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Essays on Public Policy, Children and Families

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Resumen en Castellano

Mi tesis doctoral consta de tres capítulos: El primer capítulo es "The Effects of Child Care Costs on Children's Well-Being", el segundo es "Fecundity Differentials and Child Custody" y el tercero , en co-autoría con Zoe Kuehn, es "With Strings Attached: Grandparent-Provided Child Care, Fertility and Female Labor Market Outcomes". En estos tres capítulos examino cómo los individuos de una economía reaccionan cuando hay un cambio de política familiar. Las principales decisiones que los agentes toman son con respecto a la formación de hogares, el participara en el mercado laboral o no y cuántos recursos familiares son dirigidos a los hijos presentes en el hogar.

En el primer capítulo considero cuál es el efecto de tener que pagar altos costes de educación pre-escolar en la educación de los hijos y el nivel de pobreza de los hogares con hijos para Estados Unidos. El problema es que las madres en Estados Unidos trabajan menos que el resto de las mujeres. Una de la razones por las que se observa esto es porque, si una madre quiere trabajar, tiene que dejar a sus hijos en un centro de educación pre-escolar. En Estados Unidos, el coste es de un 20 por ciento del ingreso familiar medio. Nos importa incentivar la participación laboral de las madres ya que el no trabajar es un factor que contribuye a tener más posibilidades de vivir bajo el umbral de la pobreza. Esto tiene repercusiones en la educación de los hijos y, por tanto, en el futuro laboral de los hijos cuando sean adultos. Propongo un modelo dinámico de equilibrio general con formación de hogares endógeno, fertilidad endógena y donde los agentes deciden cuantos recursos monetarios gastar en la educación de los hijos y cómo dividir el tiempo de la madre entre participación en el mercado laboral, el cuidado de los hijos y su tiempo libre. Modelo explícitamente el coste que supone para una madre el dejar a sus hijos en un centro de educación preescolar si quiere trabajar. Después calibro el modelo para que sea capaz de replicar la economía de Estados Unidos. Finalmente, llevo a cabo dos experimentos en los que considero cómo cambia la participación laboral

de las madres, el nivel de educación que reciben los hijos y el nivel de pobreza en hogares con hijos. En el primer experimento aumento los subsidios a la educación pre-escolar y en el segundo, aumento las ayudas monetarias a las familias con hijos. Encuentro que aunque las dos políticas familiares aumentan la educación que reciben los hijos, los subsidios hacen que los hijos de familias mono-parentales reciban 12 putos porcentuales más de educación que las ayudas monetarias.

En el segundo capítulo propongo las diferencias en fecundidad entre hombres y mujeres como explicación al hecho que la mujer obtiene la custodia de los hijos después del divorcio en el 80 por ciento de los casos en Estados Unidos aunque la ley favorece la custodia compartida. En Estados Unidos, el número de mujeres que tienen la custodia total de los hijos después de un divorcio es del 80 por ciento aunque la ley favorezca la custodia compartida desde la década de los setenta. Es importante entender cómo las parejas deciden quién debe tener la custodia ya que esto tiene efectos en el tiempo que los padres dedican a los hijos después de un divorcio. A su vez, el tiempo que los padres dedican a los hijos tiene efectos importantes en la educación de los hijos. Propongo un modelo de equilibrio general con formación endógena de los hogares donde los padres deciden quién debe si la madre debe tener la custodia o la custodia debe ser compartida. Modelo las diferencias existentes entre hombres y mujeres en términos de fecundidad. El hombre puede tener hijos durante un período de tiempo más largo que la mujer. Cuando se divorcia una pareja, la mujer querría quedarse con la custodia ya que no puede tener más hijos en el futuro. A la vez, el hombre accede a dejar la custodia a la ex-mujer ya que él se puede casar con una mujer más joven y tener más hijos. Encuentro que las diferencias en fecundidad pueden explicar el hecho que la madre se queda la custodia. Además, encuentro que aumentar el tiempo que los hijos están con el padre después de un divorcio puede hacer que menos parejas elijan custodia compartida.

En el tercer y último capítulo consideramos los beneficios y los costes de tener la posibilidad de que los abuelos cuiden de los nietos mientras la madre trabaja. Para Alemania, documentamos el efecto de vivir cerca de los padres o de los suegros

la participación laboral de las mujeres, la fertilidad y los ingresos de las mujeres. Encontramos que vivir cerca hace que la probabilidad de tener hijos sea más alta. Si una mujer vive cerca de sus padres o suegros tiene un probabilidad de tener un trabajo más alta que si vive lejos. Sin embargo, vivir cerca implica un coste en término de ingresos más bajos. Proponemos un modelo de equilibrio general donde las mujeres deciden dónde vivir, cuántos hijos tener, cuánto trabajar y deciden el nivel de educación de sus hijos. Si viven cerca, las mujeres pueden dejar a sus hijos con los abuelos: tienen acceso a educación pre-escolar gratuita, pero ganan sueldos bajos. Sin embargo, si viven lejos, tienen que pagar por la educación pre-escolar pero ganan sueldos más altos. Calibramos el modelo para que replique la economía Alemana. Después llevamos a cabo dos experimentos: 1) ¿Qué pasa si no hay abuelos? y 2) ¿Qué pasa si el gobierno da subsidios? Encontramos que los abuelos hacen que la participación laboral de la mujer sea más alta. Y encontramos que, cuando el gobierno ofrece subsidios, el número de mujeres que trabajan no cambia. Sólo observamos que sustituyen el cuidad informal de los abuelos por el cuidad formal en centros de educación pre-escolar subsidiados.rece subsidios, el número de mujeres que trabajan no cambia. Sólo observamos que sustituyen el cuidad informal de los abuelos por el cuidad formal en centros de educación pre-escolar subsidiados.

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CHAPTER 1

The Effects of Child Care Costs on Children's Well-Being

1.1. Introduction

Over the last decades, female labor force participation has increased in all high income OECD countries. In 1970, 44% of women in the OECD were participating in the labor market, while in 2006, 70% of women between 25 and 54 years of age were participating in the labor market. In Germany, 62 per cent of women aged between 15 and 56 are currently employed, in the UK and in the US this number is around 67 per cent, while 72% of women are employed in Sweden. As more women go into employment, there is a concern about how work and family life can be balanced. Participation rates of mothers are significantly lower than those of other women. Participation rates of mothers with small children (younger than 2 years) range from 36 per cent in Germany to 72 per cent in Sweden, with 53 per cent of mothers working in the UK and 54 per cent in the US. The fact that mothers participate less in the labor market suggests that there are some barriers that make it difficult to work while having children. High child care costs is one of the barriers preventing mothers to participate in the labor market. Child care costs in the US can amount up to 30 % of the average income of a low-income family, while in Sweden, child care costs represent 3% of average family income. Different participation rates across countries also suggest that these barriers seem to vary across countries. While in Sweden participation rates of mothers with children aged below 2 remain as high as for women overall, in Germany participation of mothers decreases to 36.1 per cent from 62 per cent for women as a whole and in the US participation rates of mothers decreases by 12 percentage points compared to all women.

Most OECD governments have on their agenda policies directed at balancing work and family life. In the US, the *American Recovery and Reinvestment Act* includes several policies aimed at providing easier access to child care for working families. Under this act, the Child and Dependant Care tax and funds for other programs that provide child care such as Head Start will be increased. The UK government has the goal of eradicating child poverty by 2020.

Governments are not concern about encouraging women's participation in the labor market per se but they care about the effect of higher participation on households well being. One measure of well being is having an income above the poverty line. In the U.S., poverty rates is 15 per cent. However, the poverty rate among workers falls to 7 per cent. Thus participation in the labor market might be a way out of poverty. In particular, governments care about children's well-being as children are more prone to poverty. Poverty rates in households with children are higher than for overall population. The poverty rate in households with children is 17 per cent while for overall population this is 15 per cent. The difference in poverty rates is greater if children are younger than 6, 21% per cent of households with children younger than 6 face poverty while 15 per cent of overall poverty have income below the poverty line. From a public policy perspective, it is important to encourage participation to the extent that it accounts for lower levels of poverty in households, especially in households with children. The US poverty in households with children is one of the highest among the OECD countries (17%), while the Swedish poverty rate is one of the lowest (3.6%).

Thus, some governments are more successful than others in promoting high female employment and achieving better measures of children's well-being at the same time. Different policies directed at balancing work and family might account for this. Table I summarizes differences in family policy between the US and Sweden. Sweden is one of the OECD countries with the lowest poverty rate among households with children, while at the same time it has one of the highest female labor force participation even among mothers. Conversely, the US has one of the highest poverty rates in the OECD and female participation in the labor market

decreases significantly for mothers. At the same time, the US and Sweden differ in their family policy across several dimensions. While child care access is universal and almost free of charge in Sweden, the US only provides small subsidies to child care. This leads to differences in spending on preschool education. Sweden spends around 2 per cent of its GDP on the education of children below the age of 3, while the US spends 0.4 per cent of its GDP.

Table I: Policies in US and Sweden

	Sweden	USA
Family benefits	Universal child benefit	Means-tested benefit
Child care	Universal free access	Small subsidies
Family benefits	3.21% of GDP	1.27% of GDP
Pre-school funding	1.9% of GDP	0.4 % of GDP
Income Tax rate	High	Low

Source: OECD, 2007

The main contribution of my paper is to assess the extent to which these differences in policies account for differences in female labor force participation, fertility rates and children's well-being. To this end, I present an overlapping generations model (OLG) of endogenous household formation and fertility choice where households invest in their children and divide their time between work, child-rearing and leisure. Child care is costly and for each hour that mothers work, they have to purchase child care. I first study a benchmark economy that features the current labor market (child care subsidies) and welfare policies (family benefits) in the U.S. The model economy is able to capture the key aspects of the data regarding marital status of the population, level and timing of fertility, well-being of children and welfare dependency. Then I carry out two experiments to assess the

effects of a change in U.S. family policy towards a Swedish style family policy. The first experiment consists of increasing the available child care subsidy. I consider an increase such that the U.S. child care subsidy is comparable to the OECD average subsidy. With an increase in child care subsidy, which lowers the cost of children, the participation of women in the labor market increases significantly, especially for single women and women with lower productivity. Fertility also increases. However, the fraction of poor households with children declines and this translates into higher human capital levels for children, especially for children of poorer and single women. The second experiment consists of giving higher family benefits to all households with children. Contrary to the results yielded by the first experiment, labor market participation of mothers decreases significantly. Fertility as well as the human capital investment received by children increases under higher benefits as they did under higher child care subsidies. However, education for children living in single mother households is higher under the child care subsidy. Moreover, in contrast to child care subsidies, poverty among households with children increases if family benefits are used as a policy instrument.

Background. Child care costs could be one of the barriers preventing women with children from participating in the labor market.[1] When mothers work, they face the problem of who is going to take care of their children. This is especially true for young children. Formal child care can take a sizeable share of family income. In table II, I present monthly child care fees per two year olds attending full time early child care education as a percentage of average worker wage income for several OECD countries. In Sweden child care costs represent one of the lowest fraction of income in the OECD, while in the US and the UK, child care costs take 20 per cent or more of the average wage income of a worker. In table III, I present monthly child care costs as a percentage of family income for different household's characteristics for the US. Families with a monthly income in the $3000- $4499 bracket face child care costs that amount to 10 per cent of their income. If the

[1]See Del Boca (2002), Del Boca and Sauer (2009), Baker, Milligan and Gruber (2008), and Haan and Wrohlich (2009), Nicodemo and Waldman (2009).

family lives under the poverty line, child care costs amount to 30 per cent of their income. These costs are substantial and they could be preventing mothers from joining the labor force.

Table II: OECD Monthly Child care cost, 2004

Country	Child care cost as % of average earnings
Sweden	4.5
Germany	9.1
UK	24.7
US	19.5

Source: OECD, 2007

Table III: Child care costs, 2005

Characteristics		USA	
		as % of family income	as % of mother's income
Family income, monthly			
	<$1,500	32.7	34.0
	$1,500 - $2,999	16.2	21.4
	$3,000 - $4,499	10.8	18.8
	$4,500 and over	5.0	1.1
Work status			
	Full time employ	6.8	13.3
Poverty status			
	Below poverty line	29.2	41.6
Marital status			
	Married	5.6	12.9
	Divorced	10.7	12.2
	Never married	12.3	17.9

Source: US Census Bureau, 2005

Moreover, employment of mothers and household structure seem to have a significant impact on children's well being. A measure of children's well-being often considered is the poverty rate in households with children. Table IV presents child poverty rates for different types of households in Sweden, the US and Germany. Poverty rates of households with children vary widely across countries. In Sweden, the proportion of households with children with an income below 50 per cent of the median income is 3.6 per cent while in the US, it is 17.6 per cent. In Germany 13.16 per cent of households with children are poor. One-parent families as well as couple families where only one parent works suffer higher poverty rates. The

poverty rate in two parent families where two parents are working is 20 percentage points lower than in two parent families where only one parents works. Thus encouraging participation in the labor market might be a way of fighting poverty in households with children.

Table IV: Poverty rate in households with children

	Households		Singles		Couples	
	all ages	age<6	Not working	working	1 worker	2 workers
Sweden	3.6	-	18,15	6,29	13,65	1,11
USA	17.6	21	91,53	36,20	27,01	6,19
Germany	13.16	-	56.1	26.34	5.7	1.48
UK	8.9	-	39	7	27	6

Source: OECD, 2007

Child development and well being are major concerns in the OECD countries. As noted in Kamerman et al (2003), children living in poor households are more prone to experience bad health and bad school outcomes. These might in turn lead to worse outcomes in adult life. Cunha, Heckman, Lochner and Masterov (2005) show that important differences in the skills of children across family types appear at early ages and are persistent (see also Almond and Currie, 2010 for a recent review). They look at Peabody Individual Achievement Test in Math (PIAT Math), which measures age-appropriate math knowledge and they find that there are large gaps. Once they control for maternal education, cognitive ability and family structure (broken home or not), the gap across racial and income groups is reduced. Higher levels of family resources in a child formative years are associated with higher quality education and, therefore, the fact that a family is credit constraint and it does not have adequate resources is an important issue for the children's human capital accumulation.

Household structure is an important factor to take into account when considering children's well-being. Not only one parent households seem to exhibit higher poverty rates but there is substantial evidence indicating that family background is a key determinant of success in adulthood, see Haveman and Wolfe (1995) for a review. McLanahan and Sandefur (1994) also point out that children raised by a single parent perform worse in adulthood than those in a two parent household. Those adults who have spent their childhood in a single-parent household have a greater risk of being poor, experiencing teenage pregnancy and participating in criminal activities. Neal and Johnson (1996) argue that differences in skills are accountable for most of the black-white wage gap and in turn the skill gap can be traced back to observable differences in family background. They show that the black-white wage gap is mostly accounted for by differences in human capital accumulation (as measured by the Armed Forces Qualification Test) before the ages of 16-18.

Finally, it is important to note that household structure in most industrialized countries has changed over the last decades. With divorce rates and out-of-wedlock births on the rise, the two parent model of family unit is no longer the norm, and a significant fraction of children live in one-parent households in most OECD countries (26 per cent in US, 21 percent in Sweden, 13.4 per cent in Germany). Therefore household structure should be taken into account when analyzing the balance between family life and work.

Related Literature This paper is related to recent papers that use quantitative equilibrium models of family formation to evaluate public policy. In a general equilibrium framework, Greenwood, Guner and Knowles (2000) investigate the effect of the rise in the generosity of welfare payments on the rising incidence of single motherhood.[2] Guner and Knowles (2009) compare welfare policies in Canada to the ones in the U.S. and check whether differences in welfare policy can account for

[2]See also see, among others, Erosa, Fuster and Restuccia (2010), Attanassio, Low and Sanchez-Marcos (2008), Brown and Flinn (2006), Casarico and Sommacal (2008), and Del Boca, Flinn and Wiswall (2010).

the higher rates of single parenthood observed in the U.S. The authors use a model of endogenous marriage, and divorce decisions and endogenous fertility choice.

Domeij and Klein (2008) also formally model the need for child care for employed mothers. In a framework of stochastic dynamic life-cycle model of household decision making with exogenous fertility, the authors try to answer the question of whether subsidies on day child care raise welfare by encouraging women to work. Bernal and Fruttero (2006) focus on the effect of parental leave policy on female labor supply decisions, intrahousehold allocation and investment in children's human capital. They find that introducing maternity leave will increase female labor force participation, time spent with child and human capital investments in children. Erosa, Fuster and Restuccia (2010) develop a model of fertility choice and labor market decisions to study the role of parental leave policies. Bick (2010) investigates the relationship between the provision of child care and female labor force participation and fertility in a life cycle model. He finds that the lack of child care is in fact a barrier to female labor force participation and it reduces fertility. In my paper, I also allow for policies to have an effect on the level of human capital that children acquire and I account for the effect of a change in policy on the poverty faced by households with children.

1.2. Environment

The economy is populated by overlapping generations of individuals who live for two periods as children and for three periods as adults. I refer to the first, second and third period of adulthood as young, middle aged and old, respectively. There is a continuum of men and women of unit mass in each age group. Agents differ in productivity. Let the productivity of women be denoted by $x \in X = \{x_1, ..., x_N\}$, and that of men by $z \in Z = \{z_1, ..., z_N\}$. The productivity in the second and third period depends on the productivity of the previous period in the following way

$$\Pr\left[x' = x_j \mid x = x_i\right] = \pi_x\left(x_j \mid x_i\right) \text{ and } \Pr\left[z' = z_j \mid z = z_i\right] = \pi_z\left(z_j \mid z_i\right).$$

When individuals become young adults, they observe their productivity and they randomly meet their potential spouses from the same cohort. Potential couples draw a match quality $\gamma \in G = \left\{\gamma_1, ..., \gamma_Q\right\}$ with probability $\Gamma(\gamma)$. Both partners observe their types and match quality and they marry if both agree to do so. Otherwise they remain single for that period.

At the beginning of individuals' middle age, their new productivity is realized. Agents who are married also observe their spouses' productivity and their match quality. They face a probability p_γ of having the same match quality as last period and with probability $(1 - p_\gamma)$ they have to draw a new match from the same distribution as above. Then, they decide whether to stay married or get divorced. Divorced individuals have to wait one period to be able to remarry. Agents who have remained single in the previous period meet and, as before, depending on their productivities and match quality, decide whether to marry or not. In the last period of their lives, agents who are married decide whether to stay married or divorce and those who were single or divorced in the last period, meet potential spouses and face the choice to marry.

After marriage market decisions have been taken, couples and single females have to decide how many children to have, how women's time is split between working, taking care of children and leisure and how much income to spend on children's education. Men are assumed to work a fixed amount of time n, whether they are married or single. This assumption is made to concentrate on the decisions of women. Women can have children when they are young and middle aged. Let K denote the total number of children in the household. Agents receive utility from consumption, leisure, from educating their children, e and the number of children. For women, utility per period is given by

$$F(c, e, K, 1 - l - t, \gamma) = \begin{cases} \nu^c(c) + \nu^e(Q(e, K)) + \nu^l\left(1 - l - t - \psi_f K\right) - \gamma, \text{ if married,} \\ \nu^c(c) + \nu^e(Q(e, K)) + \nu^l\left(1 - l - t - \psi_f K\right) \text{ if single} \end{cases}$$

If a woman is married, she enjoys the value of the match quality, γ. Women have to decide how much to work l and in case they have children the time they

dedicate to them, t. They also have to incur a fixed time cost for each child, ψ_f. $Q(.,.)$ is a function representing the quality-quantity trade off between having more children and giving each child more education.

Utility for a man is given by

$$M(c,e,K,1-n,\gamma)=\begin{cases} u^c(c)+u^e(Q(e,K))+u^n(1-n-\psi_m K)-\gamma \text{ if married,} \\ u^c(c)+u^n(1-n) \text{ if single.} \end{cases}$$

It is similar to that of a woman if he is married. A father also incurs a fixed time cost, but he does not spend any time taking care of children. If he is single or divorced, he does not receive any utility from his children. A couple takes decisions by maximizing a weighted average of the individuals' utilities, where μ is the weight given to the wife's utility. Children spend two periods with their parents after which they become young adults. Children take no decisions. During childhood, children need to go to private child care for as long as the mother works out of home. For each unit of time that the mother is at work, the child must be a unit of time in private child care at a cost δ. Upon divorce, children are assumed to remain with their mothers and their fathers do not receive any utility from them nor do they have to pay any child support nor alimony.[3]

Education per child depends on the time that mothers spend with the child t, the cost of sending the child to private child care δl and the monetary cost of raising a child, g. The education received by a child is denoted by

$$e=\Xi(t,g,l,K)$$

The probability of different productivity realizations when young is affected by the education received as a child. It is denoted by

$$\Pr[x=x_j \mid e]=\Pi^x(x_j \mid e) \text{ and } \Pr[z=z_j \mid e]=\Pi^z(z_j \mid e),$$

[3]In terms of the data, around 75 per cent of custodial parents who are awarded child support receive at least some payment. Child support is an important source of income for custodial parents as it accounts on average for 12 per cent of household income. Thus child support is quantitatively important. However I make this assumption to reduce the computational burden of the model.

where $e = e_{-1} + e_{-2}$ is the total education received by an individual during her/his childhood.

There is a government that collects taxes and it uses them to pay out subsidies and transfers and for government consumption G.[4] Agents have to pay income taxes $\tau(Y)$ and they receive transfers $T(K, Y)$ that might depend on the number of children, K and income, Y. The government also offers a subsidy to private child care, ω.

1.3. Value functions

I start with the problem faced by agents when they are old and go backwards to the problem of a young agent.

1.3.1. Single/ Divorced Old

I start with the problem of a single/ divorced woman. A woman who is single when old could have been married when young and divorced when middle aged or she could have never been married. A divorced woman might have married in the first or second period and divorced in the last period of her life. Old women cannot have children but any children they had when middle aged still live with them. The value function of single life for an old woman is given by

$$S_3^f(x_i, K) = \max_{c,e,g,l,t} F(c, e, l, K, 1 - l - t, 0),$$

subject to

$$c = \Psi(1, K)(x_i l - \tau(x_i l) - \delta l(1 - \omega) + T(K, Y) - g),$$

and

$$e = \Xi(t, g, l, K).$$

The problem facing a divorced woman is the same as that of a single woman. $\Psi(a, K)$ is the adult-equivalent size of a household with a adults and K children.

[4]Government consumption is not productive and it does not give any utility.

Income of the household is equal to labor income plus transfers minus income taxes. A single woman has to pay for private child care δ for each hour she is working and in addition she faces other kinds of expenditure that affect the education of her children g.[5]

The problem of a man is simple as he just works a fixed time n

$$S_3^m(z_j) = \max_c M(c, 0),$$

subject to

$$c = z_j n - \tau(z_j n).$$

A divorced old man has the same problem as that of a single old man.

1.3.2. Married Old

An old married couple could have been newly formed, i.e. they matched and married when old, or they could have been married for one or two periods already. The value of being married in the last period is given by

$$V_3(x_i, z_j, K, \gamma) = \max_{c,e,g,l,t} \mu F(c, e, K, 1 - l - t, \gamma) + (1 - \mu) M(c, e, K, \gamma),$$

subject to

$$c = \Psi(2, K)[x_i l + z_j n - \tau(x_i l + z_j n) - \delta l(1 - \omega) + T(K, Y) - g],$$

and

$$e = \Xi(t, g, l, K).$$

An old married couple upon observing their productivities and their match quality, has to decide if they want to remain married or divorce. They will stay married if and only if $W_3(x_i, z_j, K, \gamma) \geq S_3^f(x_i, K)$ and $H_3(x_i, z_j, K, \gamma) \geq S_3^m(z_j)$

[5]Note that I assume that the cost of child care does not depend on the number of children. Parents pay the same whether they have two or more children in child care or whether they have only one. There is some evidence that there are economies of child care in the data (see Laughlin, 2010), though not perfect.

where

$$W_3(x_i, z_j, K, \gamma) = F^* (c, e, K, 1 - l - t, \gamma)$$

and $F^* (c, e, K, 1 - l - t, \gamma)$ denotes the utility of a woman evaluated at the decision taken by the couple and

$$H_3(x_i, z_j, \gamma, K) = M^* (c, e, K, \gamma)$$

where $M^* (c, e, K, \gamma)$ denotes the utility of a man evaluated at the decision taken by the couple.

The decision of staying married is represented by the following indicator function

$$I^d_{3,f} = \begin{cases} 1, \text{ if } W_3(x_i, z_j, K, \gamma) \geq S^f_3 (x, k), \\ \\ 0, \text{ otherwise,} \end{cases}$$

and

$$I^d_{3,m} = \begin{cases} 1, \text{ if } H_3(x_i, z_j, K, \gamma) \geq S^m_3 (z_j), \\ \\ 0, \text{ otherwise,} \end{cases}$$

for a woman and a man respectively.

1.3.3. Single/ Divorced Middle aged

A single middle aged woman was also single when young while the divorced female was married. A single woman starts her middle aged with labor productivity x_i and k children from when she was young. She has to decide on how much to consume, how many children to have this period, how to split her time between leisure, work and time with her children and how much money she will spend on her children. Let $b \in \{0, 1, ...N_k\}$ be the number of number of children the woman can give birth to this period. She has k children who were born while she was young. Therefore, the total number of children she will have this period will be the number of children born while she was young and the number of children born this period. Let the total of children in the household be denoted by K. A woman

values her current utility and the expected continuation value for the next period. In order to form expectations about their future status women need to know the distribution of single men in the third period, $\Omega_3(z)$. In the next period, the productivity of a middle aged woman evolves according to the process $\pi_x(. \mid x_i)$ and she has to decide whether to remain single or marry. She will be matched to a single man of type z_l from the distribution $\Omega_3(z)$ and they will draw a match quality γ_q with probability $\Gamma(\gamma_q)$. The value of not being married this period is given by

$$S_2^f(x_i,k) = \max_{c,e,g,l,t,b} F(c,e,K,1-l-t,0) + \beta \sum_{p=1}^{N} \pi_x(x_p \mid x_i) \times$$
$$\max\{S_3^f(x_p,k'), \sum_{l=1}^{N} \Omega_3(z_l) \sum_{q=1}^{Q} \Gamma(\gamma_q) W_3(x_p,z_l,k',\gamma_q) I_{3,m}^d\}],$$

subject to

$$\begin{aligned} c &= \Psi(1,K)(x_i l - \tau(x_i l) + T(K,Y) - \delta l(1-\omega) - g), \\ e &= \Xi(t,g,l,K), \end{aligned}$$

where

$$K = k + b \text{ and } k' = b.$$

Men also need to know the distribution of single women next period, $\Phi_3(x,k)$ over types and the number of children living with them. Again, men just work a fix amount of time and their problem is the following

$$\begin{aligned} S_2^m(z_j) &= \max_c M(c) + \beta \sum_{l=1}^{N} \pi_z(z_l \mid z_j) \times \\ &\max\{S_3^m(z_l), \sum_{j=0}^{N_k} \sum_{p=1}^{N} \Phi_3(x_p,k_j) \sum_{q=1}^{Q} \Gamma(\gamma_q) H_3(x_p,z_l,k_j,\gamma_q) I_{3,f}^d\}], \end{aligned}$$

subject to

$$c = z_j n - \tau\left(z_j n\right).$$

1.3.4. Married middle aged

There are two types of marriages in the second period. There are newly formed marriages and those that were formed in the first period of the cohort's adult life. Couples observe their productivities and their match quality. A couple formed by a woman of type x_i and a man of type z_j with k children and a match quality γ has to decide on how many children to have this period b, how much to spend educating the K children present in the household, g, and how to split the woman's time between work, taking care of the children and her leisure. In order to make decisions, the couple maximizes a weighted sum of expected values of marriage. The expected weighted value of marriage for the woman depends on the current utility $F\left(.,.\right)$ and the expected value of the marriage. In the next period, the couple faces a probability p_γ of keeping the same match quality, γ as in the current period. Else, they will have a match quality γ_q with probability $\Gamma\left(\gamma_q\right)$ in the next period. The productivity of the woman and the man evolve stochastically according to the processes $\pi_x\left(x. \mid x_i\right)$ and $\pi_z\left(. \mid z_j\right)$ respectively and they will have k' children that are those born in the current period, b, as children borne in the first period have become young adults. The continuation value of being married in the next period depends on whether the expected utility they get as a couple is greater than the utility as divorced individuals.

The expected utility of a couple formed by a woman of type x_i and a man of type z_j with k children and a match quality γ is

$$V_2\left(x_i, z_j, k, \gamma\right) =$$

$$\max_{c,e,g,l,t,b} \mu(F\left(c, e, K, 1-l-t, \gamma\right) + \beta p_\gamma \sum_{p=1}^{N} \pi_x\left(x_p \mid x_i\right) \times$$

$$\left[\max\{S_3^f\left(x_p, k'\right), \sum_{l=1}^{N} \pi_z\left(z_l \mid z_j\right) W_3\left(x_p, z_l, k', \gamma\right) I_{3,m}^d\}\right]$$

$$+ \beta\left(1-p_\gamma\right) \sum_{k=1}^{N} \pi_x\left(x_k \mid x_i\right) \times$$

$$\left[\max\{S_3^f\left(x_p, k'\right), \sum_{l=1}^{N} \pi_z\left(z_l \mid z_j\right) \sum_{q=1}^{Q} \Gamma\left(\gamma_q\right) W_3\left(x_p, z_l, k', \gamma_q\right) I_{3,m}^d\}\right])$$

$$+ \left(1-\mu\right)\left(M\left(c, e, K, \gamma\right) + \beta p_\gamma \sum_{l=1}^{N} \pi^z\left(z_l \mid z_j\right) \times\right.$$

$$\left[\max\{S_3^m\left(z_l\right), \sum_{p=1}^{N} \pi_x\left(x_p \mid x_i\right) H_3\left(x_p, z_l, k', \gamma\right) I_{3,f}^d\}\right]$$

$$+ \beta\left(1-p_\gamma\right) \sum_{l=1}^{N} \pi_z\left(z_l \mid z_j\right) \times$$

$$\left.\left[\max\{S_3^m\left(z_l\right), \sum_{p=1}^{N} \pi_x\left(x_p \mid x_i\right) \sum_{q=1}^{Q} \Gamma\left(\gamma_q\right) H_3\left(x_p, z_l, k', \gamma_q\right) I_{3,f}^d\}\right]\right),$$

subject to

$$c = \Psi\left(2, K\right)\left[\tau\left(x_i l + z_j n\right) + T\left(K, Y\right) - \delta l\left(1-\omega\right) - g\right],$$

and

$$e = \Xi\left(t, g, l, K\right),$$

where$K = k + b$ and $k' = b$.

They decide to remain married if and only if they both agree to do so. For the woman, the value of remaining in the marriage should be greater or equal than

divorcing, $W_2(x_i, z_j, k, \gamma) \geq S_2^f(x_i, k)$ and for the man this condition should also hold, $H_2(x_i, z_j, k, \gamma) \geq S_2^m(z_j)$ where

$$\begin{aligned} W_2(x_i, z_j, k, \gamma) = F^*(c, e, K, 1-l-t, \gamma) + \beta p_\gamma \sum_{p=1}^{N} \pi_x(x_p \mid x_i) \times \\ [\max\{S_3^f(x_p, k'), \sum_{l=1}^{N} \pi_z(z_l \mid z_j) W_3(x_p, z_l, k', \gamma) I_{3,m}^d\}] \\ + \beta(1-p_\gamma) \sum_{k=1}^{N} \pi_x(x_k \mid x_i) \times \\ [\max\{S_3^f(x_p, k'), \sum_{l=1}^{N} \pi_z(z_l \mid z_j) \sum_{q=1}^{Q} \Gamma(\gamma_q) W_3(x_p, z_l, k', \gamma_q) I_{3,m}^d\}]). \end{aligned}$$

$W_2(x_i, z_j, k, \gamma)$ is the value of marriage for a woman evaluated at the optimal decisions made by the couple and $H_2(x_i, z_j, k, \gamma)$ is the value of marriage for a man evaluated at the decisions made by the couple,

$$\begin{aligned} H_2(x_i, z_j, k, \gamma) = M^*(c, e, K, \gamma) + \beta p_\gamma \sum_{l=1}^{N} \pi_z(z_l \mid z_j) \times \\ [\max\{S_3^m(z_l), \sum_{p=1}^{N} \pi_x(x_p \mid x_i) H_3(x_p, z_l, k', \gamma) I_{3,f}^d\}] \\ + \beta(1-p_\gamma) \sum_{l=1}^{N} \pi_z(z_l \mid z_j) \times \\ [\max\{S_3^m(z_l), \sum_{p=1}^{N} \pi_x(x_p \mid x_i) \sum_{q=1}^{Q} \Gamma(\gamma_q) H_3(x_p, z_l, k', \gamma_q) I_{3,f}^d\}]). \end{aligned}$$

The decision is represented by the following indicator function

$$I_{2,f}^{d}=\begin{cases} 1, \text{ if } W_2\left(x_i,z_j,k,\gamma\right)\geq S_2^f\left(x_i,k\right), \\ \\ 0, \text{ otherwise,} \end{cases}$$

and

$$I_{2,m}^{d}=\begin{cases} 1, \text{ if } H_2\left(x_i,z_j,k,\gamma\right)\geq S_2^m\left(z_j\right), \\ \\ 0, \text{ otherwise,} \end{cases}$$

for a woman and a man respectively. Therefore, if the value of being married is greater or equal than the value of being single for a woman , then she wants to be married and the indicator function $I_{2,f}^{d}$ takes the value one. For the marriage to take place, the man also needs to get a higher value from marriage than from being a bachelor, if this is so, the indicator function $I_{2,m}^{d}$ takes also the value 1.

1.3.5. Single Young

When young, a single woman has to decide how much to work, how many children to have, the time she will spend taking care of them, how much private child care to purchase and how much to spend on her children's' education in order to maximize her expected lifetime utility. She also needs to know how many single men there will be in the second period, as there are N different productivity types of men she expects to be matched to a single man with productivity z_l with probability $\Omega_2\left(z_l\right)$. A young single woman's value function is

$$\begin{aligned} S_1^f\left(x_i\right) &= \max_{c,e,g,l,t,b} F\left(c,e,b,1-l-t,0\right)+\beta\sum_{p=1}^{N}\pi_x\left(x_p\mid x_i\right)\times \\ &\quad \max\{S_2^f\left(x_p,k\right),\sum_{l=1}^{N}\Omega_2\left(z_l\right)\sum_{q=1}^{Q}W_2\left(x_p,z_l,k,\gamma_q\right)\Gamma\left(\gamma_q\right)I_{2,m}^{d}\}], \end{aligned}$$

subject to

$$c = \Psi(1, K)(x_i l - \tau(x_i l) + T(K, Y) - \delta l(1 - \omega) - g),$$

and

$$e = \Xi(t, g, l, K)$$

where

$$k = b.$$

For the young single man, the problem is the following

$$\begin{aligned} S_1^m(z_j) &= \max_c M(c, 0) + \beta \sum_{l=1}^{N} \pi_z(z_l \mid z_j) \times \\ &\quad \max\{S_2^m(z_l), \sum_{j=0}^{N_k} \sum_{p=1}^{N} \Phi_2(x_p, k_j) \sum_{q=1}^{Q} \Gamma(\gamma_q) H_2(x_p, z_l, k_j, \gamma_q) I_{2,f}^d\}, \end{aligned}$$

subject to

$$c = z_j n - \tau(zn).$$

1.3.6. Married Young

When a young couple meets, they have to decide whether to marry or to remain single. The expected value of being married when young, $V_1(x_i, z_j, \gamma)$ is given by

$$\begin{aligned}
V_1(x_i, z_j, \gamma) = & \max_{c,e,g,l,t,b} \mu(F(c, e, b, 1-l-t, \gamma) + \beta p_\gamma \sum_{p=1}^{N} \pi_x(x_p \mid x_i) \times \\
& \times \max\{S_2^f(x_p, k), \sum_{l=1}^{N} \pi_z(z_l \mid z_j) W_2(x_p, z_l, k, \gamma) I_{2,m}^d\} + \\
& + \beta(1-p_\gamma) \sum_{p=1}^{N} \pi_x(x_p \mid x_i) \times \\
& \times \max\{S_2^f(x_p, k), \sum_{l=1}^{N} \pi_z(z_l \mid z_j) \sum_{q=1}^{Q} \Gamma(\gamma_q) W_2(x_p, z_l, k, \gamma_q) I_{2,m}^d\}) \\
& + (1-\mu)(M(c, e, k, \gamma) + \beta p_\gamma \sum_{l=1}^{N} \pi_z(z_l \mid z_j) \times \\
& \times \max\{S_2^m(z_l), \sum_{p=1}^{N} \pi_x(x_p \mid x_i) H_2(x_p, z_l, k, \gamma) I_{2,f}^d\} \\
& + \beta(1-p_\gamma) \sum_{l=1}^{N} \pi_z(z_l \mid z_j) \times \\
& \times \max\{S_2^m(z_l), \sum_{p=1}^{N} \pi_x(x_p \mid x_i) \sum_{q=1}^{Q} \Gamma(\gamma_q) H_2(x_p, z_l, k, \gamma_q) I_{2,f}^d\}),
\end{aligned}$$

subject to

$$c = \Psi(2, K)(x_i l + z_j n - \tau(xl + zn) + T(K, J) - \delta l(1-\omega) - g),$$

and

$$e = \Xi(t, g, l, K),$$

where

$$k = b.$$

A couple will get married if and only if $W_1(x_i, z_j, \gamma) \geq S_1^f(x)$ and $H_1(x_i, z_j, \gamma) \geq S_1^m(z_j)$, where

$$\begin{aligned} W_1(x_i, z_j, \gamma) &= F(c, e, b, 1-l-t, \gamma) + \beta p_\gamma \sum_{p=1}^{N} \pi_x(x_p \mid x_i) \times \\ &\quad \max\{S_2^f(x_p, k), \sum_{l=1}^{N} \pi_z(z_l \mid z_j) W_2(x_p, z_l, k, \gamma) I_{2,m}^d\} + \\ &\quad + \beta(1-p_\gamma) \sum_{p=1}^{N} \pi_x(x_p \mid x_i) \times \\ &\quad \max\{S_2^f(x_p, k), \sum_{l=1}^{N} \pi_z(z_l \mid z_j) \sum_{q=1}^{Q} \Gamma(\gamma_q) W_2(x_p, z_l, k, \gamma_q) I_{2,m}^d\} \end{aligned}$$

and

$$\begin{aligned} H_1(x_i, z_j, \gamma) &= M(c, e, b, \gamma) + \beta p_\gamma \sum_{l=1}^{N} \pi_z(z_l \mid z_j) \times \\ &\quad \max\{S_2^m(z_l), \sum_{p=1}^{N} \pi_x(x_p \mid x_i) H_2(x_p, z_l, k, \gamma) I_{2,f}^d\} \\ &\quad + \beta(1-p_\gamma) \sum_{l=1}^{N} \pi_z(z_l \mid z_j) \times \\ &\quad \max\{S_2^m(z_l), \sum_{p=1}^{N} \pi_x(x_p \mid x_i) \sum_{q=1}^{Q} \Gamma(\gamma_q) H_2(x_p, z_l, k, \gamma_q) I_{2,f}^d\}. \end{aligned}$$

The decision of marrying is represented by the indicator function

$$I_{1,f}^d = \begin{cases} 1, \text{ if } W_1(x_i, z_j, \gamma) \geq S_1^f(x_i), \\ \\ 0, \text{ otherwise,} \end{cases}$$

and

$$I_{1,m}^{d}=\begin{cases}1,\ \text{if } H_1\left(x_i,z_j,\gamma\right)\geq S_1^m\left(z_j\right),\\ \\ 0,\ \text{otherwise.}\end{cases}$$

1.4. Stationary Equilibrium

In order to characterize the equilibrium the optimal decision rules as well as the stationary distributions of women and men have to be determined and the government budget has to be balanced every period.

Let's denote optimal decision rules for the old single woman as follows $L_{3,S^f}\left(x,k\right)$ is the labor decision, $T_{3,S^f}\left(x,k\right)$ is the time spent with her children, $G_{3,S^f}\left(x,k\right)$ is the amount of money spent on the education of her children, $E_{3,S^f}\left(x,k\right)$ is the education given to her children and $C_{3,S^f}\left(x,k\right)$ is the level of consumption. $C_{3,S^m}\left(z\right)$ is the optimal consumption of an old single male and the optimal decisions for the old married couple are: $L_{3,V}\left(x,z,k,\gamma\right)$ is the labor decision for the wife, $T_{3,V}\left(x,z,k,\gamma\right)$ is the time the wife spends with their children, $G_{3,V}\left(x,z,k,\gamma\right)$ is the amount of money the couple spends on the education of their children, $E_{3,V}\left(x,z,k,\gamma\right)$ is the education they give to their children and $C_{3,V}\left(x,z,k,\gamma\right)$ is the household consumption level. For the second period, the decision rules are $L_{2,S^f}\left(x,k\right)$, $T_{2,S^f}\left(x,k\right)$,

$G_{2,S^f}\left(x,k\right)$, $E_{2,S^f}\left(x,k\right)$, $C_{2,S^f}\left(x,k\right)$,$G_{2,S^f}\left(x,k\right)$ for women, $C_{2,S^m}\left(z\right)$ for single men and $L_{2,V}\left(x,z,\gamma,k\right)$, $T_{2,V}\left(x,z,\gamma,k\right)$, $G_{2,V}\left(x,z,\gamma,k\right)$, $E_{2,V}\left(x,z,\gamma,k\right)$,

$C_{2,V}\left(x,z,\gamma,k\right)$,$G_{2,V}\left(x,z,\gamma,k\right)$ for married couples. For the first period, the optimal decisions for a single female are $L_{1,S^f}\left(x\right)$, $T_{1,S^f}\left(x\right)$, $G_{1,S^f}\left(x\right)$, $E_{1,S^f}\left(x\right)$,

$C_{1,S^f}\left(x\right)$ for the single male $C_{1,S^m}\left(z\right)$ and for the married couple $L_{1,V}\left(x,z,k,\gamma\right)$, $T_{1,V}\left(x,z,k,\gamma\right)$, $G_{1,V}\left(x,z,k,\gamma\right)$, $E_{1,V}\left(x,z,k,\gamma\right)$, and $C_{1,V}\left(x,z,k,\gamma\right)$.

DEFINITION. Given the government policies, $\{\tau,\ T,\ \omega,G\}$, a stationary equilibrium is a set of decision rules defined above, the number of children that single and married women have K_{S^f}, K_V respectively, and distributions $\Phi_1\left(x\right)$, $\Phi_2\left(x,k\right)$, $\Phi_3\left(x,k\right)$ and $\Omega_1\left(z\right)$, $\Omega_2\left(z\right)$, $\Omega_3\left(z\right)$ such that:

- Given the government policy and the distributions, the rules above are the solutions to the value functions described above.
- The distributions $\Phi_1(x)$, $\Phi_2(x,k)$, $\Phi_3(x,k)$ and $\Omega_1(z)$, $\Omega_2(z)$, $\Omega_3(z)$ are stationary distributions which are consistent with the decision rules
- Government budget is balanced

$$\tau Y = G + P$$

where Y is the economy's income and P is the amount of family benefits and child care subsidies handed out to families.[6]

1.5. Quantitative Analysis

I start by presenting the explicit functional forms of the utility functions, the education function, the process mapping human capital received during childhood and the process determining the productivity from one period to the next. I keep functional forms quite general in order to allow for flexibility in the calibration section. Women and men have the same preferences for consumption, children and leisure. Their utility is separable in consumption, children and leisure. The curvature parameters are σ_c for the consumption, σ_k for the utility referring to children and σ_l is the curvature parameter for the utility of leisure. There are two weighting parameters. The weight parameter for children is ϕ_k and the weight for leisure in the utility function is ϕ_l. The weight for consumption is normalized to 1. The match quality does not interact with decisions on how to split time, how much to consume and how many children to have but it affects the marriage decisions. The utility of a woman $F(c, e, K, 1-l-t, \gamma)$ is

[6]See Appendix for an explicit form of P.

$$\begin{cases} \frac{1}{1-\sigma_c}c^{1-\sigma_c}+\phi_k\frac{1}{1-\sigma_k}Q^{1-\sigma_k}+\phi_l\frac{1}{1-\sigma_l}\left(1-l-t-\psi_f K\right)^{1-\sigma_l}-\gamma, \text{ if married,} \\ \\ \frac{1}{1-\sigma_c}c^{1-\sigma_c}+\phi_k\frac{1}{1-\sigma_k}Q^{1-\sigma_k}+\phi_l\frac{1}{1-\sigma_l}\left(1-l-t-\psi_f K\right)^{1-\sigma_l} \text{ otherwise.} \end{cases}$$

For a man the utility function $M\left(c,e,K,\gamma\right)$ is

$$\begin{cases} \frac{1}{1-\sigma_c}c^{1-\sigma_c}+\phi_k\frac{1}{1-\sigma_k}Q^{1-\sigma_k}+\phi_l\frac{1}{1-\sigma_l}\left(1-n-\psi_m K\right)^{1-\sigma_l}-\gamma \text{ if married,} \\ \\ \frac{1}{1-\sigma_c}c^{1-\sigma_c}+\phi_l\frac{1}{1-\sigma_l}\left(1-n\right)^{1-\sigma_l}, \text{ otherwise.} \end{cases}$$

Households get utility from the number of children in the household and from the level of education that these children have received. Following Becker and Tomes (1976), I assume that there is a trade off between the number of children households can have and the level of human capital that households can provide for their children. For the quantity quality trade off of children, a Cobb Douglas specification has been chosen as other papers in the literature.[7] The share of education in the production function of child quality is equal to λ.

$$Q=e^{\lambda}K^{1-\lambda}$$

The education production function depends on the time spent taking care of the children, t, and the amount of money spent on the education of the children. Money and time are assume to have unit elasticity of substitution. The share of time spent taking care of children in the education production function is equal to θ. Money can be spent in two different ways. If the mother works l, children have to spend that amount of time in private child care and pay an hourly cost

[7]Greenwood et al. (2000). Other specifications do not change results considerably.

of δ. The cost of private child care is productive in the sense that it educates children. The other expenditure parents face is g which represents any other type of expenditure related to the education of children. The chosen functional form to represent the relationship between expenditure on private child care and other education related expenditure is CES. The elasticity of substitution between these two types of expenditures is equal to $\frac{1}{1-\rho}$ and the weight of expenditures g is represented by α. This functional form is flexible enough to capture the degree of substitutability between these two different types of expenditure, and is given by

$$e = \Xi(t, g, l, K) = \frac{1}{K}\left[(\alpha g^{\rho} + (1-\alpha)(\delta l)^{\rho})^{\frac{1}{\rho}}\right]^{\theta} t^{1-\theta}.$$

Children receive education over two periods, so when they become young adults the human capital accumulated over their childhood maps into their initial productivity level. Both women and men initial productivities are drawn from the same distribution $\Pi(.,.)$

$$\Pr[x = x_i \mid e] = \Pi(x_i \mid e)$$

and

$$\Pr[z = z_j \mid e] = \Pi(z_j \mid e).$$

I assume that $\Pi(x_i \mid e)$ and $\Pi(z_j \mid e)$ are discrete approximations to log normal distributions. Therefore $\Pi(. \mid e)$ is a discrete approximation to a log normal distribution with mean $\varepsilon_1 e^{\varepsilon_2}$ and standard deviation σ_{ε}.

After the first period as young adults productivities for women and men evolve stochastically according to the following

$$\Pr[x' = x_j \mid x = x_i] = \pi_x(x_j \mid x_i) \text{ and } \Pr[z' = z_j \mid z = z_i] = \pi_z(z_j \mid z_i),$$

I assume that the distributions are discrete approximations of an AR(1) process in logarithms. The persistence parameter for women π_x and the one for men π_z are assumed to be the same and equal to π. Thus the productivity level of a woman next

period x' given that her productivity was x_i this period is a draw from a lognormal distribution with mean $\mu_x(1-\pi)+\pi\ln x_i$ and standard deviation $\sigma_x\sqrt{(1-\pi^2)}$. And for a man with productivity level z_j this period, the productivity level in next period z' is a draw from a lognormal distribution with mean $\mu_z(1-\pi)+\pi\ln z_j$ and standard deviation $\sigma_z\sqrt{(1-\pi^2)}$.

1.5.1. Calibration

I start by calibrating the benchmark economy to match several statistics of the US economy. The calibration strategy is the following. First I fix some parameters based on available information and I introduce the parameters that I calibrate to match several US data statistics. Finally I introduce the policy instruments characterizing US family policy. Some of these parameters will be calibrated while others will come directly from the US family policy. Most of the data statistics are obtained from the American Community Survey (2007) from now on ACS.

The parameters that are set a priori are the discount factor β, the weight of the wife in the couples valuation of marriage μ, the weekly hours worked by men n, the parameters related to the productivity distribution over individuals $\{\mu_x,\mu_z,\sigma_x,\sigma_z\}$, the parameters mapping human capital to initial productivities $\{\varepsilon_1,\varepsilon_2,\sigma_\varepsilon\}$, the fixed time cost from having children for women and men ψ.

One model period is equivalent to 10 years. The discount factor, β is set to match a 4% yearly interest rate. The weight given to the wife in the household's utility μ, is equal to 0.5 to give same weight in the household to the woman and the man. I assume that all men work the same fixed amount of time to concentrate on the problem of a woman. In the US, men work on average 44 hours per week. I allow the total disposable hours of an individual in the economy to be 100. Therefore the amount of time worked by a man, n is equal to 0.44. In the model economy, women (and men) differ in their productivities. In the US, labor productivity is distributed as a log normal across individuals. I discretize the distribution to obtain different productivity levels. I estimate the mean and

standard deviation of the productivity distribution from the ACS and obtain the following means,$\mu_x = 2.717$ and $\mu_x = 2.983$ for women and men and standard deviations, $\sigma_x = 0.72$ and $\sigma_x = 0.723$ for women and men respectively. The parameters mapping human capital levels to initial productivities are set such that the initial distributions of young women and men productivities are consistent with labor productivity distributions observed in the US data. Thus the value of ε_1 is 19, the value of ε_2 is 0.04 and the standard deviation σ_ε is set to 0.7. The time cost per child for men and women is assumed to be the same and equal to 8 per cent of time. This a mid-value that can be found in empirical studies, see Erosa et al, (2010). Thus ψ is set to 0.080.

The utility, education, productivity and matching parameters, the hourly cost of child care and the level of transfers given out in the economy are obtained by matching model moments to data. There are 15 parameters and 16 data moments. Parameters to be estimated are preference parameters from the utility $\{\sigma_c, \sigma_k, \phi_k, \sigma_l, \phi_l\}$ related to consumption, children and leisure, the weight on children's education λ in the function for parents preference for the number of children and their quality, parameters in the children's education function $\{\alpha, \rho, \theta\}$, the persistence of productivity of men and women across periods, which they are assumed to be the same $\{\pi\}$, marriage market matching parameters $\{p_\gamma, \gamma_l, \gamma_h, \pi_\gamma\}$ and the hourly cost of child care $\{\delta\}$.

Even though in a general equilibrium model all parameters affect the targets, I discuss briefly the data moments that each parameter is most likely to determine. Preference parameters referring to children $\{\sigma_k, \phi_k\}$ are chosen to match the fact that 78 per cent of children are born to mothers between the ages of 25 and 35, i.e. the young period in the model and that 26 per cent of children live in households with one parent. The value for σ_k is equal to 0 and the the value for ϕ_k is 4.620. The preference parameter for consumption, $\{\sigma_c\}$ is calibrated to match the income ratio of single women households to married households. In the US, this ratio is 0.48 and σ_c equals 0.412.

Average female labor force participation of single women is 80 per cent and average hours worked by single women as a fraction of those worked by married women equals 1.05. I use these data moments to match the parameters in the utility function associated with labor supply, $\{\sigma_l, \phi_l\}$. The curvature parameter σ_l is set to 0.730 and the weight of leisure in the utility function ϕ_l is set to 3.580. I calibrate the persistence of productivity over time π using average weekly hours worked by women in the US which is equal to 38 hours out of a 100 hours per week. π is set to 0.6.

On average US women have 2.05 children. I calibrate the parameter λ in the quantity-quality production function of children to match this fertility rate and λ is set to 0.403. To fix the parameters of the education function $\{\alpha, \rho, \theta\}$, the following 3 data moments are used: fertility of women in the 90th percentile of the income distribution as a fraction of the fertility of women in the 10th percentile (0.95), the fraction of income spent on children by single mothers as a ratio of income spent by married couples (1.387), where the data on expenditure on children comes from the report on expenditures on children by families, USDA (2007) and the fact that children in single households receive half the education of children in two parent households (McLanahan and Sandefur, 1994). The values obtained from the calibration for the education parameters are $\alpha = 0.810$, $\rho = 0.600$ and $\theta = 0.610$. The child care fee as a percentage of average income for a family with two working parents amounts to 19.5% of average worker income in the U.S. (OECD 2005). The hourly cost of child care (δ) is set to 5.903 in order to match this fact.

Finally, the matching parameters $\{p_\gamma, \gamma_l, \gamma_h, \pi_\gamma\}$ are calibrated using marriage statistics. Remarriage of 45 to 55 year olds in the US is 14 per cent. I use this to match the persistence of the match quality $p_\gamma = 0.23$. The proportion of never married in the USA is 0.245 and it is used to match the value of the low match quality,γ_l. that is set equal to 17.776. The fact that the fraction of singles between 25 and 35 years old equals 42.810 per cent of the population between 25 and 55 is used to match the high match quality,γ_l and its value is set to -2.302. The probability of receiving a high quality match π_γ, is matched using the fact that on

average 15.500 per cent of the population is divorced in the US and the value of π_γ is set to 0.580.

This leaves us with the policy parameters to be determined. I assume that welfare policy takes a simple form: households with children (married or single) who earn below a threshold level $\overline{T}$ receive T. Hence there are four policy parameters, τ, ω, T and $\overline{T}$. I calibrate the amount of transfers T to match a data moment observed in the US, while the income tax, τ, and the child care subsidy, ω, are set to be consistent with their US policy instruments counterparts in the model economy. T denotes the transfers to families and single women with children. These transfers represent some family benefits available to low income families in the U.S. as part of the "Temporary Assistance for Needy Families" (TANF). The OECD (2005) reports family benefits received conditional on having children for the state of Michigan. They use the state of Michigan as a representative of a typical manufacturing state in the US. The benefit received is equivalent to 3 per cent of the average income of the Michigan state ($ 39481). I calibrate the amount of transfers a household with children receive to equal 3% of average income in my economy.

In my benchmark economy all working individuals pay a proportional tax τ on labor income. I set τ to be equal to 17% which is equivalent to the individual income tax and employment taxes collected by the government at federal and state level as a fraction of GDP (US Census Bureau, 2007, Internal Revenue service). The child care subsidy (ω) is set to 5% of the child care cost to match the tax reduction associated with the use of child care of a lone parent earning average wages, ($OECD$ 2007) .

Finally, $\overline{T}$ is set to be consistent with the eligibility rules in the US. According to the Administration for Children and Family, it is the poverty threshold. The poverty threshold in the US is the same across states, however it differs by family size, age and sex of household head and different government aid programs use different measures of poverty. I use a simplified version of the eligibility rules and

I set the threshold $\overline{T}$ to be the poverty line, that is 50% of the median income in the model economy.

The following tables summarize the a priori parameters, the calibrated parameter and the policy parameters.

Table V: Parameters based on a priori information

β	Discount factor	0.675
μ	Weight of wife in couple's utility	0.500
n	Working time of men	0.440
μ_x	mean productivity of women	2.717
σ_x	standard deviation of women's productivity	0.720
μ_z	mean productivity of men	2.983
σ_z	standard deviation of men's productivity	0.723
ψ_f	Fixed time cost per child	0.080

Table VI: Parameter values

ϕ_k	weight of children	4.620
ϕ_l	weight of leisure	3.580
σ_k	preference for children	0
σ_c	preference for consumption	0.412
σ_l	preference for leisure	0.730
π	productivity persistence	0.600
λ	share of education in Q function	0.403
α	weight of g in the education function	0.800
ρ	elasticity parameter between g and δl	0.600
θ	share of expenditures in the education function	0.610
p_γ	probability of keeping same γ next period	0.230
γ_l	High match quality	-2.306
γ_h	Low match quality	17.776
π_γ	Probability of high match quality	0.580
δ	Hourly cost of child care	5.903

Table VII: Policy parameters

Calibration		
T	Family Benefits	0.2796
A priori		
τ	Income tax	0.170
$\overline{T}$	Transfers threshold	2.962
ω	child care subsidy	0.050

Table VIII: Human capital mapping parameters

ε_1	Mean parameter	19
ε_2	Mean parameter	0.04
σ_ε	Standard deviation parameter	0.70

The model matches the data fairly well. Table IX, reports the moments generated by the model together with the corresponding data moment.

Table IX: Data and Model Moments

	Moments	Data
Fertility rate	2.0305	2.050
Single-married income ratio	0.535	0.480
Single-married hours worked ratio	1.254	1.0500
Fraction of single young	0.425	0.428
Fraction of never married	0.225	0.245
Average Divorced rate	0.159	0.155
Average hours worked	0.391	0.381
Income-Fertility relation	0.593	0.950
Average FLFP of single females	0.810	0.800
Average FLFP of married females	0.710	0.720
Single-married education ratio	0.34	0.500
Single-married expenditure ratio	1.345	1.387
Fraction of kids living with single parents	0.246	0.260
Fraction of kids born in 1st period	0.747	0.780
Remarriage rate among 45-55 year olds	0.12	0.140
Child care costs as % of average income	19.5	19.5

1.6. The Benchmark Economy

The model provides further information about the benchmark economy that has not been exploited to match the model to the data. Thus looking at the performance of the model across dimensions not calibrated to data, allows to evaluate the validity of the model to represent the US economy.

1.6.1. Demographic structure

In the benchmark economy, individuals live for 5 periods. The first 2 periods correspond to childhood, while the other 3 periods represent adult life. The first period of adult life is referred to as young period. For calibration purposes, the young period of the model corresponds to the age group 25 to 34 year olds in the data.

Agents live for 50 years. Childhood starts when the individual is 5 years old and ends when the individual becomes 25. Note that I assume that individuals start off their lives when they are 5. This is done in order for individuals to begin adult life at 25 as this period is when decisions on marriage, fertility and labor force participation are taken. In the US, the median age of first marriage for women is 25 and this age is also the average age at first birth. Life begins when the individual is 5 and ends at 55. From 5 to 14 years old, individuals are in their early childhood and their late childhood goes from the age of 15 to the beginning of young adulthood at 25. At 35 they begin middle aged until they become old at 45.

I have not exploited the age structure of the benchmark economy for calibration. Therefore, I use it to evaluate the goodness of the model to represent the data. First I present the marital status of the population by age group in Table X. Note that I use the fraction of single young agents, the fraction of single agents of any age and the fraction of divorced agents in the economy for calibration, the other moments were not used for calibration. The model does well in replicating the marital status by age groups. In the first period of the model, divorce is not allowed thus those who are divorced in the data are counted as still married in the model. Also, the model underestimates those individuals who remain never married when old, but on the whole it replicates the marital patterns observed in the US economy.

Table X Marital Status of the Population

		Marital status		
Age group		Never married	Married	divorced
25-34	Data	42.81	48.31	8.89
	Model	42.45	57.5	-
35-44	Data	19.5	64	16.5
	Model	17.86	63.37	18.7
45-54	Data	12.65	66.73	20.62
	Model	0.08	63.2	28.78
25-54	Data	24.5	60	15.5
	Model	22.5	61	15.9

Another statistic that is obtained from the model is the average number of children present in households with children by age group. The distribution for the US is described in table XI. The average number of children present in households headed by young single women is 1.8 in the US while in the model this number is 1. The model predicts the average number of children in married households well , however it does underestimate the number of children in single and divorced female headed households, especially when old. Even so, it replicates the qualitative

structure of the average number of children in households with children in the US. Married household seem to have more children present than households headed by single females. In the US the number of children present in households is larger for the age group between 35 and 44 years and this is also the case in the benchmark model.

Table XI. Average Number of Children in Households

		Average Number of children		
Age group		Never married	Married	divorced
25-34	Data	1.8	2.03	2.04
	Model	1	2.35	-
35-44	Data	1.9	2.18	1.8
	Model	1.4	2.67	2.2
45-54	Data	1.24	1.46	1.29
	Model	0.51	1	0.46
25-54	Data	1.836	2.014	1.79
	Model	1.04	2.012	1.33

I also report the distribution of children across income quintiles. Table XII reports the U.S. cumulative distribution of children across income quintiles in 2011

and the corresponding distribution given by the model. The model does a good job in replication the distribution of children. In the data, 21 per cent of children are in the first quintile and the model predicts 25 per cent of children to be in the same quintile. The cumulative percentage of children in the third quintile in the data is 63 while in the model this percentage is 62. Thus the model is capable of replicating the distribution of children across income.

Table XII: Cumulative Distribution of Children by Income Quintile

	Distribution of Children by Income	
	Model	Data
First	0,213	0,252
Second	0,414	0,438
Third	0,632	0,621
Fourth	0,836	0,822
Fifth	1	1

Source: US Census Bureau,CPS, 2011Annual Social and Economic Support

1.6.2. Who receives Welfare?

In the benchmark economy, households receive family benefits only if there are children present in the household. Therefore, single men are not entitled to family benefits. Only single/ divorced women and couples with children will receive benefits. These benefits do not depend on the number of children nor the marital status of the mother. They depend on the household income. The eligibility threshold in the USA for TANF benefits differs across income, age of the children, the number of children and the marital status of the head of the family.

According to Lester and Tin (2003), in the USA, on average, 13 per cent of the whole population participates in a family means-tested benefit program in a given month. In the benchmark economy this proportion is 10 per cent, therefore, the model does quite well in generating the proportion of individuals on welfare in the US. Table XIII presents the proportion of families receiving family benefits by family type. 37 per cent of single female families received some family benefits in a given month in 1999. In the benchmark economy, this proportion is 33.3, which is reasonably close to the data. For married couples, the participation rate decreases significantly to 7 per cent, while in the model this number is lower.

Table XIII

Family type	Program participation rates in any means tested programs	
	1999 Data	Benchmark Model
Single female	37.1	33.29
Married couple	7.4	1.47

Source: Lester and Tin, 2003

1.6.3. Child care costs

In the model, child care costs are a barrier for women to work. For each hour that they work, they have to pay a fee for the child to be left in care. Therefore, some women might not be able to work and pay for child care. Other women might just prefer to stay home. Therefore the financial burden of child care is different for different types of families. I will be providing some of the child care costs faced by different families in the benchmark economy. I calibrate the hourly care cost to be equal to the child care costs faced on average in the US. In the US, single female families face the highest child care costs as a percentage of family income. Also,

married couple with low income spend a high proportion of their income on child care. Even when both parents are working, average costs of child care in the US can amount to almost 10 per cent of family income. In table XIV, I show the child care costs as a percentage of family income faced by different types of families in the benchmark economy.

Table XIV

Family type	Child care costs as percentage of family income	
	Data	Benchmark Model
Single female	12	28
Married couple	5.6	8

Source: US Census, 2005

1.6.4. Poor Households

Finally, I present poverty rates across different types of households with children. Poverty is defined as the proportion of household with children with an income below 50 per cent of the median income in the benchmark economy. Poverty rates in the model are higher for single female households than for married couples. If the female in the household is working, poverty rates decrease, while if the woman is not working poverty rates are higher. All single woman households are in poverty if the woman is not working and for married couples, if only the husband is working, poverty rate goes up by 13 percentage points.

Table XV

Family type	Poverty rates for households with children	
	Data	Benchmark Model
single female working	36.20	70
single female not working	91.53	100
married couple, both working	6.17	9.70
married couple, only male working	27.01	20.17

Source: OECD, 2008

1.7. Experiments

I carry out two different policy experiments to investigate the effect of different family policies. Policies will be government consumption neutral. Thus the amount of tax revenue collected that is going to government consumption is the same as in the benchmark economy. I will focus on the labor market participation of women, the fertility rate and children's well-being.

Two different kinds of experiments are performed. The first experiment consist of increasing child care subsidies. This labor market policy is designed to affect the labor market participation decision of women. The child care subsidy is conditional on working. The second experiment is a welfare type of policy. I increase the family benefits received by families with children.[8]

[8]Note that I only compare steady-states.

1.7.1. Increase Child care subsidy

Child care costs in the US amount up to 30 per cent of average income. Therefore, this cost constitutes a considerable barrier for families to leave children in private care while at work. Subsidizing child care conditional on working could decrease that barrier. This policy is expected to increase labor supply of women and thus increase family income. I increase the child care subsidy from 5% of the hourly cost to a 65%. This might seem like a large increase, however, the OECD average child care cost is 35 per cent of the child care costs in the US. A child care subsidy of 65 per cent is the necessary subsidy to bring average child care costs in the US down to the OECD average level.

Table XVI presents results of the experiment along with the results of the benchmark economy.

Table XVI

	Benchmark	$\omega = 0.65$
Fertility rate	2.035	2.530
Average hours worked	0.391	0.338
Average FLFP of single females	0.810	0.963
Average FLFP of married females	0.710	0.866
Poverty	0.353	0.300
Tax rate	0.170	0.250
Average education	0.490	0.518
Education received by child in one parent family	0.209	0.352
Education received by child in two parents family	0.632	0.624
Fraction of single young	0.425	0.419
Fraction of never married	0.225	0.223
Average Divorced rate	0.159	0.159

Keeping government consumption neutral, requires an increase in income taxes from 17 per cent to 25 per cent. Increasing child care subsidies provides an incentive for women to work. The child care subsidy is in fact a subsidy to working, therefore, the model yields the expected results as both single and married women increase their labor market participation. Under the policy experiment almost all single women decide to work while 86 per cent of married women participate in the labor market.

At the same time, average hours worked by women decrease. This is due to the fact that new women going into employment have lower productivity. Thus they decide to work fewer hours than the ones who were employed before the subsidy increased. Under this policy the fertility rate increases. It is easier to have children as the cost of having to take care of them has decreased considerably.

The poverty rate in the experiment is defined as the proportion of households with children with less income than 50 per cent of the median income in the benchmark economy. Thus, the threshold for defining who is poor is kept fixed. Otherwise poverty rate is a relative measure and if median income is going up in the economy when child care subsidies are high, then poverty rate among households with children might raise due to a higher threshold. The poverty observed decreases by around 4 per cent.

Increasing child care subsidies also has an effect on the education received by children. The average education received by a child under higher child care subsidies is 25 per cent more than under the benchmark economy. This increase in the education of children affects different types of households in different proportions. Children raised in one parent households are the ones benefitting more from the increase in child care subsidies in terms of receiving more education. Under higher child care subsidies, education for a child in a one parent household is 44 per cent more than under the benchmark economy. This policy seems to promote education among children living in one parent households, who, at the same time are the ones more prone to suffer poverty and accumulate less human capital.

1.7.2. Increase transfers

The second policy experiment is increasing the family benefits and making them universal, i.e. there are no eligibility constraints. This policy is similar to the family policy available in Sweden, where family benefits are higher than in the US and they are available to all families with children (independent of their income level). The level of transfers (12 per cent of average income) is such that the tax needed to keep government consumption as in the benchmark economy is the same as in the previous experiment. Therefore the two experiments are comparable. Table XVII compares the benchmark economy to an economy where family benefits are higher and not means tested.

Table XVII

	Benchmark	$T = 0.12\overline{y}$
Fertility rate	2.035	2.570
Average hours worked	0.391	0.317
Average FLFP of single females	0.810	0.656
Average FLFP of married females	0.710	0.641
Poverty	0.353	0.367
Tax rate	0.170	0.250
Average education	0.490	0.514
Education received by child in one parent family	0.209	0.320
Education received by child in two parents family	0.632	0.639
Fraction of single young	0.425	0.427
Fraction of never married	0.225	0.223
Average Divorced rate	0.159	0.159

Increasing family benefits and making them available to all families with children has different effects on female labor supply than an increase in the child care subsidy. Labor market participation rates of single and married women decrease. Around 65 % of women are employed. This is due to an income effect as they have now more money, some women who had to work before, decide to stay home. Fertility increases under this policy too. Women have more resources to spend on children, so they can afford to have more kids.

The poverty rate is actually slightly higher than in the benchmark economy. Even though households with children are receiving more income through family benefits, they also have less incentives to work. Therefore, women that had to work before, decide not to work any more, receiving only family benefits and thus having an income below the poverty threshold in the benchmark economy. This is especially true for single mothers whose only source of income are family benefits and earned wages.

Under this policy experiment, average education also increases. Average education is 30 per cent more than under the benchmark economy. The increase in average education is similar to the case where child care subsidies are high. Looking at different types of households, one can observe that children raised in one parent households benefit less under this policy than when their mothers were receiving child care subsidies. They receive more education than in the benchmark economy but they would receive 12 per cent more education if child care subsidies were high instead of having generous family benefits. This policy has almost no effect on the education of children raised by two couple families.

1.7.3. Discussion of policy experiments

Elasticity of price of child care. In the model, the implied elasticity of female employment to child care cost is equal to -0.25 for married women and it is equal to -0.3 for single women. This elasticity is lower than the elasticity found in studies such as Anderson and Levine (2000) and Connelly and Kimmel (2003).

They find elasticity of married women with children younger than 6 to be -0.46 and -.071 respectively. However the elasticity in my model is for all women, not for mothers, so this might be misleading. The labor participation of mothers with young children (younger than 5) is an untargeted moment. The benchmark economy predicts the labor market participation of mothers with young children to be equal to 66 % , while in the data this fraction is equal to 67 %. The model does a good job in replicating the participation of women with young children. Increasing child care subsidies from a 5% subsidy to a 65 % subsidy, 88 % of mothers with small children will participate in the labor market. After recalculating the implicit elasticity, the value is equal to -0.42 which is closer to the value provided by Anderson and Levine (2000).

Effect of child care subsidies on the price of child care I do not model the child care market. However, increasing child care subsidies might have an effect on child care prices. When the supply of child care is fixed, increasing child care subsidies will lead to an increase in child care prices. However, this will lead to more child care providers entering the child care market and it will lower prices. So the net effect is an interesting quantitative question. Also government subsidizing child care can be thought of as a way of providing state funded child care. Thus it might have no effect on prices but it will lead to an increase in government expenditure.

Effect of policies on marital distribution Marital distribution is unaffected by the change in policies. This might be surprising as if more money is given to women conditional on having children, we might expect to see less marriage and thus an increase in single mothers. However, the policies I consider are not dependent on marital status, therefore, it is not too puzzling observing no effect on the number of single women.

1.8. Conclusion

Balancing family life (having children) and work is challenging, especially for women, who are still the primary care givers of children. Participation of women in

the labor market decreases significantly for women with children because during the time that they are at work children must be left in some kind of care. Private child care is costly, amounting to almost 30 % of the average income of a low income family in the US. Therefore it might not be possible for a family to pay this cost and the mother has to stay home caring for the children. This cost might be of more concern to single parents as they do not have the income of the partner. Therefore, there is need to model labor, family structure, fertility, and the cost of private child care jointly.

In this paper I do this by building an overlapping generations model of family formation, fertility and female labor force participation. I study how the introduction of a Swedish type of family policies affects female labor participation, fertility and poverty rates. I considered two different policies: a labor market policy (increase of child care subsidy) and a welfare policy (higher family transfers).

Increasing child care subsidies leads to higher female labor force participation. The child care subsidy is like a subsidy to work. Some of the women that found the cost of child care prohibiting, they can now afford paying for child care in order to be able to work. Fertility also increases, as the family earns more, they can afford more children without compromising the education they give to each child. Finally poverty rate among households with children decreases 4 per cent.

The policy that gives higher transfers to all families with children has similar effects on fertility. However, female labor participation decreases which might not be desirable from the point of view of the government, if the government is after promoting employment among women. The poverty rate of households with children is higher when transfers are higher. Thus giving money to all families with children does not alleviate the problem of poverty in households with children. In terms of education, average education increases under both policies. However, higher child care subsidies increases the level of education received by children of single mothers more than if higher transfers are used. These children are those who tend to suffer higher poverty rates and receive less education. Thus, child

care subsides have greater positive effect on the education of those more prone to receive low investment in education.

1.9. Appendix

1.9.1. Characterization of decision rules

1.9.1.1. Old problem. Let's start with the problem of the single/ divorced single old female. The three decision rules resulting from the maximization problem are given by the following system of the three first order conditions

$$\begin{aligned} l: \ & \left(1/\left(\Psi\left(1,k^o\right)\left(x_i l-\tau\left(x_i l\right)+T\left(k,J\right)-\delta l\left(1-\theta\right)k^o-\varphi\left(J\right)S_f-b\right)\right)\right)\times \\ & \times\left(x-\tau'\left(xl\right)-\delta\left(1-\theta\right)k^o\right)+ \\ & +\phi_1\lambda\frac{\partial e}{\partial l}\left(\lambda e^{\alpha}+\left(1-\lambda\right)\left(k^o\right)^{\alpha}\right)^{\frac{1-\alpha}{\alpha}}-\phi_2/\left(1-l-t\right)=0 \\ t: \ & \phi_1\lambda\frac{\partial e}{\partial t}\left(\lambda e^{\alpha}+\left(1-\lambda\right)\left(k^o\right)^{\alpha}\right)^{\frac{1-\alpha}{\alpha}}-\phi_2/\left(1-l-t\right)=0 \\ b: \ & -1/\left(\Psi\left(1,k^o\right)\left(x_i l-\tau\left(x_i l\right)+T\left(k,J\right)-\delta l\left(1-\theta\right)k^o-\varphi\left(J\right)S_f-b\right)\right)+ \\ & +\phi_1\lambda\frac{\partial e}{\partial b}\left(\lambda e^{\alpha}+\left(1-\lambda\right)\left(k^o\right)^{\alpha}\right)^{\frac{1-\alpha}{\alpha}}=0 \end{aligned}$$

The first equation is the first order condition with respect to female labor. The first term is the marginal benefit of working on income, the second term represents the effect of working on education, this effect is not clear cut as increasing labor time might decrease time spent on the child. The last term is the disutility of working. The second equation is the first order condition with respect to time spent rasing the children. The first term is the marginal benefit of spending more time on the children while the second term is the marginal cost. Finally, the last equation is the first order condition with respect to the expenditure on children. The first term is the disutility of spending more on the children as income will be lower, while the second term is the marginal benefit as it will have a positive effect on the education of the children.

The first order conditions for the old married couple are similar

$$l:\ 1/\left(\left(\Psi\left(2,k^{o}\right)\left(x_{i}l-\tau\left(x_{i}l\right)+T\left(k,J\right)-\delta l\left(1-\theta\right)k^{o}-\varphi\left(J\right)S_{f}-b\right)\right)\right)\times$$
$$\times\left(x-\tau'\left(xl\right)-\delta\left(1-\theta\right)k^{o}\right)+$$
$$+\phi_{1}\lambda\frac{\partial e}{\partial l}\left(\lambda e^{\alpha}+\left(1-\lambda\right)\left(k^{o}\right)^{\alpha}\right)^{\frac{1-\alpha}{\alpha}}-\mu\phi_{2}\varepsilon\left(1-l-t\right)^{\varepsilon-1}=0,$$

$$t:\ \phi_{1}\lambda\frac{\partial e}{\partial t}\left(\lambda e^{\alpha}+\left(1-\lambda\right)\left(k^{o}\right)^{\alpha}\right)^{\frac{1-\alpha}{\alpha}}-\mu\phi_{2}\varepsilon\left(1-l-t\right)^{\varepsilon-1}=0,$$

$$b:\ -1/\left(\Psi\left(2,k^{o}\right)\left(x_{i}l-\tau\left(x_{i}l\right)+T\left(k,J\right)-\delta l\left(1-\theta\right)k^{o}-\varphi\left(J\right)S_{f}-b\right)\right)+$$
$$+\phi_{1}\lambda\frac{\partial e}{\partial b}\left(\lambda e^{\alpha}+\left(1-\lambda\right)\left(k^{o}\right)^{\alpha}\right)^{\frac{1-\alpha}{\alpha}}=0.$$

The single/ divorced male works a fixed amount of time so he has nothing to decide, he just consumes what it is left after taxes and transfer are accounted for.

1.9.1.2. Middle aged and Young problems. Notice that the decision rules are static in the sense that they do not depend on future values of the variables. This simplifies the analysis as there is no need to know future variables to be able to take optimal decisions in a given period.

I will not present the first order conditions for the middle aged and young cohorts as they are essentially the same

CHAPTER 2

Fecundity Differentials and Child Custody

2.1. Introduction

Most U.S. states abandoned the maternal presumption for custody by mid 1970s in favour of gender-neutral laws (best interest standard). Under this law, custody should be awarded on the basis of the child's best interest. This criterion includes the wishes of the child's parents, the child's wishes, the relationship of the child with parents as well as the child's adjustment to his /her home, school and community. Thus, there are several factors that can account for the decision to award custody. In the U.S., there are two types of custody arrangements: sole custody and joint custody. Sole custody assigns all legal rights over the child to one parent; most often sole custody is assigned to the mother. Joint custody can be either legal or physical joint custody. Legal shared custody means having the rights and obligations to make decisions about the child's upbringing, while joint physical custody involves specific amounts of time spent with each parent. Most researchers have defined joint physical custody (or dual residence) as at least between 30 and 50 percent of time spent with one of the parents (Kelly 1994).

Child custody arrangements are not necessarily imposed on individuals, as there is room for private arrangement between spouses. In the U.S., about 50 % of parents make private decisions between themselves about custody and visitation rights and the rest of the cases are decided in courts (Kelly, 1994). In 1995, about 20 % of divorce cases involved joint physical custody (Halla, 2010). This does not mean that only 20% of children had any involvement with both parents as 85 % of divorced parents had agreements for joint (legal or physical) custody or visitation privileges. Overall, 5 in 6 custodial parents are mothers (Grall, 2007). As a result,

most of the children of divorced parents spend most of their time with the divorced mothers. On average about 80 % of time is spent with mother and about 20% is spent with the father (Brown and Flinn, 2010). Hence, despite the recent changes in the law that allows for joint custody of children, fathers' involvement with their children after a divorce remains limited. The question is why. I propose fecundity differentials between women and men to account for the fact that child custody is normally allocated to the mother and the relatively small involvement of the father in his children's lives after a divorce.

It is important from a public policy perspective to know how granting of child support payments and allocation of child custody work. Divorce rates have increased in most OECD countries over the last decades. This has implications for the current living arrangements of children. In particular, 4 out of 10 children in the U.S. will experience the divorce of their parents (Kreider and Fields, 2005). There is large evidence showing that children from divorced parents perform worse in terms of lower test scores and educational achievement than those from intact families (see McLanahan and Sandefur, 1994; Gruber, 2004; Cáceres-Delpiano and Giolito, 2011, among others). This poorer performance may come about through different channels. After divorce, the household experiences a loss of income and children tend to have less contact at least with one of the parents, typically the father. As it is commonly assumed in the literature (e.g. Weiss and Willis, 1985) if children are public goods during marriage and they become private goods upon divorce, then the father's child support payments will be less than optimal. Besides diminished resources upon divorce, less time spent with parents might also have an effect on the well being of the child.

In this paper, I build a model economy of marriage, divorce and remarriage in which parents decide whether to have joint or sole custody. I explicitly model differences in fecundity between women and men. The idea is that marriage is a fertility contract (see Buckle et al, 1994). Men can only have children if they marry. Men can have children for a longer time span than women. Upon divorce, they would prefer to marry a woman who is able to have children. However,

having children from the previous marriage is costly. Therefore, child custody arrangements will have an impact on remarriage. The aim of this paper is to explore the allocation of child custody and how biological differences account for the incidence of joint child custody without further differences between women and men.

2.1.1. Facts

I provide an overview of the empirical evidence on the relationship between marriage, child custody and fertility.

Child custody. Child custody laws changed in the 1970s in most U.S. states. Until then, sole custody was assigned to the mother by default. The law changed in favour of the child's best interests. The two most common child custody arrangements are: mother's sole custody and joint custody. However, it is hard to tell which arrangement is best for children. There is evidence supporting joint custody, in terms of behavioral and emotional adjustment (Bauserman, 2002), economic well-being (Seltzer, 1991; Del Boca and Ribero, 1998; Allen, Nunley and Seals, forthcoming), educational attainment (Teng Wah, 2006; Nunley and Seals, forthcoming) and parental involvement (Huang, Han and Garfinkel, 2003), among others. Opponents object that children under joint custody are exposed to ongoing parental conflict (Kuehl, 1989). The following table shows the share of joint custody across some US states in 1995 (Halla, 2010)

Table I: Share of joint physical custody

State	Share of joint awards, 1995
AK	27.4
CT	47
IL	22.3
MI	14.1
MT	53
OR	23
PA	16

(2.1)

(2.2) Micro- level divorce certificate data from NVSS, NCHS

Thus, even though the share of joint custody awards differed across states, the incidence of joint custody was around 20 per cent. It is hard to get more recent estimates on the shares of joint custody, as in surveys the custodial parent is the one with whom the child spends more time. This can be misleading as it does not rule out some joint custody arrangement. However the average split of custody is 80 % of time is spent with mother and 20% is spent with the father. This implies that the mother is the one taking care of the child most of the time (Brown and Flinn, 2010). Therefore, the role of the mother as the main custodian of children after a divorce has not changed even though in the mid 70s child custody law moved towards a gender-neutral law.

Non biological children are costly. Having children from a previous marriage affects the marriage prospects of divorced individuals, especially of women. The remarriage rates of women are lower than those of men. The following table shows the marital status in 2001 of those ever divorced by age and sex.

Table II: Marital Status of ever divorced by sex and age, 2001

	Men		Women	
Age	**Divorced**	**Married**	**Divorced**	**Married**
>25	41.7	54.8	46.6	44
25-29	62.4	35.9	62.1	35.5
30-34	45.5	52	49.9	45.8
35-39	54.5	44.1	48.7	47.1
40-44	42.6	55.3	48.2	47.1
45-49	42	55.4	46.7	49
>50	36.8	58.4	43.5	41(+13.3)

Source: Kreider, 2005, Current Population Reports

Women tend to remain unmarried more often than men (except at age 35-39) , especially as women age. Therefore, it looks like after the fertile years it is harder for a woman to remarry than for a man. There is evidence suggesting that the presence of former children reduce the likelihood of remarriage for women, see Chiswick and Lehrer (1990) and Buckel et al (1996). However previous children do not matter for the remarriage probability of men. This might be explained by co-residence of children. Children normally remain with the mother after a divorce and this affects mother's remarriage opportunities. Meanwhile, men do not live with children and thus, their remarriage chances are not affected. Having children present in the household reduces remarriage probability as new partners do not enjoy raising someone else's child. There is an extensive literature in psychology, sociology and biology supporting this (White and Booth, 1985; Coleman and Ganong, 1990, Cherlin and Furstenberg, 1994, among others). Hence, the available evidence suggests that remarriage is affected by the presence of children

in the household from previous relationship. This is especially true for the woman as she is normally the custodian of the child.

Fertility after remarriage. After a divorce, men are more likely to form new households than women. Fustenberg et al (1983) and Manning and Smock (2000) find evidence of men "swapping" families (their old one for their new family). Men forming new families reduce social and economic investment in non resident biological children in favour of the biological children from the current relationship. Seltzer (1994) and Bergstrom (1996) argue that parent's interest in a child's well being diminishes in the presence of alternative offsprings.

There is evidence indicating that the possibility of remarriage affects the fertility decisions of individuals and that these are different for men and for women. Stewart (2002) indicates that stepchildren negatively affect childbearing intentions and childbearing risks. Intentions to have a child are weakened by one's own previous biological children and the previous biological children of one's current spouse or partner. Among couples with stepchildren, intentions remain high until each partner has had a biological child. Unlike women, men's previous biological children do not affect their intentions of having a child. Therefore, men actually have more children after a divorce consistent with the idea that men can let the ex-wife keep their children as he has the possibility of having more children. In fact, 38% of remarried man who had children with their current wife, had children from previous marriage (Male Respondent File of the National Survey of Family Growth, NSFG, 2006-2008). Moreover, men tend to remarry younger women than the first time around (Gelissen, 2004; Shafer, 2009). The fact that men form new families replacing the older ones and they marry younger women provides some evidence supporting the idea that fertility is an important factor when considering remarriage.

2.1.2. Related literature

Literature on child custody arrangements is surprisingly small – see Del Boca (2003) for a review of the literature on the economic consequences of divorce for the welfare of children and parents. Weiss and Willis (1985) present a model of optimal marriage contracts in which couples decide on the allocation of resources within marriage and the terms of a settlement (transfers and child custody) in the event of divorce. They explain why custody and transfers go towards the same person. Rasul (2006) allows spouses to decide ex ante the allocation of the child in case of divorce. Parents differ in their valuation of children. His results point out that if couples valuation of children are relatively similar, then joint custody is optimal. Brown and Flinn (2011) explore the effect of different family law environments on the educational attainment of children, their welfare and parents welfare using data from the NLSY. They find that changes in family law have little effect on children's welfare, but they have lager effects on parents welfare. Chiappori and Weiss (2007) explore the effects of an increase in the aggregate divorce rate on children's education. They propose that higher probability of remarriage can trigger an equilibrium in which child support is more generous and children are better off under higher divorce rates. Halla (2010) studies the effects of joint child custody on marriage rates, divorce rates, fertility and female labor force participation. He exploits the time variation across U.S. states on the introduction of family laws favouring gender neutral (joint) child custody. He finds that joint custody leads to an increase in marriage rates and in fertility. In another paper, Halla and Holzl (2007) investigate how the option of joint custody affects divorce in a model of bargaining. Looking at Austrian divorce court records, they find that the introduction of joint custody has no impact on the odds that children are mainly living with their mother. There has not been any attempt to model custody arrangements within an equilibrium model of marriage, divorce and remarriage. This is the gap that the current paper tries to fill.

There are several papers in economics that take into account fecundity differentials between women and men. Siow (1998) explores how differentials in fecundity interact with marriage, labor and financial markets to affect gender roles. He can account for several difference between women and men in labour participation, time rearing children and age of marriage among others. While previous literature has proposed women's comparative advantage in household production, he uses only biological difference to account for these facts. There are no other gains to marriage than having children. Thus individuals will only remarry if they can have more children within the new marriage. Thus the allocation of child custody is not an issue for the man. I consider other gains to marriage and how the allocation of children after divorce will have effects on the remarriage of individuals. While Siow (1998) argues that fecund women are scarce and men compete to marry them, Diaz-Gimenez and Giolito (2010) argue that women become less picky when choosing a partner as their shorter biological clocks are ticking. Fecundity differentials are sufficient to account for the age distributions of ever and never married men and women, for the probabilities of marrying a younger bride and a younger groom, and for the age distributions of first births observed in the United States in the year 2000.

In the following section I introduce the model environment and the value functions and in section 3, the equilibrium is defined. In section 4, I perform simulations of the model to see how it does in terms of matching the US economy. Section 5 includes a discussion of mechanism behind the model and I include some robustness checks. Section 6 concludes.

2.2. Environment

The economy is populated by overlapping generations of individuals who live for two periods as children and two as adults. The only decisions that individuals make in this economy are marriage decisions and decisions on child custody arrangements. While children, they make no decisions. The two periods living as adults will be denoted by the young and the old period. There is mass one

of women and men of each generation. Individuals are endowed with one unit of time. Individuals differ in their productivity (type). Let the productivity of women be denoted by $x \in X = \{x_1, ..., x_N\}$, and that of men by $z \in Z = \{z_1, ..., z_N\}$. The productivity in the second period depends on the productivity of the previous period in the following way

$$\Pr[x' = x_j \mid x = x_i] = \pi_x(x_j \mid x_i) \text{ and } \Pr[z' = z_j \mid z = z_i] = \pi_z(z_j \mid z_i).$$

Fertility Women are only fertile when they are young while men are fertile during young and old age. Men can have children only if they are married to a young woman. When a woman is fertile, she has 2 children who remain with her for all her lifetime. Therefore, only couples formed by a young man and a young woman and couples formed by an old man and a young woman can have children. Single women also have children, outside of any marriage.

Marriage market At the start of their adult lives, agents observe their productivity and they form households. A young individual meets another young individual with probability p. Upon their meeting individuals decide whether to form a household or remain single. Young singles who do not meet another young, fraction $(1-p)$ of the young, meet old single agents. Since the divorce rate will be smaller than 1 in equilibrium there will be a smaller number of old singles than the number of young singles. Hence some fraction of the $(1-p)$ of young singles will not meet anyone and they remain single for that period. Like young, old agents will meet another old with probability p and a young agent with probability $(1-p)$. Unlike young agents, all old agents will meet someone, either young or old.

Potential couples draw a match quality $\gamma \in G = \{\gamma_1, ..., \gamma_M\}$ from the distribution $\Gamma(\gamma)$. If two young adults meet, they observe their types and match quality and they form a household if both agree to do so. Otherwise they remain single for that period. Individuals also observe whether there is any children associated with their partner. When a young agent matches with a young each of them have no children. However, if a young matches with an old agent, the old agent might have

children associated with them from the previous period. Likewise, if an old agent matches with an old agent, both of them might have children associated with them. At the end of their young lives, couples formed by two young individuals draw next period's productivities and a new match quality. They might divorce and there can be divorced couples who share custody and couples where the mother is the sole custodian of the children. Next period they will go to the marriage market as singles with either joint or sole custody. Those young individuals who married an old individual will enter next period as widows/widowers. Thus, at the beginning of the old period, the pool of old singles will be formed by never married old agents, widows and widowers and divorced agents.

Decisions As well as marriage decisions, the only other decision in the economy is about the allocation of child custody. This decision is only made in households formed by a young man and a young woman. Young couples decide on custody arrangements, a for their children in case they were to divorce. There are two possibilities: they can agree on sharing custody or on giving sole custody to the mother.[1] Custody is thought of as the time that the child spends with each parent. The chosen custody arrangement has implications for the utility that parents receive from having their children at home and for the education that children receive. The custody policy parameter, τ_a determines how much time is allocated to the mother. Thus, τ_a is the share of time the child spends with the mother, while $(1 - \tau_a)$ is the father's share. If $a = 1$, then the mother is the sole custodian of the child, and $\tau_1 = 1$. This means that she is the only one enjoying the child and the father forgets about the child. If $a = 2$, parents will have joint custody. The share of time with the child allocated to the mother is $\tau_2 < 1$. We will set $a = 0$, for mothers who had their children outside of a marriage.

Utility Single women care about consumption and the quality and quantity of their children. Single men only enjoy consumption as they cannot have children if they remain single. Couples care about consumption, children and the match

[1] I do not allow for the possibility of fathers having the sole custody of the child as this arrangement is rare in the data.

quality. Women marry to enjoy economies of scale in consumption and the match quality. Men marry not only to enjoy economies of scale in consumption and the match quality, but to have children. Parents receive utility from the number of children they have and the education that the children receive. However, they only get utility from their own biological children. An individual has to pay a fixed utility cost φ if there are children in the household who are not his/her own. Divorced mothers with sole custody get utility from their children, however divorced fathers who agreed to assign sole custody to the mother forget about their child and they get no utility from them. Parents who share custody get utility from their children, determined by the parameter τ_2, since the mother will have the children for τ_2 of the time and the father will have the children the rest of the time. All agents have one unit of time and as they do not value leisure, their earnings are given by their types (x for females and z for males).

Education The quality (education) of children living in two parent households or in never married women households depends on the consumption level of the household. However, when the parents are divorced, a child's education depends on the custody arrangements. If parents have agreed on sole custody, the child lives with the mother and the father forgets about the children. Therefore, the education that the child receives under sole custody is determined by the consumption level of the mother's household.

Under joint custody, the education of the child depends on the level of consumption in the mothers' household and the level of consumption in the father's household. As divorced parents can remarry, the consumption in their households also depends on whether they have remarried and to whom they have remarried. This implies that couples agreeing on joint custody will need to keep track of the marital status of their ex-partners. The consumption level of a couple's household is the sum of the woman's income, x and the man's income, z. If a woman of type x shares custody with a man of type $\widetilde{z}$ and she remarries a man of type z, her children's education will depend on her household's consumption $(x + z)$ and her ex-husband's consumption level. If the ex-husband has also remarried a woman of

type $\widetilde{x}$, the ex-husband's consumption level is $(\widetilde{z} + \widetilde{x})$. Thus the value of remarrying for this woman will also depend on her ex-husband's type and his marital status. It is important to note that using consumption level as an approximation of the amount of investment parents make is a shortcut that avoids having an impossibly large state space. If one allows parents make an investment decision on children, one has to know not only the types of parent's new couples but also the complete marital connections of these new partners — see Laitner (1991) for a discussion. Note that there is no link between the education that children receive and their productivity levels when they become young adults. Education only provides utility to the parents.

When deciding whether to marry or not, young individuals need to form expectations about future marriage market conditions. If they remain single or they marry someone from the old cohort, thus entering next period as a widow/widower, they have to anticipate who will be in the single pool in the young generation(all start out as single) and in the old generation (there will be also divorcees). If they marry someone young, they also need to anticipate who would be a potential match for their ex in case of divorce, as the education of their children will depend on the consumption level of the ex-partner's household in case of shared custody. Thus they also have to form expectations over the probability of their ex-partner remarrying.

2.2.1. Value functions

I introduce the value functions for the old and young individuals. First, I introduce the value of being a single old and a married couple consisting of two olds. Then, I introduce the value of being in a marriage between an old individual and a young individual and finally the value of being a single young and the value of a marriage among two young individuals.

2.2.2. Old Individuals

I start with the value of being non-married (single, divorced, or widowed) for an old woman. It depends on the type of the woman, x and the children, k. The value of being non-married for a divorced woman also depends on the custody arrangements, a. Widows and never married women have sole custody by default, therefore, the share of time their children spend with them is equal to one and a is set to 0.

If a divorced woman has sole custody, a is equal to 1 and her children spend all their time with her, τ_1 equals 1. However, if she has shared custody with the father, the education of her children depends on the ex-husband's type, $\widetilde{z}$ and if he has remarried, on the type of the new wife, $\widetilde{x}$. Mothers care about the education that their children receive. The education production function depends on k and the education, e. Women also care about consumption, c. There are economies of scale in consumption in the sense that as a household grows, more resources are needed but the need is less than proportionate.

The value of being non-married when old for a woman is given by

$$G_2\left(x, a, k, (\widetilde{x}, \widetilde{z})\right) = \frac{1}{(1-\sigma)} c^{1-\sigma} + \tau_a \phi \ln\left(E\right),$$

where consumption is

$$c = \frac{1}{(1+\epsilon_1 k)^{\epsilon_2}} x, \quad 0 < \epsilon_1 < 1, \quad 0 < \epsilon_2 < 1,$$

and quality-quantity composite for children, E, is given by

$$E = e^{\lambda} k^{1-\lambda}.$$

Note that parameters ϵ_1 and ϵ_2 determine the economies of scale and the parameter λ is the weight of education (quality) in the quality-quantity composite for children. The education that children receive is a weighted sum of the households' consumption levels where the children lives, and is given by,

$$e = \left(\tau_a x + (1 - \tau_a)\left(\widetilde{x} + \widetilde{z}\right)\psi_a\right),$$

where τ_a is the weight given to the mother's consumption and $(1 - \tau_a)$ is the weight given to the father's consumption. These weights are taken to being the same as the share of time the child spends on each of the parents' households. The indicator function ψ_a takes the value of 1 if there is joint custody and so the father's consumption becomes of relevance, else it takes the value of zero and only the mother's consumption is important for the children education,

$$\psi_a = \begin{cases} 1 & \text{if } a = 2 \\ 0 & \text{if } a = 0, 1. \end{cases}$$

The value of being an old never married or widowed man depends on his type. He has no children from previous relationship so he only cares about consumption. However, if he is divorced, he will care about his children depending on the custody arrangements. If he agreed to giving sole custody to the mother, he will not care about the children. However, if he shares custody with his ex-wife he will care about his children. As the education of the children will also depend on the mother's household, both the type of the mother, $\widetilde{x}$ and the type of the potential new partner, $\widetilde{z}$ are state variables.

The value of being non-married (single, divorced, widower) for an old man is given by

$$B_2\left(z, a, k, (\widetilde{x}, \widetilde{z})\right) = \frac{1}{(1-\sigma)} c^{1-\sigma} + (1 - \tau_a)\,\psi_a \phi \ln\left(E\right)$$

where consumption is

$$c = \frac{1}{\left(1 + \epsilon_1 k\right)^{\epsilon_2}} z$$

and the education production function

$$E = e^{\lambda} k^{1-\lambda}$$

where e is given by

$$e = \left(\left(1 - \tau_a\right) z \psi_a + \tau_a \left(\widetilde{x} + \widetilde{z}\right)\psi_a\right).$$

The old man only cares about the children in case of joint custody. This is the case when the indicator function ψ_a takes the value of 1, i.e.

$$\psi_a = \begin{cases} 1 & \text{if } a = 2 \\ 0 & \text{if } a = 0, 1. \end{cases}$$

The value of being married when old depends on the age composition of the couple and on whether the couple is newly formed or not. Let $M^n_{i,j}$ denote the value of a newly formed marriage among a woman of age $i \in \{1, 2\}$ and a man of age $j \in \{1, 2\}$. Age 1 corresponds to being young and age 2 corresponds to being old. Let's also define the value of a newly formed marriage among a woman of age i and a man of age j for a woman be $W^n_{i,j}$ and for a man $H^n_{i,j}$. Similarly let $M^o_{i,j}$ denote the value of an old marriage among a woman of age i and a man of age j and $W^o_{i,j}$ and $H^o_{i,j}$ the value of the marriage for a woman and a man respectively.

I start with the value of a newly formed marriage among old individuals. The value of the couple depends on the type of the woman, x and the type of the man, z as well as the match quality they drew at the beginning of the period. It also depends on the children that the woman brings to the marriage, k_w and her child custody arrangements, a_w. It might also depend on the children of the husband, k_h and his child custody arrangements, a_h. If the woman has joint custody, the type of her ex-husband and his potential partner, $(\widetilde{x}_w, \widetilde{z}_w)$ are of relevance. If the man has joint custody, the value of the new marriage will also depend on the type of his ex-wife and his potential partner, $(\widetilde{x}_h, \widetilde{x}_h)$. However, if he has sole custody, he forgets about his previous children and neither k_h nor the type of his ex-wife are important. Having non biological children in the household is costly for the non-biological parent. As all women come with two children, the man has to pay a cost φ and the woman will have to pay this same cost if the man has joint custody. The couple cares about consumption, their own children, the match quality, γ and they pay a fixed cost for their non-biological children.

The value of a newly formed marriage for an old woman is given by

$$W_{2,2}^{n}\left(x,z,a_w,a_h,k_w,k_h,\left(\widetilde{x}_w,\widetilde{z}_w\right),\left(\widetilde{x}_h,\widetilde{x}_h\right),\gamma\right)=$$
$$\frac{1}{(1-\sigma)}c^{1-\sigma}+\gamma+\left[\tau_{a_w}\phi\ln\left(E_w\right)-\varphi\psi_{a_h}\right]$$

and for an old man it is equal to

$$H_{2,2}^{n}\left(x,z,a_w,a_h,k_w,k_h,\left(\widetilde{x}_w,\widetilde{z}_w\right),\left(\widetilde{x}_h,\widetilde{x}_h\right),\gamma\right)=$$
$$\frac{1}{(1-\sigma)}c^{1-\sigma}+\gamma+\left[\left(1-\tau_{a_h}\right)\phi\ln\left(E_h\right)-\varphi\psi_{k_w}\right].$$

Consumption is given by

$$c=\frac{1}{\left(2+\epsilon_1 k\right)^{\epsilon_2}}\left(x+z\right)$$

where the total number of children in the household, k is equal to the sum of the children brought by the wife and the children brought by the husband,

$$k=k_w+\psi_{a_h}k_h.$$

The education production function of the woman's children is given by

$$E_w=e_w^{\lambda}k_w^{1-\lambda}$$

where the education that the woman's children get depends on the household's income, $(x+z)$ and if she has joint custody, on the ex-husband's income $(\widetilde{x}+\widetilde{z})$ according to the time the child spends on the mother's and the father's household, τ_{a_w} and $(1-\tau_{a_w})$ respectively,

$$e_w=\left(\tau_{a_w}\left(x+z\right)+\left(1-\tau_{a_w}\right)\left(\widetilde{x}_w+\widetilde{z}_w\right)\psi_{a_w}\right).$$

Similarly for the education of the man's children,

$$E_h=e_h^{\lambda}k_h^{1-\lambda},$$

where the education that they receive depends on the father's household income $(x+z)$ and the ex-wife's household, $(\widetilde{x}+\widetilde{z})$, if he has shared custody, where $(1-\tau_{a_h})$ is the share of the man's household income that affects his children education as well

as the share of time they spend with him, i.e.

$$e_h = \left((1 - \tau_{a_h}) (x + z) \psi_{a_h} + \tau_{ah} (\widetilde{x}_h + \widetilde{z}_h) \psi_{a_h} \right).$$

Finally, the indicator function ψ_{a_w} takes the value of 1 if the woman has joint custody,

$$\psi_{a_w} = \begin{cases} 1 & \text{if } a_w = 2 \\ \\ 0 & \text{if } a_w = 0, 1 \end{cases},$$

and the indicator function ψ_{ah} takes the value of 1 if the man has joint custody, else, he will not care about his previous children,

$$\psi_{a_h} = \begin{cases} 1 & \text{if } a_h = 2 \\ \\ 0 & \text{if } a_h = 0, 1. \end{cases}.$$

A woman and a man will only marry if they both agree to do so. An old woman will only agree to marry an old man if the value as a wife is at least as high and that of remaining single. And the same goes for the old man. Let $I^n_{2,2}$ and $J^n_{2,2}$ be indicators functions for the woman and the man decisions, that take the value of 1 if they would prefer to marry. Therefore, for the woman

$$I^n_{2,2} = \begin{cases} 1 & \text{if } W^n_{2,2}(.) \geq G_2(.) \\ \\ 0 & \text{otherwise,} \end{cases}$$

and for the man

$$J^n_{2,2} = \begin{cases} 1 & \text{if } H^n_{2,2}(.) \geq B_2(.) \\ \\ 0 & \text{otherwise.} \end{cases}$$

If the couple married when both of them were young and they remain married when old, the value the couple enjoys is similar to that of a newly formed old couple, but all the children in the household are the biological children of the couple. Therefore, the education that children receive depends on the household's

consumption level and there is no penalty for raising someone else's children. The value of a continuing couple for a woman is the following

$$W_{2,2}^{o}\left(x,z,k,\gamma\right)=\frac{1}{\left(1-\sigma\right)}c^{1-\sigma}+\gamma+\phi\ln\left(E\right),$$

and for the man

$$H_{2,2}^{o}\left(x,z,k,\gamma\right)=\frac{1}{\left(1-\sigma\right)}c^{1-\sigma}+\gamma+\phi\ln\left(E\right),$$

where consumption is given by

$$c=\frac{1}{\left(2+\epsilon_{1}k\right)^{\epsilon_{2}}}\left(x+z\right),$$

and the education production function is

$$E=e^{\lambda}k^{1-\lambda},$$

where the education of the children, e now only depends on the household's income

$$e=\left(x+z\right).$$

Both members of this couple were married to each other in the previous period. In order to decide whether they wanted to remain married to each other, they have to compare the value of remaining married to the expected value of divorcing. This expected value will be introduced later on in the problem of young individuals. Let $I_{2,2}^{o}$ be an indicator function taking the value of 1 if an old woman's value of marriage, $W_{2,2}^{o}\left(x,z,k,\gamma\right)$ is at least as high as her expected value of divorce. For the man, the indicator function $J_{2,2}^{o}$ equals 1 if his value as a husband $H_{2,2}^{o}\left(x,z,k,\gamma\right)$ is at least as large as his expected value of divorce.

I continue by introducing the value of a marriage formed by individuals of different generations. First, I introduce the value of a marriage between an old woman and a young man. If a young man marries an old woman, he cannot have children while he is young, so he gets no utility from children. Moreover, he has a utility cost for raising the children that his wife brings into the marriage. The

value of the couple will depend on the custody arrangements of the woman, a_w. If she has joint custody, the type of her ex-husband and his potential partner's type, $(\widetilde{x}_w, \widetilde{z}_w)$ affect the value of the couple through their effect on the education of the woman's children. The couple enjoys consumption and their match quality. The value of the marriage for a woman is

$$W_{2,1}^n\left(x, z, a_w, k_w, 0, \left(\widetilde{x}_w, \widetilde{z}_w\right), \gamma\right) = \frac{1}{(1-\sigma)} c^{1-\sigma} + \gamma + \left[\tau_{a_w} \phi \ln\left(E_w\right)\right]$$

while for a man it is given by

$$H_{2,1}^n\left(x, z, a_w, k_w, 0, \left(\widetilde{x}_w, \widetilde{z}_w\right), \gamma\right) = \frac{1}{(1-\sigma)} c^{1-\sigma} + \gamma - \varphi$$

$$+\beta p \int_{z', \gamma', \Omega_2} \left[\max\left\{B_2\left(z'\right), H_{2,2}^n\left(x', z', a_w, k_w, 0, \left(\widetilde{x}_w, \widetilde{z}_w\right) I_{2,2}^n, \gamma'\right) I_{2,2}^n\right\}\right]$$

$$d\pi^z\left(z'|z\right) d\Omega_2\left(x', a_w, k_w\left(\widetilde{x}_w, \widetilde{z}_w\right)\right) d\Gamma\left(\gamma'\right) +$$

$$+\beta\left(1-p\right) \int_{x', \gamma', \Omega_1} \left[\max\left\{B_2\left(z'\right), H_{1,2}^n\left(x', z', \gamma'\right) I_{1,2}^n\right\}\right] d\pi^z\left(z'|z\right) d\Omega_1\left(x'\right) d\Gamma\left(\gamma'\right)]$$

where consumption is

$$c = \frac{1}{\left(2 + \epsilon_1 k_w\right)^{\epsilon_2}} \left(x + z\right)$$

and the education production function

$$E_w = \left(\tau_{a_w}\left(x + z\right) + \left(1 - \tau_{a_w}\right)\left(\widetilde{x_w} + \widetilde{z_w}\right) \psi_{a_w}\right)^{\lambda} k_w^{1-\lambda}.$$

The indicator function ψ_{a_w} takes the value of 1 if the woman has joint custody,

$$\psi_{a_w} = \begin{cases} 1 & \text{if } a_w = 2 \\ \\ 0 & \text{if } a_w = 0, 1. \end{cases}$$

An old woman will marry a young man if her value of being a wife, $W_{2,1}^n\left(.,.\right)$ is greater or equal than her value of being single, $G_2\left(.,.\right)$. Let $I_{2,1}^n$ equal 1 if this

is the case. For the young man, $J_{2,1}^n$ will take the value of 1 if the value of being a husband, $H_{2,1}^n(.,.)$ is at least as large as the value of remaining single, $B_1(.,.)$ which I introduce below.

Note that the young man will have a continuation value for the second period of his life. The old woman dies at the end of her old period and so the young man will enter next period as a widower. He forms expectations about the future marriage market. He will become of type z' with probability $\pi^z(z'|z)$. With probability p, he will meet an old woman from the distribution $\Omega_2(x', a_w, k_w, (\widetilde{x}_w, \widetilde{z}_w))$. This distribution of old non-married women consists of never married women, widows and divorced women. All the women have children with them, k_w. They draw a match quality γ' from the distribution $\Gamma(\gamma)$ and she observes his type and he observes her type, x' and the child custody arrangements, a_w. If he matches with a divorced woman, she might share custody and he can also observe her ex-husband's household income $(\widetilde{x}_w, \widetilde{z}_w)$. If he matches with a divorced woman with sole custody, a widow or a never married woman, he only observes her type and her children. Then he has to decide whether he stays single for the last period of his life with a value $B_2(z')$ or whether he marries and his utility would be $H_{2,2}^n(x', z', a_w, k_w, 0, (\widetilde{x}_w, \widetilde{z}_w), \gamma')$, both defined above. With probability $(1-p)$ he meets a young woman from the distribution of single young women $\Omega_1(x')$. The couple draws a match quality and observe each others' types. Then, he decides whether to stay single or marry. If he marries, he will get $H_{1,2}^n(x', z', \gamma')$ which is defined below.

If an old man marries a young woman, they will have children. The old man might bring children, k_h into the marriage as well if he shares the custody with his ex-wife. Then, the ex-wife's household income will affect the man's children education. In this case, the young woman has to pay a fixed cost for raising someone else's children. However, as both the young woman and the old man are fertile, they have more children and they will both get utility from the children they have in common, denoted by k_c. The value of this marriage for the young woman is $W_{1,2}^n(x, z, a_h, 0, k_h, (\widetilde{x}_h, \widetilde{z}_h), \gamma)$

$$\frac{1}{(1-\sigma)}c^{1-\sigma}+\gamma+\left(\phi\ln\left(E\right)-\psi_{a_h}\varphi\right)$$
$$+\beta\int\limits_{x',\gamma',\Theta_2}\max\left\{G_2\left(x',k\right),W_{2,2}^n\left(x',z',0,a_h,k_c,k_h,\left(\widetilde{x}_h',\widetilde{z}_h'\right),\gamma'\right)J_{2,2}^n\right\}]$$
$$\times d\pi^x\left(x'|x\right)d\Theta_2\left(z',a_h,k_h,\left(\widetilde{x}_h,\widetilde{z}_h\right)\right)d\Gamma\left(\gamma'\right)+\beta\left(1-p\right)\times$$
$$\times\int\limits_{x',\gamma',\Theta_1}\max\left\{G_2\left(x',k\right),W_{2,1}^n\left(x',z',1,k_c,\gamma'\right)J_{2,1}^n\right\}d\pi^x\left(x'|x\right)d\Gamma\left(\gamma'\right)d\Theta_1\left(z'\right)$$

and for the old man, $H_{1,2}^n\left(x,z,a_h,0,k_h,\left(\widetilde{x}_h,\widetilde{z}_h\right),\gamma\right)$

$$\frac{1}{(1-\sigma)}c^{1-\sigma}+\gamma$$
$$+\left((1-\tau_{a_h})\phi\ln\left(E_h\right)\psi_{a_h}+\phi\ln\left(E\right)\right)$$

where the household's consumption is

$$c=\frac{1}{\left(2+\epsilon_1 k\right)^{\epsilon_2}}\left(x+z\right)$$

and the total number of children in the household, k is equal to the number of children they have in common, k_c and the number of the husband's children if he has joint custody, k_h

$$k=k_c+k_h.$$

The production function of common children and of the husband's children are given by

$$E=\left(x+z\right)^{\lambda}k_c^{1-\lambda},$$

and

$$E_h=\left(\left(1-\tau_{ah}\right)\left(x+z\right)\psi_{a_h}+\tau_{ah}\left(\widetilde{x}+\widetilde{z}\right)\psi_{a_h}\right)^{\lambda}k_h^{1-\lambda},$$

respectively.

The young woman will marry the old man if the value of being single is smaller than the value of being a wife, $W^n_{1,2}(.,.)$. The indicator function $I^n_{1,2}$ equals 1 if this happens. And for the old man, let the indicator function $J^n_{1,2}$ equal 1 if the value of being a single old man, $B_2(.,.)$ is smaller than the value of marrying a young woman, $H^n_{1,2}(.,.)$.

A young woman who married an old man will be a widow next period. She will be of type x' with probability $\pi^x(x'|x)$ and she will match with a young man from the distribution $\Theta_1(z)$ with probability $(1-p)$. If she matches with a young man of type z' they will draw a match quality γ' from the distribution $\Gamma(\gamma)$. She will decide on whether to remain single and get utility $G_2(x',k)$ or get married again and enjoy the value of a marrying, $W^n_{2,1}(x',z',1,k_c,\gamma')$. She will match with an old man from the distribution $\Theta_2(z,a_h,k_h,(\widetilde{x}_h,\widetilde{z}_h))$ with probability p. The distribution of old men depends on the type of the men, z and child custody arrangements, a_h. Never married and widowed men will not have children. However, divorced men might have children attached to them if they have joint custody, $a_h = 2$. Then, if the woman meets a divorced man with joint custody, she will observe his type, the children he has and the ex-wife's household income, $(\widetilde{x}_h,\widetilde{z}_h)$. Upon observing this and the match quality, she will decide on whether to stay single with the value of $G_2(x',k)$ or marry where she would enjoy the utility $W^n_{2,2}(x',z',0,a_h,k_c,k_h,(\widetilde{x}'_h,\widetilde{z}'_h),\gamma')$.

2.2.3. Young Individuals

A young single woman will have 2 children. She will get utility from consumption, the number of children she has and the level of education they have. The value of

being a single young woman is

$$\begin{aligned} G_1(x) &= \frac{1}{(1-\sigma)}c^{1-\sigma} + \phi \ln(E) + \\ &+\beta p \int_{x',\gamma',\Theta_2} \left\{ \left[\max \left\{ G_2(x',k), W^n_{2,2}(x',z',0,a_h,k,k_h,(\widetilde{x}_h,\widetilde{z}_h),\gamma') J^n_{2,2} \right\} \right] \right\} \\ &\times d\pi^x(x'|x)\, d\Theta_2(z',a_h,k_h,(\widetilde{x}_h,\widetilde{z}_h))\, d\Gamma(\gamma') \\ &+\beta(1-p) \int_{x',\gamma',\Theta_1} \left[\max \left\{ G_2(x',k), W^n_{2,1}(x',z',0,k,\gamma') J^n_{2,1} \right\} \right] \} \times \\ &\times d\pi^x(x'|x)\, d\Theta_1(z')\, d\Gamma(\gamma') \end{aligned}$$

where her household consumes all of her income x

$$c = \frac{1}{(1+\epsilon_1 k)^{\epsilon_2}} x$$

and the children's production function depends on the number of children and the education they receive, being λ the share of education in the education production function,

$$E = x^{\lambda} k^{1-\lambda}.$$

where the education e is equal to her income, x.

Next period, with probability p the young woman will be matched to someone from her generation and with probability $(1-p)$, she will match with a young man. The distribution of non-married old men (never married, divorced and widowers) is denoted by $\Theta_2(z', a_h, k_h, (\widetilde{x}_h, \widetilde{z}_h))$ with no custodial rights if $a_h = 0, 1$ and with joint custody if $a_h = 2$. While the distribution of young single men is $\Theta_1(z')$. She will be of type x' with some probability and she will match with a man from the above distributions. They will draw a match quality, γ' and she will have to decide on whether to remain single and enjoy the value of being a single old woman, $G_2(x', k)$ or she can get married and enjoy the value of being a married old woman married to an old man, $W^n_{2,2}(x', z', 0, a_h, k, k_h, (\widetilde{x}_h, \widetilde{z}_h), \gamma')$ or if she matched with a young man her utility will be $W^n_{2,1}(x', z', 0, k, \gamma')$.

A single young man only enjoys consumption as he cannot have children. The value of being a single young man

$$\begin{aligned} B_1(z) &= \frac{1}{(1-\sigma)}c^{1-\sigma} \\ &+\beta p \int_{z',\gamma',\Omega_2} \left[\max\left\{B_2(z'), H^n_{2,2}(x',z',a_w,k_w,0,(\widetilde{x}_w,\widetilde{z}_w),\gamma')\, I^n_{2,2}\right\}\right] \times \\ &\times d\pi^z(z'|z)\, d\Gamma(\gamma')\, d\Omega_2(x',a_w,k_w,(\widetilde{x}_w,\widetilde{z}_w)) \\ &+\beta p \int_{x',\gamma',\Omega_1} \left[\max\left\{B_2(z'), H^n_{1,2}(x',z',\gamma')\, I^n_{1,2}\right\}\right] \\ &\times d\pi^z(z'|z)\, d\Gamma(\gamma')\, d\Omega_1(x'). \end{aligned}$$

Next period his type will be z' according to the process $\pi^z(z'|z)$ and he will enter the marriage market where he will match with an old woman with probability p from the distribution $\Omega_2(x', a_w, k_w, (\widetilde{x}_w, \widetilde{z}_w))$ and with a young woman with probability $(1-p)$ from the distribution $\Omega_1(x')$. The couple will draw a match quality and then he has to decide whether to marry or remain single. If he matches with an old woman, the value of their marriage will depend on her type, the children she brings into the marriage and her child custody arrangements. If she has joint custody, the type of her ex-husband, $\widetilde{z}_w$ and his potential partner's type, $\widetilde{x}_w$ will also affect the value of the marriage through the education of the woman's children. If she has sole custody or she has never married or she is a widow, there are no links with the father of the child, thus his type and marital status are of no relevance.

Finally, I present the value of a married couple formed by a young woman and a young man. The couple decides on child custody arrangements, a in case of divorce. Child custody arrangements will affect the future utility of each individual and how much they care about their children. These arrangements will also affect the marriage market opportunities if they were to divorce. Bringing children into a new marriage is costly for the non biological parent and thus, the options for remarriage are affected by this. The value of a young woman and a young man is

given by

$$\begin{aligned} M_{1,1}(x,z,\gamma) &= \max_{a}\{\frac{1}{(1-\sigma)}c^{1-\sigma}+\phi\ln(E)+\gamma+ \\ &+\int_{x',z',\gamma'}(\mu\beta[\max\{W_{2,2}^{o}(x',z',k,\gamma')J_{2,2}^{o},W_{2}^{d}(x',a,k)] \\ &+(1-\mu)\beta[\max\{H_{2,2}^{o}(x',z',k,\gamma')I_{2,2}^{o},H_{2}^{d}(z',a,k)\}])\times \\ &\times d\pi^{x}(x'|x)\,d\pi^{z}(z'|z)\,d\Gamma(\gamma') \end{aligned}$$

subject to the budget constraint

$$c=\frac{1}{(2+\epsilon_1 k)^{\epsilon_2}}(x+z)$$

and the education production function,

$$E=(x+z)^{\lambda}k^{1-\lambda}.$$

Given the optimal custody decisions, $a^{*}(x,z,\gamma)$, let the value of being married for a young female male be denoted by $W_{1,1}^{n}(x,z,\gamma)$ and $H_{1,1}^{n}(x,z,\gamma)$. Young individuals will only get married if both agree to do so. The young woman will get marry if the value of being single, $G_1(x)$ is smaller than the value of getting married, $W_{1,1}^{n}(x,z,\gamma)$. The indicator function $I_{1,1}^{n}$ will equal 1 if the young woman wants to marry. For the young man, $J_{1,1}^{n}$ will equal 1 when the value of being single, $B_1(z)$ is smaller than $H_{1,1}^{n}(x,z,\gamma)$.

At the end of the first period of their lives, they receive a match quality shock and a productivity shock. They have to decide whether to remain married or divorce. If they were to remain married, the wife will get utility $W_{2,2}^{o}(x',z',k,\gamma')$ and the man will get $H_{2,2}^{o}(x',z',k,\gamma')$. If they divorce, they enter the marriage market at the beginning of the next period and they have the possibility of remarrying. In order to decide whether to remain married or divorced they compare the expected value of staying married to the expected value of divorcing. The woman's expected value of divorcing, $W_{2}^{d}(x',a,k)$ depends on the distribution of single old

men, $\Theta_2(z'', a_h, k_h, (\widetilde{x}_h, \widetilde{z}_h))$ she would match to with probability p and the distribution of single men $\Theta_1(z'')$ that she will match to with probability $(1-p)$. She might match with an old man who has joint custody and so his children and the type of his ex-wife and her partner, $(\widetilde{x}''_h, \widetilde{z}''_h)$ will affect the value of the marriage, $W^n_{2,2}(x', z'', a, a_h, k, k_h, (\widetilde{x}_w, z'), (\widetilde{x}''_h, \widetilde{z}''_h), \gamma'')$. Her own custody arrangements, a will have an effect on the value of the marriage. If she has joint custody, $a = 2$, her ex-husband's type, z' and his new partner's if he remarries, $\widetilde{x}_w$ will be taken into account. Else, she can remain single and she will get utility $G_2(x', a, k, (\widetilde{x}'_w, z'))$. This utility will also depend on the custody, a. If she matches with a young man, the problem is similar but the young man has no children attached to him, so the value of their marriage will be $W^n_{2,1}(x', z'', a, k, (\widetilde{x}'_w, z'), \gamma'')$. The value of divorcing for a young wife is given by

$$\begin{aligned} W^d_2(x', a, k) &= p \int_{\gamma'', \Theta_2} \max\{G_2(x', a, k, (\widetilde{x}_w, z)), \\ &\quad W^n_{2,2}(x', z'', a, a_h, k, k_h, (\widetilde{x}_w, z'), (\widetilde{x}''_h, \widetilde{z}''_h), \gamma'')\} \times \\ &\quad \times d\Theta_2(z'', a_h, k_h, (\widetilde{x}_h, \widetilde{z}_h))\, d\Gamma(\gamma'') \\ &\quad + (1-p) \int_{\gamma'', \Theta_1} \max\{G_2(x', a, k, (\widetilde{x}'_w, z')), W^n_{2,1}(x', z'', a, k, (\widetilde{x}'_w, z'), \gamma'')\} \\ &\quad \times d\Theta_1(z'')\, d\Gamma(\gamma'') \end{aligned}$$

The problem for the husband is similar. If he matches with an old woman with probability p from the distribution $\Omega_2(x'', a_w, k_w, (\widetilde{x}_w, \widetilde{z}_w))$, the value of their marriage for the man, $H^n_2(x'', z', a_w, a, k_w, k, (\widetilde{x}_w, \widetilde{z}_w), (x', \widetilde{z}'_h), \gamma'')$ will depend on her child custody arrangements, a_w. If she has joint custody, it will also depend on her ex-husband's household income, $(\widetilde{x}_w, \widetilde{z}_w)$. Again, the value of remarriage also depends on the custody arrangements of the man, a. If he has joint custody, $a = 2$, his ex-wife's type, x' and her new partner's if she remarries, $\widetilde{z}_h$ will be taken into account. He has to decide whether to marry to this old woman or remain single and get utility $B_2(z', a, k, (x', \widetilde{z}'_h))$. If he matches to a young

woman, he will only observe her type x'' and the value of marrying to her will be $H_{2,1}^{n}\left(x'',z',a,k,\left(x',\widetilde{z}_{h}'\right),\gamma''\right)$. The value of divorcing for a young husband is given by

$$\begin{aligned} H_{2}^{d}\left(z',a,k\right) &= p\int_{\gamma'',\Omega_{2}}\max\{B_{2}\left(z',a,k,\left(x',\widetilde{z}_{h}'\right)\right), \\ &\quad H_{2}^{n}\left(x'',z',a_{w},a,k_{w},k,\left(\widetilde{x}_{w},\widetilde{z}_{w}\right),\left(x',\widetilde{z}_{h}'\right),\gamma''\right)\}\times \\ &\quad \times d\Omega_{2}\left(x'',a_{w},k_{w},\left(\widetilde{x}_{w},\widetilde{z}_{w}\right)\right)d\Gamma\left(\gamma''\right) \\ &\quad +\left(1-p\right)\max\int_{\gamma'',\Omega_{1}}\left\{B_{2}\left(z',a,k,\left(x',\widetilde{z}_{h}'\right)\right),H_{2,1}^{n}\left(x'',z',a,k,\left(x',\widetilde{z}_{h}'\right),\gamma''\right)\right\} \\ &\quad \times d\Omega_{1}\left(x''\right)d\Gamma\left(\gamma''\right). \end{aligned}$$

2.3. Equilibrium

Given the child custody sharing rule $\{\tau\}$, and a initial distribution of single young women $\Omega_{1}\left(x\right)$ and single young men $\Theta_{1}\left(z\right)$, a stationary equilibrium is a decision rule on child custody arrangement, $a^{*}\left(x,z,\gamma\right)$, and the distributions of singles in the old period $\Omega_{2}\left(x,a,k,\left(\widetilde{x},\widetilde{z}\right)\right)$ and $\Theta_{2}\left(z,a,k,\left(\widetilde{x},\widetilde{z}\right)\right)$ such that

- The child custody rule is the solution to the value functions described above
- The old age distributions $\Omega_{2}\left(x,a,k,\left(\widetilde{x},\widetilde{z}\right)\right)$ and $\Theta_{2}\left(z,a,k,\left(\widetilde{x},\widetilde{z}\right)\right)$ are stationary distributions that are consistent with the decision rules.
- The probability of remarrying for women and men with joint custody is consistent with the decision rules and the stationary distributions of individuals

2.4. Simulations

I present some simulations to see how the model performs in terms of fitting the data. The following parameters correspond to the benchmark case. There are initial distributions of single young women, $\Omega_{1}\left(x\right)$ and men, $\Theta_{1}\left(z\right)$. I assume

a log normal distribution over types. In the benchmark, there are 4 different types of individuals where the type refers to the productivity of the individual.[2] The individual productivities come from a log normal distribution with mean μ_x and standard deviation σ_x for women and mean μ_z and standard deviation σ_z for men. These productivities do not change over time. The mean and standard distribution of the initial productivities comes for the American Community Survey (ACS), 2009. The women's productivity is distributed with mean $\mu_x = 2.717$ and standard deviation $\sigma_x = 0.717$. For men, the mean μ_z equals 2.983 and the standard deviation σ_z equals 0.729.

There are two match qualities, high $\gamma_h = 0.6$ and low $\gamma_l = -3.0$, and the probability of getting the high match quality is equal to 0.3. One of the key parameters of the model is the probability of matching with someone from the same cohort, p. For the benchmark economy, p is set to be equal to 0.7. These 4 parameters are used to match some of the marriage statistics of the model.

There are two parameters related to children. The first is the share of education of children in the children's production function, λ. This parameter is set to 0.5. [3] The second parameter related to children is the cost of living with non-biological children, φ, which is equal to 3 in the benchmark economy. There are two utility parameters. The first utility parameter corresponds to the curvature of the utility function of consumption, σ, and it is set to 0.22. The other utility parameter is the weight of children in the utility function, ϕ, which is set to 1.8. These two parameters, σ and ϕ, and the fixed cost of non biological children, φ, play an important role in matching the share of couples choosing joint custody, the remarriage probability of women and the remarriage probability of men.

The child custody policy parameter τ represents the share of time that the child spends in the mother's household. I take the share of time spent with the mother in case of joint custody to be 0.8 as it is the most common arrangement according

[2]The number of grid points is small since solving the model is computationally quite time-consuming.

[3]I take this value from Greenwood, Guner and Knowles (2003).

to Brown and Flinn (2011). The parameters ϵ_1 and ϵ_2 correspond to the economies of scale in consumption, ϵ_1 takes the value of 0.3 which is an intermediate value from the range that Browning (1992) provides and ϵ_2 takes the value of 0.8 which is within the range of values provided by Cutler and Katz (1992). Finally, the weight of the wife in the couples utility is given by μ and it is set to 0.5 and β is the discount factor and it is consistent with a period of 10 years and 4% yearly interest rate.

Table III shows the parameters that are set based on a priori information. Table IV shows 7 parameter that are calibrated to match 7 data moments. There are further marriage statistics that the model replicates and they are not used to match the model to the data. These are used to check how well the model does in representing the economy.

Table III : Parameters based on a prior information

β	discount factor	0.916
μ_x	mean productivity of women	2.717
σ_x	standard deviation of women's productivity	0.717
μ_z	mean productivity of men	2.983
σ_z	standard deviation of men's productivity	0.729
μ	weight of wife in couple's utility	0.5
λ	share of goods in the education function	0.5
ϵ_1	economies of scale	0.8
ϵ_2	economies of scale	0.3
τ	share of time children spend with mother	0.8

Table IV: Parameters for Calibration

Marriage parameters		
γ_h	high match quality	0.6
γ_l	low match quality	-3.0
$prob\,(\gamma_h)$	probability of γ_h	0.3
p	probability of meeting an agent from same cohort	0.7
Utility parameters		
σ	curvature of utility function for consumption	0.22
ϕ	utility weight of children	1.8
φ	fixed cost of non-biological children	3

Given the parameters in Tables III and IV, I introduce the benchmark case and perform some simulations to check how child custody changes when the possibility of having more children with younger women changes. Then, I discuss how the model works and provide further robustness checks.

2.4.1. The Benchmark case

Tables V and VI show the performance of the benchmark economy. I show some moments related to the marriage market and the levels of sole and child custody in my economy. The demographic structure comes from the American Community Survey (ACS), 2009, and the Current Population Survey (CPS), 1995 Marital History Supplement. The marital status corresponds to individuals between ages 25 and 47. I consider young women to be between 25 and 34 and old women to be between 35 and 45. As there exists a gap between age at first marriage for women and men, I consider young men to be between 27 and 36 and old men between 37

and 47.[4] I only consider those ages when fertility is the highest.[5]

Table V: Benchmark Economy: Calibrated moment versus data moments

	Data	Model
% Marriage	54.12	56.21
% divorced women	11.3	10.62
% divorced men	9.1	9.82
% Never married	33.36	33.17
Remarriage of women as % of ever divorced,1995	44.10	37.40
Remarriage of men as % of ever divorced,1995	53.09	49.56
% of divorce choosing joint custody	20	18.19

The model does well in replicating the marriage statistics of the U.S. economy. The aggregate numbers for the share of married, divorced and never-married population are very close to the data. The model underestimates the remarriage probability, especially for women but it does well in terms of the remarriage of men. In terms of child custody, the average joint custody in the US is around 20%. The model does a good job in replicating this fact. In the model, around 18% of divorced couples choose to share custody of the children . The model also provides information on other statistics that are not used to match the model to the data which are summarized in Table VI. These statistics are marriages among individuals from the same cohort and marriages from different cohorts and the percentage of divorce men who have children in 2 households. In the data 38% of men have remarried and have children in 2 households while in the model it is close to 30. The model overestimates marriages among individuals of the same generation but on the whole, it does quite well in replicating these statistics.

[4]The median age gap at first marriage between man and woman is 2.3 years, see Díaz-Gimenez and Giolito, 2008.

[5]The median age for having a child is 25. I f the ages considered are between 20 and 45, the share of individuals in each category is very similar.

Table VI: Additional moments not used for calibration

	Data	Model
Marriage among young	34	44.67
Marriage Young woman-Old man	9	8.76
Marriage Young man-Old woman	5	6.13
Marriage among old	50	56.83
% of remarried men with children in 2 households	38	29.19

2.5. Discussion

2.5.1. Why choose joint custody?

When deciding whether to choose joint or shared custody in case of divorce, couples face a trade off between enjoying the child and affecting their remarriage probability. For women both sole and joint custody imply a cost in terms of their remarriage probabilities. Under both arrangements, the child remains in the mother's household and potential partners will have to pay a fixed cost φ if they marry, thus the child affects negatively the probability of remarriage. In terms of utility, joint custody implies that the utility she receives from the child is decreased to $\tau 100$ per cent of what she would enjoy him under sole custody. For men, under sole custody, there is no link between the father and the child. He does not get any utility from the child as they have no contact and the father does not have to pay any child support. Under joint custody the father enjoys $(1-\tau)100$ per cent of what he enjoyed the child under marriage. Now, the child is also present in the father's household and so the father's potential partners would pay the same fixed cost φ in case of remarriage.

The main advantage of joint custody is the fact that children might receive more education than under sole custody. The education that a child receives depends on both the mother's household income and the father's household income. Women would always prefer sole custody to joint custody if child custody arrangements

had no effect on children's education. The importance of the father's income is determined by the share of time the child spends in his household, $(1-\tau)$. Thus if the ex-husband's income is high relative to the woman's, then joint custody is more likely. This is consistent with evidence presented in Cancian and Meyer (1998). They look at a sample of Wisconsin divorcees with physical custody arrangements and they find, among other things, that shared custody is more likely the higher the proportion of the couple's income is generated by the father. On the other hand, couples where the woman is of relative higher income prefer sole custody. Sharing children's custody implies a utility loss for the mother that is not compensated by the education the child would receive under joint custody.

2.5.2. Effects of Fecundity Differentials

In order to explore the effect of fecundity differentials on child custody arrangements, I vary the probability of meeting someone young, p. I look at the impact of changing this probability on the fraction of divorced couples choosing joint custody. Men who meet a young woman have the chance of having more children after a divorce. As having children from a previous marriage is costly for the new partner, the chances of marrying if the man has joint custody decrease. Therefore, if it becomes more likely to meet someone young, men will prefer not to have joint custody. In Table VII, there are several statistics for the benchmark case and for different values of the probability of matching with someone from the same cohort.

Table VII: Changing probability of meeting own cohort, p

	$p = 0.6$	$p = 0.7$ (benchmark)	$p = 1$
% Marriage	43.22	56.21	80.45
% divorced women	16.04	10.62	4.88
% divorced men	14.21	9.82	4.58
% Never married	40.74	33.17	14.67
Remarriage of women as % of ever divorced	23.85	37.40	10
Remarriage of men as % of ever divorced	43.91	49.56	21.42
% of divorce choosing joint custody	11.18	18.19	50.84
Marriage among young	31.27	44.67	78.45
Marriage Young woman-Old man	8.55	8.76	0
Marriage Young man-Old woman	14.77	6.13	0
Marriage among old	42.61	56.83	82.46

First, I decrease the probability of meeting someone from your own cohort, p from 0.7 to 0.6. This implies that there is a higher probability of meeting someone young. When there is a higher probability of meeting someone young, the share of joint custody decreases from 18% in the benchmark case to around 11%.[6] There are more individuals divorcing in the hope of getting a better match and those who do divorce, prefer less joint custody to be able to remarry in the second period. Men's chances of having children are higher, thus divorce increases. As there are more divorcees, women are choosier and they will only marry the highest types. Thus in equilibrium it leads to lower remarriage rates. Now, I consider the extreme case where you can only meet with individuals from your own cohort. Therefore, p is equal to 1. This means that the probability of meeting a person from a different cohort is zero. In this case, the share of divorced parents agreeing on joint custody increases to 50%. When deciding child custody arrangements, couples decide by

[6]I have tried with different lower values of p than in the benchmark and the share of custody is lower than in the benchmark case.

maximizing the couple's present value. Whether joint or sole custody is chosen depends on the husband's weight in the couple's utility with respect to that of the wife's. If there is a higher probability of meeting someone young, men prefer sole custody. Leaving sole custody to the mother increases men's chances of meeting a young woman and having more children, however, women do not gain anything from this increase in the probability of meeting someone young. When there is no possibility of meeting someone to have children with, couples choose shared custody more often. Men would like to keep this bond with children as they get utility from them. Divorce decreases as the marriage market opportunities are worse than before, as there is no possibility of remarrying and having more children.

2.5.3. Changing τ

Now, I change the policy parameter, τ. This parameter represents the time that a child spends in the mother's household under joint custody. In the benchmark economy, the time the child spent with the mother was equal to 80% of the total time. Now, I make it such that the time the child spends in each household is equal, therefore, τ equals 0.5. Men have more utility from spending time with their children, thus they would prefer more joint custody. This increase in the share of time that children spend with their fathers affects women negatively. Thus women prefer less joint custody. This results in a small increase in the share of divorced couples choosing joint custody from 18% in the benchmark economy to almost 19% when τ decreases to 0.5.

However, if the share of time a child spends in the father's household is 80 percent, joint custody decreases to 15.27%. The reason is that the woman gets much less utility than before and she still pays the cost of having children, therefore, she prefers sole custody rather than joint custody. Thus it seems that making the time split more equal between partners has small effect or even negative effects on the share of divorced couples with joint custody.

Table VIII: Changing τ

	τ= 0.2	τ= 0.8 (benchmark)	τ= 0.5
% Marriage	46.86	56.21	47.85
% divorced women	11.81	10.62	12.19
% divorced men	9.74	9.82	10.21
% Never married	41.33	33.17	39.96
Remarriage of women as % of ever divorced	2.58	37.40	5.17
Remarriage of men as % of ever divorced	37.19	49.56	36.78
% of divorce choosing joint custody	15.27	18.19	18.98

2.5.4. Changing φ

The cost of having non-biological children in the household, φ is an important parameter. If it is too high, no individual would be willing to marry someone with children. This leads to low remarriages rates both for men and women and for higher share of joint custody among divorced couples. When φ equals 6, twice the amount in the benchmark economy, joint custody increases to 66%. Individuals with joint custody face a lower probability of remarrying and thus they prefer to keep the children.[7] When the cost associated with children for non biological parents is set to zero, the share of joint custody among divorced couples decreases to 8%. Women lose utility if they share custody, therefore, as the cost of bringing children into the marriage is zero, they prefer sole custody. However, in equilibrium, the remarriage rate of women decreases. They get enough utility from their children if they have sole custody so that they do not have to marry low type men. They become choosier than if they had to share custody.

[7]Fertility is exogenous in the model. This might change if people are allowed to choose how many children to have and they might decide on having no children.

Table IX: Changing φ

	φ= 0	φ= 3 (benchmark)	φ= 6
% Marriage	48.96	56.21	59.11
% divorced women	18.33	10.62	3.35
% divorced men	16.21	9.82	3.14
% Never married	32.72	33.17	37.54
Remarriage of women as % of ever divorced	29.41	37.40	13.38
Remarriage of men as % of ever divorced	49.09	49.56	25.14
% of divorce choosing joint custody	8.50	18.19	66.09

2.5.5. Further Robustness Checks

I also checked how sensitive the results are to changes in other parameters. I check how the benchmark statistics react to small changes in the weight of children ϕ and to changes in the curvature of the utility from consumption, σ. The benchmark value of ϕ is 1.8 and I consider $\phi = 1.6$ and $\phi = 2$. The results do not differ significantly when the weight of children decreases. However, when the weight increases joint custody increases from 18% to around 21%. If the weight of children increases, men will prefer to have his children at home, thus I observe this increase in joint custody even if the increase in the weight is small. The results are more sensitive to changes in the curvature of the utility from consumption, σ. I try a higher value so that σ equals 0.24. The share of joint custody increases to 21%. Divorce and marriage are also affected but changes are not large. I also try a lower value, $\sigma = 0.20$. The share of joint custody decreases significantly to 13%. Thus this parameter seems to play a key role in matching the share of joint custody in the economy.[8]

[8]More moments referring to the robustness checks can be found in the Appendix.

2.5.6. Other mechanisms

I do not claim that fecundity differentials can account for the whole process of deciding on child custody arrangement. The decision is complicated and other factors play a role in accounting for this as well. I briefly discuss other factors that might favor women when deciding on child custody arrangements.

Women are better at raising children. Another explanation might be that women have a comparative advantage in raising children. Women still are the primary care givers of children, thus upon divorce, they would want to keep the children as they have made a large investment. However, we observe men spending more time with their children, thus this trend should have changed. Moreover, this behavior might be triggered by fecundity differentials. Siow (1998) proposes that the fact that women invest more time in raising children is an outcome of fecundity differentials. If women know they will not be able to have more children in the future, they will invest in their current children so that in case of divorce they are the ones who keep the child, while men do not see the need of investing on children as they can have more children in the future.

Distribution of marital property. Upon divorce, marital property has to be split between the members of the marriage. In the U.S., there are two types of distribution of property: Common property distribution and Equitable property distribution. Up to the 1970s, the majority of states had Common property distribution, which entitled each member to what they owned prior to the marriage, or fault was to play a role in the division of assets, or some states had explicit "two thirds" rules for property division. By the end of the 1970s the majority of states had moved to an equitable property distribution regime. Marital property is shared in a more equitable way under this regime (Rasul, 2003). If women were to receive a larger share of the marital property in case of sole custody, the share of joint custody should be affected by distributional regimes. Under this regime, women would like to remain sole custodians, however men would like to

share custody. Thus, this mechanism has ambiguous effects on the share of joint custody.[9]

2.6. Conclusion

Even though U.S. child custody law moved towards a gender-neutral law in the mid-70s, still most of the children of divorced couples are under the custody of their mothers as children spend most of their time with the divorced mothers. The average split of custody is 80 % of time is spent with mother and 20% is spent with the father. Overall, 5 in 6 custodial parents are mothers, i.e., either the mother has sole custody or parents have joint custody but children spend more time with their mother. It is interesting to ask why this is the case and if this is the best arrangement for the children. In this paper I ask how biological differences between women and men affect child custody arrangements. I explore how the fact that men are fertile for a longer amount of time than woman interacts with the share of divorced couples choosing joint custody. Men have to marry a young fertile woman in order to have children. If a couple decides to divorce, they can remarry next period but their choice of child custody arrangement will affect their remarriage opportunities as non biological children are costly. Divorced men can have more children with a young woman, however, this is not an option for the divorced woman as she is not fertile anymore. Thus, they might decide on leaving sole custody to the mother. By changing the probability of meeting young women after a divorce, I have checked whether the possibility of remarrying a young fertile woman affects child custody. When this probability increases, there is less child custody. Thus, to some degree men prefer to give up their children for a chance of forming a new family. If the probability of meeting a young woman decreases, the share of joint custody increases. Men cannot form new families so they want to be linked to their previous children.

[9]Several papers have analyzed the effects of different regimes on divorce, marriage and marriage-specific investments such as children and homeownership, Gray, 1998; Rasul, 2003; Stevenson, 2007, among others. However, they do not seem to suggest a link between child custody and a larger share of marital property nor any effect of marital property regimes on child custody.

A key policy question is what happens if fathers were to spend more time with the child under joint custody. Increasing the time that the children spend with the father leads to a decrease in the share of joint custody. Women still bear the cost of children and they cannot have new children. The woman's loss of utility from spending less time with their children makes couples choose mother's sole custody. Even when children are costless in terms of remarriage, non-biological parents do not mind raising someone else's children, the share of joint custody decreases. Women become more picky as they enjoy their children and they do not have to marry low type men. Therefore, biological differences in terms of fecundity between women and men might play a role when couples decide on how to allocate children after a divorce. From a public policy perspective it is important to be aware of this as changes in public policy and law aiming at increasing joint custody might not have the desired effects on individuals' decisions.

2.7. Appendix

2.7.1. Robustness checks

(1) Changing the curvature of the utility function for consumption, σ

Table X: Robustness check 1, σ changed

	σ= 0.20	σ= 0.22 (benchmark)	σ= 0.24
% Marriage	55.69	56.21	58.09
% divorced women	10.80	10.62	8.83
% divorced men	9.87	9.82	8.44
% Never married	33.52	33.17	33.08
Remarriage of women as % of ever divorced	37.62	37.40	42.77
Remarriage of men as % of ever divorced	51.54	49.56	49.81
% of divorce choosing joint custody	13.74	18.19	21.14

(2) Changing the weight of children in the utility function, ϕ

Table XI: Robustness check, ϕ changed

	ϕ= 1.6	ϕ= 1.8 (benchmark)	ϕ= 2
% Marriage	55.54	56.21	58.14
% divorced women	10.64	10.62	8.83
% divorced men	9.82	9.82	8.38
% Never married	33.82	33.17	33.03
Remarriage of women as % of ever divorced	37.04	37.40	42.77
Remarriage of men as % of ever divorced	49.68	49.56	50.78
% of divorce choosing joint custody	18.19	18.19	21.14

CHAPTER 3

With Strings Attached: Grandparent-Provided Child Care, Fertility, and Female Labor Market Outcomes (joint with Zoe Kuehn)

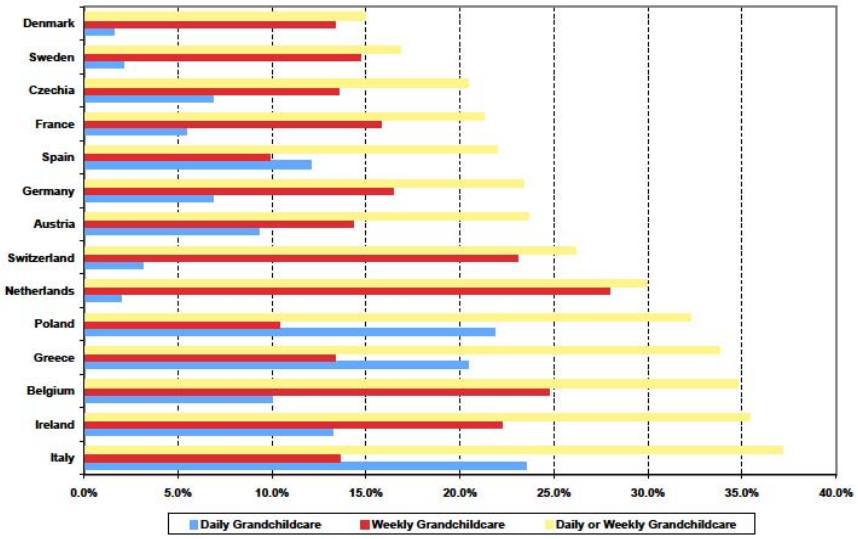
3.1. Introduction

Grandparents are regular providers of free child care. Similar to any other form of child care, availability of grandparent-provided child care affects fertility and labor market decisions of women positively. We find that women in Germany, residing close to parents or in-laws are more likely to have children and that as mothers they are more likely to hold a regular part-or full-time job. However, different from any other type of child care, for individuals to enjoy grandparent-provided child care on a regular basis, residence choices must coincide with those of parents or in-laws. Thus while living close provides access to free child care, it imposes costly spatial restrictions. We find that hourly wages of mothers residing close to parents or in-laws are lower compared to those residing further away, and having relatives taking care of ones' children increases the probability of having to commute. We build a general equilibrium model of residence choice, fertility decisions, and female labor force participation that can account for the relationships between grandparent-provided child care, fertility and labor market outcomes. We simulate our model to analyze how women's decisions regarding residence, fertility, and labor force participation change under different family policies and how these decisions affect their wage income.

Grandparents are an important source of child care. According to data from the 2^{nd} wave of the Survey of Health, Ageing and Retirement in Europe (SHARE),

between 16% (Denmark) and 36% (Italy) of grandparents take care of their grandchildren on a daily or weekly basis. In the Netherlands, Belgium, Switzerland, and Ireland more than 20% of grandparents take care of their grandchildren each week, while in Italy, Greece, and Poland more than 20% of grandparents provide daily care (see Figure I).[1] The availability of child care and especially cheap or even costless child care has important effects on fertility and mothers' labor force participation. This is important, because while female labor force participation has increased tremendously over the last decades, mothers are still participating significantly less than other women.

Figure I: Grandparent-Provided Care



Data: SHARE, 2^{nd} wave

There exists an extensive empirical literature that has studied the link between female labor force participation and child care. Many papers propose a joint analysis of the effect of child care costs on fertility and labor force participation. For

[1] In the US, 22.7% of children under 5 years are regularly cared for by their grandparents (Overturf Johnson [**2005**]).

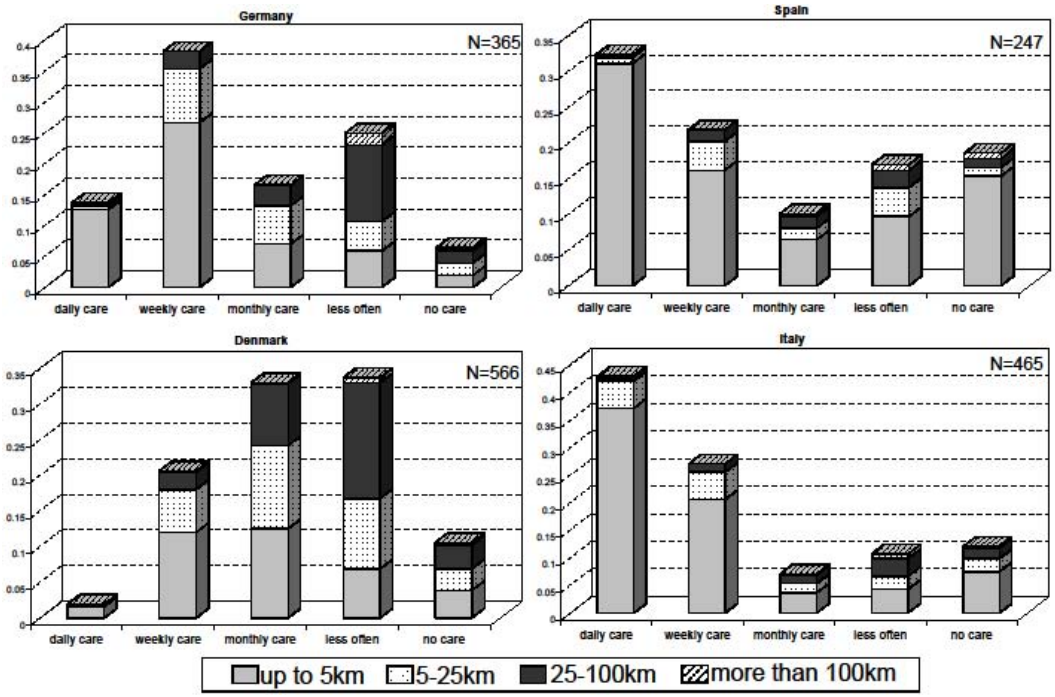
Italy, Del Boca [**2002**] shows that both the availability of child care and the possibility of part time work increase labor force participation and fertility. Blau and Robins [**1989**] establish a similar pattern for the US. Within the context of already high female participation rates in Sweden, Moerck et al [**2009**] is one of the few papers that focuses exclusively on the effect of child care costs on fertility. In a literature summary, Del Boca and Viuri [**2007**] point out that most studies find that high child care costs deter female labor supply, while availability of child care has a positive effect on labor force participation by mothers. Thus these findings suggest that the main barrier that mothers face at the time of working is to obtain affordable child care (e.g. child care costs in the US can amount to 30% of the income of a family living below the poverty line).[2]

In this sense, free grandparent-provided child care seems to be the perfect solution for working mothers. However, in order to enjoy grandparent-provided child care on a regular basis, residence choices of adult children and elderly parents have to coincide. Data from the 2^{nd} wave of the Survey of Health, Ageing and Retirement in Europe (SHARE) shows that the frequency of grandparent-provided child care is clearly linked to the geographical distance between caregivers and caretakers. Figure II displays the relative geographical distance between grandparents and their small grandchildren (younger than 10 years) together with the frequency of care provided, for Italy, Spain, Germany, and Denmark. As already suggested in Figure I, the overall frequency of care varies strongly across the four selected countries, with Italian and Spanish grandparents clearly providing child care more frequently than German or Danish grandparents. However, similar across all countries, those who provide more frequent care tend to live close by.[3]

[2]US Census Bureau [**2011**].

[3]The same pattern can be observed across the rest of the countries included in the SHARE data set; see Figures A–1-A-3 of the Appendix A.

Figure II: Frequency of Care and Distance to closest grandcgildage 10 or younger



Data: SHARE, 2^{nd} wave

Hence, while grandparent-provided child care may induce positive effects on fertility and mothers' labor force participation, different from any other type of child care, it imposes spatial restrictions that might affect labor market outcomes negatively. In this paper we document benefits and costs of grandparent-provided child care. Looking at German data we find that women residing close to parents or in-laws are more likely to have children and as mothers they are more likely to hold a regular full-or part time job. However, their wages are lower and they are more likely to incur daily commutes. We then build a general equilibrium model of residence choice, fertility decisions, and female labor force participation that can account for the relationships between grandparent-provided child care, fertility and labor market outcomes. We simulate our model to analyze how women's decisions

on residence, fertility, and labor force participation change under different family policies and how these decisions affect their wage income.

The current paper thus contributes to the literature by being the first paper, to the best of our knowledge that explicitly incorporates spatial restrictions imposed by grandparent-provided child care into a general equilibrium model of fertility and labor force participation decisions. To the best of our knowledge, our paper is also the first one to document both costs and benefits of the reduced geographical distance between parents and adult children implied by grandparent-provided child care. The existing literature, on the contrary, has focused on the positive implications of a reduced geographical distance between parents and adult children. Holdswoth and Dale [**2009**] for instance, study labor force participation of mothers in Spain and Britain and estimate that for Spanish women whose parents live in the same 'municipio' the probability of being in employment is 1.24 times higher than for those who do not live close to their parents. Studying fertility intentions rather than outcomes Raymo et al [**2010**] find that Italian and Japanese women living close to their parents have higher fertility intentions.

Our paper is also related to the literature on intergenerational linkages. The majority of this literature focuses mainly on two aspects: (i) monetary transfers in terms of bequests from parents to children and (ii) time transfers in terms of care from children to elderly parents. One interesting paper regarding the latter aspect that also incorporates residence choices is Konrad et al [**2002**]. The authors develop a game theoretical model of strategic choice of residence among siblings who try to avoid having to take care of elderly parents. Looking at German data, they find support for their model's predictions of older siblings locating further away from their parents than younger siblings. With a similar approach in mind, Stern [**1995**] estimates care choices of elderly parents together with location decisions of children. However, his work is even more closely related to the current paper as he also takes into account how the child's location decision

affects his or her work decision. Some of the few empirical works that consider time transfers from parents to children in form of grandparent-provided child care is Dimova and Wolff [**2011**] who look at data from the Survey of Health, Ageing and Retirement in Europe (SHARE) and find a positive effect on the extensive margin of female labor force participation but no effect along the intensive margin. Other authors such as Smith Koslowski [**2009**] have focused on the costs that grandparent-provided child care implies for grandparents. In this sense we consider the paper by Cardia and Ng [**2003**] complementary to the current paper, as it also proposes a general equilibrium model for grandparent-provided child care but explicitly takes into account grandparents' decisions. The authors suggests that subsidizing grandparents' time to be the most effective policy in terms of output and capital accumulation. However, different from the current paper, the authors do not consider the spatial restrictions and thus potential costs in terms of labor market outcomes for women of grandparent-provided child care nor the effect of the close presence of potential grandparents on fertility.

Our paper is also related to another strand of literature that uses general equilibrium models to assess how different public policies interact with family decisions.[4] Greenwood, Guner and Knowles [**2000**] for instance investigate the effect of the rise in the generosity of welfare payments on the rising incidence of single motherhood while García-Morán [**2010**] evaluates the effect of child care subsidies on female labor force participation, fertility and children's educational levels. She finds that child care subsidies promote employment, fertility and education, especially for children in single parent households. Erosa, Fuster and Restuccia [**2010**] develop a model of fertility choice and labor market decisions to account for the observed gender differences in job attachment, employment and earnings. Their aim is to provide a framework to study the interactions of fertility choice and labor market turnover in the determination of employment and wages. They argue that having this framework is important for the evaluation of family policies. Our aim

[4]See Attanassio, Low and Sanchez-Marcos [**2010**], Guner and Knowles [**2009**] among others

is similar to these papers, as within a general equilibrium framework we asses the effects of different family policies on women's decisions regarding residence, fertility, and labor force participation and we analyze how these decisions affect their labor market outcomes in the presence of grandparent-provided child care that imposes costly spatial restrictions. However, for the sake of tractability we abstain form several features present in the papers mentioned, such as a marriage market or employers demand for labor.[5] Also related to this paper is Bick [**2010**] who within a life cycle model analyzes data for Germany and concludes that informal child care (by relatives) plays an important role given that mothers' labor force participation exceeds child care enrollment for children up to 2 years. However, different from the current paper the author does not model informal child care nor takes into account the spatial restrictions that it imposes.

The remaining of this paper is organized as follows. The next section presents our empirical analysis. Section 3.3 presents the general equilibrium model. Section 3.4 describes our calibration strategy and Section 3.5 presents the results of the paper. In Section 3.6 we describe the mechanisms at work in greater detail and we perform two counterfactual experiments in Section 3.7. Section 3.8 concludes.

3.2. Empirical Analysis

For our empirical analysis, we consider data from the German Socio-Economic Panel (GSOEP). The GSOEP is an annual household survey that has been carried out since 1984. The first sample in 1984 included 5,921 households with 16,205 individuals (76% adults, 24% children) of which 44% still remained in the sample in 2004, after 20 years. In addition, new samples for refreshment of the sample and for specifically targeting certain groups of the population (East Germans, foreigners, high-income individuals) were added in 1990, 1994, 1995, 1998, 2000, and 2002.

[5]However, these features could be included in future analysis.

The GSOEP provides extensive information on individuals' labor market participation, marital and family status, wages, education, the size of the town they live in etc.[6] For our analysis we only consider women age 25 to 50 living in Germany. We exclude those born outside of Germany, given that for these individuals both key variables of our analysis, availability of child care by relatives and residence relative to parents, might be determined by very different aspects compared to individuals who were born in Germany. Given stark differences in mothers' labor force participation rates between East and West Germany, we introduce dummy variables to distinguish between individuals living in East and West Germany.[7] In addition, high migration rates between East and West Germany lead us to differentiate also among those who moved from East to West Germany after 1989.[8] To account for possible cultural differences, we also distinguish among those of German nationality and those of other nationalities. We define three levels of education following the International Standard Classification of Education (ISCED 1997) designed by the UNESCO[**1997**]. These levels correspond to (i) primary education (ISCED levels 0 and 1), (ii) secondary education (ISCED levels 2,3, and 4) and (iii) tertiary education (ISCED levels 5 and 6). Town sizes are grouped into small communities (up to 20.000 inhabitants), medium-sized communities (20.000-100.000 inhabitants), and large communities (more than 100.000 inhabitants).

[6]For more details on the SOEP and its development, see SOEP [**2005**].

[7]Labor force participation rates for East German mothers of small children (0-3 years) have traditionally been very high and even today they continue to be around 15 percentage points higher than rates for West German mothers (Bundesministerium für Familie, Senioren, Frauen und Jugend [**2005**].)

[8]In total we construct six different dummy variables. To this end this we use information on the region of residence at the time of the survey together with answers to the question "Where did you live in 1989?": (i) West German residents as of 1989 currently in West Germany, (ii) West German residents as of 1989 currently in East Germany, (iii) East German residents as of 1989 currently in East Germany, (iv) East German residents as of 1989 currently in West Germany and (v)Residents in foreign country as of 1989 in West Germany, and (vi) Residents in foreign country as of 1989 in East Germany.

For our empirical analysis we make use of two alternative ways of measuring the effect of grandparent-provided child care. The first one is an indirect measure that consists of the variables 'where does mother live' and 'where does father live'. However, only during four waves of the survey (1991, 1996, 2001, and 2006) were participants asked to categorize their parents' relative residence as in: i)the same house, ii)the same neighborhood, iii)the same town, iv)another town but within one hour by car, v)further away, or vi)in a foreign country. Thus, for our analysis we use an unbalanced sample of individuals with at least one parent or in-law alive and pool observations from these four waves. We construct a dummy variable "parents close" that takes on value one for those individuals whose mother, father, or in-law lives in the same neighborhood or town and another dummy variable "parents far" for those individuals who live more than one hour or further away from their parents or inlaws. For individuals who live in the same house as their parents or in-laws we construct a different dummy variable "parents in same house", given that this particular form of co-residence often arises due to the need for intensive care of parents and in most cases represents a temporary living arrangement. This indirect measure reflects "potentially" provided child care by grandparents and thus proves particularly useful to test effects on fertility.

Our second measure is a more direct one and uses the variable 'regular child care by relatives'. While this includes child care by any relative, grandparent-provided child care is the most common form of relative-provided child care and even for child care by relatives other than grandparents similar spatial restrictions apply. The variable 'regular child care by relatives', on the other hand is only available for the waves: 1997, 1999, 2000, 2001, 2002, 2004, 2005, and 2006. For our analysis we focus on individuals with children younger than six years and again we pool data from the available waves. We consider mothers of children age six and younger, given that children in Germany enter compulsory education at age six or seven, thus making child care particularly important for mothers of children age six and younger. We thus construct a dummy variable "child care by relatives"

for all mothers with children younger than six years that includes the information if relatives regularly take care of this child. Another dummy variable "child care nursery" takes on value one if the child of age six and younger is attending nursery school. Tables I and II provide weighted summary statistics for both samples, for both women and mothers.[9] We also use individual weighting factors for all estimations.

Description of the sample Women in both samples are between 25 and 50 years old, with an average age of 37 to 38 years. With an average age of around 34 years, mothers in our second sample are slightly younger given that in this sample we only consider mothers of children age six and younger. Around two thirds of women and 70% of mothers in both samples are married and less than 1% has a nationality different from the German nationality. Approximately 70% of women between 25 and 50 in both samples have children and around 15% are mothers of small children of age up to three. Among both mothers and women, around 1% only completed primary education, 70% finished secondary education and around 30% completed tertiary education. For mothers this last percentage is slightly lower, while a larger fraction of mothers has completed secondary education. However, while around 43% of women have a regular full time job and only 22% hold a regular part time job, for mothers both percentages are similar of around 29% and 28% respectively in our first sample and very different with 13% and 24% in our second sample, that only considers mothers of children age 6 and younger. Slightly more women live in small and large communities than in medium sized communities. The large majority (70%) of women and mothers in both samples are West Germans living in West Germany, followed by East Germans living in East Germany. Percentages of women who lived abroad in 1989 are negligible. Around 40% of women and mothers in the sample live in the same neighborhood or town as their parents or in-laws, while only 2% live in the same house or household.

[9]Unweighted statistics are very similar - see Tables A.1 and A.2 of the Appendix.

Considering only those women or mothers whose spouse has a strictly positive income, the average hourly spouse's income is around 17 Euros.[10]

[10]Note that when pooling the sample we only adjusted for the change of Deutschmark to Euro while we did not adjust explicitly for wage growth in our pooled sample, given stagnant real hourly net wages in Germany between 1991 and 2006 (see Figure 1 in DIW [**2009**]).

Table I: Weighted Means (Std.)- GSOEP pooled sample

-1991,1996,2001,2006-

First Sample:	Women 25-50	Mothers 25-50
Age	36.88 (7.16)	38.24 (6.70)
Married, living together	0.60 (0.49)	0.73 (0.44)
Other than German nationality	0.01 (0.10)	0.01 (0.10)
Children	0.69 (0.46)	1
Children 0-3	0.16 (0.37)	0.24 (0.43)
Primary education	0.01 (0.10)	0.01 (0.10)
Secondary education	0.71 (0.46)	0.74 (0.44)
Tertiary education	0.29 (0.45)	0.25 (0.43)
Regular fulltime job	0.43 (0.49)	0.29 (0.45)
Regular part time job	0.22 (0.42)	0.28 (0.45)
Small community	0.37 (0.48)	0.40 (0.49)
Medium community	0.28 (0.45)	0.29 (0.46)
Large community	0.36 (0.48)	0.30 (0.46)

*Only taking into account strictly positive hourly wages (N=5340, N=4366 for mothers)

**Only considering those working regular part or fulltime jobs, more than 20 hours a month, earning a strictly positive hourly wage (N=4834 ,N=3136 for mothers)

*** Only those working regular part or fulltime jobs, more than 20 hours a month, earning a strictly positive hourly wage with firm tenure strictly positive (N=4785, N=3106, for mothers)

****Resided in foreign country in 1989

Table I: Weighted Means (Std.)- GSOEP pooled sample -1991,1996,2001,2006- Cont.

West German in West Germany	0.71 (0.46)	0.67 (0.47)
West German in East Germany	0.04 (0.20)	0.04 (0.20)
East German in East Germany	0.18 (0.38)	0.22 (0.41)
East German in West Germany	0.01 (0.08)	0.01 (0.09)
Other in West Germany****	0.001 (0.04)	0.001 (0.04)
Other in East Germany****	0.0001 (0.01)	0.0002 (0.01)
Parents or inlaws close	0.42 (0.49)	0.44 (0.50)
- Parents or inlaws in same neighborhood	0.17 (0.38)	0.19 (0.40)
- Parents or inlaws in same town	0.26 (0.44)	0.26 (0.44)
Parents or inlaws in same house	0.02 (0.13)	0.02 (0.14)
Parents or inlaws far away	0.58 (0.49)	0.56 (0.50)
- Parents or inlaws one hour away	0.37 (0.48)	0.38 (0.49)
- Parents or inlaws further away	0.24 (0.42)	0.21 (0.41)
Parents or inlaws in foreign country	0.01 (0.09)	0.01 (0.08)
Spouse' hourly income*	16.53 (10.73)	16.40 (10.48)
Hourly wage**	12.56 (6.40)	12.24 (7.01)
Tenure in firm***	8.02 (7.05)	8.49 (7.22)
N	9672	7235

*Only taking into account strictly positive hourly wages (N=5340, N=4366 for mothers)

**Only considering those working regular part or fulltime jobs, more than 20 hours a month, earning a strictly positive hourly wage (N=4834 ,N=3136 for mothers)

*** Only those working regular part or fulltime jobs, more than 20 hours a month, earning a strictly positive hourly wage with firm tenure strictly positive (N=4785, N=3106, for mothers)

****Resided in foreign country in 1989

Table II: Weighted Means (Std.)- GSOEP pooled sample-1997,1999,2000,2001,2002,2004,2005,2006

Second Sample:	Women 25-50	Mothers 25-50 of children age ≤ 6
Age	37.63 (7.23)	33.77 (4.81)
Married, living together	0.60 (0.49)	0.73 (0.44)
Other than German nationality	0.01 (0.10)	0.02 (0.13)
Children	0.70 (0.46)	1
Children 0-3	0.15 (0.36)	0.61 (0.49)
Primary education	0.01 (0.10)	0.01 (0.10)
Secondary education	0.71 (0.45)	0.73 (0.44)
Tertiary education	0.27 (0.45)	0.26 (0.44)
Regular fulltime job	0.41 (0.49)	0.13 (0.34)
Regular part time job	0.24 (0.42)	0.24 (0.43)
Small community	0.41 (0.49)	0.42 (0.49)
Medium community	0.26 (0.44)	0.30 (0.46)
Large community	0.33 (0.47)	0.28 (0.45)
West German in West Germany	0.71 (0.45)	0.74 (0.44)
West German in East Germany	0.04 (0.19)	0.05 (0.21)

Table II: Weighted Means (Std.)- GSOEP pooled sample-
1997,1999,2000,2001,2002,2004,2005,2006, Cont

East German in East Germany	0.19 (0.39)	0.15 (0.35)
East German in West Germany	0.01 (0.07)	0.01 (0.10)
Other in West Germany*****	0.001 (0.04)	0.001 (0.04)
Other in East Germany*****	0.0001 (0.01)	0 (0)
Children in Nursery	-	0.57 (0.50)
Children cared for by relatives	-	0.33 (0.47)
Spouse' hourly income*	16.61 (10.60)	17.68 (11.22)
Tenure in firm**	8.16 (7.32)	7.05 (6.11)
Distance to work***	17.71 (31.98)	15.92 (20.02)
Job in town***	0.53 (0.50)	0.53 (0.50)
N	38128	7924

*Only taking into account strictly positive hourly wages (N=22150, N=5542 for mothers)

*** Only those working regular part or fulltime jobs, more than 20 hours

a month, with firm tenure strictly positive (N=23396 N=2880, for mothers)

***Only those working regular part or fulltime jobs,

more than 20 hours a month, with distance to work strictly positive (N=15801, N=2238, for mothers)

****Only those working regular part or fulltime jobs,

more than 20 hours amonth (N=20835, N=2919 for mothers)*****Resided in foreign country in 1989

Hourly wages of women and mothers who work regular part or full time jobs, of more than 20 hours a month are around 12 Euros. On average, these individuals have been with their current employer for the last 7 to 8.5 years. A little over half of all women in the second sample work and reside in the same town. Their

average distance to work is around 15 to 18 kilometers.

Table III : Effect of close presence of grandparents on fertility,
Odd Ratios from Logit Estimation for Having Children

Married, living together	4.681***	(0.005)
Other than German nationality	1.462***	(0.006)
Log (Spouse' hourly income)*	1.044***	(0.000)
Primary education (ISCED: 0,1)	4.767***	(0.026)
Tertiary education (ISCED: 5,6)	0.517***	(0.000)
Parents or inlaws close	1.330***	(0.001)
Parents or inlaws in same house	0.714***	(0.003)
Small community	0.911***	(0.001)
Large community	0.541***	(0.001)
Constant	0.217***	(0.000)
Observations	36,990,976	

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Logistic Estimation; Data: GSOEP unbalanced panel 91,96,01,06; Women 25-50. All regressions include age dummies, year dummies as well as dummies for East and West Germany. Reference group: unmarried women age 25 living in West Germany who lived in West Germany in 1989, with education level 2 (ISCED: 3,4,5)in 1991, in a medium-sized town, far from parents or in-laws. *Missing values and values < 1 are set to 0.

Proximity to Parents and Fertility Women living in the same neighborhood or town as their parents or in-laws are 1.3 times more likely to have children.

Table III displays odd ratios from the logit estimation of the probability of having children. Controlling for marital status, spouse's income, the size of the community, age, year effects, and education, proximity to potential grandparents has a significantly positive effect on fertility. Concerning the other variables of the regression, the likelihood of being a mother for women in Germany between 25 and 50 is clearly positively influenced by their marital status. Being married raises the odds of having children by almost 5 times. Furthermore, higher spouse's income increases the odds as does being of a different nationality than the German one. Higher education reduces the odds as does living in a large community, relative to living in a medium-sized community. Living in the same house as parents or in-laws also reduces the odds of having children. This results could be due or to the young age of those still living with their parents or to the fact that this particular form of co-residence often arises due to the need for intensive care of parents.[11]

Proximity to Parents, Child Care by Relatives and Participation of Mothers

For our estimations regarding labor force participation we only consider a woman in the labor force if she works a regular part or full-time job. The probability to hold a regular part or full time job for mothers residing close to their parents is 5 percentage points higher compared to mothers residing further away. The first column of Table IV displays the marginal effects from a probit regression for the probability of having a regular part or full time job in Germany for mothers age 25 to 50. In addition to the control variables of the first regression, we also include a dummy variable that indicates if the mother has a small child (age 0 to 3). The probability of holding a regular part-or full-time job decreases strongly in the presence of a small child, decreases with marriage, and increases with tertiary

[11]Results are consistent to the inclusion of a polynomial for age instead of age dummies (see Table A-3 of the Appendix). Given that marital status and spouse's income might be correlated with living close to parents or in-laws we also check consistency of results, excluding both variables (see Table A-4 of the Appendix). Results change little when using years of education instead of education dummies (see Table A–5 of the Appendix.)

education compared to secondary education.

We obtain stronger results for our alternative analysis that uses the more direct measure 'child care by relatives' (see column two of Table IV). For mothers of children age six and younger, having relatives taking care of their child increases chances of holding a regular full-or part time job by 18 percentage points, an effect much stronger than that caused by having the child attending a nursery school, associated to an increase of 5.6 percentage points. Hence, the net effect of relative-provided child care on the probability of holding a regular part-or full-time job is given by the difference of 12 percentage points. For this alternative estimation, marginal effects of all other variables on the probability of holding a regular part-or full-time job are similar, with the exception of the significant and positive effect of living in a large community.[12]

[12]Again results are consistent to the way age and education are included (see Table A-6 and A-7 of the Appendix). Marital status and spouse's income might be correlated with living close to parents or in-laws, and having a child in a nursery may be correlated with child care by relatives. Hence, we also check the robustness results to the exclusion of these variables(see Table A-8 of the Appendix).

Table IV: Effect of grandparent-provided child care on mothers' labor force participation:

Marginal Effects from Probit Estimation for Mothers' Labor Force Participation

	Regular Part or Fulltime Job		Regular Part or Fulltime Job	
	(1)		(2)	
Children 0-3	-0.344***	(0.025)	-0.212***	(0.021)
Married, living together	-0.097***	(0.024)	-0.106***	(0.026)
Other than German nationality	0.102	(0.129)	0.126	(0.083)
Log (Spouse' hourly income)*	-0.001	(0.003)	0.001	(0.003)
Primary education (ISCED: 0,1)	-0.105	(0.088)	-0.153	(0.125)
Tertiary education (ISCED: 5,6)	0.204***	(0.020)	0.137***	(0.021)
Parents or in-laws close	0.050**	(0.020)		
Parents or in-laws in same house	0.047	(0.051)		
Children cared for				
by relatives			0.184***	(0.020)
Children in nursery			0.056***	(0.020)
Small community	0.028	(0.023)	0.008	(0.022)
Large community	0.016	(0.025)	0.052**	(0.025)
Observations	7,235		7,923	

Standard errors in parentheses;*** p<0.01, ** p<0.05, * p<0.1; Probit Estimation;

Data: GSOEP unbalanced panel 1) 91,96,01,06; mothers 25-50. Reference group: unmarried mothers age 25 with education level 2 (ISCED: 3,4,5) in 1991, in a medium-sized community in West Germany (who lived in West Germany in 1989), far from parents or in-laws, with children older than 3 . 2) 97,99,00,01,02,03,05,06; mothers (25-50) of children <= 6 years. Reference group: unmarried mothers age 25 in 1997, with education level 2 (ISCED: 3,4,5), in a medium-sized town in West Germany (who lived in West Germany in 1989), with children older than 3 who are nor in nursery nor cared for by relatives.

All regressions include age dummies, year dummies, as well as . dummies for living and being from West or East Germany

*Missing values and values < 1 are set to 0.

Proximity to Parents and Wages While grandparent-provided child care seems to be a way to promote fertility and mothers' labor force participation, the required proximity to one's parents or in-laws may imply a cost given the spatial restriction it imposes on one's potential labor market. In order to study the possible negative effect of living close to parents or in-laws on wage incomes of mothers we exclude self-employed individuals and consider only dependent workers working regular full or part time jobs and mothers who do not work regular full or part time jobs.[13] We also exclude individuals who report to have worked fewer than twenty hours a month and those who report to have worked regular full or part time jobs but report zero or negative hourly wages. Controlling for selection effects, we find that mothers living close to their parents earn significantly lower hourly wages. The first column of Table V displays the coefficients for the Heckman selection model for log hourly wages for West German mothers age 25 to 50. While living close to parents or in-laws increases the probability of holding a regular part-or full-time job, it reduces hourly wages by 4.1%.[14]

[13]The effect of spatial restrictions on wages is best measured by "living close to one's parents or in-laws", more so than by the fact if children are actually cared for by grandparents. Because any effect on wages will be long-lasting even after children have grown and do not need to be cared for anymore. This consideration together with the fact that our second sample only includes mothers of children age six and younger of which only 14% work fulltime (see Table II)is the reason why we only consider our first indirect measure of grandparent-provided child care to measure the effect on wages.

[14]Monthly wages, controlled for by hours worked, show the same discount for living close (see Table A-9 of the Appendix). Not controlling for selection produces a similar discount of 5.5% (see Table A-10 of the Appendix for a simple OLS regression of log hourly wages).

Table V: Effect of close presence of grandparents on hourly wages,

Coefficients of Heckman Selection Model for Mothers' log Hourly Wages

	Log hourly wage		Selection Equation	
	(1)		(2)	
Married, living together	-0.021	(0.019)	-0.433***	(0.051)
Other than German nationality	-0.030	(0.108)	0.181	(0.228)
Primary education (ISCED: 0,1)	-0.105	(0.092)	-0.323*	(0.174)
Tertiary education (ISCED: 5,6)	0.348***	(0.021)	0.580***	(0.048)
Parents or in-laws close	-0.042**	(0.017)	0.133***	(0.039)
Parents or in-laws in same house	-0.074	(0.050)	0.083	(0.117)
Small community	0.017	(0.021)	0.076	(0.046)
Large community	0.017	(0.022)	0.025	(0.049)
Log (Spouse' hourly income)*			0.035***	(0.006)
Children 0-3			-0.922***	(0.054)
Tenure in firm	0.016***	(0.001)		
Constant	1.614***	(0.102)	-0.329*	(0.168)
Observations	5,144		5,144	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Heckman Selection Model; Data: GSOEP unbalanced panel 91,96, 01,06; mothers 25-50, Reference group: . unmarried mothers of age 25 of children older than 3 living in West Germany who lived in West Germany in 1989, with education level 2 (ISCED: 3,4,5) in 1991, in a medium-sized West German town,far from parents or in-laws . *Missing values and values < 1 are set to 0. All regressions include age dummies, year dummies, as well as dummies for being from and living in East or West Germany.

Concerning the other variables and controlling for selection effects (see column two of Table V), hourly wages in Germany of mothers between 25 and 50 increase with firm tenure, each additional year increases hourly wages by 1.6%.[15] Having tertiary education rather than secondary education increases hourly wages by 35%.[16]

[15]Note that coefficients of the selection equation and marginal effects for our participation equation (see column 1 of Table II) are comparable but not equivalent due to the additional restrictions made on the sample.

[16]Again results are consistent to the way age and education are included (see Table A-11 and A-12 of the Appendix). Marital status and spouse's income might be correlated with living close to parents or in-laws. Hence, we also check the robustness results to the exclusion of these variables(see Table A-13 of the Appendix).

Table VI: Effect of grandparent-provided child care on commutes

Odd Ratios from logit Estimation of Working and Residing in same town

Married, living together	0.570***	(0.001)
Other than German nationality	4.308***	(0.030)
Log (Spouse' hourly income)*	1.035***	(0.000)
Primary education (ISCED: 0,1)	15.998***	(0.481)
Tertiary education (ISCED: 5,6)	0.887***	(0.001)
Tenure in firm	0.971***	(0.000)
Children cared for by relatives	0.912***	(0.001)
Children in nursery	1.210***	(0.002)
Small community	0.250***	(0.000)
Large community	1.698***	(0.003)
Constant	2.164***	(0.014)
Observations	9,222,606	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Logit Estimation

Data: GSOEP unbalanced panel, 97,99,00,01,02,03,05,06

, mothers 25-50 of children <= 6 years. Reference Group: unmarried mothers

of age 25 in 1997 with education level 2 (ISCED: 3,4,5) in a medium-sized

West German town (who for by lived in West Germany in 1989),

with children older than 3, who are nor in nursery nor cared for by relatives.

All regressions include age dummies, year dummies

as well as dummies for being from and living in West

or East Germany. *Missing values and values < 1 are set to 0.

Proximity to Parents and Commutes Lower wages are just one way in which costs of spatial restrictions may become apparent. Other costs may arise from longer commutes, as suggested by Rupert et al [**2009**] who looking at French data find that mothers in particular with small children who have low bargaining power as workers incur in longer commuting times. We find that for working mothers of children age six and younger the odds of residing and working in the same town are around 9% lower, and hence they are more likely to have to incur in costly commuting if their children are regularly cared for by relatives. Table VI displays odd ratios from the logit estimation for the probability of working and residing in the same town, i.e. not having to commute, for mothers in Germany age 25 to 50 with children of age six and younger.[17] While having relatives caring for children on a regular basis increases chances of having to commute, having children in a nursery on the other hand, clearly increases the odds of being able to work and reside in the same town. These odds are also higher for foreign mothers, those living in large communities and mothers with primary education or a higher spouse's income. Odds to work and reside in the same town, on the other hand, decrease with marriage, firm tenure, and tertiary education, and they are smaller for mothers in small communities.[18] Similarly, we find that distance to work is increasing in having relatives taking care of children (see Table A-17 of the Appendix).

[17]We exclude women who do not have a regular full or part time work as well as those reporting to have worked fewer than twenty hours a month. Contrary to the effect on grandparent-provided child care on wages, its effect on commuting is much more contemporaneous and can thus in principle be measured using any of the two measure. However, given data restriction we cannot provide results for commuting for our first sample (the question for commuting was introduced in 1997 into the GSOEP data set, thus is not available for 2 out of 4 years of our first pooled sample).

[18]Again results are consistent to the way age and education are included (see Table A-14 and A-15 of the Appendix). Having a child in a nursery may be correlated with child care by relatives. Hence, we also check the robustness results to the exclusion of this variable(see Table A-16 of the Appendix).

Table VII: Grandparent-provided child care and participation,

Coefficients of Individual Fixed Effects Estimation

	Regular Part or Fulltime Job		Regular Part or Fulltime Job	
	(1)		(2)	
Children 0-3	-1.734***	(0.011)	-1.947***	(0.009)
Married, living together	-1.146***	(0.016)	1.012***	(0.013)
Log (Spouse' hourly income)*	-0.060***	(0.001)	-0.214***	(0.001)
education level 1 (ISCED: 0,1)	-326.978	(0.000)		
education level 3 (ISCED: 5,6)	1.431***	(0.014)	1.767***	(0.011)
parents or in-laws close	0.048***	(0.017)	1.610***	(0.018)
parents or in-laws in same house	3.314***	(0.029)	2.064***	(0.020)
small community	-0.141***	(0.050)	-5.361***	(0.249)
large community	0.267***	(0.050)	-7.876***	(0.249)
Observations	224		222	
Number of person.	112		111	

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1;

Fixed Effect Estimation Data: (other nationality omitted because of no within-group variance)

(1) GSOEP balanced panel 91-01 (2) GSOEP balanced panel 96-06 (education level

one omitted because of no within-group variance); mothers 25-50

Reference group: unmarried mothers with education evel 2 (ISCED: 3,4,5)

l in a medium-sized town, living far from their parents or in-laws, with children older than 3.

All regressions include age dummies, year dummise

as well as dummies for and living in West or East Germany. *Missing

values and values < 1 are set to 0.

Individual Fixed Effects We also try to exploit the panel nature of this data set and run individual fixed effect regressions. This allows us to control for unobservable individual heterogeneity (for instance in preferences for living close to one's parents) which might be correlated with the outcome variables: having children or participating in the labor market. To this end, we consider two groups of West German women aged 25 to 50: (i) those who stayed in the sample from 1991 to 2001 and (ii) those remaining in the sample from 1996 through 2006.[19] Given the small size of the balanced sample and in particular very few women becoming first-time mothers during the course of staying in the sample, most regressions produce insignificant estimates.[20] However, we can report significant estimates for the probability of holding a regular part-or full time job (see Table V). Controlling for individual fixed effects, mothers living close to their parents or in-laws are more likely to hold a regular part-or full-time job. Coefficients of other control variables of the individual fixed effect estimation are comparable to the marginal effects found for the pooled sample (see Table II). While higher education and living in large towns increase the probability of holding a regular full-or part time job, marriage, having small children and a higher spouse's income have negative effects as does living in small communities compared to medium sized towns.

While we found a positive relationship between grandparent-provided child care and fertility, and grandparent-provided child care and regular labor force participation by mothers, on the other hand, we saw that for mothers, grandparent-provided child care is related to lower wages and longer commutes. From these opposing relationships a set of interesting questions arise: What are the net effects of grandparent-provided child care on aggregate employment and fertility? How costly is grandparent-provided child care for parents in terms of forgone

[19]Longitudinal weights were constructed as products of the cross-section weight of the first sample year considered and the inverse staying probabilities, as suggested in SOEP [**2005**].
[20]No convergence is achieved for any of the logit estimations for fertility (log-likelihood not different from zero and no significant coefficients). Results for wage regressions are also characterized by only few significant coefficients. See Tables A-18 of the Appendix for results.

wages and additional commutes? How valuable is grandparent-provided child care in terms of fertility and employment?. In order to answer these question, we build a model economy that explicitly takes into account the spatial restrictions of grandparent-provided child care. Our goal is to account for the relationships between grandparent-provided child care, fertility and labor market outcomes observed in the data. We calibrate our model to the German economy along several key dimensions. We then highlight the model's mechanism behind women's decisions that can potentially generate the observed relationships. Finally, we perform several counterfactual exercises to analyze how women's decisions change when public policy changes. To the best of our knowledge the current paper is the first one that documents the opposing effects of grandparent-provided child care and proposes a general equilibrium model that studies the conflicting forces of availability of this type of child care and its spatial restrictions.

3.3. The Model

We have a model of fertility and employment choice where individuals also decide where to live. They choose between living close or far from their parents, and thus whether to be able to access free child care and whether to access a restricted or unrestricted labor market. We only model women's decisions and even though marriage and joint residence choices may have an important impact on the distance to ones' parents we do not model a marriage market in order to keep the analysis tractable.

The model economy is inhabited by a continuum of overlapping generations of female individuals of mass one. Individuals live for three periods, one as children (0-20 years), one as fertile adults (20-40 years), and one as old adults (40-60

years).[21] Decisions in this economy are taken by fertile adults and old adults. They decide where to reside - close to their parents or far away -, how many children to have, and how much time to spend working and how many resources to spend on their children's education - in terms of money and their own time. There is also a government in this economy that taxes labor income at rate τ, and may provide family benefits T conditional on having children and/or conditional on family income being below a certain threshold ($\bar{T}$). The government may also subsidize child care at rate ω. Individuals are born close to their parents so initially they reside in 'Home', H. If they decide to move they will reside in 'Far', F. We assume that moving away provides access to a labor market with better wage opportunities. The region of residence of each individual is denoted by j, where $j = H, F$.

Residence Choice Individuals decide whether to exclusively access the labor market of their region in order to stay close to their parents or whether to move away so as to access the labor market of the whole economy. Individual's residence choice, D is thus a binary variable that takes on value 0 if individuals reside close to their parents and 1 if their possible residence covers the whole economy

$$D = \begin{cases} 1 & if \quad j = F \\ 0 & if \quad j = H. \end{cases}$$

Endowments Individuals differ in productivity, x. As young adults, individuals randomly draw their productivity, x from a distribution with cdf $F(x)$ and density $f(x)$. Individuals' productivity is time invariant. Individuals are also endowed with one unit of productive time. They potentially dispose of an exogenous source of income (z) representing their spouse's income, where z is drawn from a distribution $g(z)$. The probability that a woman of type x has an exogenous income z is given by the matching matrix $\Pi(x, z)$.

[21] Availability of free child care obviously depends on grandparents being able to take care of grandchildren. Even though individuals might still work as old adults, we assume that there is some type of family network that takes care of children free of charge.

Working Choice Individuals can decide on the extensive and intensive margin of their labor force participation where l is the fraction of time they allocate to work. They thus have the following after-tax wage income

$$w = (1 - \tau)(1 + D\kappa)xl,$$

where κ is the wage premium in region F. Therefore, individuals earn wages that depend not only on how productive they are, but also on their region of residence.

Children Individuals can have children when they are fertile. Children receive education depending on the resources that the mother decides to spend on the child. We denote by b the amount of money that an individual decides to spend on her children, and t is the amount of time that she dedicates to take care of the child. Time spent in child care (t_c) can enhance the child's education. We assume that time spent in child care is equal to the amount of time an individual is at work, and thus t_c is actually equal to l . The child's education function is denoted by

$$e = E(k, t, t_c, b).$$

Child care Individuals with children who work require child care. The price of child care, $p(D)$ depends on the individuals' residence choice in the following way: $p(0) = 0$ and $p(1) > 0$. Thus, if the individual lives close to her parents she obtains free child care, else she has to purchase child care at price $p(1)$. The individual might receive a subsidy ω from the government, thus actually paying $(1 - \omega)p(1)$ for each unit of time the child spends in child care.[22]

Utility Fertile adults derive utility from consumption, children, and leisure. Let k be the number of children an individual decides to have. The utility that individuals enjoy each period is given by

$$U(c, 1 - l, k, e) = u(c) + u^l(1 - l) + u^e(k, e),$$

[22]We assume that this subsidy is only paid to those individuals who purchase child care at price $p(1)$, i.e. to those living in Far.

Children do not take any decisions. Children receive education and old adults decide how much to work.

Timing of Decisions When individuals become fertile adults, they observe their productivity and decide whether to reside close to their parents or not. After residence decisions have been taken, individuals have to decide how many children to have, and how to split their time between working, taking care of children, and leisure. Individuals move or not, they work the respective share of time, and if they have children, they might purchase child care if they live away from their parents, they decide on how many resources to devote to their children, and they consume. From then on, they remain in the chosen region of residence. When old, they only decide how much to work.

Government The government in this economy collects labor income taxes τ, pays lump-sum transfers T conditional on having children and having an income below a certain threshold, $\bar{T}$, provides a child care subsidy, ω and consumes G. The budget constraint of the government has to be balanced each period.

$$\tau Y = G + P,$$

where Y is the total income in the economy and P is the amount of subsidies and transfers that the government pays out to individuals.

3.3.1. Value functions

We start by defining the value functions of old adults. In the last period of individuals' lives, residence decisions do not change and children are no longer present in the household. Thus old adults have neither benefits nor costs from children. Old adults derive utility from consumption and leisure.

Old adult living close An old individual who has not moved when young only has access to a restricted labor market. She has a source of extra income, $z(x)$ representing her husband's labor income. She has to choose how much to

work when old. The value of being an old individual living close is given by

$$H^o(x, z(x)) = \max_l U(c, 1 - l, 0, 0)$$

subject to the following budget constraint

$$(1 - \tau)(xl + z(x)) = c.$$

The old individual will pay taxes on her labor income and her husband's income. As she has no other expenditures, she will consume all of her disposable income. The optimal labor decision of an old individual living close is $L_o^c(x, z(x))$.

Old adult living away An old individual living further away earns more per unit of time than if she would had she stayed close to her parents. As her children do not live in her household anymore, she does not have to pay for child care. The value function for an old individual living far away is

$$F^o(x, z(x)) = \max_l U(c, 1 - l, 0, 0)$$

subject to the following budget constraint

$$(1 - \tau)((\kappa)xl + z(x)) = c.$$

Again she consumes all of her disposable income. The only difference between living further away and living at Home in the individuals' last period of life is that living further away implies higher wages per unit of time. Child care costs are no longer an issue as children are now young fertile adults. The optimal labor decision of an old individual living further away is $L_o^f(x, z(x))$.

Young fertile adult Young fertile adults have to decide whether to stay close to home or not. If they stay close they face a restricted labor market but they obtain free child care. If they move they earn a wage premium κ, but if they have children they have to pay child care costs per unit of time worked. Once they have decided where to live, they decide how much to work and how many children to have and how many resources to spend on educating their children. The value of

being a young fertile woman remaining close to her parents ($D = 0$) is given by

$$H^y(x, z(x)) = \max_{k,l,t,b} U(c, k, e, l) + \beta H^o(x, z(x)),$$

subject to the following budget constraint

$$(1 - \tau)(xl + z(x)) + TI_{\bar{T}} I_k = c + b$$

and the education production function

$$e = E(k, t, t_c, b).$$

Note that young fertile adults living at home have access to free child care as they remain close to their parents. Thus, they spend an amount b of resources on their children and during a fraction t of their available time they take care of their children. If they work they leave their children under their grandparents' care. Women staying close to home work in a restricted labor market thus they do not earn as much as they could if they were living further away. If the individual has children and her family income is below the threshold $\bar{T}$ she might receive some family benefits from the government, T. We denote by $I_{\bar{T}}$ the indicator function that takes on value one if the family income is below the threshold, $\bar{T}$. The indicator function I_k equals one if the individual has children. The continuation value of living at home is the value of being an old woman living at home given that there is no uncertainty about the future and no residence decisions are made in the last period of individuals' lives. For a woman living close to her parents or in-laws, the optimal decision regarding how much to work is denoted by $L_y^c(x, z(x))$, the optimal number of children is given by $K_y^c(x, z(x))$, and the optimal resources she spends on her children are $T_y^c(x, z(x))$, referring to the amount of time spent taking care of her children, and the amount of money spent on her children, $B_y^c(x, z(x))$.

If the individual decides to move away ($D = 1$), then the value of living further away is denoted by

$$F^y(x, z(x)) = \max_{k,l,t,b} U(c, k, e, l) + \beta F^o(x, z(x)),$$

subject to the following budget constraint

$$(1 - \tau)((1 + \kappa)xl + z(x)) + TI_{\bar{T}} I_k = c + (1 - \omega)p(1)l + b$$

and the education production function

$$e = E(k, t, t_c, b).$$

A young fertile adult living further away has to purchase child care at price $p(1)$ for each unit of time she decides to work. She has to decide how to divide her time between work, l taking care of her children, t, and leisure. She also decides on how much to spend on the education of her children, b. She also disposes of an additional source of income, $z(x)$. If her family income is below a certain threshold and she has children she receives family benefits from the government. Moreover, if she works, she might also receive child care subsidies, ω per unit of time her children spend in child care. Optimal decisions for a woman living further away are denoted by $L_y^f(x, z(x))$, $K_y^f(x, z(x))$, $T_y^f(x, z(x))$ and, $B_y^f(x, z(x))$.

Residence Decision Women have to decide whether to stay home or move away. They face a trade-off between higher wage rates and lower child care costs. They decide to move away if the utility of living further away exceed the utility of staying close by, i.e.

$$D(x, z(x)) = \begin{cases} 1 & if \quad F^y > H^y \\ 0 & otherwise. \end{cases}$$

3.3.2. Equilibrium

The optimal decision rules for fertile young adults are as follows: $L_y^j(x, z(x))$ is the labor decision, $T_y^j(x, z(x))$ is time spent with her children, $B_y^j(x, z(x))$ is the amount of money spent on children and $C_y^j(x, z(x))$ is the level of consumption, where $j = H, F$ denotes the region where the individual resides. Optimal decision rules for old individuals are as follows: $L_o^j(x, z(x))$ is the labor decision and $C_o^j(x, z(x))$ is the level of consumption, where $j = H, F$. The distribution of residence is given by $\Omega^j(x, z)$. Given a government policy $(\tau, T, \bar{T}, \omega, G)$, an initial distribution of women $\Omega(x)$, and an initial distribution of men $\Theta(z)$, a stationary equilibrium is a set of decision rules, a distribution of residential choices, and the number of children born, K such that

(1) The decision rules are the solutions to the value functions.
(2) The distribution of residential choices is consistent with the decisions.
(3) The government budget is balanced.

3.4. Calibration Strategy

3.4.1. Functional Forms

In this part of the paper we present the explicit functional forms for the utility function and the education function. Individuals' utility is separable in consumption, children, and leisure. We assume log utility in consumption and in leisure, while the utility in children's quality is linear. There are two weighting parameters. The weighting parameter for children is denoted by ϕ_e and the weighting parameter for leisure in the utility function is ϕ_l. The weighting parameter for consumption is normalized to 1. The utility of an individual is thus given by

$$W(c, e, k, l) = log(c) + \phi_e Q(e, k) + \phi_l log(1 - l - t).$$

Individuals receive utility from the number of children in the household and from the level of education that their children have received. Following Becker and Tomes [**1976**], we assume that there is a trade-off between the number of children

in the household and the education that households can provide for their children which is represented by $Q(e,k)$. To obtain this quantity-quality trade-off regarding children in the utility function, we choose the following Cobb Douglas specification
.

$$Q(e,k) = e^{\lambda}k^{1-\lambda},$$

where λ denotes the share of education in the production function of child quality.[23]

The education production function depends on the woman's time spent taking care of the children, t, the amount of money spent on the education of children, b and the form of child care. Money and time are assumed to have a unit elasticity of substitution. The share of time spent taking care of children in the education production function is equal to θ. There are two types of child care: grandparent-provided child care and privately or publicly provided child care. Grandparent-provided child care is only available to those living close to their parents. We assume that both types of child care are equally productive in terms of education.[24]

If women live far away from their parents, money can be spent on children in two different ways. If the mother works an amount of time, l her children have to spend that same amount of time in private or public child care and she has to pay an hourly cost of $p(1)$. Private child care enhances children's education. The other possible expenditure on children is b, which represents any other type of expenditure related to children's education. If the woman lives close to her parents she does not have to spend the money she would otherwise spend on child care. To her the price for child care is 0. Given that time spent with grandparents is assumed to be as productive as time spent in private or public child care, leaving her children with her parents while working is equivalent to investing in child care. The chosen functional form to represent the relationship between expenditure in private child care and other education related expenditure is of the CES type.

[23]Other papers in the literature use this specification; see for instance Greenwood et al [**2000**].
[24]However, this assumption can easily be relaxed.

The elasticity of substitution between these two types of expenditures is equal to $\frac{1}{(1-\rho)}$ and the weight of expenditures b is represented by α. This functional form is flexible enough to capture the degree of substitutability between these two different types of expenditure. We thus specify the functional form of the education function as

$$e = ((\alpha(b)^{\rho} + (1-\alpha)l^{\rho})^{\frac{1}{\rho}})^{\theta} t^{1-\theta}.$$

3.4.2. Parameters

Some parameters of the model are fixed based on available evidence. We calibrate the model's remaining parameters to match several labor market statistics of the German economy as well as German data on fertility. Most statistics used for calibrating the remaining parameters come from the German Socio-Economic Panel (GSOEP). For our statistics we use pooled data from waves 1991, 1996, 2001, and 2006, in which information on the relative location of parents and adult children is available (see Section 3.2 for more details on the GSOEP). Finally, we have a set of policy parameters which we will set such as to represent German family policies. We only consider data on married women for our calibration.

In the model economy, there is an initial distribution of young women, $\Omega(x)$ and an initial distribution of men $\Theta(z)$. We assume a log normal distribution over types. We discretize the distribution to obtain different productivity levels, where the mean and standard deviation are denoted by μ_x and σ_x respectively for women and μ_z and σ_z for men. Women and men are matched according to the matching matrix $\Pi(x, z)$ where the probability that a woman of type x_1 (being the lowest type) meets with a man of the same type,z_1 is equal to ψ. In the benchmark calibration there are ten different types of individuals where the type refers to the productivity of the individual and hence we have ten types of different exogenous incomes. There will thus be a hundred different types of matches between a woman and an exogenous income (husband). The exogenous income z assigned to

a woman of type x comes from the distribution $g(z)$.

Parameters set a priori are the discount factor β, parameters related to the productivity distribution over individuals $\mu_x, \mu_z, \sigma_x, \sigma_z$, the wage premium earned in Far, κ and the assortative matching parameter, ψ. One model period is equivalent to 20 years. The discount factor, β is set to match a yearly interest rate of 4%. Estimates for mean and standard deviation of the productivity distribution for women are taken from log-hourly wages in the GSOEP data, which gives us the following parameter values, $\mu_x = 2.44$ and $\sigma_x = 0.479$. Similarly for men we have $\mu_z = 2.98$ and $\sigma_z = 0.72$. As we abstain from modeling a marriage market we assign an exogenous income to each woman to represent her husband's income. To this end, we use a matching matrix that assigns this income to each woman based on information on who marries whom in the German economy. In order to build this matrix we take the degree of assortative matching, i.e. how likely it is to meet your own type, ψ in Germany from Fernandez et al. [**2005**]. The authors calculate this value to be 0.7 in Germany, i.e. 70% of each type of women matches with the exactly same type of men while the remaining 30% are equally likely to match with other types of men. From our regressions, we obtain that women living far from their parents earn 4.1% more than women who remain close to their parents (see Table III). Therefore, we set κ equal to 0.041. Table VIII displays all parameters set a priori.

Table VIII: Parameters based on a priori information

Parameter	Explanation	Value
β	Discount Factor	0.44
μ_x	mean log productivity of women	2.44
σ_x	standard deviation of women's log productivity	0.479
μ_z	mean log productivity of men	2.98
σ_z	standard deviation of men's log productivity	0.72
n	average working time of men	0.4
κ	wage premium for living far away	0.041
ψ	assortative matching parameter	0.7

Parameters to be calibrated are the utility parameters, ϕ_e, ϕ_l and the children's education parameters, $\lambda, \rho, \alpha, \theta$. Even though in a general equilibrium model all parameters affect all targets, we discuss briefly the data moments that each parameter is most likely to determine. The weight of children's quality in utility, ϕ_e is set to a value of 5, such as to match the difference in fertility between women living close to their parents or in-laws, 1.73 and those living far away, 1.69. The weight of leisure in the utility function, ϕ_l is given a value of 2.4 in order to match a labor force participation rate of 54% for married women in Germany. The share of the number of children in the quality-quantity trade-off function, λ is set to 0.47 in order to match a fertility rate of married women in Germany of 1.71.

Values for the three parameters of the education production function, ρ, α, θ are chosen such as to match data on expenditure on children as a percentage of average income, time spent with children by parental working status, and mothers' productivities. According to the German Federal Office of Statistics, in 2003, on average families spent 500 euros per month on each child. The average family income in Germany was 3,750 Euros per month in 2003 (German FSO) and German

households with children have on average 1.9 children. Therefore, the expenditure on children for an average household is close to 10% of family income. The ratio of time that a working mother spends on her children in comparison to a non working mother is 0.65. We take this data from Ichino and Sanz de Galdeano [**2004**]. Using data provided by Sayer et al. [**2004**], we calculate the ratio of time a highly educated mother (corresponding to a highly productive woman in our economy) dedicates to her children in comparison to a low educated mother to be equal to 1.4. Hence parameters ρ, α, θ of the education production function are assigned values 0.43, 0.8, and 0.58 respectively. Table IX displays the calibrated parameters of the model.

Table IX: Calibrated Parameters

Parameter	Explanation	Value
ϕ_e	weight of children	5
ϕ_l	weight of leisure	2.4
λ	share of education in Q function	0.47
α	weight of b in the education function	0.8
ρ	elasticity parameter between b and child care	0.43
θ	share of expenditures in the education function	0.58

Finally, the model's policy parameters are the income tax rate, τ, and the family policy in terms of child care subsidies and family benefits, i.e. ω, T, and the threshold for eligibility of family benefits $\bar{T}$ respectively. All working individuals pay a proportional tax, τ on labor income. We set τ to be equal to 37% which is equivalent to the income tax revenue collected by the German government as a fraction of GDP (OECD [**2010**]). According to the OECD [**2009**], all German families receive some family benefits for each child up to the age of eighteen (Kindergeld). In particular, they receive 184 Euros per month for the first child,

190 for the second and 205 for the third, fourth, fifth child etc. We set the amount of family benefits in our economy, T such as to match the amount of Kindergeld as a percentage of average family income received by a family with the average number of children in Germany (1.9). Hence, T is set equal to 1.04. As all families receive this help, the threshold $I_{\bar{T}}$ is not binding and $\bar{T} = 0$. According to the same source, child care subsidies are negligible in Germany and therefore, we set child care subsidies (ω) to be equal to zero. For the cost of child care $p(1)$, the OECD [**2007**] estimates that child care costs in Germany amount to 9.1% of average income. Thus we set the price of child care per hour such that child care costs in our model economy matches the average cost in Germany. It takes the value of 0.32. All policy parameters are displayed in Table X.

Table X: Policy Parameters

Parameter	Explanation	Value
Calibrated		
T	Family Benefits	1.04
$p(1)$	cost of child care	0.32
Set a priori		
ω	child care subsidy	0
$\bar{T}$	eligibility threshold	0

3.5. Results: Benchmark Economy

In Table XI we present data moments of our benchmark economy together with the corresponding data moments.

Table XI: Data and Model Moments

	Data	Model
Fertility rate	1.71	1.5
Labor force participation of married women	54.21	49.94
Difference in Fertility close vs far	1.02	1.09
Time spent with non-working vs working mother	1.32	1.2464
Time spent with high vs medium educated mother	1.08	1.1332
Expenditure on children as per cent of income	25	33.21
Child care costs as per cent of average income	9.1	2.0
Family benefits as per cent of income	10	10

Our model underestimates the labor force participation of married women by four percentage points. The share of women who participate in the labor market in Germany is equal to 54.21%, while in our economy this share is slightly below 50%. In terms of fertility and the fertility differential between women living close to and far away from their parents, the model does a fairly good job. The fertility rate in Germany is equal to 1.71 while in our economy it is equal to 1.5. The difference in fertility between women living close and far is not large and this is also true in our model. Regarding time spent by non working mothers with their children in comparison to time spent by working mothers, the model predicts that non-working mothers spend 25% more time with their children than working mothers. In the data this number is 32%. As for differences in time spent with children by highly educated and medium educated women, we calculate this figure

by assuming that medium educated women are those whose productivity is below the mean productivity of the economy. Our model overestimates the time that more educated mothers spend looking after their children by 5 percentage points. In our model, highly educated mothers spend 13% per cent more time with their children than medium educated mothers while according to German data this figure is approximately 8%. According to data, the average German family spends 25% of their income on children. In our model this number is equal to 33%. The model replicates well the amount of family benefits available in Germany. However, we underestimate the cost of child care. On average, the cost of child care is 9% of average income, while in our model it is only 2%.

Turning to other statistics of the model that have not been used for calibration (see Table XII). In Germany, women living close to their parents or in-laws participate more in the labor market compared to those living further away. This difference in participation rate is equal to 4 percentage points. We find that in the model there is also a difference but it is smaller than in the data. Even though in Germany there is a difference between participation rates of all women and mothers, our benchmark economy is not able to capture this given that under the current calibration scenario all women decide to have children. Our model also produces statistics on how many women move away from both parents or in-laws. In Germany, around 45% per cent of women live far from their parents (see Figure II). In our model, only 20% per cent live far away from parents or in-laws. Therefore, given the conservative estimate of living away from parents, our model can account for around 40% of women moving in the German economy.

Table XII: Data and Model Moments : Not used for calibration

	Data	Model
Labor force participation of mothers	55.18	49.94
Labor force participation of mothers, close	56.55	49.96
Labor force participation of mothers, away	53.70	49.85
Labor force participation of women, away	53.31	49.85
Labor force participation of women, close	55.07	49.96
share of population moving away	45	20

3.6. Mechanisms at work: Who moves and who works

When women decide whether to move or not they face a trade-off between better labor market opportunities and free child care. If they move away they face better opportunities in the labor market. However, if they have children and they want to work, they will have to pay child care services for each unit of time they work. We represent better labor market opportunities by the fact that women who choose to live in the Far region earn a higher wage rate, receiving a wage premium, κ. If women decide to stay Home, they only have access to a restricted labor market and they earn their labor market productivity. However, if they have children, they have access to free informal child care. Thus we would expect high productivity type women to move away as they can afford to pay for child care if they work. However, the woman's exogenous income (husband's type) also plays an important role in the residence decision.

In our model we observe that high productivity type women who are married to relatively lower productivity type men move away from their parents and in-laws. In the Far region they earn more and they can afford the necessary child care costs. On the other hand, low productivity type women who are married to higher type men also move away. While these women could also afford to pay for child care, they decide not to work. In this case, the reason for moving is not a higher wage premium but the fact that if they remain close to their parents, they would find it optimal to work. However, if they move away, they will not work and they receive higher utility from leisure. Moving away and enjoying leisure is preferred to staying close and working. As these women dispose of a relatively high exogenous income they prefer not to work and their marginal value of leisure is higher in the Far region.

Remaining in the Home region are thus those women who have married similar productivity type men. In terms of the allocation of income according to the matching matrix, those who are on the diagonal of the matching matrix are the ones remaining close to parents or in-laws. Low productivity women who are married to low productivity men will work as their income effect dominates. While high productivity type women married to high productivity type men will also decide to stay close to parents and in-laws but not to work. They prefer to spend their time between leisure and taking care of their children. High productivity type women married to high productivity type men will not work in any of the two regions. Child care costs do not have any effect on their working decision.

We can thus identify four subgroups of women in our model: (i) low productivity type women married to low productivity type men, (ii) low productivity type women married to high productivity type men, (iii) high productivity type women married to low productivity type men, and (iv) high productivity type women married to high productivity type men. Two sub-groups will remain close: the low-low productivity and the high-high productivity. Therefore, women in the diagonal of

the matching matrix will remain in the Home region. The other two sub-groups will move to the Far region: low-high productivity and high-low productivity.

In Table XIII we display the share of women who move away in the model and in the data by these four sub-groups . In our model low productivity individuals are identified as the six lowest types on the productivity distribution while the high productivity individuals are the four highest types. The six lowest types represent 70% of the total population. This is equivalent to the share of individuals who have less education than college or tertiary type of education in Germany. [25] We see that all women belonging to the high-low subgroup and 77% of the low-high subgroup move away. Meanwhile, only around 11% of women in the low-low subgroup move away. The same is true for the high-high subgroup, where only also around 4% of them move away. The majority of women in these last two subgroups remain close to their parents or in-laws. However, in the data it looks like around 50% of individuals in each sub-group move away. Therefore, the model is underestimating the share of low-low and high-high couples who live away and we are overestimating the share of couples moving away from the two other sub-groups.

Table XIII: % of women moving away by type and husband's type

	Low productivity men		High productivity men	
	data	model	data	model
Low productivity women	45	11.2	51	77
High productivity women	54	100	55	4.07

[25] In the model, types refer to hourly wage rates. However, we are comparing productivity in the model to data on education of the women as some of these women might not be working and so their wage rate is zero. Therefore, we consider education to be a proxy for productivity.

We find that women work less if they live far away from their parents or in-laws, even after controlling for education and wage of their spouses (see Table II). Our model replicates this fact as in both regions there are both high productivity women, equivalent to high educated women, and low productivity women. And in both regions there are women who are married to high productivity type men and also low productivity type men. In the presence of child care costs, the existence of free informal child care arrangements allows mothers with low productivity to work. In absence of grandparents, their income would be too low to pay for child care costs and therefore they would not work. These are the women who remain in the Home region. Meanwhile women who have relatively high exogenous income will have a higher marginal value of leisure in the Far region and they will decide to move but will not work.

3.7. Counterfactual Experiment

First, we analyze a situation in which there ate no grandparents available and everyone has to pay for child care. Under these conditions all women who are of higher productivity than their husbands will move away and all of them will work. Women whose husbands are of a higher productivity type will remain close and none of them will work. Women who cannot afford child care, stay close and are not able to participate in the labor market. Therefore, we observe a decrease in the participation rate of women. In a situation without informal child care arrangements, the labor force participation rate for married women drops to 12.37%, from approximately 50% in the benchmark economy. Also note that the share of women moving away decreases because the marginal value of leisure becomes the same in both regions as informal child care arrangements disappear. Table XIV provides the moments for this counterfactual experiment when there is no grandparent-provided child care available.

Table XIV: No Grandparent-provided child care

	No grandparents	Benchmark economy
Fertility rate	1.36	1.5
Labor force participation of married women	12.37	49.94
Difference in Fertility close vs far	1.2	1.09
Labor force participation of women, away	1	49.85
Labor force participation of women, close	0	49.96
share of population moving away	12.37	20

In a second counterfactual experiment we consider a public policy meant to encourage mothers' labor force participation: child care subsidies. Child care subsidies are financed through taxes. Therefore, child care subsidies might imply higher taxes. This policy will be government consumption neutral. Thus the amount of tax revenue collected that is going to government consumption is the same as in the benchmark economy. We consider subsidizing 50% care costs. Therefore, the policy parameter corresponding to child care subsidies, ω is set equal to 0.5.

We can see from Table XV the effects of subsidizing half of the child care costs with respect to zero subsidy in the benchmark case. The fertility rate remains unaltered by this policy, even though it seems that women moving far now have fewer children as the ratio of fertility between close and far has increased. In terms of aggregate employment rate, there are no changes, the same percentage of women participate in the labor market as before which is consistent with some findings in the literature that argue that child care subsidies might not affect maternal employment but simply induce a shift from informal child care to formal child care, see Havnes and Mogstad [**2011**]. However, we find that if there is no informal child care available, some women will not work. In fact, there are still some women who

cannot afford to work even if 50% of child care costs are subsidized. These women remain close to their parents so they have access to free child care. In particular, 10% of all women remain close and work as they still cannot afford the child care costs.

Table XV: Child care subsidized, ω=0.5

	$\omega = 0.5$	Benchmark economy
Fertility rate	1.54	1.5
Labor force participation of married women	49.94	49.94
Difference in Fertility close vs far	1.2	1.09
Labor force participation of women, away	95	49.85
Labor force participation of women, close	5	49.96
share of population moving away	49.74	20
Tax rate	0.38	0.37

3.8. Conclusion

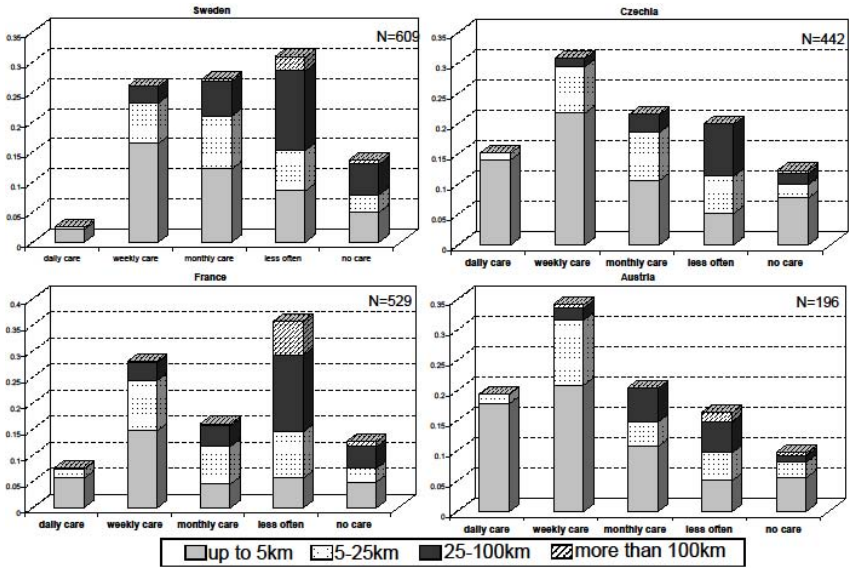
In this paper we document benefits and costs of grandparent-provided child care. Looking at German data we find that women residing close to parents or in-laws are more likely to have children and mothers are more likely to hold a regular full-or part time job. However, we find that their wages are lower and they are more likely to incur daily commutes. We build a general equilibrium model of residence choice, fertility decisions, and female labor force participation to account for this trade-off. We simulate the model to match the German economy in terms of fertility, women's labor force participation and other dimensions related to time spent with children and expenditures made on children. We then perform two counterfactual exercises to analyze the effect of grand-parent provided child care and publicly provided child care on women's decisions. We find that if there is no

grandparent-provided child care, there are fewer women participating in the labor market. They cannot afford child care costs and hence they decide not to work. In addition, fertility decreases. This is consistent with empirical evidence showing that having access to free child care increases fertility. We also show that subsidizing 50% of child care costs does not increase aggregate women's employment rates with respect to the benchmark case. However, most of the women working before move away and thus labor mobility is increased. Still, 10% of all women remain close to their parents or in-laws and work. These women still cannot afford these reduced child care costs. In this sense it seems that providing child care subsidies does not increase women's labor market participation but rather encourages labor mobility. However, in the absence of child care subsidies, grandparent-provided child care plays an important role by allowing some women to work.

In this paper we simply assumed that being close to one's grandparents' implies that grandparents take care of their grandchildren and we do not consider grandparents' decisions to provide or not child care to their grandchildren. However, this decision might be very related to individuals' retirement age and in the case of grandmothers, to previous decisions about labor force participation. In this sense, opposing forces for cohort effects of female labor force participation could arise. On the one hand, having a mother who is actively participating in the labor force could increase chances for women to also do so , while a negative effect could come from the fact that a grandmother actively participating in the labor market might be less likely to provided child care for her grandchild. We consider further analysis of how late first birth and improved health after retirement might interact with these aspects a very interesting road for future research. Another interesting path for future research could be to consider the macroeconomic effects of spatial restrictions imposed by grandparent-provided child care on optimal labor mobility and the optimal allocation of talent.

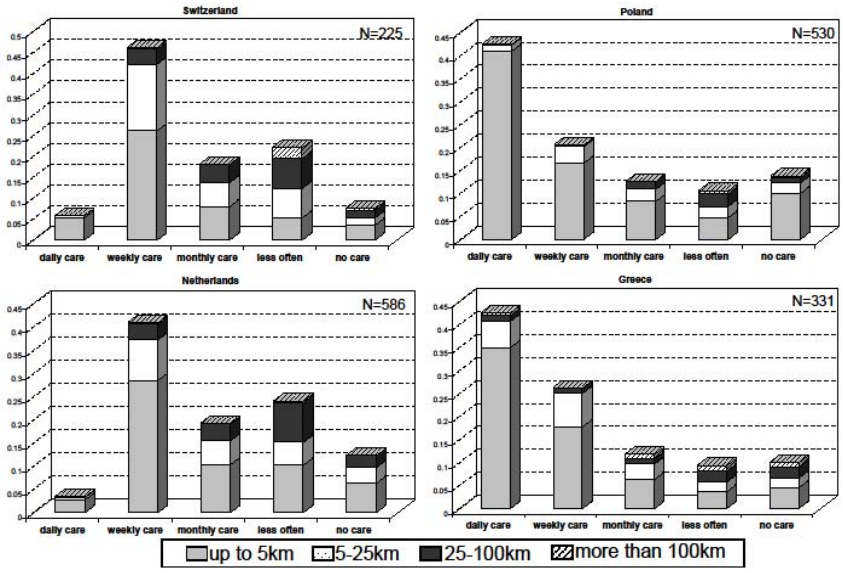
3.9. Appendix A

Figure A-1: Frequency of Care and Distance to closest grandchild, age10 and younger



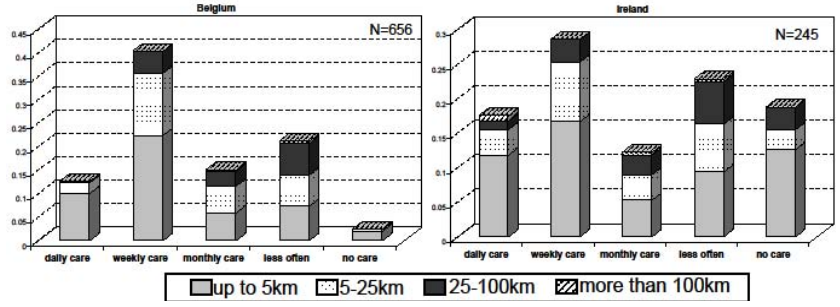
Data : Survey of Health, Ageing and Retirement in Europe (SHARE), 2^{nd} wave.

Figure A-2: Frequency of Care and Distance to closest grandchild, age10 and younger



Data : Survey of Health, Ageing and Retirement in Europe (SHARE), 2nd wave.

Figure A-3: Frequency of Care and Distance to closest grandchild, age10 and younger



Data : Survey of Health, Ageing and Retirement in Europe (SHARE), 2nd wave.

Table A-1: Unweighted Means (Std.) - GSOEP pooled sample- 1991, 1996, 2001, 2006

First Sample:	Women 25-50	Mothers 25-50)
Age	37.31 (7.05)	38.55 (6.59)
Married, living together	0.66 (0.47)	0.76 (0.42)
Other than German nationality	0.02 (0.13)	0.01 (0.11)
Children	0.74 (0.43)	1
Children 0-3	0.16 (0.37)	0.22 (0.41)
Primary education	0.01 (0.10)	0.01 (0.10)
Secondary education	0.70 (0.46)	0.71 (0.45)
Tertiary education	0.30 (0.46)	0.28 (0.45)
Regular fulltime job	0.41 (0.49)	0.31 (0.46)
Regular part time job	0.24 (0.43)	0.29 (0.45)
Small community	0.41 (0.49)	0.45 (0.50)
Medium community	0.27 (0.44)	0.27 (0.45)
Large community	0.32 (0.46)	0.28 (0.45)
West German in West Germany	0.62 (0.49)	0.59 (0.49)
West German in East Germany	0.05 (0.21)	0.04 (0.20)
East German in East Germany	0.27 (0.44)	0.31 (0.46)
East German in West Germany	0.01 (0.08)	0.01 (0.08)
Other in West Germany****	0.001 (0.04)	0.001 (0.03)
Other in East Germany****	0.0003 (0.02)	0.0003 (0.02)
Parents' or inlaws close	0.45 (0.50)	0.47 (0.50)
- Parents' or inlaws in same neighborhood	0.20 (0.40)	0.21 (0.41)
- Parents' or inlaws in same town	0.27 (0.45)	0.28 (0.45)
Parents' or inlaws in same house	0.02 (0.15)	0.03 (0.16)
Parents' or inlaws far away	0.55 (0.50)	0.53 (0.50)
- Parents' or inlaws one hour away	0.36 (0.48)	0.36 (0.48)
- Parents' or inlaws further away	0.22 (0.41)	0.20 (0.40)
Parents' or inlaws in foreign country	0.01 (0.09)	0.01 (0.08)
Spouse' hourly income*	16.64 (11.96)	16.63 (10.16)
Hourly wage**	12.65 (6.31)	12.31 (6.39)
Tenure in firm***	8.18 (7.24)	8.62 (7.45)
N	10003	7475

*Only taking into account strictly positive hourly wages (N=5571, N=4548 for mothers)

Table A-2: Unweighted Means (Std.) - GSOEP pooled sample

-1997, 1999, 2000, 2001, 2002, 2004, 2005, 2006

Second Sample:	Women 25-50	Mothers 25-50 of children age ≤ 6
Age	37.87 (7.19)	33.73 (4.81)
Married, living together	0.66 (0.47)	0.78 (0.42)
Other than German nationality	0.02 (0.14)	0.04 (0.19)
Children	0.74 (0.44)	1
Children 0-3	0.15 (0.36)	0.60 (0.49)
Primary education	0.01 (0.10)	0.01 (0.10)
Secondary education	0.70 (0.46)	0.72 (0.45)
Tertiary education	0.29 (0.45)	0.27 (0.44)
Regular fulltime job	0.41 (0.49)	0.13 (0.34)
Regular part time job	0.25 (0.43)	0.25 (0.43)
Small community	0.46 (0.50)	0.48 (0.50)
Medium community	0.25 (0.44)	0.26 (0.44)
Large community	0.29 (0.45)	0.26(0.44)
West German in West Germany	0.64 (0.48)	0.70 (0.46)
West German in East Germany	0.04 (0.20)	0.04 (0.20)
East German in East Germany	0.27 (0.44)	0.20 (0.40)
East German in West Germany	0.01 (0.07)	0.002 (0.10)
Other in West Germany*****	0.002 (0.04)	0.001 (0.04)
Other in East Germany*****	0.0002 (0.01)	0 (0)
Children in Nursery	-	0.58 (0.49)
Children cared for by relatives	-	0.33 (0.47)
Spouse' hourly income*	17.06 (12.48)	17.29 (9.84)
Tenure in firm**	8.41 (7.42)	6.55 (5.70)
Distance to work***	17.47 (33.88)	17.32 (36.81)
Job in town***	0.51 (0.50)	0.50 (0.50)
N	40082	8269

*Only taking into account strictly positive hourly wages (N=23589, N=5822 for mothers))

*** Only those working regular part or fulltime jobs, more than 20 hours a month,

with firm tenure strictly positive (N=24804, N=3050, for mothers)

***Only those working regular part or fulltime jobs, more than 20 hours a month, with distance to

Table A-3: Effect of close presence of grandparents on fertility :

Odd Ratios from Logit Estimation for Having Children with Age Polynomials

Married, living together	4.583***	(0.005)
Other than German nationality	1.370***	(0.006)
Log (Spouse' hourly income)*	1.046***	(0.000)
Primary education (ISCED: 0,1)	4.733***	(0.026)
Tertiary education (ISCED: 5,6)	0.517***	(0.000)
Parents or inlaws close	1.331***	(0.001)
Parents or inlaws in same house	0.721***	(0.003)
Small community	0.923***	(0.001)
Large community	0.548***	(0.001)
Age	1.797***	(0.001)
Age^2	0.993***	(0.000)
Constant	0.000***	(0.000)
Observations	36,990,976	

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Logistic Estimation; Data: GSOEP unbalanced panel 91,96,01,06; Women 25-50. All regressions include year dummies as well as dummies for East and West Germany. Reference group: unmarried women living in West Germany who were living in West Germany in 1989, with education level 2 (ISCED: 3,4,5) in 1991, in a medium-sized town, far from parents or in-laws. *Missing values and values < 1 are set to 0.

Table A-4: Effect of close presence of grandparents on fertility:

Odd Ratios from Logit Estimation for Having Children exclusive of marital status and spouse's income

Other than German nationality	1.838***	(0.007)
Primary education (ISCED: 0,1)	3.666***	(0.019)
Tertiary education (ISCED: 5,6)	0.514***	(0.000)
Parents or inlaws close	1.360***	(0.001)
Parents or inlaws in same house	1.298***	(0.004)
Small community	1.032***	(0.001)
Large community	0.474***	(0.001)
Constant	0.510***	(0.001)
Observations	37,006,121	

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Logistic Estimation; Data: GSOEP unbalanced panel 91,96,01,06; Women 25-50. All regressions include age dummies, year dummies as well as dummies for East and West Germany. Reference group: women age 25 living in West Germany who were living in West Germany in 1989, with education level 2 (ISCED: 3,4,5)in 1991, in a medium-sized town, far from parents or in-laws.

Table A-5: Effect of close presence of grandparents on fertility:
Odd Ratios from Logit Estimation for Having Children with Years of Education

Married, living together	4.629***	(0.005)
Other than German nationality	1.249***	(0.005)
Log (Spouse' hourly income)*	1.049***	(0.000)
Years of education	0.823***	(0.000)
Parents or inlaws close	1.215***	(0.001)
Parents or inlaws in same house	0.650***	(0.002)
Small community	0.888***	(0.001)
Large community	0.588***	(0.001)
Constant	2.024***	(0.006)
Observations	36,839,421	

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 Logistic Estimation; Data: GSOEP unbalanced panel 91,96,01,06; Women 25-50. All regressions include age dummies, year dummies as well as dummies for East and West Germany. Reference group: unmarried women age 25 living in West Germany who were living in West Germany in 1989, in 1991, in a medium-sized town, far from parents or in-laws. *Missing values and values < 1 are set to 0.

Table A-6: Effect of grandparent-provided child care on participation:
Marginal Effects from Probit Estimation for
Mothers' Labor Force Participation with Age Polynomial

	Regular Part or Fulltime Job		Regular Part or Fulltime Job	
	(1)		(2)	
Children 0-3	-0.338***	(0.025)	-0.209***	(0.022)
Married, living together	-0.095***	(0.024)	-0.104***	(0.026)
Other than German nationality	0.099	(0.137)	0.128	(0.088)
Log (Spouse' hourly income)*	-0.001	(0.003)	0.001	(0.003)
Primary education (ISCED: 0,1)	-0.104	(0.089)	-0.146	(0.132)
Tertiary education (ISCED: 5,6)	0.206***	(0.020)	0.136***	(0.021)
Parents or in-laws close	0.047**	(0.020)		
Parents or in-laws in same house	0.044	(0.051)		
Children cared for by relatives			0.185***	(0.021)
Children in nursery			0.058***	(0.020)
Small community	0.029	(0.023)	0.008	(0.022)
Large community	0.019	(0.025)	0.048**	(0.025)
Age	0.003	(0.017)	0.061***	(0.022)
Age^2	-0.000	(0.000)	-0.001***	(0.000)
Observations	7,235		7,924	

Standard errors in parentheses;*** p<0.01, ** p<0.05, * p<0.1; Probit Estimation; Data: GSOEP unbalanced panel 1) 91,96,01,06; mothers 25-50. Reference group: unmarried mothers with education level 2 (ISCED: 3,4,5) in 1991, in a medium-sized community in West Germany (who were living in West Germany in 1989), far from parents or in-laws, with children older than 3. 2) 97,99,00,01,02,03,05,06; mothers (25-50) of children <= 6 years. Reference group: unmarried mothers in 1997, with education level 2 (ISCED: 3,4,5), in a medium-sized town in West Germany (who were living in West Germany in 1989), with children older than 3 who are nor in nursery nor cared for by relatives. All regressions include year dummies, as well as dummies for living and being from West or East Germany. *Missing values and values < 1 are set to 0.

Table A-7: Effect of grandparent-provided child care on participation:
Marginal Effects from Probit Estimation for
Mothers' Labor Force Participation with Years of Education

	Regular Part or Fulltime Job		Regular Part or Fulltime Job	
	(1)		(2)	
Children 0-3	-0.365***	(0.025)	-0.228***	(0.021)
Married, living together	-0.106***	(0.024)	-0.109***	(0.025)
Other than German nationality	0.119	(0.133)	0.152*	(0.084)
Log (Spouse' hourly income)*	-0.001	(0.003)	0.001	(0.003)
Years of education	0.042***	(0.005)	0.030***	(0.004)
Parents or in-laws close	0.053***	(0.020)		
Parents or in-laws in same house	0.063	(0.051)		
Children cared for				
by relatives			0.183***	(0.020)
Children in nursery			0.053***	(0.020)
Small community	0.029	(0.023)	0.008	(0.022)
Large community	0.012	(0.025)	0.043*	(0.025)
Observations	7,204		7,891	

Standard errors in parentheses;*** p<0.01, ** p<0.05, * p<0.1; Probit Estimation; Data: GSOEP unbalanced panel 1) 91,96,01,06; mothers 25-50. Reference group: unmarried mothers age 25 in 1991, in a medium-sized community in West Germany (who were living in West Germany in 1989), far from parents or in-laws, with children older than 3. 2) 97,99,00,01,02,03,05,06; mothers (25-50) of children <= 6 years. Reference group: unmarried mothers age 25 in 1997, in a medium-sized town in West Germany (who were living in West Germany in 1989), with children older than 3 who are nor in nursery nor cared for by relatives. All regressions include age dummies, year dummies, as well as dummies for living and being from West or East Germany. *Missing values and values < 1 are set to 0.

Table A-8: Effect of grandparent-provided childcare on participation: Marginal Effects from Probit Estimation for Mothers' Labor Force Participation without variables posing a possible endogeneity problem (marital status and income of spouse (1) and child care by nursery (2)

	Regular Part or Fulltime Job		Regular Part or Fulltime Job	
	(1)		(2)	
Children 0-3	-0.352***	(0.024)	-0.241***	(0.020)
Married, living together		-0.103***	(0.025)	
Other than German nationality	0.082	(0.132)	0.131	(0.083)
Log (Spouse' hourly income)*		0.001	(0.003)	
Primary education (ISCED: 0,1)	-0.086	(0.085)	-0.158	(0.122)
Tertiary education (ISCED: 5,6)	0.202***	(0.020)	0.138***	(0.021)
Parents or in-laws close	0.050**	(0.019)		
Parents or in-laws in same house	0.026	(0.051)		
Children cared for by relatives			0.189***	(0.020)
Small community	0.020	(0.023)	0.008	(0.022)
Large community	0.020	(0.025)	0.053**	(0.025)
Observations	7,235		7,923	

Standard errors in parentheses;*** p<0.01, ** p<0.05, * p<0.1; Probit Estimation; Data: GSOEP unbalanced panel 1) 91,96,01,06; mothers 25-50. Reference group: mothers age 25 with education level 2 (ISCED: 3,4,5) in 1991, in a medium-sized community in West Germany (who were living in West Germany in 1989), far from parents or in-laws, with children older than 3. 2) 97,99,00,01,02,03,05,06; mothers (25-50) of children <= 6 years. Reference group: unmarried mothers age 25 in 1997, with education level 2 (ISCED: 3,4,5), in a medium-sized town in West Germany (who were living in West Germany in 1989), with children older than 3 who are not cared for by relatives. All regressions include age dummies, year dummies, as well as dummies for living and being from West or East Germany. *Missing values and values < 1 are set to 0.

Table A-9: Effect of close presence of grandparents on monthly wages:

Coefficients of Heckmann Selection Model for Mothers' Log Monthly Wages

	Log hourly wage		Selection Equation	
	(1)		(2)	
Married, living together	-0.049**	(0.020)	-0.442***	(0.052)
Other than German nationality	-0.048	(0.111)	0.185	(0.227)
Primary education (ISCED: 0,1)	-0.081	(0.095)	-0.319*	(0.175)
Tertiary education (ISCED: 5,6)	0.331***	(0.022)	0.577***	(0.048)
Parents or in-laws close	-0.042**	(0.018)	0.133***	(0.039)
Parents or in-laws in same house	-0.072	(0.052)	0.084	(0.117)
Small community	0.024	(0.021)	0.075*	(0.046)
Large community	0.042*	(0.023)	0.026	(0.049)
Log (Spouse' hourly income)*			0.037***	(0.006)
Children 0-3			-0.919***	(0.054)
Tenure in firm	0.016***	(0.001)		
Monthly hours worked	0.008***	(0.000)		
Constant	5.447***	(0.107)	-0.336*	(0.168)
Observations	5,145		5,145	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Heckman Selection Model; Data: GSOEP unbalanced panel 91,96, 01,06; mothers 25-50. Reference group: unmarried mothers of age 25 of children older than 3 with education level 2 (ISCED: 3,4,5) in 1991, in a medium-sized West German town, far from parents or in-laws. *Missing values and values < 1 are set to 0. All regressions include age dummies, year dummies, as well as dummies for being from and living in East or West Germany.

Table A-10: Effect of close presence of grandparents on hourly wages :
Coefficients of Simple OLS Estimation of Mothers' Log Hourly Wages

Married, living together	0.004	(0.018)
Other than German nationality	-0.065	(0.104)
Primary education (ISCED: 0,1)	-0.093	(0.090)
Tertiary education (ISCED: 5,6)	0.308***	(0.019)
Tenure in firm	0.016***	(0.001)
Parents or inlaws close	-0.055***	(0.017)
Parents or inlaws in same house	-0.087*	(0.048)
Small community	0.006	(0.020)
Large community	0.010	(0.021)
Constant	1.794***	(0.092)
Observations	2,649	

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1 OLS Estimation; Data: GSOEP unbalanced panel 91,96,01,06; mothers 25-50 with full or part time regular job. All regressions include age dummies, year dummies as well as dummies for East and West Germany. Reference group: unmarried women age 25 living in West Germany who were living in West Germany in 1989, with education level 2 (ISCED: 3,4,5)in 1991, in a medium-sized town, far from parents or in-laws. *Missing values and values < 1 are set to 0.

Table A-11: Effect of close presence of grandparents on hourly wages:
Coefficients of Heckmann Selection Model for
Mothers' Log Hourly Wages with Age Polynomial

	Log hourly wage		Selection Equation	
	(1)		(2)	
Married, living together	-0.019	(0.019)	-0.421***	(0.051)
Other than German nationality	-0.048	(0.104)	0.244	(0.219)
Primary education (ISCED: 0,1)	-0.104	(0.092)	-0.289*	(0.172)
Tertiary education (ISCED: 5,6)	0.348***	(0.021)	0.584***	(0.048)
Parents or in-laws close	-0.041**	(0.018)	0.131***	(0.038)
Parents or in-laws in same house	-0.078	(0.050)	0.084	(0.116)
Small community	0.016	(0.021)	0.075*	(0.045)
Large community	0.018	(0.022)	0.034	(0.049)
Log (Spouse' hourly income)*			0.035***	(0.006)
Children 0-3			-0.906***	(0.053)
Tenure in firm	0.016***	(0.001)		
Age	0.060***	(0.016)	0.019	(0.033)
Age^2	-0.001***	(0.000)	-0.000	(0.000)
Constant	0.593***	(0.313)	-0.498	(0.619)
Observations	5,144		5,144	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Heckman Selection Model; Data: GSOEP unbalanced panel 91,96, 01,06; mothers 25-50. Reference group: unmarried mothers of children older than 3 with education level 2 (ISCED: 3,4,5) in 1991, in a medium-sized West German town, far from parents or in-laws. *Missing values and values < 1 are set to 0. All regressions include year dummies, as well as dummies for being from and living in East or West Germany.

Table A-12: Effect of close presence of grandparents on hourly wages:
Coefficients of Heckmann Selection Model for
Mothers' Log Hourly Wages with Years of Education

	Log hourly wage		Selection Equation	
	(1)		(2)	
Married, living together	-0.037*	(0.019)	-0.464***	(0.052)
Other than German nationality	0.034	(0.105)	0.233	(0.227)
Years of education	0.077***	(0.004)	0.119***	(0.009)
Parents or in-laws close	-0.035**	(0.017)	0.140***	(0.039)
Parents or in-laws in same house	-0.039	(0.049)	0.124	(0.117)
Small community	0.028	(0.020)	0.088*	(0.046)
Large community	0.011	(0.021)	0.020	(0.049)
Log (Spouse' hourly income)*			0.035***	(0.006)
Children 0-3			-0.976***	(0.055)
Tenure in firm	0.016***	(0.001)		
Constant	0.826***	(0.116)	-1.580***	(0.196)
Observations	5,144		5,144	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Heckman Selection Model; Data: GSOEP unbalanced panel 91,96, 01,06; mothers 25-50. Reference group: unmarried mothers of age 25 of children older than 3 in 1991, in a medium-sized West German town, far from parents or in-laws. *Missing values and values < 1 are set to 0. All regressions include age dummies, year dummies, as well as dummies for being from and living in East or West Germany.

Table A-13: Effect of close presence of grandparents on hourly wages: Coefficients of Heckmann Selection Model for Mothers' Log Hourly Wages without variables posing a possible endogeneity problem (marital status and income of spouse)

	Log hourly wage		Selection Equation	
	(1)		(2)	
Other than German nationality	-0.017	(0.106)	0.065	(0.226)
Primary education (ISCED: 0,1)	-0.107	(0.092)	-0.276	(0.173)
Tertiary education (ISCED: 5,6)	0.351***	(0.021)	0.578***	(0.048)
Parents or in-laws close	-0.039**	(0.018)	0.133***	(0.038)
Parents or in-laws in same house	-0.077	(0.050)	0.070	(0.116)
Small community	0.017	(0.021)	0.061	(0.045)
Large community	0.019	(0.022)	0.050	(0.049)
Children 0-3			-0.938***	(0.053)
Tenure in firm	0.016***	(0.001)		
Constant	1.579***	(0.103)	-0.447***	(0.163)
Observations	5,149		5,149	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Heckman Selection Model; Data: GSOEP unbalanced panel 91,96, 01,06; mothers 25-50. Reference group: mothers of age 25 of children older than 3 living in West Germany who lived in West Germany in 1989, with education level 2 (ISCED: 3,4,5) in 1991, in a medium-sized West German town, far from parents or in-laws. All regressions include age dummies, year dummies, as well as dummies for being from and living in East or West Germany.

Table A-14: Effect of grandparent-provided child care on commutes :
Odd Ratios from Logit Estimation of Working
and Residing in same town with Age Polynomials

Married, living together	0.586***	(0.001)
Other than German nationality	4.608***	(0.032)
Log (Spouse' hourly income)*	1.031***	(0.000)
Primary education (ISCED: 0,1)	17.546***	(0.523)
Tertiary education (ISCED: 5,6)	0.905***	(0.001)
Tenure in firm	0.972***	(0.000)
Children cared for by relatives	0.901***	(0.001)
Children in nursery	1.206***	(0.002)
Small community	0.257***	(0.000)
Large community	1.681***	(0.003)
Age	0.765***	(0.002)
Age^2	1.004***	(0.000)
Constant	182.340***	(6.263)
Observations	9,224,321	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Logit Estimation Data: GSOEP unbalanced panel, 97,99,00,01,02,03,05,06 , mothers 25-50 of children <= 6 years. Reference Group: unmarried mothers in 1997 with education level 2 (ISCED: 3,4,5) in a medium-sized West German town (who lived in West Germany in 1989), with children older than 3, who are nor in nursery nor cared for by relatives. All regressions include year dummies as well as dummies for being from and living in West or East Germany. *Missing values and values < 1 are set to 0.

Table A-15: Effect of grandparent-provided child care on commutes :
Odd Ratios from Logit Estimation of Working
and Residing in same town with Years of Education

Married, living together	0.578***	(0.001)
Other than German nationality	4.392***	(0.031)
Log (Spouse' hourly income)*	1.034***	(0.000)
Years of Education	0.963***	(0.000)
Tenure in firm	0.969***	(0.000)
Children cared for by relatives	0.925***	(0.001)
Children in nursery	1.188***	(0.002)
Small community	0.252***	(0.000)
Large community	1.762***	(0.004)
Constant	3.306***	(0.025)
Observations	9,209,835	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Logit Estimation Data: GSOEP unbalanced panel, 97,99,00,01,02,03,05,06 , mothers 25-50 of children <= 6 years. Reference Group: unmarried mothers of age 25 in 1997 in a medium-sized West German
town (who lived in West Germany in 1989), with children older than 3, who are nor in nursery nor cared for by relatives. All regressions include age dummies, year dummies as well as dummies for being from and living in West or East Germany. *Missing values and values < 1 are set to 0.

Table A-16: Effect of grandparent-provided child care on commutes :
Odd Ratios from Logit Estimation of Working and Residing
in same town without variable posing
a possible endogeneity problem - child care by nursery

Married, living together	0.580***	(0.001)
Other than German nationality	4.505***	(0.031)
Log (Spouse' hourly income)*	1.034***	(0.000)
Primary education (ISCED: 0,1)	15.061***	(0.454)
Tertiary education (ISCED: 5,6)	0.895***	(0.001)
Tenure in firm	0.970***	(0.000)
Children cared for by relatives	0.932***	(0.001)
Small community	0.250***	(0.000)
Large community	1.679***	(0.003)
Constant	2.282***	(0.014)
Observations	9,222,606	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Logit Estimation Data: GSOEP unbalanced panel, 97,99,00,01,02,03,05,06 , mothers 25-50 of children <= 6 years. Reference Group: unmarried mothers of age 25 in 1997 with education level 2 (ISCED: 3,4,5) in a medium-sized West German town (who lived in West Germany in 1989), with children older than 3, who are not cared for by relatives. All regressions include age dummies, year dummies as well as dummies for being from and living in West or East Germany. *Missing values and values < 1 are set to 0.

Table A-17: Effect of grandparent-provided child care on distance to work : Coefficients of OLS Estimation of Distance to Work

Married, living together	1.633***	(0.017)
Other than German nationality	-9.790***	(0.061)
Log (Spouse' hourly income)*	0.281***	(0.003)
Primary education (ISCED: 0,1)	-15.088***	(0.116)
Tertiary education (ISCED: 5,6)	5.259***	(0.017)
Tenure in firm	-0.052***	(0.001)
Children cared for by relatives	0.395***	(0.016)
Children in nursery	-5.233***	(0.017)
Small community	3.814***	(0.019)
Large community	-1.339***	(0.021)
Constant	14.572***	(0.062)
Observations	6,866,442	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1 Logit Estimation Data: GSOEP unbalanced panel, 97,99,00,01,02,03,05,06 , German mothers 25-50 of children <= 6 years. Reference Group: unmarried West German mothers of age 25 in 1997 with education level 2 (ISCED: 3,4,5) in a medium-sized West German town, with children older than 3, who are nor in nursery nor cared for by relatives. All regressions include age dummies, year dummies as well as dummies for being from and living in West or East Germany.

*Missing values and values < 1 are set to 0.

Table A-18: Grandparent-provided child care and Log Hourly wages:

Coefficients of Individual Fixed Effects Estimation

	Log Hourly Wages		Log Hourly Wages	
	(1)		(2)	
Married, living together	-0.293***	(0.102)	-0.095	(0.076)
Other than German nationality	0.000	(0.000)		
education level 1 (ISCED: 0,1)	0.000	(0.000)	0.000	(0.000)
education level 3 (ISCED: 5,6)	0.125	(0.101)	-0.244	(0.149)
parents or in-laws close	0.046	(0.123)	0.033	(0.093)
parents or in-laws in same house	-0.115	(0.256)	-0.052	(0.333)
small community	0.310**	(0.119)	0.183	(0.129)
large community	-0.094	(0.141)	0.232	(0.182)
Tenure in firm	-0.001	(0.005)	0.015**	(0.007)
Constant	2.177***	(0.120)	2.286***	(0.173)
Observations	588		692	
Number of person.	526	566		

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Fixed Effect Estimation Data: (1) GSOEP balanced panel 91-01 (2) GSOEP balanced panel 96-06 (other nationality omitted because of no within-group variance); mothers 25-50 Reference group: unmarried mothers with education level 2 (ISCED: 3,4,5) in a medium-sized community, living far from their parents or in-laws, with children older than 3. r All regressions include age dummies, year dummies as well as dummies for and living in West or East Germany. *Missing values and values < 1 are set to 0.

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