmark is taken into account. In general, the economy with a small informal care market yields significantly larger responses in maternal labor supply to the same policy change than the economy with a large informal care market. Empirical studies have found that a large fraction of families substitute informal for formal care due to a reduction in the price of formal childcare. Yet, mothers do not enter labor force as they take up formal childcare. A model suitable for policy analysis thus needs to account for the reallocation between formal and informal care in response to policy reforms.

## 8 Concluding Remarks

In this paper, I develop a structural model of joint household labor supply, in which female human capital evolves endogenously and a fraction of households with young children has access to informal care. I use the model to explain the maternal participation gap, i.e. the difference in the participation rates of married females with and without children in two countries: the US and Denmark. The US participation gap is sizable with 13% and comparable to many Western European countries such as Austria, France, or Luxembourg. The Danish participation gap is small and negative instead with -3.7%. The two countries differ along four dimensions that are of first-order importance to maternal labor supply: the labor income tax code (joint vs. separate), out-of-pocket childcare costs, the design of child-related transfers, and the size of the informal care market.

I find that child-related transfers determine the sign and magnitude of the maternal participation gap in the US and Denmark. These transfers introduce important differences in the effective tax rates for households with and without children. Households with children face lower average taxes and higher tax progressivity relative to childless



households. In particular, the effects of child-related transfers on maternal participation depend on the design of these transfers. Introducing child-related transfers into the US economy increases the maternal participation gap and reduces the maternal participation gap for the Danish economy. This is due to the differential effect of these transfers on the effective tax rates that households with young children face. Finally, to understand how maternal employment rates respond to a change in the design of child-related transfers, I explore key drivers of the maternal labor supply elasticity and identify the size of the informal care market as a main determinant.

The results further suggest that the parental choice of formal and informal childcare in response to policy reforms is an important margin to understand the effect of a reduction in the price of formal childcare on maternal labor supply. This is an interesting extension for future research.

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# Appendix

## A Stylized Facts

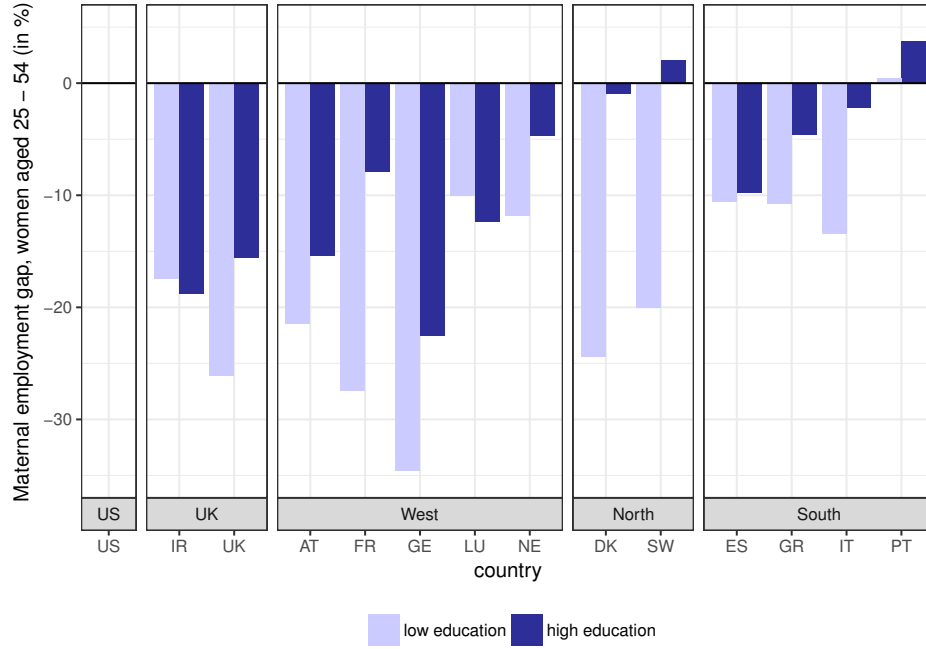


Figure 8: Maternal Participation Gap by female education

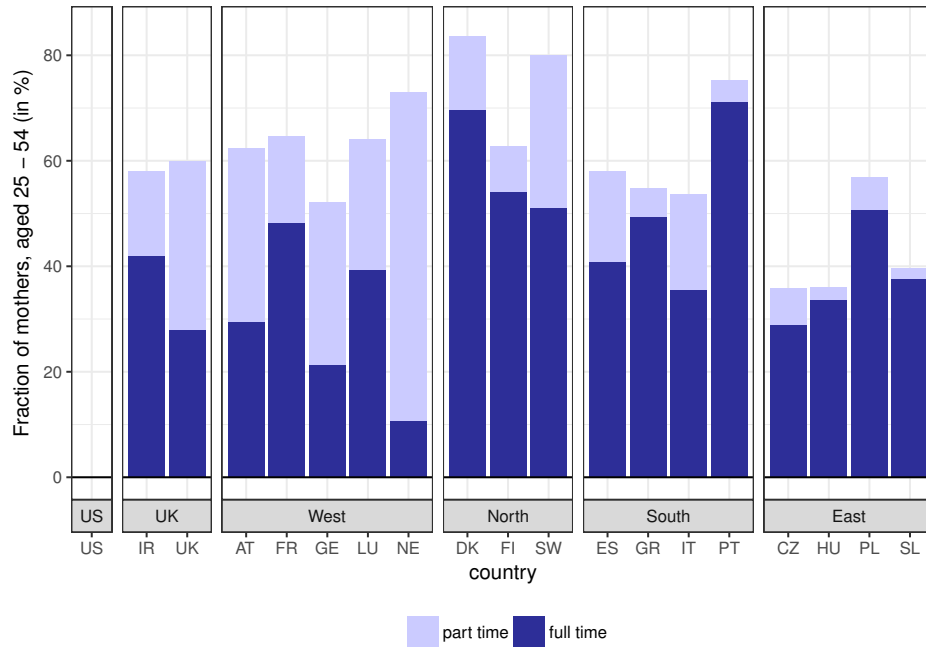


Figure 9: Decomposition of female employment rates, 2005-2007

## A.1 Effective Tax Rates Across European Countries

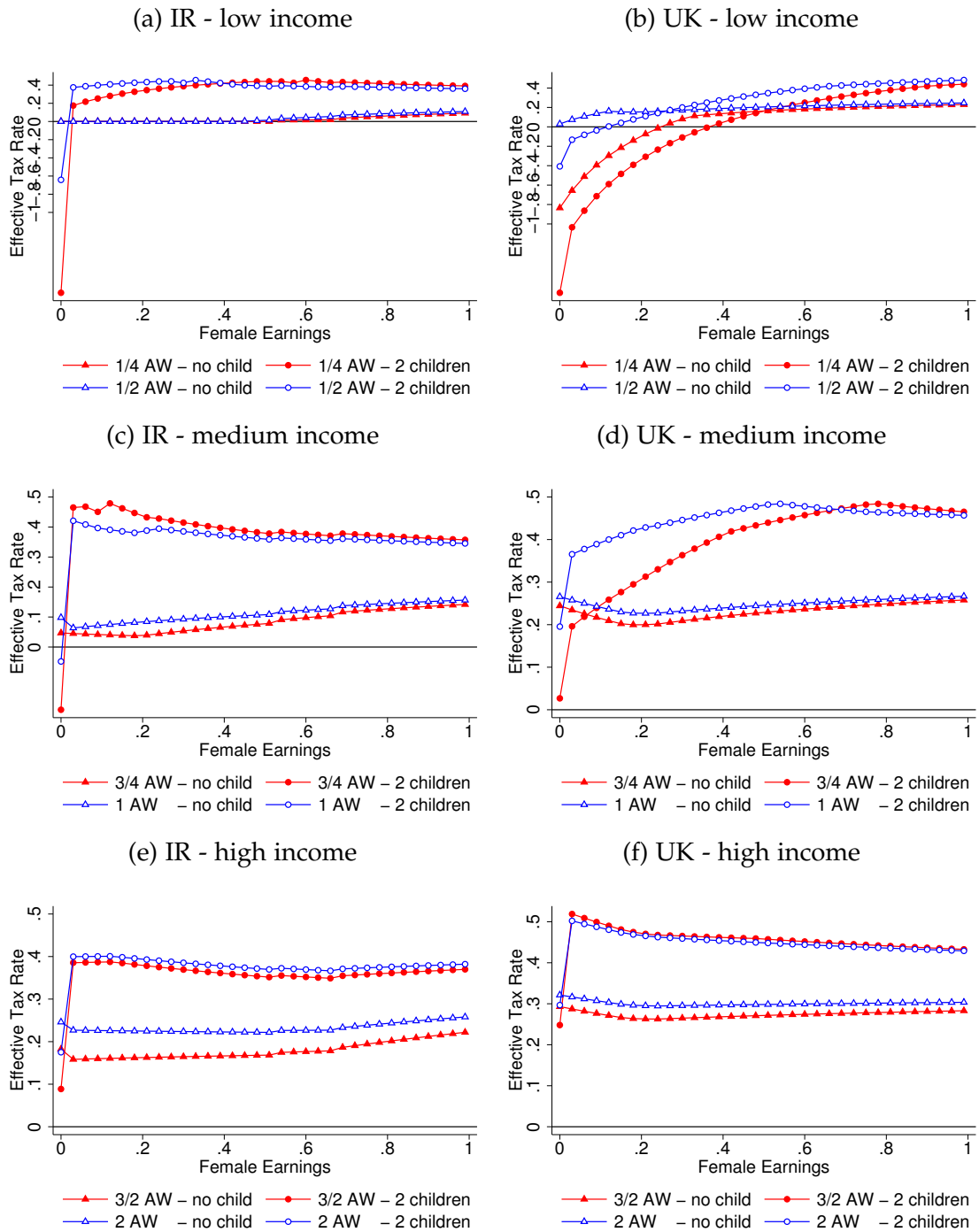


Figure 10: Effective Tax Rates: Ireland and United Kingdom

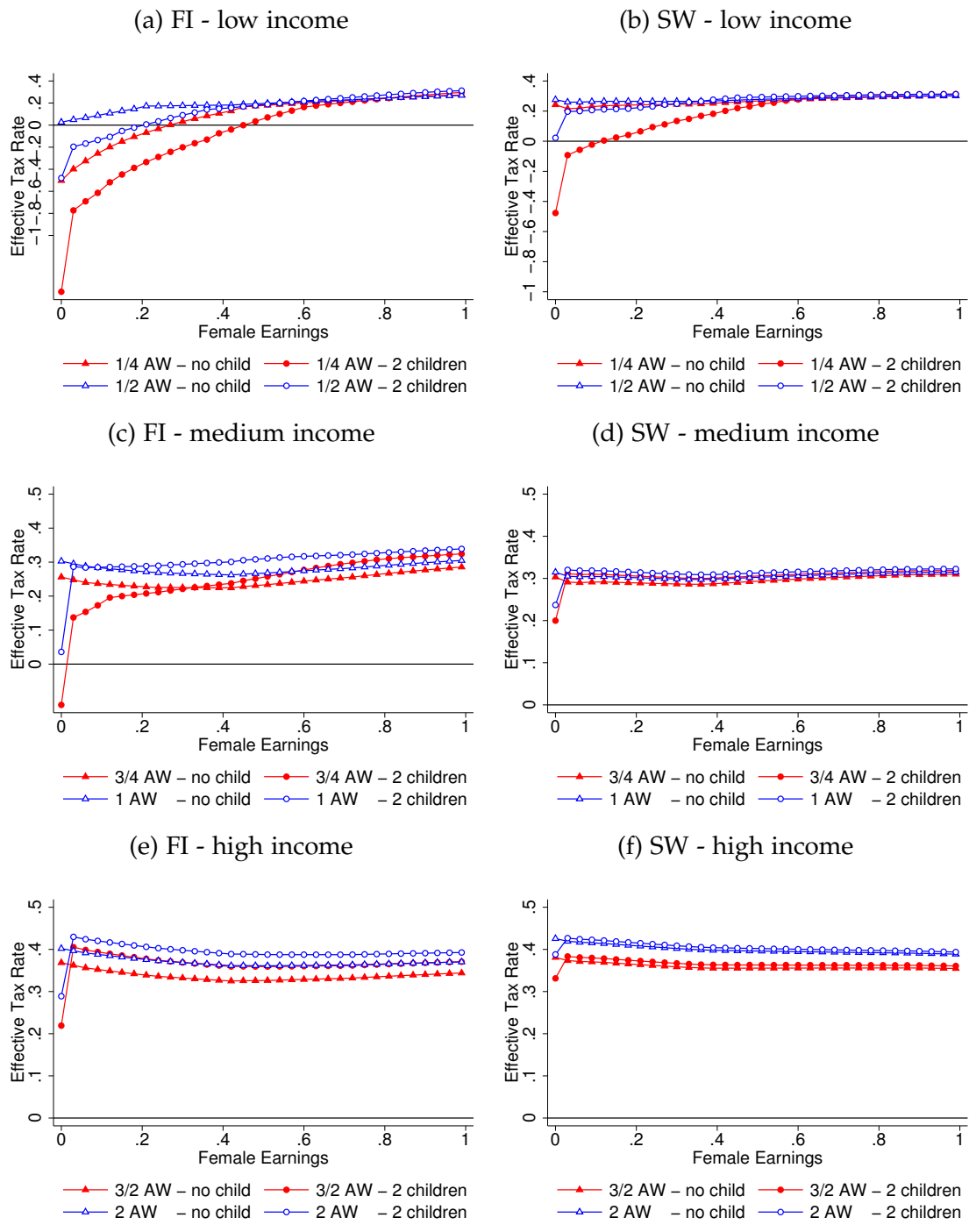


Figure 11: Effective Tax Rates: Finland and Sweden



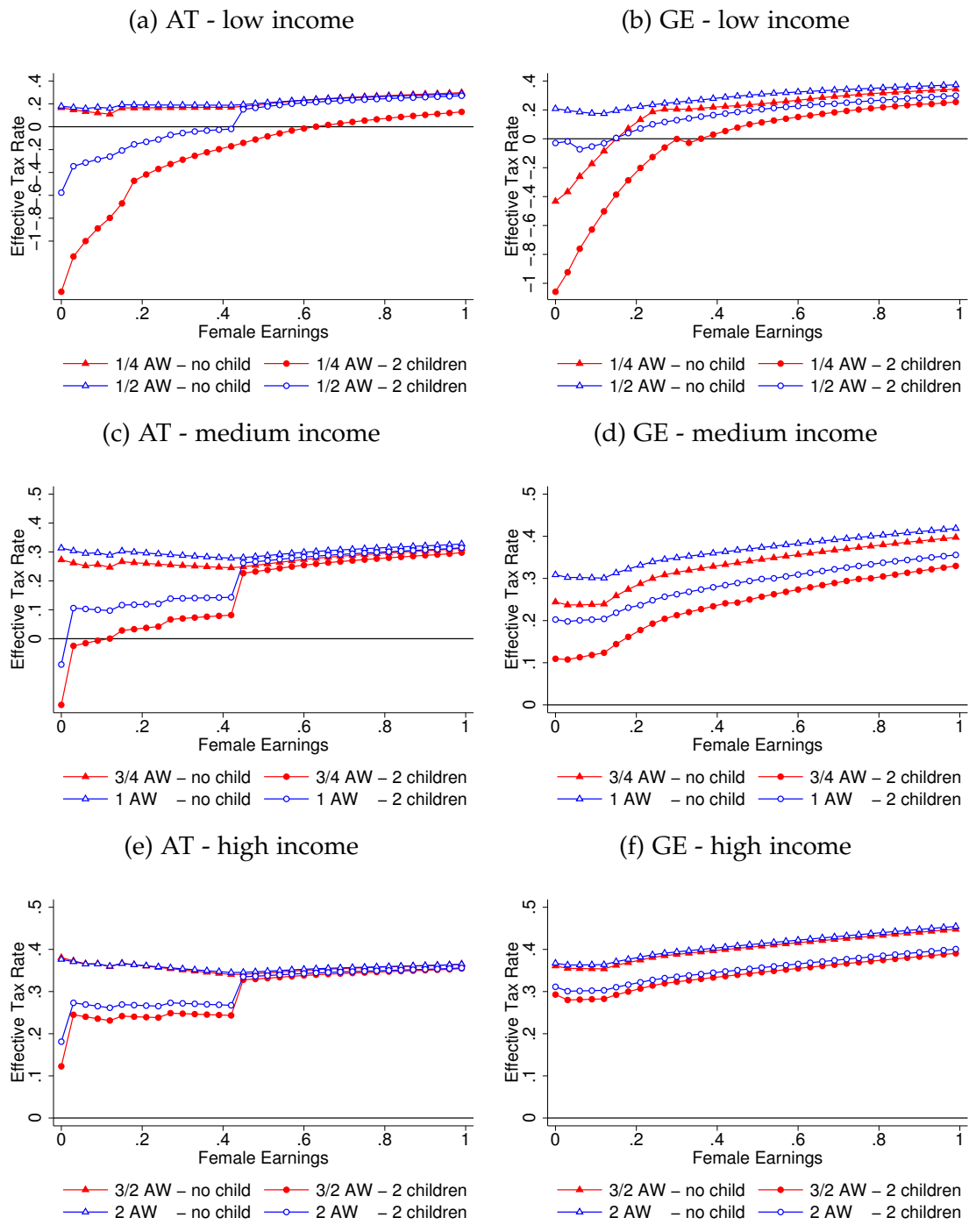


Figure 12: Effective Tax Rates: Austria and Germany

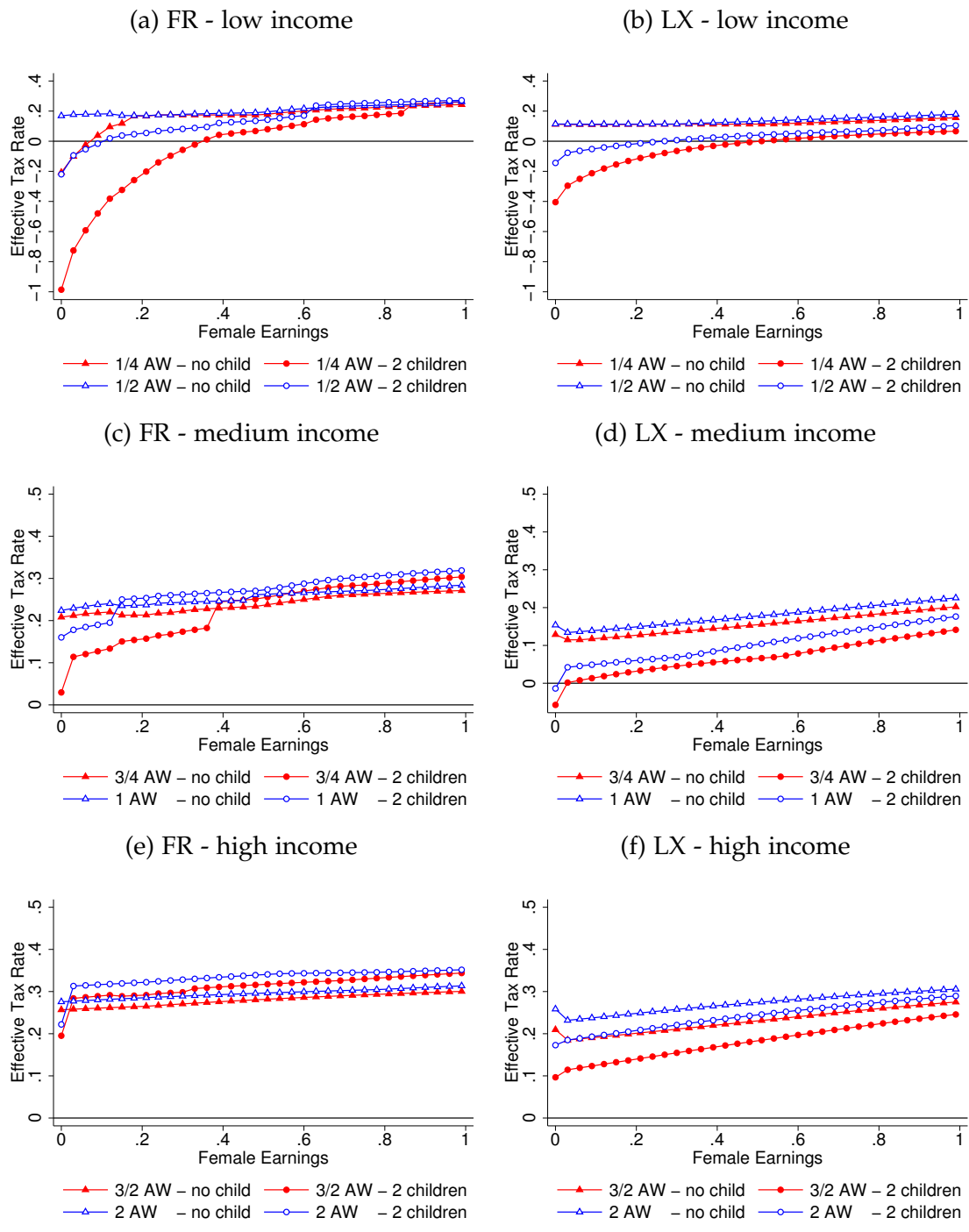


Figure 13: Effective Tax Rates: France and Luxembourg

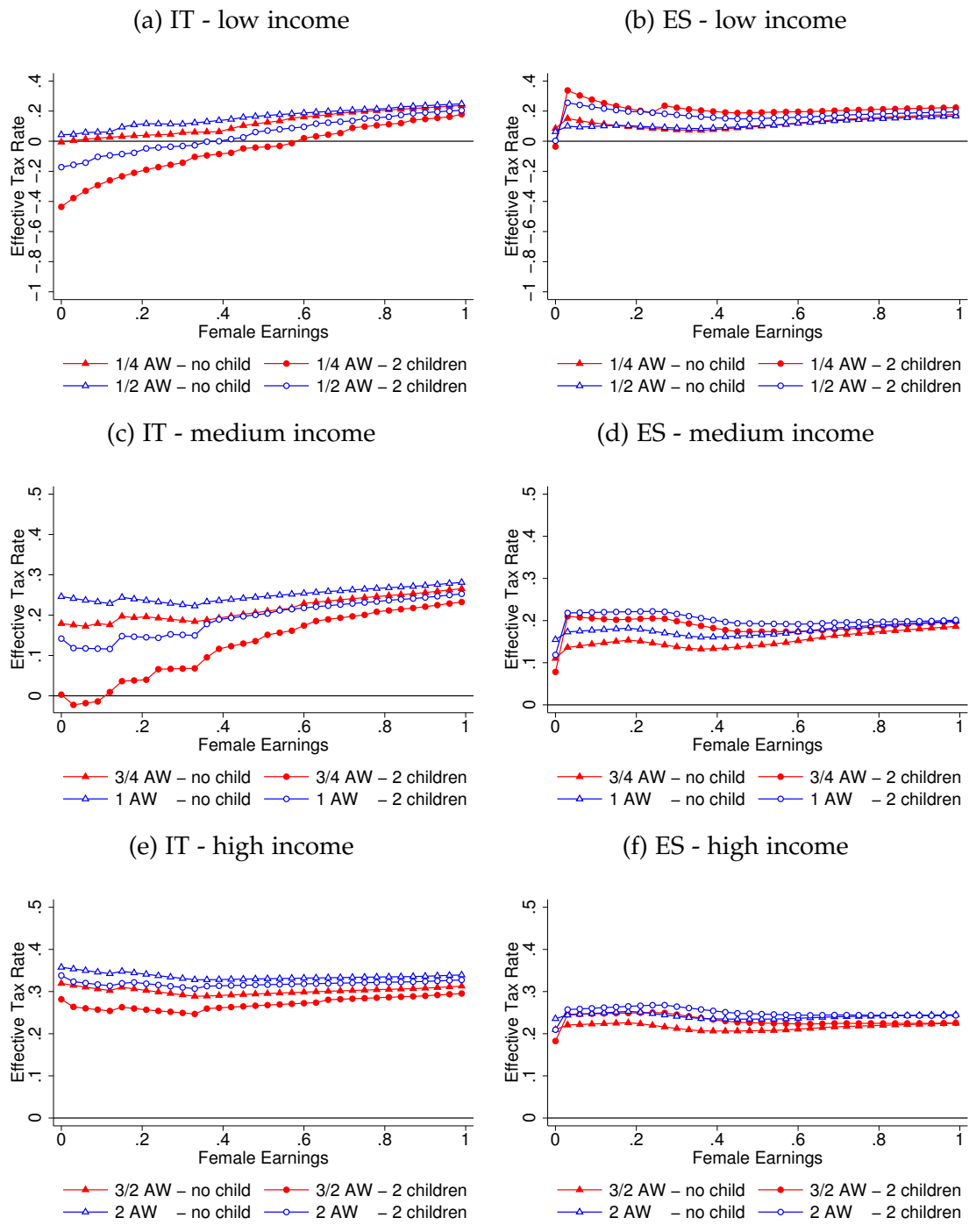


Figure 14: Effective Tax Rates: Italy and Spain

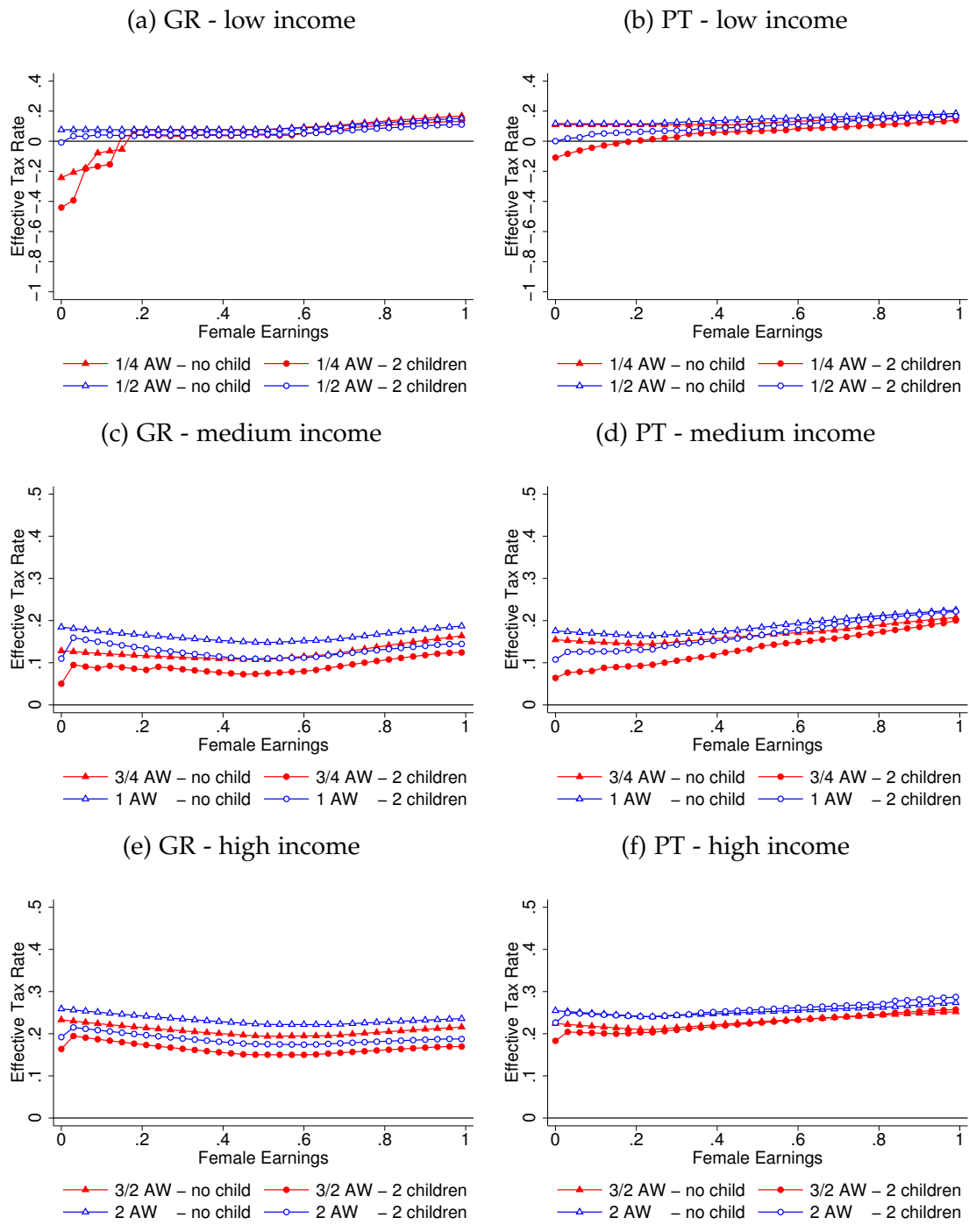


Figure 15: Effective Tax Rates: Greece and Portugal

## B Stationary Equilibrium

In the stationary equilibrium of this economy, all factor markets clear. The aggregate state of the economy consists of the stationary distributions of households across different household types, over assets and human capital levels.  $\chi_{m,j}^S(a, \mathbf{s}_m^S)$  is the distribution of single males across assets and exogenous states in period  $j$ . Similarly,  $\chi_{f,j}^S(a, h, \mathbf{s}_f^S)$  is the distribution of single females and  $\chi_j^M(a, h, \mathbf{s}^M)$  for married couples, both across assets, female human capital levels and exogenous states. The state space is defined as  $\mathbf{s}^M \equiv (z, x, q, b, g)$ . While assets,  $a$ , and female human capital levels,  $h$ , are continuous, that is  $a \in A = [0, \bar{a}]$  and  $h \in H = [0, \bar{h}]$ . In contrast, education types  $z$  and  $x$ , as well as childbearing types  $b$ , access to informal care  $g$  and utility cost  $q$  are finite.

The distribution of married couples of type  $(x, z)$  satisfies at all ages

$$\Omega(z, x) = \sum_q \sum_b \sum_g \int_{A \times H} \chi_j^M(a, h, \mathbf{s}^M) dh da$$

The fraction of single males and females is given by

$$\begin{aligned} \Lambda(x) &= \sum_b \sum_g \int_{A \times H} \chi_{f,j}^S(a, h, \mathbf{s}_f^S) dh da \\ \Pi(z) &= \int_A \chi_{m,j}^S(a, h, \mathbf{s}_m^S) da \end{aligned}$$

The distribution of married couples and single females across childbearing types  $b = \{0, 1, 2\}$  and the fraction of households that have access to informal care  $g \in \{0, 1\}$  have to obey the following:  $\sum_b \sum_g \phi_{b,g}^M(x, z) = 1$  and  $\sum_b \sum_g \phi_{b,g}^S(x) = 1$ .

The decision rules for savings and labor supply are given by  $a_m^S(a, \mathbf{s}_m^S, j)$  and  $l_m^S(a, \mathbf{s}_m^S, j)$  for single males and  $a_f^S(a, h, \mathbf{s}_f^S, j)$  and  $l_f^S(a, h, \mathbf{s}_f^S, j)$  for single females. Married couples choose savings, husband labor supply and wife labor supply according to  $a^M(a, h, \mathbf{s}^M, j)$ ,  $l_m^M(a, h, \mathbf{s}^M, j)$  and  $l_f^M(a, h, \mathbf{s}^M, j)$ . The level of human capital is defined by  $\mathbf{h}^S$  and  $\mathbf{h}^M$  for single and married females:

$$\begin{aligned} \mathbf{h}^S(a, h, \mathbf{s}_f^S, j) &= H(a, h, l_f^S(a, h, \mathbf{s}_f^S, j-1), j-1) \\ \mathbf{h}^M(a, h, \mathbf{s}^M, j) &= H(a, h, l_f^M(a, h, \mathbf{s}^M, j-1), j-1) \end{aligned}$$

Finally, the law of motion for the distributions of household types in period  $j > 1$  are determined as follows for married, single female and single male households, respectively:

$$\chi_j^M(a', h', \mathbf{s}^M) = \int_{A \times H} \chi_{j-1}^M(a, h, \mathbf{s}^M) \mathbb{I}\{a^M(a, h, \mathbf{s}^M, j-1) = a', h^M(a, h, \mathbf{s}^M, j-1) = h'\} da dh \quad (12)$$

$$\chi_{f,j}^S(a', h', \mathbf{s}_f^S) = \int_{A \times H} \chi_{f,j-1}^S(a, h, \mathbf{s}_f^S) \mathbb{I}\{a^S(a, h, \mathbf{s}_f^S, j-1) = a', h^S(a, h, \mathbf{s}_f^S, j-1) = h'\} da dh \quad (13)$$

$$\chi_{m,j}^S(a', \mathbf{s}_m^S) = \int_A \chi_{m,j-1}^S(a, \mathbf{s}_m^S) \mathbb{I}\{a^S(a, \mathbf{s}_m^S, j-1) = a'\} da \quad (14)$$

Initial distributions for married couples, single females and single males at  $(j = 0)$  are given by

$$\chi_1^M(a', h', \mathbf{s}^M) = \begin{cases} \Omega(z, x) \phi_{b,g}^M(x, z) p(q|z) & \text{if } a = 0, h = \eta(x) \\ 0, & \text{otherwise} \end{cases} \quad (15)$$

$$\chi_{f,1}^S(a', h', \mathbf{s}_f^S) = \begin{cases} F(x) \phi_{b,g}^S(x) & \text{if } a = 0, h = \eta(x) \\ 0, & \text{otherwise} \end{cases} \quad (16)$$

$$\chi_{m,1}^S(a', \mathbf{s}_m^S) = \begin{cases} M(z) & \text{if } a = 0 \\ 0, & \text{otherwise} \end{cases} \quad (17)$$

Given these recursions, the stationary competitive equilibrium for the economy is given by:

1. The value function  $V^M(\chi^M)$ , and the policy functions  $c(\chi^M)$ ,  $a(\chi^M)$ ,  $l_f(\chi^M)$  and  $l_m(\chi^M)$  solve the household optimization problem for married couples given tax functions, factor prices and initial conditions. Similarly, the value function  $V_f^S(\chi_f^S)$  and the policy functions  $c(\chi_f^S)$ ,  $a(\chi_f^S)$ ,  $l_f(\chi_f^S)$  and solve the optimization problem for single females, and value function  $V_m^S(\chi_m^S)$  with policy functions  $c(\chi_m^S)$ ,  $a(\chi_m^S)$ , and  $l_m(\chi_m^S)$  for single males given tax functions, factor prices and initial conditions.

2. Markets for aggregate capital  $K$  and labor  $L$  clear:

$$\begin{aligned}
K = \sum_j \mu_j \{ & \sum_z \sum_x \sum_b \sum_g \sum_q \int_{A \times H} a \chi_j^M(a, h, \mathbf{s}^M) dh da \\
& + \sum_x \sum_b \sum_g \int_{A \times H} a \chi_{f,j}^S(a, h, \mathbf{s}_f^S) dh da \\
& + \sum_z \int_A \chi_{m,j}^S(a, \mathbf{s}_m^S) da \}
\end{aligned}$$

and

$$\begin{aligned}
L = \sum_j \mu_j \{ & \sum_z \sum_x \sum_b \sum_g \sum_q \int_{A \times H} [h l_f^M(a, h, \mathbf{s}^M, j) + \omega(z, j) l_m^M(a, h, \mathbf{s}^M, j)] \chi_j^M(a, h, \mathbf{s}^M) dh da \\
& + \sum_x \sum_b \sum_g \int_{A \times H} a \chi_{f,j}^S(a, h, \mathbf{s}_f^S) dh da \\
& + \sum_z \int_A \chi_{m,j}^S(a, \mathbf{s}_m^S) da \}
\end{aligned}$$

3. The factor prices are determined competitively and satisfy

$$w = (1 - \alpha) \left( \frac{K}{L_y} \right)^\alpha \quad \text{and} \quad r = \alpha \left( \frac{K}{L_y} \right)^{\alpha-1} - \delta_a$$

4. The distributions  $\chi_j^M(a, h, \mathbf{s}^M)$ ,  $\chi_{f,j}^S(a, h, \mathbf{s}_f^S)$  and  $\chi_{m,j}^S(a, \mathbf{s}_m^S)$  are consistent with individual decisions.

5. The government budget balances, i.e. the tax revenue finances government consumption  $G$ , childcare transfers  $TR_c$  and mean-tested transfers  $TR_m$

$$\begin{aligned}
G + TR_c + TR_m = \{ & \sum_z \sum_x \sum_b \sum_g \sum_q \int_{A \times H} T^M(I, k) \chi_j^M(a, h, \mathbf{s}^M) dh da \\
& + \sum_x \sum_b \sum_g \int_{A \times H} T^S(I, k) \chi_j^S(a, h, \mathbf{s}_f^S) dh da \\
& + \sum_z \int_A T^S(I, 0) \chi_{m,j}^S(a, \mathbf{s}_m^S) da \} + \tau_a r K
\end{aligned}$$

and government spending on childcare services is defined as

$$TR_c = \theta \sum_{\{\mathbf{s}^M|b\}} \sum_{b=1,2} \sum_{j=b,b+2} \mu_j \int_{A \times H} \mathbb{I}(I \leq \bar{I}) \omega \psi_i \mathbb{I}(I_f > 0) \chi_j^M(a, h, \mathbf{s}^M) dh da$$

$$+ \theta \sum_{\{\mathbf{s}_f^S|b\}} \sum_{b=1,2} \sum_{j=b,b+2} \mu_j \int_{A \times H} \mathbb{I}(I \leq q \bar{I}) \omega \psi_i \mathbb{I}(I_f > 0) \chi_{f,j}^S(a, h, \mathbf{s}_f^S) dh da$$

and means-tested transfers as

$$TR_m = \sum_j \mu_j \left[ \sum_{\mathbf{s}^M} \int_{A \times H} TR^M(I, k) \chi_j^M(a, h, \mathbf{s}^M) dh da \right.$$

$$+ \sum_{\mathbf{s}_f^S} \int_{A \times H} TR_f^S(I, k) \chi_{f,j}^S(a, h, \mathbf{s}_f^S) dh da$$

$$\left. + \sum_{\mathbf{s}_m^S} \int_A TR^S(I, 0) \chi_{m,j}^S(a, \mathbf{s}_m^S) da \right]$$

## 6. The social security balances

$$\tau_p wL = \sum_{j \geq J} \left[ \sum_{\mathbf{s}^M} \int_{A \times H} b^M(z, x) \chi_j^M(a, h, \mathbf{s}^M) dh da \right.$$

$$+ \sum_{\mathbf{s}_f^S} \int_{A \times H} b_f^S(x) \chi_{f,j}^S(a, h, \mathbf{s}_f^S) dh da$$

$$\left. + \sum_{\mathbf{s}_m^S} \int_A b_m^S(z) \chi_{m,j}^S(a, \mathbf{s}_m^S) da \right]$$

## C Calibration

Table C1: Initial Labor Productivity Differences, by Education and Gender

	USA			Denmark		
	males (z)	females (x)	x/z	males (z)	females (x)	x/z
hs	0.640	0.511	0.799	0.837	0.727	0.869
sc	0.802	0.619	0.771			
col	1.055	0.861	0.816			
col+	1.395	1.139	0.817	1.212	1.079	0.890

*Notes:* The table displays initial productivity levels for males and females, ages 25-29, based on weekly wages. Data for the US comes from the 2004 March Supplement and data for Denmark comes from the SILC. For Denmark, data between 2004 and 2013 is pooled due to the small sample size of the SILC.



Table C2: Evolution of Female Labor Market Productivity (%)

	USA				Denmark	
	hs	sc	col	col+	hs-sc	col-col+
25-29	0.129	0.153	0.207	0.145	0.057	0.204
30-34	0.091	0.109	0.134	0.111	0.139	0.142
35-39	0.061	0.076	0.083	0.085	0.064	0.039
40-44	0.036	0.050	0.043	0.064	0.096	0.046
45-49	0.014	0.027	0.009	0.047	0.013	0.006
50-54	-0.008	0.006	-0.025	0.032	0.010	0.004
55-60	-0.029	-0.014	-0.062	0.019	0.024	0.005

Notes: The table displays values for the human capital appreciation parameter  $\alpha_j^x$ , which governs the evolution of female labor efficiency over the lifecycle. Notice that the education groups for Denmark are collapsed into high skilled and low skilled females due to the small sample size of the data. Data for the US comes from the 2004 CPS and estimates for Denmark are based on the SILC, pooled for years 2004-2013 to ensure a sample size of 33,478. The regression for Denmark thus includes year dummy variables.

Table C3: Distribution of Married Couples By Education

Males	Females			
	hs	sc	col	col+
hs	28.44	9.19	3.55	0.81
sc	7.54	12.50	5.13	1.50
col	2.14	4.52	10.65	3.63
col+	0.44	1.24	4.39	4.33

Notes: The table shows the fraction of married couples broken down by wife and husband education. The data comes from the 2004 CPS March Supplement. The statistics are based on age group 30-39. All entries add up to 100.

Table C4: Distribution of Individuals by Gender, Education, and Marital Status

	Males			Females		
	All	Married	Singles	All	Married	Singles
hs	40.42	31.12	9.30	38.39	29.56	8.83
sc	26.58	20.47	6.11	29.33	22.58	6.75
col	21.72	16.72	5.00	23.01	17.72	5.29
col+	11.02	8.49	2.53	9.28	7.15	2.13

Notes: The table shows the fraction of individuals by gender, education and marital status. The data comes from the 2004 CPS March Supplement. The statistics are based on age group 30-39. The breakdown between married and singles is derived under the stationary population assumption that is described in the text.

Table C5: Childbearing Status of Single Females

	Childless	Early	Late
hs	29.44	59.27	11.29
sc	34.80	48.40	16.80
col	53.07	31.45	15.31
col+	70.56	8.33	21.11

Notes: The table shows the fraction of single females by education and childbearing status. The data comes from the 2002 CPS June Supplement due to the small sample size of the 2004 CPS June Supplement.

Table C6: Childbearing Status of Married Couples

Male	Childless				Early			
	Female				Females			
	hs	sc	col	col+	hs	sc	col	col+
hs	9.29	10.63	14.63	18.47	68.03	59.90	42.14	42.39
sc	10.44	10.29	12.95	15.30	60.72	59.91	38.72	29.38
col	8.05	10.64	11.48	13.85	59.78	54.13	32.46	19.62
col+	7.79	9.89	8.99	13.13	56.73	39.50	31.30	23.98

Notes: The table shows the distribution of married couples by education type of husband and wife and by childbearing status. The data comes from the 2002 CPS June Supplement due to the small size of the 2004 CPS June Supplement.

Table C7: Social Security Benefits for Singles

	USA		Denmark	
	Males	Females	Males	Females
hs	1	0.914	1	1.019
sc	1.173	1.059	1.128	1.243
col	1.213	1.067	1.962	1.732
col+	1.291	1.066	1.962	1.732

Notes: The table shows the distribution of social security income for single males and females. The US data comes from the 2000 Census and includes all individuals 70 years and older.

Table C8: Social Security Benefits for Married Couples

Male	USA				Denmark			
	Female				Females			
	hs	sc	col	col+	hs	sc	col	col+
hs	1.755	1.874	1.969	1.879	1.667	2.044	2.291	2.291
sc	1.888	1.996	1.978	2.141	1.833	2.108	2.709	2.709
col	2.012	2.057	2.096	2.200	2.672	2.887	3.649	3.649
col+	2.033	2.110	2.175	2.254	2.672	2.887	3.649	3.649

Notes: The table shows the distribution of social security income for married couples by education type of husband and wife. The data comes from the 2000 CPS Basic monthly data.