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Chapter 1

Introduction

Over the past few decades, fertility has declined sharply in most member countries of the Organization for Economic Co-operation and Development (OECD). Today, almost no OECD country has a total fertility rate (TFR) [1] above the population replacement rate of 2.1 children per woman. [2] Important factors associated with this general decline in developed countries' TFRs are not only the improvement of contraceptive technology and a decline in infant mortality (see e.g Goldwin and Katz, 2000, 2002), but also increased income and, hence, higher opportunity costs of children (see e.g. Becker, 1981), the rise in the labor force participation of women (see e.g. Ahn and Mira, 2002 and Feyrer et al., 2008) as well as the expansion of social security systems and the redundancy of children as providers in old age (see e.g. Sinn, 2004).

There are various economic consequences of low fertility, ranging from a decline in the working-age share of the population to a slowdown of economic growth as well as financial difficulties in health care and pensions systems (Bloom et al., 2010). Concerns about low fertility and the sustainability of welfare-state systems are therefore increasing in most OECD countries. These concerns revived debates about family policies as a remedy against fertility decline and its consequences. Being confronted with distinct

[1] Total fertility rates represent the average number of children that would be born to a woman during her lifetime if she were to pass through her childbearing years conforming to the age-specific fertility rates of that period (OECD Family Database, 2010a).
[2] The replacement rate is the rate of fertility at which the population of developed countries can remain constant in the long run (OECD Family Database, 2010a).

policy objectives and instruments, governments in affected countries have therefore introduced policy measures intended to support the private decision to have children and to reverse the trend of population aging. At the European level, the need to increase female participation in the labor market is an explicit political objective, to be reached, along with other measures, by improving the provision of child care facilities (European Council, 2002). Moreover, the European Union has set the struggle against child poverty as one of the priorities of the "European Social Model", also by supporting women's employment through job security, flexibility and quality, and through an adequate support via care facilities (Esping-Andersen, 2002).

Especially the reconciliation of having children and female labor market participation is seen as a desirable path of family policy. Against this background, this thesis aims to shed light on the link between family policies, fertility, employment, and child care within the framework of theoretical models with endogenous fertility.

From the literature we can discern three microeconomic theories of fertility: The "Chicago Model", "Leibenstein's Model", and "Easterlin's Theories". All three approaches apply the theory of consumer behavior to childbearing decisions. The authors, however, disagreed regarding the relevant determinants and therefore developed different fertility theories. The "Chicago Model" assumes children to be consumer durable goods from which parents consume a flow of services (Becker, 1960). Leibenstein (1957, 1974), on the other hand, considers children to be commitment goods.[3] The major difference between the two theories lies in the consumption theory used. While the "Chicago Model" uses the conventional microeconomic theory of consumption, Leibenstein introduces a new theory of consumer behavior which assumes the existence of goods which are subject to increasing marginal utility up to some level and normal diminishing marginal utility beyond that level. Both theories focus on developed countries and conclude that the relationship between income and fertility is positive despite the evidence showing that higher income households have fewer children and, that in the course of economic development, family size has decreased. Easterlin (1969, 1973) introduces a broader framework of the production of children which is applicable not only to fertility trends in developed countries but also to the developing countries. He uses two different theories of fertility to capture these differentiated trends: the relative income hypothesis and the threshold of fertility regulation hypothesis. The first hypothesis is intended to explain the

[3] Leibenstein (1957) assumes that expenditures on children reflect a commitment undertaken by parents such as the provision for old-age security.

post World War II baby boom, while the second hypothesis is intended to explain the high fertility rates in the less developed countries.

The theory of fertility that was mainly founded by Gary S. Becker (1960, 1965), Robert J. Willis (1973), Theodore P. Schultz (1973), Dennis De Tray (1973), and Yoram Ben-Porath (1973) is based on the consolidation of three theoretical concepts: the household production function, the individual human capital and the theory time allocation. This so called New Home Economics, also known as "Chicago School", is one of the main approaches in the field of family economics. This dissertation will also focus on the "Chicago Model" and the key assumptions of this model are therefore explained in further detail in the following.

In a first approach to the economic analysis of fertility, Becker (1960) created a framework for the analysis of fertility decisions. He identified five key determinants of the demand for children: individual preferences of the parents and their income, the quality of children, the costs of children, and the supply of children. These determinants were adopted by many economists (see e.g. Becker and Lewis, 1973; Willis, 1973; De Tray, 1973; Cigno, 1986, 1991) and form the basis of the New Home Economics.

From an economic perspective, children in developed economies are referred to as consumer goods and are thus part of the parents' utility function. According to Becker (1960), the parents' utility function and therefore the course of the indifference curves depends among others on individual preferences such as cultural and social differences. Individual preferences regarding children, for example, may be linked to religion, ethnicity or the parents' age. Another important component of the demand for children described by Becker (1960) is the quality of a child. In his model, a child's quality increases in additional expenses for the child and is measured by the real expenses of parents per child. Children can thus not be considered homogeneous consumer goods and the fertility theory of Becker (1960) therefore shows a significant interaction between quantity and quality of children. This interaction between quantity and quality of children has been taken up by many economists and will also be discussed in this thesis.

Becker also stresses two further elements of the demand for children: the income of the parents and the cost of a child. Willis (1973) likewise emphasizes the importance of the cost of a child in fertility theory and names explicitly the opportunity costs to the parents caused by an extra child. The opportunity costs equal the unused opportunities of the

parents in form of income and mobility loss in life due to having children. Both authors stress the role of female wages, representing the opportunity cost of childbearing, as a determinant of fertility. Female wages are seen to have both (positive) income and (negative) substitution effects on fertility, with opposite effects on female labor force participation. Income from sources other than women's wages is expected to have a positive effect on the demand for child services, assuming such services are a normal good.[4] As already mentioned, Becker (1960) hypothesizes that child services have both quality and quantity dimensions, so that rising incomes need not necessarily lead to larger desired numbers of children.

In the following chapters, this dissertation analyses three main issues in the area of family economics: the effects of different family policies on fertility and the secondary earner's labor supply, the demand for external child care as well as an analysis of the demand for quantity and quality of external child care. In the following, I provide non-technical summaries and outlooks of the three chapters of this thesis.

Chapter 2: Three Family Policies to Reconcile Fertility and Labor Supply

This chapter presents a comparison of the effects of three different benefit programs (child benefits, parental leave payments, subsidies for external child care) on fertility, investments in quality of children, labor supply, and welfare within a static model of a family with endogenous fertility and labor supply of the secondary earner.[5]

Since the 1960s, all OECD countries have experienced a considerable decline in fertility. TFR dropped to an unprecedented low, reaching an average of 1.65 in the OECD-30 countries at the turn of the century. This gave rise to a focus on family policy in several countries. Monetary and in-kind transfers, child care systems, labor market conditions etc. were re-considered as means to foster the birth of children and to reverse the trend of population aging. Some countries already achieved first results such that the average TFR in the OECD-30 countries in 2010 therefore amounted to 1.7. Nevertheless, fertility levels in many countries are still very low and vary considerably among the OECD countries. In

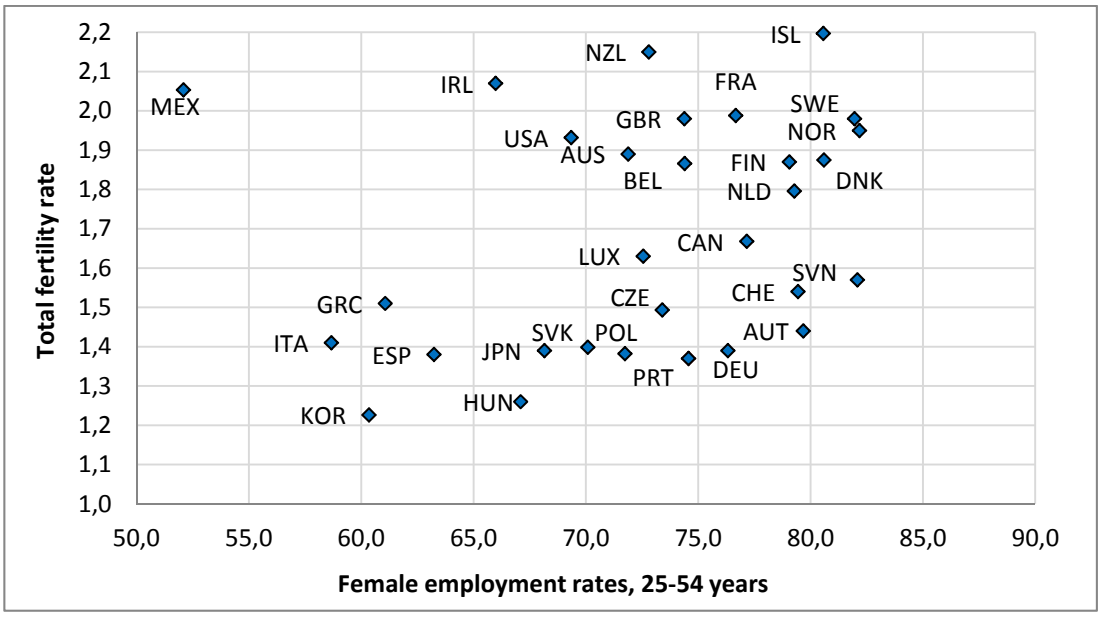
[4] Willis (1973) introduced the term child services for the total amount of child quality. He was the first to use the concept of a household production function as a basis for the relationship of child quantity and quality and to consider time inputs in the child's quality function.

[5] This chapter is based on the article "Three family policies to reconcile fertility and labor supply", which is joint work with Robert Fenge from the University of Rostock.

2010, Iceland and New Zealand were the only OECD-30 countries with a fertility rate above the replacement fertility rate of 2.1. In Southern Europe, Eastern Europe, and in Germany fertility is still below 1.5, while Iceland, New Zealand, Ireland, Mexico, France, the Scandinavian countries as well as the USA constitute the countries with the highest total fertility rates in the OECD-30.

Researchers attribute the differences in the patterns of Western European fertility levels to mainly demographic and to socio-economic factors, among the latter in particular to the change in women's labor force participation. Since the 1970s, women's employment rates have increased in all OECD countries. However, averaging across developed countries, the correlation between fertility and female labor force participation has recently turned positive. Figure 1.1 shows the cross-country relationship between female employment rates and total fertility rates of the OECD-30 countries in 2010. The figure demonstrates that many countries with high female labor force participation also have high fertility rates. By implementing new or improving their existing family policies, those countries found a way to reconcile fertility and female labor supply.

Figure 1.1: Cross-country relationship between female employment rates and total fertility rates (2010)



Data Source: OECD Family Database (2010a)

In order to explain this variation in both the fertility and the female employment rates across countries, we analyze the effects of three different family policies on fertility and the secondary earner's labor supply: Child benefits and parental leave payments, which are implemented in almost all OECD countries, as well as child care subsidies, which

have been well-developed in France and Sweden but are also existent in other countries. We compare the effectiveness of the three policy instruments in raising the number of children and increasing secondary earner's labor supply.

Within the framework of our static model with endogenous fertility, we consider both absolute and differential effects of the family policy instruments. The differential effects of budget-neutral policy changes are important to compare the relative performance of the policy instruments in fostering the number of children or parental labor supply. Our differential analysis shows that the only policy reform which can produce incentives to have more children, a higher demand for external child care, and, at the same time, act as stimulation for more labor supply of parents is given by an increase in child benefits compensated by a budget-neutral reduction of parental leave payments. This policy therefore qualifies as a way to improve the incentives to combine family and work. Comparing the effectiveness of parental leave payments to a subsidy for external child care, we find that the family policy instrument that supports the child care (external or parental) with the less elastic response is more effective in fostering fertility. A policy change that shifts transfers from leave payments to subsidies for external child care increases the demand for external child care and the employment of secondary earners. At the same time, this policy change can set positive incentives for having children if the demand for external child care is not too elastic.

Our welfare analysis shows that if child benefits are part of the family policy in an economy, it is welfare improving to complement this by introducing subsidies to external child care in exchange for lower child benefits up to a certain provision level. We also find that substituting very high levels of parental leave payments by subsidies for external child care may also increase welfare.

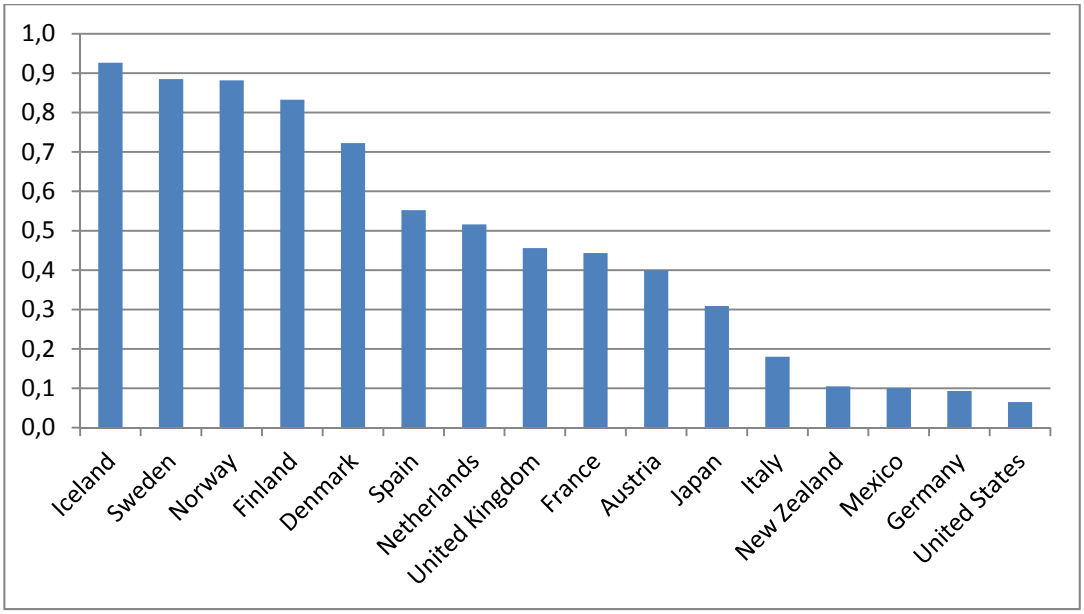
Chapter 3: Public Provision versus Subsidization of Private External Child Care

The focus of Chapter 3 lies on the provision of child care. In this chapter, we compare the effectiveness of an improved public provision of child care to a subsidization of privately provided external child care.

In recent decades, child care services have become a matter of serious public concern. As also shown in Chapter 2, affordable child care services may improve the reconciliation of

work and family life and thus foster labor market participation and gender equality. At the Barcelona meeting in March 2002, the European Council passed a recommendation that its member states remove "barriers and disincentives for female labor force participation by, inter alia, improving the provision of child care facilities" (European Council, 2002). The purpose of the initiative was to increase women's labor-force participation rates in member states to 60% (European Council, 2002). The main objectives of an improved provision of external child care are thus to fight family poverty by increasing mothers' participation in the labor market and to enhance child development and equality of opportunity for children. By lowering the cost of childbearing in terms of labor market and career opportunities, child care facilities may also provide an important answer to declining fertility rates. The question that arises is whether the provision should be organized by the public or be left to private forces and in this case may be subsidized by the state.

Figure 1.2: Public expenditure on child care (2009, in % of GDP)

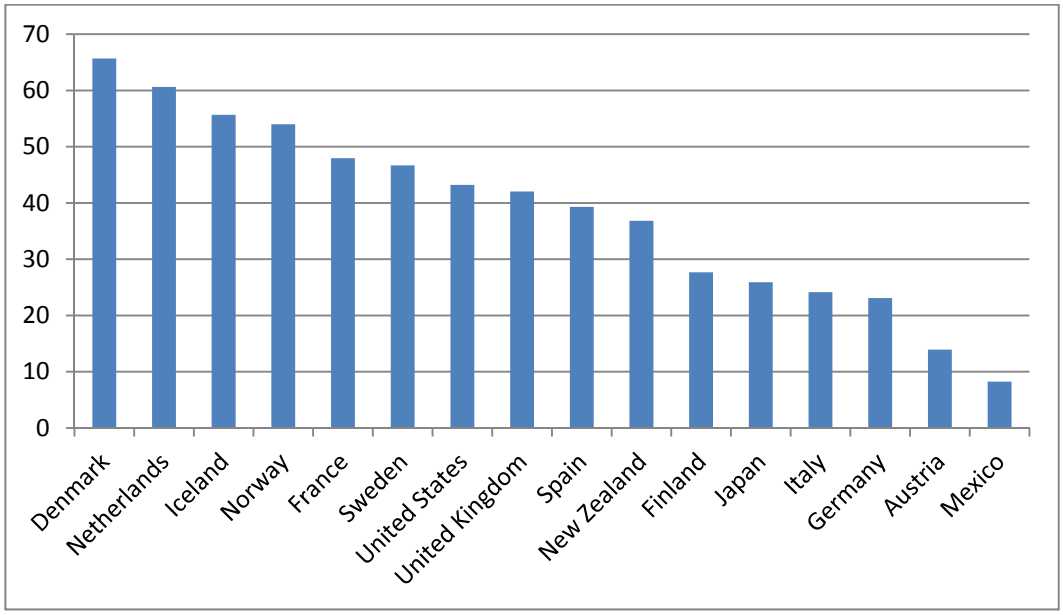


Data Source: OECD Family Database (2010b)

Figure 1.2 shows the public expenditure on child care in 2009 as a percentage of the gross domestic product (GDP) for selected OECD countries. It can be seen that the Nordic countries have the highest child care expenditures, while Italy, New Zealand, Mexico, Germany and the United States have the lowest spending. There are thus wide differences regarding the public expenditure on child care among the OECD countries.

When comparing the expenditure of a country to its enrolment rates (Figure 1.3) one can see that it is not necessarily those countries with the highest spending that have the highest enrolment rates.

Figure 1.3: Enrolment rates in child care among children under age three (2010, in %)



Data Source: OECD Family Database (2010c)

There might therefore also be other important factors such as cultural aspects that are essential for the demand for external child care. One nevertheless notices that countries like Germany, Italy or the Mexico with the lowest expenditure relative to GDP are also those countries with the lowest enrolment rates for children under age three.

In this chapter, we analyze parental preferences for external child care and compare the effects of publicly provided child care as well as of a subsidy on child care provided by the private market on both fertility and the secondary earner's labor supply. Our model predicts that a subsidy for external child care leads to an increase in both fertility and the secondary earner's labor supply. Publicly provided child care, on the other hand, has both a negative effect on fertility and on the secondary earner's labor supply due to the negative income effect. We find that as long as there is no full subsidy, richer households prefer a subsidy for private child care to a regime with purely private child care, while poorer households prefer publicly provided child care. The larger the subsidy for privately provided external child care, the more households benefit as more households can afford external child care. In case of a full subsidy, all households demand external child care

and low income households benefit the most from the subsidy from redistribution both via taxation and via the number of children. By offering free child care provided by the private market, the government could therefore foster both fertility and the secondary earner's labor supply.

Chapter 4: The Role of Government in Child Care Provision

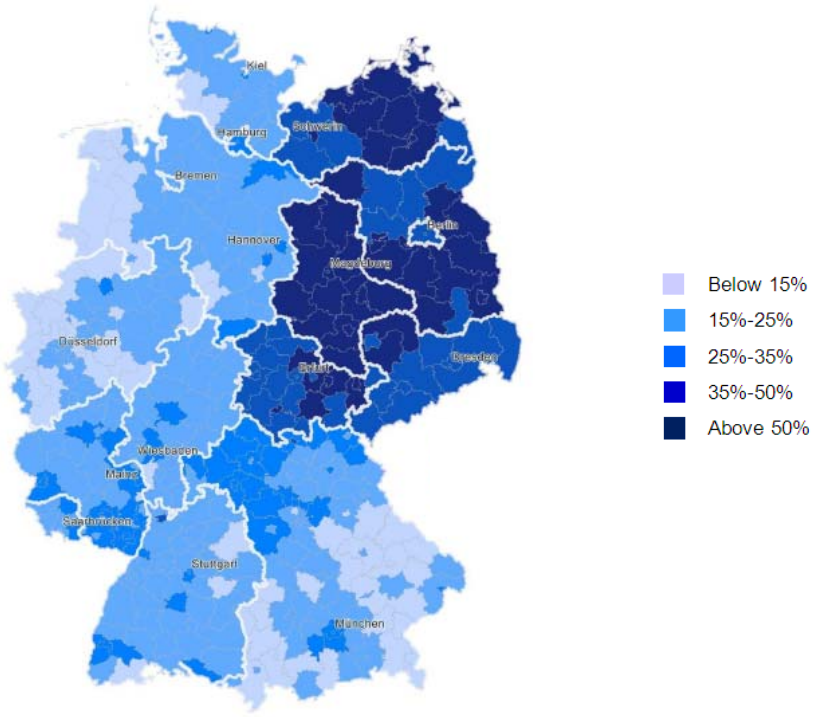
In Chapter 4, we model the household's decision for choosing publicly provided child care or a parental child care benefit and compare the effects of the policy instruments on fertility, the secondary earner's labor supply as well as on welfare.[6]

Most OECD countries are facing dilemmas and tensions related to the complex interaction between changes in the labor market, demography, fertility trends, and children's opportunities. One policy option that has received considerable attention is making high quality child care available and affordable. (Attanasio et al., 2008) In this chapter, we therefore analyze the impact of changes in both the quantity and the quality of child care provision. In order to account for the aspect of the affordability of child care, we consider price effects and the parent's choice whether to demand publicly provided child care or to receive a child benefit. Parents can opt for publicly provided child care or receive a parental child care benefit. This reflects the German system of parental child care benefits, the so called "Betreuungsgeld"[7], that are only obtainable for parents who either care for their children themselves or demand privately provided external child care.

Comparing the proportion of children under age three enrolled in formal child care in Germany in 2011 (Figure 1.4), it becomes obvious that there are large differences between the German states. While there has been universally high child care coverage in the East built up by the socialist regime of the former German Democratic Republic, the provision of public child care in the West has only been expanded within the last couple of years. The enrollment rates therefore vary from below 15% in the South-East and the West to above 50% in the East.

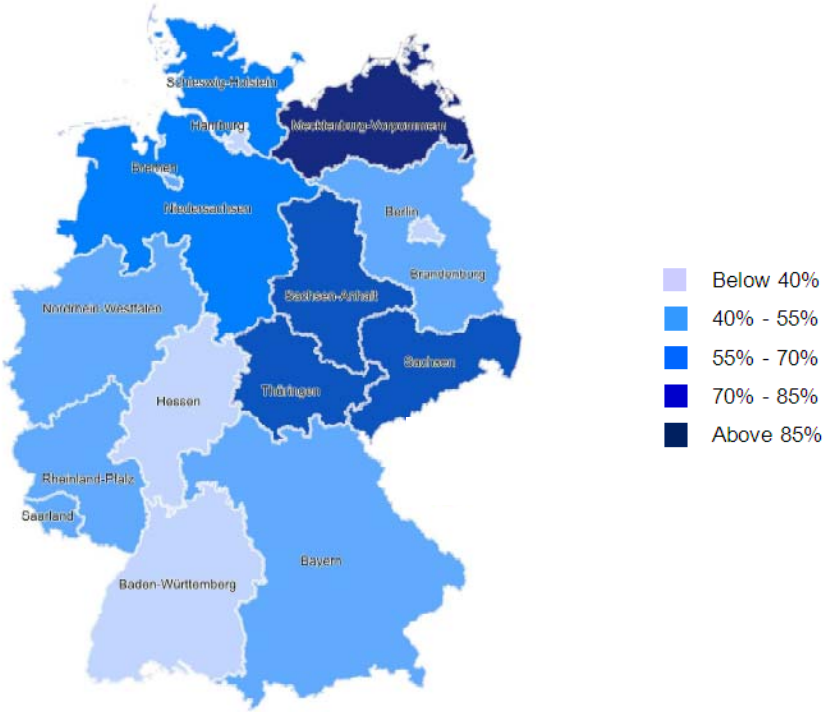
[6] This chapter is based on the article "The Role of Government in Child Care Provision", which is joint work with Robert Fenge from the University of Rostock.
[7] The "Betreuungsgeld" was introduced at the beginning of 2013 and is a monthly child care supplement for parents whose children aged three and under are not in a state-subsidized nursery. (Federal Ministry for Family Affairs, Senior Citizens, Women and Youth, 2013)

Figure 1.4: Proportion of children under age three enrolled in formal child care in Germany (2011)



Source: Federal Ministry for Family Affairs, Senior Citizens, Women and Youth (2012)

Figure 1.5: Proportion of nursery teachers with a professional education or formal education (>160 hours) in Germany (2011)



Source: Federal Ministry for Family Affairs, Senior Citizens, Women and Youth (2012)

Comparing the proportion of nursery teachers with a professional or formal education in Germany in 2011 (Figure 1.5) one also finds large qualitative differences within the German states. The proportion varies from below 40 percent in Baden-Württemberg, Hesse, and Berlin to above 85 percent in Mecklenburg-Western Pomerania. This demonstrates that there are not only large differences with respect to the quantity of publicly provided child care but also large variations regarding the quality of public child care in Germany. In order to be able to differentiate between the impact of a change in the quantity and the quality of child care provision, we analyze the parents' preferences for both quantity and quality of publicly provided child care.

Our main findings are the following. We find that for households opting for public child care, an increase in the quantity of publicly provided child care has a negative effect on both fertility and secondary earner's labor supply while the effects of an increase in its quality depend on the price effect and may be positive. Our results also suggest that both a price subsidy for publicly provided child care and the parental child care benefit has a negative effect on fertility and the secondary earner's labor supply for all households.

Regarding welfare, we find that for households choosing an interior solution of parental and external child care both policy instruments, a parental child care benefit and publicly provided child care, are equally effective. The household's decision which policy instrument to choose only depends on the relative benefit the household receives in total. This decision is independent of the household's income. For households choosing a corner solution, on the other hand, the decision depends on a variety of parameters: their income, their preferences for children, child care and consumption as well as on the policy parameters. Low income households choosing a corner solution of staying at home and not consuming external child care opt for a parental child care benefit if they have a small preference for children and their quality. For high income households, the decision depends on differences between the qualities of private and public external child care. If the relative benefit a household receives from the policy instruments is identical and the quality of private external child care is larger than the quality of publicly provided child care, a household in this corner solution also benefits more from the parental child care benefit than from publicly provided child care.

Chapter 2

Three Family Policies to Reconcile Fertility and Labor Supply [8]

2.1 Introduction

There has been a steady and significant decline in birth rates in most industrialized countries over the last 40 years. According to OECD statistics, total fertility rates in the 1970s were well above 2 children per woman and are now in 2010 as low as 1.4 in countries like Italy, Spain, Germany, and Japan. Within the high-income countries of the world, today no country is solidly above the fertility rate of 2.1 children per woman that is needed to replace the population at a constant level. Some other countries like France, Sweden, and the United Kingdom managed to counteract this downside trend and to re-increase their birth rates. Hence, those countries could avert an as dramatic population decrease as for example in Germany. (OECD Family Database, 2010a)

Important factors linked to the decline of birth rates are higher incomes, and hence higher opportunity costs of children, the rise in labor-force participation of women, and the expansion of social security systems in developed countries. According to Becker (1960

[8] This chapter is based on joint work with Robert Fenge

and 1981) and Becker and Lewis (1973), income increases may reduce fertility if the income elasticity for the quality of children exceeds the income elasticity for the quantity of children. Willis (1973) points out that increasing female wages will increase female labor-force participation and thus have a negative impact on the demand for children because of the higher opportunity costs. Sinn (2005) emphasizes the redundancy of having children as providers for old-age in the presence of social security systems and the positive externality of children in pay-as-you-go pension systems.

Due to the aging process associated with this decline in fertility, the developed countries are facing severe challenges for social security systems and labor markets. To counter this, most developed countries have implemented political incentives to correct for the low fertility rate and to improve the income position of families in the last decades. A central role in those family policies plays the compatibility of employment and children. High opportunity costs arise because a parent has to reduce labor supply in order to take care of the children. The foregone wage income and also the lost time of on-the-job training and qualification which reduces the wage opportunities in the future is a strong obstacle for having children. Family policies are constructed to provide relief to this quandary and to give secondary earners the opportunity to go to work and at the same time to bring up children.

However, increasing fertility may not be a goal of public policies per se. A higher number of children comes at a cost in terms of consumption and income of the parents. Even for children the quality of life may decrease if policies address only the quantity of children. Therefore, a comparative static analysis of policy instruments with respect to fertility and labor supply is not sufficient to evaluate the effects and to assess the effectiveness of family policies. For a comparison of family policies a welfare analysis is necessary which takes account of all impacts on the families, who in particular carry the costs of financing the family policies as tax payers.

This paper presents a comparison of benefit programs for families and analyzes the effects on welfare, fertility, employment and investments in quality of children within a model with endogenous fertility and labor supply of a secondary earner. In this paper, we do not deal with a justification for family policies. Nor do we analyze reasons in our model why the government should foster the number of children in the economy. This has been discussed in several other papers (e.g. Demeny, 1986 and Sinn, 2004). Instead, we are concerned with the relative performance of instruments of family policies which are

widely used in developed countries. We analyze how effectively instruments of family policies are able to achieve a compatibility of family and work. In particular, we compare the incentives of policy measures to have children and at the same time at least not to reduce the employment of parents. Furthermore, a welfare analysis compares the effects of family policies on the well-being of families. We use a standard Beckerian welfare approach to families and consider the number of children and a quality function of children which both enter the parental utility. Within this framework, we analyze the effects of changes in child benefits, in a child subsidy on bought-in child care as well as in parental leave payments.

Child benefits have been implemented in almost all OECD countries and there have been several empirical studies (e.g. Gauthier and Hatzius, 1997, Cigno et al., 2003, and Laroque and Salanié, 2008) showing that they have a positive impact on the demand for children. Nevertheless countries such as Germany with very low fertility rates and relatively low female employment rates pay relatively high child benefits. Policy differences between high and low fertility countries as well as countries with high and low female employment rates can rather be found in the rates for parental leave payments, child care subsidies, and tax breaks towards families.

Both Sweden and France have achieved to keep their fertility rates relatively high and both countries have well developed subsidized care systems. This might lead to the conclusion that investing in child care is an important political instrument to help increasing fertility rates. In the empirical literature one finds mixed evidence about the success of child care subsidies in fostering fertility. While Hank et al. (2004) find positive effects of full-time subsidized child care on fertility for Germany, Haan and Wrohlich (2009) only find significant effects for highly-educated women and women who give birth for the first time.

The third policy parameter we want to analyze, the rate of parental leave payments, has especially been implemented in Germany and Sweden. In the empirical literature one also finds mixed evidence on the effects of parental leave payments on fertility and the secondary earner's labor supply. Spiess and Wrohlich (2008) simulate fiscal costs and expected labor market outcomes of a parental leave benefit reform in Germany. They provide evidence that all income groups benefit and that in the second year, mothers increase their working hours and labor market participation significantly. Lalive and Zweimüller (2009) show that an extension of the Austrian parental leave period increases

fertility but lengthens the time women spend at home. Other studies also show that leave expansions are associated with increased leave-taking (e.g. Pronzato, 2009 and Han et al., 2009). Bergemann and Riphahn (2011) study the labor supply effects of a major change in the maternity leave benefit system in Germany on the intention of mothers to return to the labor market. They find that the change to a benefit system that replaced two-thirds of pre-birth earnings for at most one year succeeded in speeding up mothers' return to work.

In this paper, we complement the empirical literature by analyzing a simple model of household decisions on children and labor supply and isolating the incentive effects of the policy instruments which sometimes work in opposite directions. These results explain some of the ambiguity of the empirical evidence. There is also some theoretical literature on family decisions and family policies (see e.g. Cigno, 1986 and 1991; Ermisch, 1989; Apps and Rees, 2004; Cigno and Luporini, 2011). This paper contributes to this literature by analyzing the differential effects of the chosen policy instruments on fertility as well as labor supply and thus addressing the problem of work-family balance. The differential effects of a budget-neutral policy change, in particular, are important to compare the relative performance of the policy instruments in fostering the number of children or parental labor supply. We qualify our results by considering re-distributional effects and also distinguish between high- and low-income earners. Furthermore, we add a welfare analysis or - to be accurate - an analysis of the policy effects on the parental utility which comprises the number and quality (of life) of children. This enables us to calculate the distortions of the different policies and to compare them regarding to the benefit of parents.

Our main results are the following. Comparing child benefits with subsidies for external child care, we find that a higher subsidy for external child care and a budget-neutral reduction of child benefits increases the employment rate of a secondary earner in a family who is net contributor to the policy change but induces negative incentives for fertility. The comparison of child benefits with parental leave payments leads to the following cases. In the case of identical families increasing child benefits combined with a budget-neutral decrease in parental leave payments sets positive incentives for having children and the demand for external child care and, at the same time, increases the labor supply of the parents. In the case of heterogeneous families with differing wages this policy change stimulates fertility and external child care only for parents with low opportunity costs of staying at home with the children. However, the effect on the labor

supply of the secondary earner is ambiguous. A budget-neutral policy reform that increases the subsidy for external child care and reduces parental leave payments has a positive effect on the secondary earner's employment and the demand for external child care in the case of identical families. Furthermore, fertility increases if the families respond less elastic to price changes of external child care than to the change of opportunity costs of parental child care. These results are based on the fact that parental leave payments have a negative impact on the employment of parents because they set the same incentives as an implicit wage tax on continued work. Therefore, the other two policy instruments are more effective in fostering fertility while at the same time maintaining incentives for work.

The welfare analysis includes all the effects of the policy instruments on parental utility, in particular the consumption effects. We find that the introduction of subsidies for external child care from zero up to a certain provision level and a budget-neutral reduction of child benefits make all families better off in the case of identical households. In the case of heterogeneous households it is welfare improving for all families who are net recipients of the subsidy system. The welfare of the families who are net payers can go in either direction depending on the tax burden they face relative to the advantage of receiving subsidies. Furthermore, introducing subsidies and cutting parental leave payments can increase parental utility in families who respond more elastic to opportunity costs than prices of external child care if the replacement rate of the leave payments for net wage income is very high.

The paper is organized as follows. In the next section we introduce the model. Section 2.3 presents the comparative static results. In section 2.4, we calculate the welfare effects of exchanging family policies and section 2.5 concludes.

2.2 The model

For simplicity, we divide the life cycle of each person into two phases of the same duration. During the first phase, a person entirely depends on parental support, while in the second, the adult person allocates his or her time to either working and thus contributing to family income or to raising children. For ease of exposition, we also assume that all men and women are neatly paired off into conventional families. Family

i's decisions are assumed to be taken by the parents who derive utility from their own consumption, c_i, their number of children, n_i, and their children's quality of life, q_i, according to the additively separable utility function

$$U(c_i, n_i, q_i) = u(c_i) + u(n_i) + u(q_i) \tag{2.1}$$

for $i \in \{1, \dots, N\}$. We assume the utility function to be continuous, strictly concave, and strictly increasing in all arguments. The quality per child, q_i, can be understood as a good produced domestically by the parents who use as inputs time spent with the child and a child-specific consumption good, z_i, bought on the market. The price on the market for the child-specific consumption good is B. For simplicity, we assume that only the secondary earner of family i spends time with the children. Time spent with a child can be divided into the secondary earner's own time, h_i, and the time the child spends at external child care, g_i. The market price for child care, g_i, is denoted by π. The strictly concave domestic production function for quality is given by

$$q_i = q(h_i, g_i, z_i) \tag{2.2}$$

and increases monotonically in all arguments.

The secondary earner allocates her time to working which yields wage at the rate w_i and to leisure time. We assume that child rearing is the only domestic time requiring parental time so that she spends her leisure time completely with the children. Through the endogeneity of n_i, the secondary earner's labor supply is also endogenous. If she has n_i children her parental time equals $h_i n_i$. The rest of secondary earner i's total time is working time and given by $L_i = 1 - h_i n_i$, her gross income therefore equals $w_i L_i$. Secondary earners carrying a larger wage rate w_i thus have higher opportunity costs of raising children. The primary earner allocates all her time to working and her gross salary is Y.

The family's budget constraint is given by

$$(1-t)(Y + w_i L_i) + \alpha n_i + \gamma w_i (1-t) h_i n_i = c_i + B z_i n_i + (1-\beta)\pi g_i n_i \tag{2.3}$$

where α represents the child benefit, β the share of bought-in child care which is subsidized and γ the share of foregone net wage income of the secondary earner staying at home with the children which is granted as parental leave payment by the government.

The parents choose consumption, c_i, the number of children, n_i, the secondary earner's time spent with a child, h_i, the amount of bought-in child care, g_i, and the child-specific consumption, z_i, so as to maximize their utility, $u(c_i, n_i, q_i)$, by taking account of the child's quality production and their budget constraint. We abbreviate the first derivative of a function $y(x)$ by y_x.

The household decision problem is given by

$$\begin{aligned} &\max_{c_i, n_i, h_i, g_i, z_i} u\big(c_i, n_i, q_i(h_i, g_i, z_i)\big) \\ &s.t.\ (1-t)(Y + w_i L_i) + \alpha n_i + \gamma w_i (1-t) h_i n_i = c_i + B z_i n_i + (1-\beta)\pi g_i n_i \end{aligned} \tag{2.4}$$

The first-order conditions yield the following necessary and sufficient conditions of the concave maximization problem:

$$\frac{u_n}{u_c} = B z_i + (1-\beta)\pi g_i + w_i (1-t)(1-\gamma) h_i - \alpha \equiv P_{n,i} \tag{2.5}$$

$$\frac{u_q}{u_c} q_h = w_i (1-t)(1-\gamma) n_i \equiv P_{q_h,i} \tag{2.6}$$

$$\frac{u_q}{u_c} q_g = (1-\beta)\pi n_i \equiv P_{q_g,i} \tag{2.7}$$

$$\frac{u_q}{u_c} q_z = B n_i \equiv P_{q_z,i} \tag{2.8}$$

All conditions have the well-known meaning that the marginal rate of substitution between the respective decision variables has to be equal to the marginal rate of transformation at the utility maximum. A variation in any of the policy parameters may affect the price of quantity as well as quality of children. Next to costs of parental time, the upbringing of children also incurs a cost per child, Bz_i, which covers child-specific consumption expenditure. The net cost of children $P_{n,i}$ in (2.5) is therefore composed of family i's consumption cost per child plus the net cost of external child care plus the opportunity cost of forgone net wage income of the secondary earner minus the child benefits. Children are considered consumption goods with positive net costs. The marginal net price of a child, $P_{n,i}$, decreases with a higher child benefit, α, as well as with a higher subsidy for child care, β, and higher parental leave payments, γ.

The marginal net price of parental time spent with the children, $P_{q_h,i}$, in (2.6) consists of the net wage loss while the marginal price for external child care, $P_{q_g,i}$, in (2.7) equals the

net cost for the utilization of this service. Obviously, child benefits have no effect on the price of quality while the subsidy for child care decreases the price for bought-in child care and the parental leave payment reduces the net price of parental time spent with the child.

In the following, the net wage is abbreviated by $\widehat{w}_i = (1-t)w_i$ and the first derivative of utility with respect to the quality inputs $x_i \in \{h_i, g_i, z_i\}$, $U_q q_x > 0$, by U_{q_x} and the second derivative, $\left(U_q q_{xx} + U_{qq} q_x q_x\right) < 0$, by $U_{q_x q_x}$.

2.3 Comparative statics: The effects of changes in the family policy system

First, we analyze the absolute effects of the policy instruments on fertility, secondary earner's labor supply, the demand for external child care and parental and child-specific consumption. Second, we compare the policies by investigating the differential or relative effects of exchanging mutually the instruments in a budget-neutral reform. By implicit differentiation of the first-order conditions (2.5) - (2.8), we derive the results and present in the following the impact on fertility, labor supply and demand for external child care. The derivation and the other effects on consumption can be found in Appendix 2.A.

2.3.1 Absolute effects

We start by analyzing the effects of a variation in the child benefit rate on quantity and quality of children. The effect of an increase in the child benefit rate on the quantity of children

$$\frac{\partial n_i}{\partial \alpha} = -s_{nn} - n_i i_n = \frac{1}{D_i} u_{q_h q_h} u_{q_g q_g} u_{q_z q_z} \left(u_c - n_i u_{cc} P_{n,i}\right) > 0 \tag{2.9}$$

is positive as the determinant of the bordered Hessian matrix is negative ($D_i < 0$) and $\left(u_c - n_i u_{cc} P_{n,i}\right) > 0$. As expected, additional child benefits encourage fertility as they reduce the cost of having children. The income effect, $-ni_n$, with respect to α is positive and the substitution effect, $-s_{nn}$, is positive since an increase in α decreases the marginal

net price of a child in (2.5). The size of the effect is driven by family i's number of children, n_i, and their marginal price for a child, $P_{n,i}$. The impact of an increase in α is therefore larger for high income families. On the contrary, secondary earners with a smaller wage rate invest more in parental consumption when α is increased (see Appendix 2.A).

An increase in the child benefit rate has also a positive effect on both parental time and time the child spends in external child care as $\left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i}\right) > 0$ (see Appendix 2.A):

$$q_h \frac{\partial h_i}{\partial \alpha} = s_{nq_h} + n_i i_{q_h} = -\frac{1}{D_i} u_{q_g q_g} u_{q_z q_z} P_{q_h,i} \left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i}\right) > 0 \tag{2.10}$$

$$q_g \frac{\partial g_i}{\partial \alpha} = -s_{nq_g} - n_i i_{q_g} = -\frac{1}{D_i} u_{q_h q_h} u_{q_z q_z} P_{q_g,i} \left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i}\right) > 0 \tag{2.11}$$

Regarding the effects of an increase in the child benefit rate on the inputs of children's quality, parental and external child care time, the substitution effects of the marginal cost of quantity on the demand for quality are negative. As child benefits have no direct effect on the quality of children, the ratio of quality and quantity will fall since the relative price of quality to quantity rises with α. This can be illustrated by a comparison of the net price of children with respect to the number of children in (2.5) and to the quality of children in (2.6) and (2.7). The price for quality of children is not affected by changes in the child benefit rate. Therefore, the change of the relative price in favor of the quantity of children reduces the parental time and the child care and, hence, the quality of children. However, the positive income effect dominates this substitution effect.

The size of the effect of an increase in α on parental time in (2.10) is driven by the marginal net price of parental time, $P_{q_h,i}$, and is thus larger for high income families. The size of the effect on the time the children spend in external child care in (2.11) depends on the marginal price for external child care, $P_{q_g,i}$, which is independent of the wage income. Hence, child benefits have a stronger impact on high income earners to stay home with the children than on low income earners whereas the effect on the demand for external

child care is the same. Thus, the labor supply of the high income secondary earner decreases by more.

Proposition 2.1*: Increasing the child benefit rate encourages fertility and the demand for external child care while it discourages the secondary earner's labor supply. The effects on fertility and labor supply are larger for high income secondary earners. As child benefits only have a direct effect on the quantity of children, an increase in the child benefit rate leads to a decrease in the ratio of quality and quantity of children.*

The other two policy instruments have no clear effect on fertility. The absolute effect of an increase in the subsidy for bought-in child care, β, depends on the price elasticity of demand for external child care time, that is $\left(1+\frac{g_i u_{q_g q_g}}{u_{q_g}}\right)=\left(1+\frac{1}{\varepsilon_{g,i}}\right)$, where $\varepsilon_{g,i} \equiv \frac{dg_i}{dP_{q_g,i}}\frac{P_{q_g,i}}{g_i} < 0$. If family i's demand for external child care time is inelastic, $\varepsilon_{g,i} > -1$, fertility increases with a higher subsidy, and vice versa.

$$\begin{aligned}\frac{\partial n_i}{\partial \beta} &= -\pi\left(g_i s_{nn} + n_i s_{q_g n} + g_i n_i i_n\right) \\ &= \frac{\pi}{D_i} u_{q_g} u_{q_h q_h} u_{q_z q_z}\left(u_c - n_i u_{cc} P_{n,i}\right)\left(1+\frac{1}{\varepsilon_{g,i}}\right) \gtreqless 0\end{aligned} \tag{2.12}$$

The size of the effect on fertility in (2.12) rises with the price of external child care, π, the number of children of family i, n_i, and the marginal price for quantity, $P_{n,i}$. A higher β decreases the net price of a child, $P_{n,i}$, which induces a positive income effect, $-\pi g_i n_i i_n$, and a positive substitution effect on the demand for the number of children, $-\pi g_i s_{nn}$. Both effects exceed the negative substitution effect of the marginal cost of bought-in child care on the demand for quantity, $-\pi n_i s_{q_g n}$, if $\varepsilon_{g,i} > -1$ holds. For families with $\varepsilon_{g,i} < -1$, the negative substitution effect dominates the other two effects and the total effect on fertility is thus negative. This negative substitution effect arises because a higher β decreases the net price of a child less than the net price of external child care. Hence, the relative price between the quantity of children and child care increases so that the family decides for fewer children relative to the demand for child care.

The absolute effect of an increase in the parental leave payments, γ, is similar to the effect of the subsidy. The difference is that now the size of the effect increases in the

secondary earner's net wage rate, $\widehat{w}_i$, and the direction of the effect on fertility depends on the elasticity of demand for parental child care time, that is $\left(1+\frac{h_i u_{q_h q_h}}{u_{q_h}}\right) \equiv \left(1+\frac{1}{\varepsilon_{h,i}}\right)$, with $\varepsilon_{h,i} \equiv \frac{dh_i}{dP_{q_h,i}} \frac{P_{q_h,i}}{h_i} < 0$. Only for families whose demand for parental child care time is inelastic, that is $\varepsilon_{h,i} > -1$, parental leave payments have a positive impact on the number of children. The impact of an increase in the parental leave payment on fertility is thus ambiguous.

$$\begin{aligned}\frac{\partial n_i}{\partial \gamma} &= -\widehat{w}_i\left(h_i s_{nn} - n_i s_{q_h n} + h_i n_i i_n\right) \\ &= \frac{\widehat{w}_i}{D_i} u_{q_h} u_{q_g q_g} u_{q_z q_z}\left(u_c - n_i u_{cc} P_{n,i}\right)\left(1+\frac{1}{\varepsilon_{h,i}}\right) \gtreqless 0\end{aligned} \tag{2.13}$$

The size of this effect depends on the secondary earner's net wage rate $\widehat{w}_i$. If $\varepsilon_{h,i} > -1$ holds, the positive income effect, $-\widehat{w}_i h_i n_i i_n$, and the positive substitution effect of the marginal price of quantity on the demand for children, $-\widehat{w}_i h_i s_{nn}$, exceed the negative substitution effect of the marginal costs of parental child care time on the demand for children, $-\widehat{w}_i n_i s_{q_h n}$, and the total effect on fertility is thus positive. The last substitution effect is negative because higher parental leave payments reduce the opportunity costs of staying home with the children.

Considering the effects on the time management, we find the following pattern of both the subsidy for external child care and the parental leave payments. Each instrument increases the demand for that type of child care (parental or external) which marginal price it directly lowers. The indirect effect on the complementing type of child care is ambiguous.

The effect of an increase in β is ambiguous with respect to parental time and positive for the demand of time children spend in external child care.

$$\begin{aligned}q_h \frac{\partial h_i}{\partial \beta} &= \pi\left(g_i s_{n q_h} + n_i s_{q_g q_h} + g_i n_i i_{q_h}\right) \\ &= -\frac{\pi}{D_i} u_{q_g} u_{q_z q_z} P_{q_h,i}\left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i}\right)\left(1+\frac{1}{\varepsilon_{g,i}}\right) \gtreqless 0\end{aligned} \tag{2.14}$$

$$q_g \frac{\partial g_i}{\partial \beta} = -\pi \left(g_i s_{nq_g} + n_i s_{q_g q_g} + g_i n_i i_{q_g} \right)$$
$$= \frac{\pi}{D_i} \left[\left(u_c u_{q_z q_z} P_{q_h,i}^2 + u_c u_{q_h q_h} P_{q_z,i}^2 - g_i u_{q_h q_h} u_{q_z q_z} P_{q_g,i} \right) \left(n_i u_{cc} u_{nn} \right. \right.$$
$$\left. \left. + 2u_n u_{cc} - \frac{u_c^2}{n_i} \right) + n_i u_c u_{q_h q_h} u_{q_z q_z} \left(u_{cc} P_{n,i}^2 + u_{nn} \right) \right] > 0 \tag{2.15}$$

The effect of an increase in the subsidy on external child care on parental time in equation (2.14) is positive if $\varepsilon_{g,i} > -1$ and negative if $\varepsilon_{g,i} < -1$ holds.

Both of the substitution effects in (2.14) are negative for the following reason: A higher β decreases the price of a child but not the opportunity cost of parental time. Hence, the quantity of children becomes relatively less costly than increasing the quality by staying at home. Furthermore, as the net cost of external child care decreases it becomes relatively more attractive to buy more child care on the market than to provide own parental time for the children. However, the positive income effect, $\pi g_i n_i i_{q_h}$, exceeds the negative substitution effects for families with $\varepsilon_{g,i} > -1$. As before, the size of the total effect increases in the secondary earner's income.

Regarding the demand for external child care in (2.15), both the income effect, $-\pi g_i n_i i_{q_g}$, and the own substitution effect of the marginal costs of bought-in child care on the time the child spends in external child care, $-\pi n_i s_{q_g q_g}$, are positive and they exceed the negative substitution effect of the marginal cost of quantity on the time the child spends in child care, $-\pi g_i s_{nq_g}$.

The overall effect of an increase in parental leave payments γ on parental time is positive while the effect on external child care time is ambiguous.

$$q_h \frac{\partial h_i}{\partial \gamma} = \widehat{w}_i \left(h_i s_{nq_h} - n_i s_{q_h q_h} + h_i n_i i_{q_h} \right)$$
$$= \frac{\widehat{w}_i}{D_i} \left[\left(u_c u_{q_g q_g} P_{q_z,i}^2 + u_{q_c} u_{q_z q_z} P_{q_g,i}^2 - h_i u_{q_g q_g} u_{q_z q_z} P_{q_h,i} \right) \left(n_i u_{cc} u_{nn} \right. \right.$$
$$\left. \left. + 2u_n u_{cc} - \frac{u_c^2}{n_i} \right) + n_i u_c u_{q_g q_g} u_{q_z q_z} \left(u_{cc} P_{n,i}^2 + u_{nn} \right) \right] > 0 \tag{2.16}$$

$$q_g \frac{\partial g_i}{\partial \gamma} = -\widehat{w}_i \left(h_i s_{nq_g} - n_i s_{q_h q_g} + h_i n_i i_{q_g} \right)$$
$$= -\frac{\widehat{w}_i}{D_i} u_{q_h} u_{q_z q_z} P_{q_g,i} \left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i} \right) \left(1 + \frac{1}{\varepsilon_{h,i}} \right) \gtreqless 0 \quad (2.17)$$

Concerning parental time in (2.16), the positive income effect, $\widehat{w}_i h_i n_i i_{q_h}$, and the positive own substitution effect of the marginal costs of parental time on the demand for parental time, $-\widehat{w}_i n_i s_{q_h q_h}$, exceed the negative substitution effect of the marginal price for quantity on the demand for parental time, $\widehat{w}_i h_i s_{nq_h}$. Parental leave payments work like an implicit tax on continued work. Therefore, they set incentives to decrease labor supply. At the same time they improve the quality of the children. Since the net price of the number of children decreases by less than the net price of parental time, the quality of children increases relatively to the quantity. Regarding the time the children spend at external child care in (2.17), on the other hand, the two substitution effects are negative and only fall short of the positive income effect, $-\widehat{w}_i h_i n_i i_{q_g}$, if $\varepsilon_{h,i} > -1$ holds. For family i with $\varepsilon_{h,i} < -1$, the total effect on g_i is thus negative.

The more the government subsidizes external or parental child care, the more family i takes advantage of the subsidized type of child care and the share of this type of child care in total time spent with the children increases disproportionately.

Proposition 2.2*: A subsidy for external child care and parental leave payments have similar effects on fertility and the use of time for child care. Both policy instruments have positive effects on fertility only for families whose demand for external child care - in the case of the subsidy - or whose demand for parental child care time - in the case of leave payments - is inelastic. The subsidy increases the demand for external child care for all families, while the leave payments increase the parental time (reduce the secondary earner's labor supply) for all families. Parental leave payments reduce the opportunity cost of staying home so that they work like an implicit tax on continued work.*

2.3.2 Differential effects

We now compare mutually the effectiveness of the three policy instruments in raising the number of children and increasing the secondary earner's labor supply. Considering a budget neutral substitution of two instruments allows us to determine the relative size of the effect of each instrument. The government's budget is given by:

$$t(Y + \bar{w}L) = \alpha\bar{n} + \beta\pi\bar{g}\bar{n} + \gamma\bar{\widehat{w}}\bar{h}\bar{n} \tag{2.18}$$

where $\bar{n}$, $\bar{g}$, $\bar{h}$, $\bar{w}$, and $\bar{\widehat{w}}$ represent the average number of children, use of external child care, parental child care, wage and net wage respectively. In the following, we consider first average families, i.e. families with average wage income and average demand. This is also the case of identical families. Second, we consider re-distributional effects and families who are heterogeneous in wage earnings and demand. We differentiate between two groups of families in the benefit system: families who are initially, i.e. before the reform, net contributors or net receivers of the tax-financed family policies.

Looking at first at an exchange of child benefits and subsidies for bought-in child care, the budget keeps constant if $d\alpha = -\pi\bar{g}d\beta$. We distinguish ceteris paribus between two groups of families, those who initially consume below average, that is $g_i < \bar{g}$, and those who initially consume above average external child care, that is $g_i > \bar{g}$. The families of the first group are net contributors to the policy change while families of the second group are net recipients. As both the child benefit and the subsidy for external child care depend on the number of children, there is no redistribution with respect to the number of children.

An increase in the subsidy, β, accompanied by a reduction of the child benefit, α, so as to keep the budget constant has the following differential effects. Taking account of equations (2.9) and (2.12), the effect on the number of children, n_i, is given by:

$$\begin{aligned}\frac{dn_i}{d\beta}\Big|_{d\alpha=-\pi\bar{g}d\beta} &= \frac{\partial n_i}{\partial\beta}d\beta + \frac{\partial n_i}{\partial\alpha}d\alpha = -\pi\left[(s_{nn} + n_i i_n)(g_i - \bar{g}) + n_i s_{q_g n}\right] \\ &= \frac{\pi}{D_i}u_{q_g}u_{q_h q_h}u_{q_z q_z}\left(u_c - n_i u_{cc}P_{n,i}\right)\left[1 + \frac{(g_i - \bar{g})u_{q_g q_g}}{u_{q_g}}\right]\end{aligned} \tag{2.19}$$

Combining equations (2.10) and (2.14) gives the differential effect for the secondary earner's parental time, h_i:

$$\frac{dh_i}{d\beta}|_{d\alpha=-\pi\bar{g}d\beta} = \frac{\partial h_i}{\partial \beta}d\beta + \frac{\partial h_i}{\partial \alpha}d\alpha = \pi\left[\left(s_{nq_h} + n_i i_{q_h}\right)(g_i - \bar{g}) + n_i s_{q_g q_h}\right]$$

$$= -\frac{\pi}{D_i} u_{q_g} u_{q_z q_z} P_{q_h,i}\left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i}\right)\left[1 + \frac{(g_i - \bar{g})u_{q_g q_g}}{u_{q_g}}\right] \tag{2.20}$$

With equations (2.11) and (2.15) a budget-neutral comparison of the effects of the two policy instruments on the demand for external child care yields:

$$\frac{dg_i}{d\beta}|_{d\alpha=-\pi\bar{g}d\beta} = \frac{\partial g_i}{\partial \beta}d\beta + \frac{\partial g_i}{\partial \alpha}d\alpha = -\pi\left[\left(s_{nq_g} + n_i i_{q_g}\right)(g_i - \bar{g}) + n_i s_{q_g q_g}\right]$$

$$= -\frac{\pi}{D_i}\left\{\left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i}\right)\left[u_{q_h q_h} u_{q_z q_z} P_{q_g,i}(g_i - \bar{g})\right.\right.$$

$$\left.\left. - u_c u_{q_z q_z} P_{q_h,i}^2 - u_c u_{q_h q_h} P_{q_z,i}^2\right] - n_i u_c u_{q_h q_h} u_{q_z q_z}\left(u_{cc} P_{n,i}^2 + u_{nn}\right)\right\} \tag{2.21}$$

From the three derivations (2.19), (2.20) and (2.21) we can infer the following results. In the case of identical families (or families with average demand for child care), $g_i = \bar{g}$ for all i, a reduction of child benefits in favor of higher subsidies for child care decreases fertility and parental time and increases the demand for external child care. In case of a subsidy for external child care the money is bound to this service whereas the child benefits are paid unconditional. Therefore, an increase in β has a smaller impact on fertility than an increase in α, and it leads to a substitution of parental child care by external child care so that the secondary earner's labor supply increases.

For heterogeneous families whose initial demand for external child care is lower than average, $g_i < \bar{g}$, the subsidy for child care has again a weaker effect on fertility and on parental child care than child benefits. The reason is that this policy change increases the price of a child $P_{n,i}$ from (2.5) and decreases the price of external child care $P_{q_g,i}$ from (2.7) for all families with $g_i < \bar{g}$ inducing the substitutional effect mentioned above. However, this is the group of families who are net contributors to the policy change. If the financial net burden of the family is high enough, $g_i \ll \bar{g}$, the demand for external child care may even diminish with this policy change.

The effect of the budget neutral increase in β for all families with $g_i > \bar{g}$ is straightforward with respect to the demand for external child care. For those net recipients of the subsidy the policy change leads to more external child care. The effects are ambiguous for fertility behavior and parental child care. They depend on family i's price elasticity of the demand for external child care. The policy change decreases the price of a child $P_{n,i}$ and, at the same time, the price of external child care $P_{q_g,i}$ goes down. If the family's demand is inelastic, $\varepsilon_{g,i} > -1$, the last price relief increases external child care only to a small amount but transmits to a higher fertility and even higher parental child care.

Hence, supporting the demand for child care is only a more promising way of fostering fertility than child benefits for net recipients if their demand for external child care is inelastic. At the same time, it decreases the labor supply of the secondary earner. For all families, the effect increases in $P_{n,i}$ and it therefore depends on the secondary earner's income.

Combining our results from (2.20) and (2.21), we can conclude that for most families a higher subsidy of external child care and a budget-neutral reduction of child benefits leads to an increase in the demand for bought-in child care and a decrease in parental child care. The last effect is equivalent to an increase in the secondary earner's employment rate. However, at the same time the incentives for having children are negative.

The same policy exchange also leads to both less parental and child-specific consumption for net contributors while the effect is ambiguous for the others (see Appendix 2.B). This negative effect on consumption can be explained by the fact that in the case of the subsidy the money is bound to external child care and thus does not benefit consumption in the way the child benefit does.

Proposition 2.3*: A budget-neutral increase in a subsidy for external child care accompanied by a decrease in child benefits has a negative effect on fertility and a positive effect on the secondary earner's labor supply for family i consuming $g_i \leq \bar{g}$. The same policy exchange leads to an increase in the demand for external child care for families with $g_i > \bar{g}$.*

Comparing child benefits and the rate of parental leave payments, a budget neutral substitution requires $d\alpha = -\bar{\widehat{w}}\bar{h}d\gamma$. In this case, we have to again differentiate between two groups of families: Net contributors, that is $\widehat{w}_i h_i < \bar{\widehat{w}}\bar{h}$, and net recipients, that is $\widehat{w}_i h_i > \bar{\widehat{w}}\bar{h}$, of the policy change. As both the child benefit and the parental leave payments depend on the number of children, there is no redistribution with respect to the number of children.

Taking account of (2.9) and (2.13), the effect of increasing parental leave payments on the number of children is given by:

$$\begin{aligned}\frac{dn_i}{d\gamma}|_{d\alpha=-\bar{\widehat{w}}\bar{h}d\gamma} &= \frac{\partial n_i}{\partial \gamma}d\gamma + \frac{\partial n_i}{\partial \alpha}d\alpha = \left(\bar{\widehat{w}}\bar{h} - \widehat{w}_i h_i\right)(s_{nn} + n_i i_n) + \widehat{w}_i n_i s_{q_h n} \\ &= \frac{\widehat{w}_i}{D_i} u_{q_h} u_{q_g q_g} u_{q_z q_z}\left(u_c - n_i u_{cc} P_{n,i}\right)\left[1 + \frac{\left(\widehat{w}_i h_i - \bar{\widehat{w}}\bar{h}\right)u_{q_h q_h}}{\widehat{w}_i u_{q_h}}\right]\end{aligned} \tag{2.22}$$

The effect of the policy exchange on the time parents spend with their children at home, h_i, we derive from (2.10) and (2.16):

$$\begin{aligned}\frac{dh_i}{d\gamma}|_{d\alpha=-\bar{\widehat{w}}\bar{h}d\gamma} &= \frac{\partial h_i}{\partial \gamma}d\gamma + \frac{\partial h_i}{\partial \alpha}d\alpha = -\left(\bar{\widehat{w}}\bar{h} - \widehat{w}_i h_i\right)\left(s_{nq_h} + n_i i_{q_h}\right) - \widehat{w}_i n_i s_{q_h q_h} \\ &= -\frac{1}{D_i}\left\{\left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i}\right)\left[\left(\widehat{w}_i h_i - \bar{\widehat{w}}\bar{h}\right)u_{q_g q_g} u_{q_z q_z} P_{q_h,i}\right.\right. \\ &\quad \left. - \widehat{w}_i u_c\left(u_{q_g q_g} P_{q_z,i}^2 + u_{q_z q_z} P_{q_g,i}^2\right)\right] \\ &\quad \left. - \widehat{w}_i n_i u_c u_{q_g q_g} u_{q_z q_z}\left(u_{cc} P_{n,i}^2 + u_{nn}\right)\right\}\end{aligned} \tag{2.23}$$

And the effect of the budget-neutral exchange of instruments on the time spent at external child care, g_i, follows from (2.11) and (2.17):

$$\begin{aligned}\frac{dg_i}{d\gamma}|_{d\alpha=-\bar{\widehat{w}}\bar{h}d\gamma} &= \frac{\partial g_i}{\partial \gamma}d\gamma + \frac{\partial g_i}{\partial \alpha}d\alpha = \left(\bar{\widehat{w}}\bar{h} - \widehat{w}_i h_i\right)\left(s_{nq_g} + n_i i_{q_g}\right) + \widehat{w}_i n_i s_{q_h q_g} \\ &= -\frac{\widehat{w}_i}{D_i} u_{q_h} u_{q_z q_z} P_{q_g,i}\left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i}\right)\left[1\right. \\ &\quad \left. + \frac{\left(\widehat{w}_i h_i - \bar{\widehat{w}}\bar{h}\right)u_{q_h q_h}}{\widehat{w}_i u_{q_h}}\right]\end{aligned} \tag{2.24}$$

The impact of a policy reform with higher parental leave payments and a budget-neutral decrease in child benefits can thus be derived from (2.22), (2.23) and (2.24). For identical (or average) families with $\widehat{w}_i = \overline{\widehat{w}}$ and $h_i = \bar{h}$, the incentives for children and for the demand for external child care are negative while incentives for parental time with the children are positive. This means the reverse policy may generate desired incentives for family behavior. An increase in child benefits at the cost of lower parental leave payments will raise the number of children and the demand for external child care and, at the same time, it will stimulate the labor supply of parents. The reason is that the child benefits have directly positive (income) effects on the number of children and the demand for external child care. Additionally, the budget-neutral decrease in leave payments reduces the implicit tax on work. Hence, if the positive effect of external child care on the quality of children is equal or higher than the positive effect of parental child care a policy reform with higher child benefits and lower parental leave payments may support fertility and parental employment without lowering the quality of children. Such a policy would qualify as a way to balance family and work.

The results are not clear-cut when we consider heterogeneous families with differing wages. The impact of higher leave payments at the cost of lower child benefits on fertility is negative for secondary earners whose income weighted parental time is smaller than the average, that is $\widehat{w}_i h_i < \overline{\widehat{w}}\bar{h}$. In this case the parental leave payment therefore has a weaker effect on fertility than child benefits. Hence, for families with low opportunity costs of staying home and taking care of their children, a child benefit is a more effective instrument to set incentives for children than a parental leave payment. At the same time, the policy leads to a decrease in the demand for external child care. However, the effect on parental child care is ambiguous. The reason is that this group of families is net contributor to the policy change and the quantity as well as the quality of the children may be effectively reduced.

For secondary earners with above-average initial opportunity costs, $\widehat{w}_i h_i > \overline{\widehat{w}}\bar{h}$, the policy reform induces a higher demand for time spent with the children and, hence, a lower labor supply. The net recipients of this policy therefore reduce employment. The effects on the number of children and external child care depend on the price elasticity of the demand for parental child care time. For family i having high initial opportunity costs $\widehat{w}_i h_i \gg \overline{\widehat{w}}\bar{h}$ such that $\left[\left(\widehat{w}_i h_i - \overline{\widehat{w}}\bar{h}\right)u_{q_h q_h} + \widehat{w}_i u_{q_h}\right] < 0$, the budget-neutral increase in parental leave payments leads to an increase in both fertility and the demand for external

child care. Net recipients of the policy with high opportunity costs of staying home therefore may benefit from an increase in γ to an extent that they also raise their demand for external child care and for children.

Combining our results from (2.23) and (2.24), we can conclude that the policy exchange has a negative effect on the demand of external child care for families with $\widehat{w}_i h_i \leq \bar{\widehat{w}}\bar{h}$ and a positive effect on parental child care for secondary earners with $\widehat{w}_i h_i \geq \bar{\widehat{w}}\bar{h}$. Only families who initially have very large opportunity costs of staying at home, may use the additional parental leave payments to consume more external child care.

The policy exchange of child benefits and parental leave payments by $d\alpha = -\bar{\widehat{w}}hd\gamma$ leads also to less parental and child-specific consumption for families with $\bar{\widehat{w}}\bar{h} > \widehat{w}_i h_i$ (see Appendix 2.B). This reduction in parental and child-specific consumption can be explained by the increased parental child care time and thus reduced family income.

Proposition 2.4*: An increase in parental leave payments accompanied by a budget-neutral reduction in child benefits leads to a decrease (increase) in fertility and a lower (higher) demand for external child care for secondary earners with $\widehat{w}_i h_i \leq \bar{\widehat{w}}\bar{h}$ ($\widehat{w}_i h_i \gg \bar{\widehat{w}}\bar{h}$). The same policy exchange leads to an increase in parental child care for families with $\widehat{w}_i h_i > \bar{\widehat{w}}\bar{h}$.*

When comparing the effects of an increase in the subsidy for external child care and a budget-neutral reduction of parental leave payments such that $d\gamma = -\frac{\pi\bar{g}}{\bar{\widehat{w}}\bar{h}}d\beta$ we obtain the fertility change with (2.12) and (2.13):

$$\begin{aligned}\frac{dn_i}{d\beta}\Big|_{d\gamma=-\frac{\pi\bar{g}}{\bar{\widehat{w}}\bar{h}}d\beta} &= \frac{\partial n_i}{\partial \beta}d\beta + \frac{\partial n_i}{\partial \gamma}d\gamma \\ &= -\pi\left(g_i - \frac{\widehat{w}_i h_i}{\bar{\widehat{w}}\bar{h}}\bar{g}\right)(s_{nn} + n_i i_n) - \pi n_i\left(s_{q_g n} + \frac{\bar{g}}{\bar{h}}\frac{\widehat{w}_i}{\bar{\widehat{w}}}s_{q_h n}\right) \\ &= -\frac{\pi}{D_i}u_{q_z q_z}\left(n_i u_{cc}P_{n,i} - u_c\right)\left[\left(g_i - \frac{\widehat{w}_i h_i}{\bar{\widehat{w}}\bar{h}}\bar{g}\right)u_{q_h q_h}u_{q_g q_g}\right. \\ &\quad \left. + u_c\left(u_{q_h q_h}P_{q_g,i} - \frac{\bar{g}}{\bar{h}}\frac{\widehat{w}_i}{\bar{\widehat{w}}}u_{q_g q_g}P_{q_h,i}\right)\right]\end{aligned} \tag{2.25}$$

From equations (2.14) and (2.16) we derive the impact on parental child care:

$$\begin{aligned}\frac{dh_i}{d\beta}\Big|_{d\gamma=-\frac{\pi\bar{g}}{\bar{\hat{w}}\bar{h}}d\beta} &= \frac{\partial h_i}{\partial \beta}d\beta + \frac{\partial h_i}{\partial \gamma}d\gamma \\ &= \pi\left(g_i - \frac{\hat{w}_i h_i}{\bar{\hat{w}}\bar{h}}\bar{g}\right)\left(s_{nq_h} + n_i i_{q_h}\right) + \pi n_i\left(s_{q_g q_h} + \frac{\bar{g}}{\bar{h}}\frac{\hat{w}_i}{\bar{\hat{w}}}s_{q_h q_h}\right) \\ &= -\frac{\pi}{D_i}\left\{\left(n_i u_{cc}u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i}\right)\left[\left(g_i - \frac{\hat{w}_i h_i}{\bar{\hat{w}}\bar{h}}\bar{g}\right)u_{q_g q_g}u_{q_z q_z}P_{q_h,i}\right.\right. \\ &+ u_c u_{q_z q_z}P_{q_h,i}^2 + \frac{\bar{g}}{\bar{h}}\frac{\hat{w}_i}{\bar{\hat{w}}}u_c\left(u_{q_g q_g}P_{q_z,i}^2 + u_{q_z q_z}P_{q_g,i}^2\right)\Big] \\ &\left.+ \frac{\bar{g}}{\bar{h}}\frac{\hat{w}_i}{\bar{\hat{w}}}n_i u_c u_{q_g q_g}u_{q_z q_z}\left(u_{cc}P_{n,i}^2 + u_{nn}\right)\right\}\end{aligned} \tag{2.26}$$

The effect on external child care follows from (2.15) and (2.17):

$$\begin{aligned}\frac{dg_i}{d\beta}\Big|_{d\gamma=-\frac{\pi\bar{g}}{\bar{\hat{w}}\bar{h}}d\beta} &= \frac{\partial g_i}{\partial \beta}d\beta + \frac{\partial g_i}{\partial \gamma}d\gamma \\ &= -\pi\left(g_i - \frac{\hat{w}_i h_i}{\bar{\hat{w}}\bar{h}}\bar{g}\right)\left(s_{nq_g} + n_i i_{q_g}\right) - \pi n_i\left(s_{q_g q_g} + \frac{\bar{g}}{\bar{h}}\frac{\hat{w}_i}{\bar{\hat{w}}}s_{q_h q_g}\right) \\ &= -\frac{\pi}{D_i}\left\{\left(n_i u_{cc}u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i}\right)\left[\left(g_i - \frac{\hat{w}_i h_i}{\bar{\hat{w}}\bar{h}}\bar{g}\right)u_{q_h q_h}u_{q_z q_z}P_{q_g,i}\right.\right. \\ &\left.- u_c\left(u_{q_z q_z}P_{q_h,i}^2 + u_{q_h q_h}P_{q_z,i}^2 + \frac{\bar{g}}{\bar{h}}\frac{\hat{w}_i}{\bar{\hat{w}}}u_{q_z q_z}P_{q_g,i}^2\right)\right] \\ &\left.- n_i u_c u_{q_h q_h}u_{q_z q_z}\left(u_{cc}P_{n,i}^2 + u_{nn}\right)\right\}\end{aligned} \tag{2.27}$$

For identical families ($\hat{w}_i = \bar{\hat{w}}, g_i = \bar{g}, h_i = \bar{h}$), we get the following results. Given a policy change that shifts transfers from leave payments to subsidies for external child care it is hardly surprising that the demand for external child care increases while the parental time with children at home will be reduced (see (2.26) and (2.27)). Whether the subsidy for external child care or the parental leave payments are more effective in fostering fertility depends on the elasticity of demand for external child care and parental child care (see (2.25)). The family policy instrument that supports the child care (external or parental) with the less elastic response is more effective in fostering fertility. E.g. if the

demand for external child care responds less elastic to changes in the price than the willingness of parents to stay at home – which means the (negative) price elasticity of external child care is larger than the elasticity of parental child care, that is $\varepsilon_g > \varepsilon_h$ [9] – we find that the subsidy for external child care, β, sets better incentives for children than a parental leave payment at rate, γ. In summary, a policy change of higher subsidies for external child care and lower leave payments increases the demand for external child care and the employment of secondary earners. At the same time, it can set positive incentives for having children if the demand for external child care is not too elastic.

For heterogeneous families, the response to this policy change is not so clear-cut and depends on a family's demand for external child care relative to average demand and the relative opportunity costs of staying at home, that is the relation between $\frac{g_i}{\bar{g}}$ and $\frac{\widehat{w}_i h_i}{\widehat{\bar{w}}\bar{h}}$. The budget-neutral increase in the subsidy for external child care has a negative effect on parental child care for all secondary earners whose relative demand for external child care is smaller than the relative opportunity costs of staying at home, that is $\frac{g_i}{\bar{g}} < \frac{\widehat{w}_i h_i}{\widehat{\bar{w}}\bar{h}}$. Hence, this group's labor supply will increase due to the policy exchange. Furthermore, the demand for external child care increases in all families with $\frac{g_i}{\bar{g}} > \frac{\widehat{w}_i h_i}{\widehat{\bar{w}}\bar{h}}$. For this group, the effect on parental child care is also likely to be negative. Combined with the result for the effect of the budget-neutral policy exchange on g_i in (2.27), we find that the ratio of external to parental child care will increase for all families. Increasing the subsidy for external child care has thus a positive effect on secondary earner i's labor supply.

The effect of the budget-neutral policy exchange on fertility is ambiguous and depends next to the relation between $\frac{g_i}{\bar{g}}$ and $\frac{\widehat{w}_i h_i}{\widehat{\bar{w}}\bar{h}}$ also on the relation between the price elasticity of external child care and the income weighted elasticity of parental child care, that is $\frac{u_{q_g q_g}}{u_{q_g}}\bar{g}$ and $\frac{u_{q_h q_h}}{u_{q_h}}\frac{\bar{\widehat{w}}\bar{h}}{\widehat{w}_i}$. The budget-neutral increase in the subsidy for external child care has a positive effect on fertility for all families with $\frac{g_i}{\bar{g}} > \frac{\widehat{w}_i h_i}{\widehat{\bar{w}}\bar{h}}$ whose price elasticity of external child care is larger than the income weighted elasticity of parental child care, that is $\varepsilon_g > \frac{\widehat{w}_i}{\bar{\widehat{w}}}\varepsilon_h$.

[9] This condition is equivalent to the requirement that the elasticity of marginal utility w.r.t. h is larger than w.r.t. g, that is $\frac{u_{q_h q_h}}{u_{q_h}}\bar{h} > \frac{u_{q_g q_g}}{u_{q_g}}\bar{g}$.

The differential effects on parent's and children's consumption are again shown in Appendix 2.B.

Proposition 2.5*: An increase in subsidies for external child care accompanied by a budget-neutral decrease in parental leave payments has a positive effect on the secondary earner's labor supply and the demand for external child care in the case of identical families. Moreover, fertility increases if the price elasticity of external child care is larger than the elasticity of parental time with the children, that is* $\frac{u_{q_h q_h}}{u_{q_h}} \bar{h} > \frac{u_{q_g q_g}}{u_{q_g}} \bar{g}$*. In the case of heterogeneous families, the same budget-neutral exchange leads to an increase in the demand for external child care for all families whose relative demand for external child care is larger than the relative opportunity costs of staying at home, that is* $\frac{g_i}{\bar{g}} > \frac{\widehat{w}_i h_i}{\widehat{\bar{w}}\bar{h}}$*. Parental child care decreases in all families with* $\frac{g_i}{\bar{g}} < \frac{\widehat{w}_i h_i}{\widehat{\bar{w}}\bar{h}}$*.*

2.4 Welfare analysis

In the welfare analysis, we analyze the differential impact of an exchange of family policy instruments on family i's utility. We dare to talk of family's utility or welfare because the quality function $q(h, g, z)$ can be taken as a utility of a child nested in the parents' utility function. Nevertheless, the decisions which influence the utility of the children are taken by the parents. In the following, we discuss in particular the redistribution effects of budget-neutral policy exchanges on different income groups. We assume that the benevolent government maximizes the household's indirect utility function subject $V(\alpha, \beta, \gamma)$ to the government's budget constraint in (2.18). The maximization problem can be written as:

$$\begin{aligned}&\max_{\alpha,\beta,\gamma} V(\alpha,\beta,\gamma)\\&= u\left(c_i(\alpha,\beta,\gamma), n_i(\alpha,\beta,\gamma), q_i\big(h_i(\alpha,\beta,\gamma), g_i(\alpha,\beta,\gamma), z_i(\alpha,\beta,\gamma)\big)\right)\\&+ \mu\left\{t\left[Y + \bar{w}\left(1 - \bar{h}(\alpha,\beta,\gamma)\bar{n}(\alpha,\beta,\gamma)\right)\right] - \alpha\bar{n}(\alpha,\beta,\gamma) - \beta\pi\bar{g}(\alpha,\beta,\gamma)\bar{n}\right.\\&\left.- \gamma\widehat{\bar{w}}\bar{h}(\alpha,\beta,\gamma)\bar{n}(\alpha,\beta,\gamma)\right\}\end{aligned} \tag{2.28}$$

The total derivative of $V(\alpha, \beta, \gamma)$ is then given by:

$$
\begin{aligned}
dV = \Bigg\{ & \frac{\partial u}{\partial c_i}\frac{\partial c_i}{\partial \alpha} + \frac{\partial u}{\partial n_i}\frac{\partial n_i}{\partial \alpha} + \frac{\partial u}{\partial q_h}\frac{\partial h_i}{\partial \alpha} + \frac{\partial u}{\partial q_g}\frac{\partial g_i}{\partial \alpha} + \frac{\partial u}{\partial q_z}\frac{\partial z_i}{\partial \alpha} \\
& - \mu\left[\left(t\bar{w} + \gamma\bar{\widehat{w}}\right)\left(\frac{\partial \bar{h}}{\partial \alpha}\bar{n} + \bar{h}\frac{\partial \bar{n}}{\partial \alpha}\right) + \bar{n} + \alpha\frac{\partial \bar{n}}{\partial \alpha} + \beta\pi\left(\frac{\partial \bar{g}}{\partial \alpha}\bar{n} + \bar{g}\frac{\partial \bar{n}}{\partial \alpha}\right)\right]\Bigg\} d\alpha \\
& + \Bigg\{\frac{\partial u}{\partial c_i}\frac{\partial c_i}{\partial \beta} + \frac{\partial u}{\partial n_i}\frac{\partial n_i}{\partial \beta} + \frac{\partial u}{\partial q_h}\frac{\partial h_i}{\partial \beta} + \frac{\partial u}{\partial q_g}\frac{\partial g_i}{\partial \beta} + \frac{\partial u}{\partial q_z}\frac{\partial z_i}{\partial \beta} \\
& - \mu\left[\left(t\bar{w} + \gamma\bar{\widehat{w}}\right)\left(\frac{\partial \bar{h}}{\partial \beta}\bar{n} + \bar{h}\frac{\partial \bar{n}}{\partial \beta}\right) + \alpha\frac{\partial \bar{n}}{\partial \beta} + \pi\bar{g}\bar{n}\right. \\
& \left. + \beta\pi\left(\frac{\partial \bar{g}}{\partial \beta}\bar{n} + \bar{g}\frac{\partial \bar{n}}{\partial \beta}\right)\right]\Bigg\} d\beta \\
& + \Bigg\{\frac{\partial u}{\partial c_i}\frac{\partial c_i}{\partial \gamma} + \frac{\partial u}{\partial n_i}\frac{\partial n_i}{\partial \gamma} + \frac{\partial u}{\partial q_h}\frac{\partial h_i}{\partial \gamma} + \frac{\partial u}{\partial q_g}\frac{\partial g_i}{\partial \gamma} + \frac{\partial u}{\partial q_z}\frac{\partial z_i}{\partial \gamma} \\
& - \mu\left[\left(t\bar{w} + \gamma\bar{\widehat{w}}\right)\left(\frac{\partial \bar{h}}{\partial \gamma}\bar{n} + \bar{h}\frac{\partial \bar{n}}{\partial \gamma}\right) + \alpha\frac{\partial \bar{n}}{\partial \gamma} + \beta\pi\left(\frac{\partial \bar{g}}{\partial \gamma}\bar{n} + \bar{g}\frac{\partial \bar{n}}{\partial \gamma}\right)\right. \\
& \left. + \bar{\widehat{w}}\bar{h}\bar{n}\right]\Bigg\} d\gamma
\end{aligned}
\tag{2.29}
$$

Using the comparative static results in (2.9) – (2.17) as well as the comparative static results for parental and child-specific consumption in Appendix 2.A, we can derive the welfare change due to policy reforms with the following mutual exchanges of policy instruments.

First, we keep the parental leave rate, γ, constant and consider a budget neutral substitution of child benefits, α, and subsidies for external child care, β. Taking account of the results of the comparative statics, an increase in β accompanied by a reduction in α keeps the government's budget constant if $d\alpha = -\pi\bar{g}d\beta$:

$$
\begin{aligned}
\frac{dV}{d\beta}\Big|_{d\alpha=-\pi\bar{g}d\beta} = & \lambda\pi(g_i - \bar{g})n_i \\
& + \lambda\pi\bar{n}\frac{\mu}{\bar{D}}\Bigg\{\Big[\left(t\bar{w} + \gamma\bar{\widehat{w}}\right)u_{q_zq_z}\overline{P_{q_h}P_{q_g}} \\
& - \beta\pi\left(u_{q_zq_z}\overline{P_{q_h}^2} + u_{q_hq_h}\overline{P_{q_z}^2}\right)\Big]\left(\bar{n}u_{cc}u_{nn} + 2u_nu_{cc} - \frac{u_c^2}{\bar{n}}\right) \\
& + u_{q_hq_h}u_{q_zq_z}\overline{P_{q_g}}\left[\alpha + \beta\pi\bar{g} + \bar{h}\left(\gamma\bar{\widehat{w}} + t\bar{w}\right)\right]\left(u_{cc}\bar{P}_n - \frac{u_c}{\bar{n}}\right) \\
& - \beta\pi\bar{n}u_{q_hq_h}u_{q_zq_z}\left(u_{cc}\overline{P_n^2} + u_{nn}\right)\Bigg\}
\end{aligned}
\tag{2.30}
$$

where the determinant of the bordered Hessian matrix for the average consumer is negative: $\overline{D} < 0$ [10].

This policy exchange can lead to changes of welfare in both directions depending on the initial consumption of external child care, the number of children, and the size of the subsidy β which already exists. For example, families with average or below average demand for external child care will be affected negatively by a further increase in the subsidy if the subsidy is already quite high. For those families, the subsidy is not important as a transfer and as net contributors to the subsidy scheme their utility falls by a further increase in β.

A definite improvement of welfare can be derived when looking at an introduction of a subsidy for external child care (the case of $\beta = 0$). If child benefits are already used, we find that complementing this instrument by subsidies increases the utility of all families consuming at least the average time of external child care, that is $g_i \geq \bar{g}$, as the second term is positive:

$$\begin{aligned}\frac{dV}{d\beta}\Big|_{d\alpha=-\pi\bar{g}d\beta,\beta=0} &= \lambda\pi(g_i-\bar{g})n_i \\ &+ \lambda\pi\bar{n}u_{q_zq_z}\overline{P_{q_g}}\frac{\mu}{\overline{D}}\left\{\overline{P_{q_h}}\left(t\overline{w}+\gamma\widehat{\overline{w}}\right)\left(\bar{n}u_{cc}u_{nn}+2u_nu_{cc}-\frac{u_c^2}{\bar{n}}\right)\right. \\ &\left.+\, u_{q_hq_h}\left[\alpha+\bar{h}\left(\gamma\widehat{\overline{w}}+t\overline{w}\right)\right]\left(u_{cc}\overline{P_n}-\frac{u_c}{\bar{n}}\right)\right\}\end{aligned} \tag{2.31}$$

The budget-neutral policy exchange of child benefits to a subsidy for external child care is therefore positive for all families consuming $g_i \geq \bar{g}$ starting at the introduction up to a certain initial provision level of the subsidy. The larger the initial provision level of the subsidy for external child care, the smaller becomes the group of families who benefit from the policies exchange.

[10] The determinant of the bordered Hessian matrix of an average individual is given by

$$\begin{aligned}\overline{D} = &-\left(u_{q_gq_g}u_{q_zq_z}\overline{P_{q_h}^2}+u_{q_hq_h}u_{q_zq_z}\overline{P_{q_g}^2}+u_{q_hq_h}u_{q_gq_g}\overline{P_{q_z}^2}\right) \\ &\left(u_{cc}u_{nn}+\frac{2u_{cc}u_n}{\bar{n}}-\frac{u_c^2}{\overline{n^2}}\right)-u_{q_hq_h}u_{q_gq_g}u_{q_zq_z}\left(u_{cc}\overline{P_n^2}+u_{nn}\right)<0\end{aligned}$$

***Proposition 2.6**: A budget-neutral increase in a subsidy for external child care accompanied by a decrease in child benefits leads to higher parental welfare in the case of identical families and for heterogeneous families consuming at least average external child care ($g_i \geq \bar{g}$) if the subsidy is being introduced and up to a certain initial provision level.*

Keeping β constant, a budget neutral substitution of child benefits and the rate of parental leave payments requires $d\alpha = -\bar{\widehat{w}}\bar{h}d\gamma$. Using our results of the comparative statics, an increase in γ accompanied by a reduction in α has the following effect on the families' welfare:

$$\begin{aligned}\frac{dV}{d\gamma}\Big|_{d\alpha=-\bar{\widehat{w}}\bar{h}d\gamma} &= \lambda\left(\widehat{w}_i h_i - \bar{\widehat{w}}\bar{h}\right)n_i \\ &+ \lambda\bar{\widehat{w}}\bar{n}\frac{\mu}{\bar{D}}\Bigg\{\Big[\beta\pi u_{q_z q_z}\overline{P_{q_h}P_{q_g}} \\ &- \left(t\bar{w} + \gamma\bar{\widehat{w}}\right)\left(u_{q_g q_g}\overline{P_{q_z}^2} + u_{q_z q_z}\overline{P_{q_g}^2}\right)\Big]\left(\bar{n}u_{cc}u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{\bar{n}}\right) \\ &+ \left[\alpha + \beta\pi\bar{g} + \bar{h}\left(t\bar{w} + \gamma\bar{\widehat{w}}\right)\right]u_{q_g q_g}u_{q_z q_z}\overline{P_{q_h}}\left(u_{cc}\bar{P}_n - \frac{u_c}{\bar{n}}\right) \\ &- \left(t\bar{w} + \gamma\bar{\widehat{w}}\right)\bar{n}u_{q_g q_g}u_{q_z q_z}\left(u_{cc}\overline{P_n^2} + u_{nn}\right)\Bigg\}\end{aligned} \tag{2.32}$$

As before, the welfare effect in general can go in either direction. The effect of higher parental leave payments is likely to be positive for families with secondary earners whose opportunity costs for parental time are above average, that is $\widehat{w}_i h_i > \bar{\widehat{w}}\bar{h}$, and if the initial parental leave payment rate γ is small. As before, we observe redistribution with respect to the income weighted parental child care time but in case of the parents' welfare additionally with respect to the number of children due to the redistribution of income for family policies. The size of this effect therefore depends on the secondary earner's net wage rate, her parental child care time, and the family's number of children.

When looking at the case of $\gamma = 0$, we find that the size of the welfare effect depends on the size of the average tax payments $t\bar{w}$ of secondary earners. If the average secondary earners' tax payments $t\bar{w}$ are small enough, the welfare effect is positive for secondary earners whose opportunity costs for parental time are at least at the average, that is

$\widehat{w}_i h_i \geq \bar{\widehat{w}}\bar{h}$. For those net recipients of parental leave payments, the positive effect of introducing the transfers is higher than the burden of tax financing the scheme.

$$\begin{aligned}\frac{dV}{d\gamma}\Big|_{d\alpha=-\bar{\widehat{w}}\bar{h}d\gamma,\gamma=0} &= \lambda\left(\widehat{w}_i h_i - \bar{\widehat{w}}\bar{h}\right)n_i \\ &+ \lambda\bar{\widehat{w}}\bar{n}\frac{\mu}{\overline{D}}\Bigg\{\Big[\beta\pi u_{q_z q_z}\overline{P_{q_h}P_{q_g}} \\ &- t\bar{w}\left(u_{q_g q_g}\overline{P_{q_z}^2} + u_{q_z q_z}\overline{P_{q_g}^2}\right)\Big]\left(\bar{n}u_{cc}u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{\bar{n}}\right) \\ &+ \left(\alpha + \beta\pi\bar{g} + t\bar{w}\bar{h}\right)u_{q_g q_g}u_{q_z q_z}\overline{P_{q_h}}\left(u_{cc}\bar{P}_n - \frac{u_c}{\bar{n}}\right) \\ &- t\bar{w}\bar{n}u_{q_g q_g}u_{q_z q_z}\left(u_{cc}\overline{P_n^2} + u_{nn}\right)\Bigg\}\end{aligned} \tag{2.33}$$

For $\gamma = 1$, we find that the size of the welfare effect depends only on the average wage rate of the secondary earners:

$$\begin{aligned}\frac{dV}{d\gamma}\Big|_{d\alpha=-\bar{\widehat{w}}\bar{h}d\gamma,\gamma=1} &= \lambda\left(\widehat{w}_i h_i - \bar{\widehat{w}}\bar{h}\right)n_i \\ &+ \lambda\bar{\widehat{w}}\bar{n}\frac{\mu}{\overline{D}}\Bigg\{\Big[\beta\pi u_{q_z q_z}\overline{P_{q_h}P_{q_g}} - \bar{w}\left(u_{q_g q_g}\overline{P_{q_z}^2} + u_{q_z q_z}\overline{P_{q_g}^2}\right)\Big]\Bigg(\bar{n}u_{cc}u_{nn} \\ &+ 2u_n u_{cc} - \frac{u_c^2}{\bar{n}}\Bigg) + \left(\alpha + \beta\pi\bar{g} + \bar{w}\bar{h}\right)u_{q_g q_g}u_{q_z q_z}\overline{P_{q_h}}\left(u_{cc}\bar{P}_n - \frac{u_c}{\bar{n}}\right) \\ &- \bar{w}\bar{n}u_{q_g q_g}u_{q_z q_z}\left(u_{cc}\overline{P_n^2} + u_{nn}\right)\Bigg\}\end{aligned} \tag{2.34}$$

The welfare effect is now positive for secondary earners whose opportunity costs for parental time are above average, that is $\widehat{w}_i h_i > \bar{\widehat{w}}\bar{h}$, if the average wage rate is relatively small.

If γ equals unity, all of the foregone net wage income due to the parental child care at home is fully compensated by the leave payments. Hence, the implicit tax on wage income is maximum at this rate of γ. The net wage income of the household including leave payments according to (2.3) is then given by $(Y + w)(1 - t)$. This shows us that with increasing provision level of parental leave payments, the distortive part of taxes on

wage income becomes less important and what remains is a lump-sum tax on the full income. The higher the full income, the less likely the welfare effect is positive.

As described before, families with $\widehat{w}_i h_i > \bar{\widehat{w}}\bar{h}$ are net recipients of the parental leave payments. Nevertheless, families with $\widehat{w}_i > \bar{\widehat{w}}$ finance the policy instruments and, therefore, only benefit from a budget-neutral increase in parental leave payments if the average secondary earners' income is low and there is thus little redistribution with respect to parental leave payments.

Proposition 2.7: *A budget-neutral increase in parental leave payments accompanied by a decrease in child benefits leads to a higher parental welfare for families with* $\widehat{w}_i h_i \geq \bar{\widehat{w}}\bar{h}$ *from the introduction up to a certain initial provision level of leave payments if the average tax payments of secondary earners are sufficiently small.*

Keeping α constant, an increase in a subsidy for child care accompanied by a decrease in the rate of parental leave payments is budget neutral if $d\gamma = -\frac{\pi\bar{g}}{\bar{\widehat{w}}\bar{h}}d\beta$. This equals a comparison of the two aforementioned welfare effects of the budget-neutral exchanges of α and β as well as α and γ. Substituting γ for β has the following effect on the parents' welfare:

$$\begin{aligned}
\frac{dV}{d\beta}\Big|_{d\gamma=-\frac{\pi\bar{g}}{\bar{\widehat{w}}\bar{h}}d\beta} &= \lambda\pi n_i\left(g_i - \frac{\widehat{w}_i h_i}{\bar{\widehat{w}}\bar{h}}\bar{g}\right) \\
&+ \lambda\pi\bar{n}\frac{\mu}{\bar{D}}\Bigg\{\Bigg[\beta\pi\left(u_{q_z q_z}\overline{P_{q_h}^2} + u_{q_h q_h}\overline{P_{q_z}^2} + \frac{\bar{g}}{\bar{h}}u_{q_z q_z}\overline{P_{q_h}P_{q_g}}\right) \\
&- \left(t\bar{w} + \gamma\bar{\widehat{w}}\right)\left(\frac{\bar{g}}{\bar{h}}u_{q_z q_z}\overline{P_{q_g}^2} + \frac{\bar{g}}{\bar{h}}u_{q_g q_g}\overline{P_{q_z}}\right. \\
&\left.+ u_{q_z q_z}\overline{P_{q_h}P_{q_g}}\right)\Bigg]\left(\bar{n}u_{cc}u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{\bar{n}}\right) \\
&- u_{q_z q_z}\left(u_{q_h q_h}\overline{P_{q_g}} - \frac{\bar{g}}{\bar{h}}u_{q_g q_g}\overline{P_{q_h}}\right)\left[\alpha + \beta\pi\bar{g}\right. \\
&\left.+ \bar{h}\left(t\bar{w} + \gamma\bar{\widehat{w}}\right)\right]\left(u_{cc}\overline{P_n} - \frac{u_c}{\bar{n}}\right) \\
&+ \bar{n}u_{q_z q_z}\left[\beta\pi u_{q_h q_h} - \frac{\bar{g}}{\bar{h}}\left(t\bar{w} + \gamma\bar{\widehat{w}}\right)u_{q_g q_g}\right]\left(u_{cc}\overline{P_n^2} + u_{nn}\right)\Bigg\}
\end{aligned} \tag{2.35}$$

The size of the welfare effect of the budget neutral increase in the subsidy for child care in (2.35) depends to a large extent on family i's ratio of consumption of g_i to h_i as well

as on the average ratio of consumption of $\bar{g}$ to $\bar{h}$. In general, the welfare effect can go in either direction. We can say more in two special cases.

Considering the case that the subsidy for external child care is being introduced ($\beta = 0$),

$$\begin{aligned}\frac{dV}{d\beta}\Big|_{d\gamma=-\frac{\pi\bar{g}}{\bar{\widehat{w}}\bar{h}}d\beta,\beta=0} &= \lambda\pi n_i\left(g_i - \frac{\widehat{w}_i h_i}{\bar{\widehat{w}}\bar{h}}\bar{g}\right) \\ &- \lambda\pi\bar{n}\frac{\mu}{\overline{D}}\left\{\left[\left(t\overline{w}+\gamma\overline{\widehat{w}}\right)\left(\frac{\bar{g}}{\bar{h}}u_{q_zq_z}\overline{P_{q_g}^2}+\frac{\bar{g}}{\bar{h}}u_{q_gq_g}\overline{P_{q_z}}\right.\right.\right. \\ &\left.\left.\left.+u_{q_zq_z}\overline{P_{q_h}P_{q_g}}\right)\right]\left(\bar{n}u_{cc}u_{nn}+2u_nu_{cc}-\frac{u_c^2}{\bar{n}}\right)\right. \\ &+u_{q_zq_z}\left(u_{q_hq_h}\overline{P_{q_g}}-\frac{\bar{g}}{\bar{h}}u_{q_gq_g}\overline{P_{q_h}}\right)\left[\alpha+\bar{h}\left(t\overline{w}+\gamma\overline{\widehat{w}}\right)\right]\left(u_{cc}\overline{P_n}\right. \\ &\left.\left.-\frac{u_c}{\bar{n}}\right)+\bar{n}\frac{\bar{g}}{\bar{h}}\left(t\overline{w}+\gamma\overline{\widehat{w}}\right)u_{q_gq_g}u_{q_zq_z}\left(u_{cc}\overline{P_n^2}+u_{nn}\right)\right\}\end{aligned} \tag{2.36}$$

we find that the welfare effect is negative for all secondary earners whose ratio of own to average external child care is not larger than their ratio of own to average opportunity costs of staying at home, that is $\frac{g_i}{\bar{g}} \leq \frac{\widehat{w}_i h_i}{\bar{\widehat{w}}\bar{h}}$, if the average negative price elasticity of external child care is smaller than the average negative elasticity of parental child care with respect to the opportunity costs, that is $u_{q_hq_h}\overline{P_{q_g}} < \frac{\bar{g}}{\bar{h}}u_{q_gq_g}\overline{P_{q_h}}$ [11]. This group of secondary earners benefits most from high parental leave payments. Therefore, a budget-neutral increase in the subsidy for external child care creates a welfare loss for those families as long as the provision level is low. For an increasing provision level, the welfare effect is ambiguous for families with $\frac{g_i}{\bar{g}} \leq \frac{\widehat{w}_i h_i}{\bar{\widehat{w}}\bar{h}}$ and likely to be positive for families with $\frac{g_i}{\bar{g}} > \frac{\widehat{w}_i h_i}{\bar{\widehat{w}}\bar{h}}$.

For very high levels of parental leave payments ($\gamma = 1$) and with $\frac{g_i}{\bar{g}} \geq \frac{\widehat{w}_i h_i}{\bar{\widehat{w}}\bar{h}}$ at the starting point of the policy change, we derive the following welfare result in (2.37). If the average gross wage $\overline{w}$ is small so that the income effect of parental leave payments is low and if the rate of leave payments is very high ($\gamma \to 1$), the substitution of the high parental leave payments by subsidies for external child care improves the welfare if $\bar{\varepsilon}_g < \bar{\varepsilon}_h$ in the society holds. For those families who benefit relatively more from the subsidy for

[11] This condition is equivalent to the requirement that the average elasticity of marginal utility w.r.t. h is smaller than w.r.t. g, that is $\bar{\varepsilon}_g < \bar{\varepsilon}_h$.

external child care than from the parental leave payments, i.e. $\frac{g_i}{\bar{g}} \geq \frac{\hat{w}_i h_i}{\bar{\hat{w}}\bar{h}}$, the replacement rate of leave payments is thus too high so that an exchange towards more subsidies is welfare improving.

$$\begin{aligned}
\frac{dV}{d\beta}\Big|_{d\gamma=-\frac{\pi\bar{g}}{\bar{\hat{w}}\bar{h}}d\beta,\gamma=1} &= \lambda\pi n_i\left(g_i - \frac{\hat{w}_i h_i}{\bar{\hat{w}}\bar{h}}\bar{g}\right) \\
&+ \lambda\pi\bar{n}\frac{\mu}{\bar{D}}\Bigg\{\Bigg[\beta\pi\left(u_{q_z q_z}\overline{P_{q_h}^2} + u_{q_h q_h}\overline{P_{q_z}^2} + \frac{\bar{g}}{\bar{h}}u_{q_z q_z}\overline{P_{q_h}P_{q_g}}\right) \\
&- \bar{w}\left(\frac{\bar{g}}{\bar{h}}u_{q_z q_z}\overline{P_{q_g}^2} + \frac{\bar{g}}{\bar{h}}u_{q_g q_g}\overline{P_{q_z}} + u_{q_z q_z}\overline{P_{q_h}P_{q_g}}\right)\Bigg]\left(\bar{n}u_{cc}u_{nn}\right. \\
&\left.+ 2u_n u_{cc} - \frac{u_c^2}{\bar{n}}\right) \\
&- u_{q_z q_z}\left(u_{q_h q_h}\overline{P_{q_g}} - \frac{\bar{g}}{\bar{h}}u_{q_g q_g}\overline{P_{q_h}}\right)\left[\alpha + \beta\pi\bar{g} + \bar{h}\bar{w}\right]\left(u_{cc}\bar{P}_n\right. \\
&\left.- \frac{u_c}{\bar{n}}\right) + \bar{n}u_{q_z q_z}\left[\beta\pi u_{q_h q_h} - \frac{\bar{g}}{\bar{h}}\bar{w}u_{q_g q_g}\right]\left(u_{cc}\overline{P_n^2} + u_{nn}\right)\Bigg\}
\end{aligned} \tag{2.37}$$

Proposition 2.8: *A budget-neutral increase in a subsidy for external child care accompanied by a decrease in parental leave payments leads to a decrease in parental welfare for families with* $\frac{g_i}{\bar{g}} \leq \frac{\hat{w}_i h_i}{\bar{\hat{w}}\bar{h}}$ *if the society responds more elastic to price changes of external child care than to changes of opportunity costs of staying at home, i.e.* $\bar{\varepsilon}_g < \bar{\varepsilon}_h$*, in case the provision level of the subsidy is low. If, on the other hand, the rate of parental leave payments is very high and the average gross wage income is low the same policy exchange can be welfare improving for families with* $\frac{g_i}{\bar{g}} \geq \frac{\hat{w}_i h_i}{\bar{\hat{w}}\bar{h}}$ *if* $\bar{\varepsilon}_g < \bar{\varepsilon}_h$*holds.*

2.5 Conclusion

Summarizing our results with respect to the absolute effects, we find that child benefits have a larger impact in increasing fertility and reducing labor supply for high income earners than low income earners. The reason is that the marginal prices of children and parental child care time are higher for high wage incomes so that a reduction of those prices by child benefits is more important for high income earners. This result contradicts the conventional wisdom that child benefits have more impact on low income families and might be driven by our assumption of additive separable utility functions. Apps and Rees (2004) show that child benefits might also have a negative effect on fertility as the income effect may be negative. In our model, we only consider the direct effects of the family policy instruments and child benefits therefore decrease the price for children. Hence, child benefits have a stronger impact on high income earners to stay home with the children than on low income earners, whereas the effect on the demand for external child care is the same. Thus, the labor supply of the high income secondary earner decreases by more. Fehr and Ujhelyiova (2013) analysis supports this result with respect to in-kind benefits (we do not differentiate between child benefits and in-kind benefits in our model). They analyze reform options for child benefits and family taxation in Germany within a static model of fertility choice and a simulation. Their simulation analysis indicates that higher transfers to families alone may increase birth rates but would come at the cost of lower female employment. An increase in in-kind benefits in their model also has a stronger effect on the fertility rate of the high-skilled class than that of the low skilled class. They show that high-skilled women therefore work significantly less since they have more children and the effect on their labor supply is thus stronger than on low-skilled women. However, their results regarding child benefits are opposite to ours: in this case low-skilled women benefit the most and therefore increase fertility and at the same time decrease labor supply by more than high-skilled women.

Our results suggest that both a subsidy for external child care and parental leave payments have ambiguous effects on fertility. This result is in line with empirical findings that show mixed evidence about the success of the two policy parameters in fostering fertility (see Thévenon and Gauthier, 2011, and Luci-Greulich and Thévenon, 2013 for an overview). Luci-Greulich and Thévenon (2013) argue that the ambiguity of the impact of parental leave payments on fertility is due to the policy design: On the one hand, the policy instrument supports household income and labor market participation around the time of

childbirth, which has a positive effect on fertility. However, as entitlements are often conditional on employment, they encourage men and women to postpone childbirth (which has a negative effect on overall fertility) until they have established themselves in the labor market. This hypothesis is confirmed by Adsera (2004) who uses a panel of 23 OECD nations to study how different labor market arrangements shaped the correlation between fertility and female labor participation rates in the countries respectively. Her results suggest that labor market insecurity, as measured by unemployment, has a significantly negative impact on fertility. She thus finds that an increase in paid leave duration has a positive impact on fertility rates. This result is in line with our finding that the impact of an increase in leave payments on fertility depends on the secondary earner's wage rate and on the elasticity of demand for parental child care time. Our model, however, sheds a very negative light on parental leave payments as we model the instrument within a static framework. We therefore ignore the positive long-term effects of the policy instrument on the secondary earner's labor supply via the channel of job market security. In our model, parental leave payments work like an implicit tax on continued work and therefore decrease the secondary earner's labor

Concerning the differential effects, we find that the family policy instrument that supports child care (external or parental) with the less elastic response is more effective in fostering fertility. Regarding the reconciliation of family and work, our results show that the only policy reform which can produce incentives to have more children, a higher demand for external child care and, at the same time, act as stimulation for more labor supply of parents is given by an increase in child benefits compensated by a budget-neutral reduction of parental leave payments. This policy qualifies as a way to improve the conditions to combine family with work. Another finding is that a policy change that shifts transfers from leave payments to subsidies for external child care increases the demand for external child care and the employment of secondary earners. This budget-neutral policy exchange can also set positive incentives for having children if the demand for external child care is not too elastic. There is also proof for those findings in the empirical literature. Luci-Greulich and Thévenon (2013) empirically test the impact of the three family policy instruments on fertility, using macro panel data from 18 OECD countries that spans the years 1982–2007. Their results show that paid leave, child care services and financial transfers have a positive influence on average, suggesting that the combination of these forms of support has a positive effect on the demand for children for working parents. However, their findings also suggest that the policy instruments do not

all have the same weight: cash benefits covering childhood after the year of childbirth and the provision of child care services for children under age three have a larger potential influence on fertility than leave entitlements and benefits granted around childbirth. Luci-Greulich and Thévenon (2013) show that a mix of in-cash and in-kind support has a positive influence on fertility and that the development of child care services has a more significant impact on fertility trends at the aggregate level than policies extending leave entitlements. This result reflects our result that a policy change that shifts transfers from leave payments to child benefits or to subsidies for external child care (if the demand for external child care is not too elastic) increases the demand for children. Fehr and Ujhelyiova (2013) also find that in principle it is possible to increase birth rates and female employment rates simultaneously if the government invests in child care facilities for children of all ages.

Our results with respect to welfare show that if child benefits are part of the family policy in an economy it is welfare improving to complement this by introducing subsidies to external child care in exchange for lower child benefits up to a certain provision level. This holds true in the case of identical families as well as for families with above average demand for external child care – the net beneficiaries. We find that it may also increase welfare to substitute very high levels of parental leave payments by subsidies for external child care. For those families who benefit relatively more from the subsidies for external child care than from the parental leave payment, the replacement rate of leave payments is too high so that an exchange towards more subsidies is welfare improving.

Appendix

2.A: Derivation of the comparative statics results

Total differentiation of the first-order conditions of individual utility maximization (2.5) - (2.8) yields

$$\begin{pmatrix} u_{cc} & 0 & 0 & 0 & 0 & -1 \\ 0 & u_{nn} & -\lambda\widehat{w}_i(1-\gamma) & -\lambda(1-\beta)\pi & -\lambda B & -P_{n,i} \\ 0 & -\lambda\widehat{w}_i(1-\gamma) & u_{q_h q_h} & 0 & 0 & -P_{q_h,i} \\ 0 & -\lambda(1-\beta)\pi & 0 & u_{q_g q_g} & 0 & -P_{q_g,i} \\ 0 & -\lambda B & 0 & 0 & u_{q_z q_z} & -P_{q_z,i} \\ -1 & -P_{n,i} & -P_{q_h,i} & -P_{q_g,i} & -P_{q_z,i} & 0 \end{pmatrix} \begin{pmatrix} dc_i \\ dn_i \\ dh_i \\ dg_i \\ dz_i \\ d\lambda \end{pmatrix}$$

$$= \begin{pmatrix} 0 & 0 & 0 \\ -\lambda & -\lambda\pi g_i & -\lambda\widehat{w}_i h_i \\ 0 & 0 & -\lambda\widehat{w}_i n_i \\ 0 & -\lambda\pi n_i & 0 \\ 0 & 0 & 0 \\ -n_i & -\pi g_i n_i & -\widehat{w}_i h_i n_i \end{pmatrix} \begin{pmatrix} d\alpha \\ d\beta \\ d\gamma \end{pmatrix} \tag{2.A.1}$$

where the determinant of the bordered Hessian matrix on the left-hand side is denoted by D_i.

The Cramer rule yields the following derivatives:

$$\begin{aligned} dc_i = &\left(\lambda\frac{D_{21}}{D_i} + n_i\frac{D_{61}}{D_i}\right)d\alpha + \left(\lambda\pi g_i\frac{D_{21}}{D_i} + \lambda\pi n_i\frac{D_{41}}{D_i} + \pi g_i n_i\frac{D_{61}}{D_i}\right)d\beta \\ &+ \left(\lambda\widehat{w}_i h_i\frac{D_{21}}{D_i} - \lambda\widehat{w}_i n_i\frac{D_{31}}{D_i} + \widehat{w}_i h_i n_i\frac{D_{61}}{D_i}\right)d\gamma \end{aligned} \tag{2.A.2}$$

$$\begin{aligned} dn_i = &\left(-\lambda\frac{D_{22}}{D_i} - n_i\frac{D_{62}}{D_i}\right)d\alpha + \left(-\lambda\pi g_i\frac{D_{22}}{D_i} - \lambda\pi n_i\frac{D_{42}}{D_i} - \pi g_i n_i\frac{D_{62}}{D_i}\right)d\beta \\ &+ \left(-\lambda\widehat{w}_i h_i\frac{D_{22}}{D_i} + \lambda\widehat{w}_i n_i\frac{D_{32}}{D_i} - \widehat{w}_i h_i n_i\frac{D_{62}}{D_i}\right)d\gamma \end{aligned} \tag{2.A.3}$$

$$dh_i = \left(\lambda\frac{D_{23}}{D_i} + n_i\frac{D_{63}}{D_i}\right)d\alpha + \left(\lambda\pi g_i\frac{D_{23}}{D_i} + \lambda\pi n_i\frac{D_{43}}{D_i} + \pi g_i n_i\frac{D_{63}}{D_i}\right)d\beta + \left(\lambda\widehat{w}_i h_i\frac{D_{23}}{D_i} - \lambda\widehat{w}_i n_i\frac{D_{33}}{D_i} + \widehat{w}_i h_i n_i\frac{D_{63}}{D_i}\right)d\gamma \quad (2.A.4)$$

$$dg_i = \left(-\lambda\frac{D_{24}}{D_i} - n_i\frac{D_{64}}{D_i}\right)d\alpha + \left(-\lambda\pi g_i\frac{D_{24}}{D_i} - \lambda\pi n_i\frac{D_{44}}{D_i} - \pi g_i n_i\frac{D_{64}}{D_i}\right)d\beta + \left(-\lambda\widehat{w}_i h_i\frac{D_{24}}{D_i} + \lambda\widehat{w}_i n_i\frac{D_{34}}{D_i} - \widehat{w}_i h_i n_i\frac{D_{64}}{D_i}\right)d\gamma \quad (2.A.5)$$

$$dz_i = \left(\lambda\frac{D_{25}}{D_i} + n_i\frac{D_{65}}{D_i}\right)d\alpha + \left(\lambda\pi g_i\frac{D_{25}}{D_i} + \lambda\pi n_i\frac{D_{45}}{D_i} + \pi g_i n_i\frac{D_{54}}{D_i}\right)d\beta + \left(\lambda\widehat{w}_i h_i\frac{D_{25}}{D_i} - \lambda\widehat{w}_i n_i\frac{D_{35}}{D_i} + \widehat{w}_i h_i n_i\frac{D_{565}}{D_i}\right)d\gamma \quad (2.A.6)$$

where the minors of the Hessian matrix are given by:

$$D_i = -\left(u_{q_g q_g}u_{q_z q_z}P_{q_h,i}^2 + u_{q_h q_h}u_{q_z q_z}P_{q_g,i}^2 + u_{q_h q_h}u_{q_g q_g}P_{q_z,i}^2\right)\left(u_{cc}u_{nn} + \frac{2u_{cc}u_n}{n_i} - \frac{u_c^2}{n_i^2}\right) - u_{q_h q_h}u_{q_g q_g}u_{q_z q_z}\left(u_{cc}P_{n,i}^2 + u_{nn}\right) < 0$$

$$D_{21} = -u_{q_h q_h}u_{q_g q_g}u_{q_z q_z}P_{n,i} - \frac{u_c}{n_i}\left(u_{q_g q_g}u_{q_z q_z}P_{q_h,i}^2 + u_{q_h q_h}u_{q_z q_z}P_{q_g,i}^2 + u_{q_h q_h}u_{q_g q_g}P_{q_z,i}^2\right) < 0$$

$$D_{22} = -u_{cc}\left(u_{q_g q_g}u_{q_z q_z}P_{q_h,i}^2 + u_{q_h q_h}u_{q_z q_z}P_{q_g,i}^2 + u_{q_h q_h}u_{q_g q_g}P_{q_z,i}^2\right) - u_{q_h q_h}u_{q_g q_g}u_{q_z q_z} > 0$$

$$D_{23} = D_{32} = -u_{q_g q_g}u_{q_z q_z}P_{q_h,i}\left(u_{cc}P_{n,i} - \frac{u_c}{n_i}\right) > 0$$

$$D_{24} = D_{42} = u_{q_h q_h}u_{q_z q_z}P_{q_g,i}\left(u_{cc}P_{n,i} - \frac{u_c}{n_i}\right) < 0$$

$$D_{25} = -u_{q_h q_h}u_{q_g q_g}P_{q_z,i}\left(u_{cc}P_{n,i} - \frac{u_c}{n_i}\right) > 0$$

$$D_{31} = u_{q_g q_g}u_{q_z q_z}P_{q_h,i}\left(u_{nn} + \frac{u_n}{n_i}\right) < 0$$

$$D_{33} = -\left(u_{q_g q_g}P_{q_z,i}^2 + u_{q_z q_z}P_{q_g,i}^2\right)\left(u_{cc}u_{nn} + \frac{2u_{cc}u_n}{n_i} - \frac{u_c^2}{n_i^2}\right) - u_{q_g q_g}u_{q_z q_z}\left(u_{cc}P_{n,i}^2 + u_{nn}\right) > 0$$

$$D_{34} = D_{43} = -u_{q_z q_z} P_{q_h,i} P_{q_g,i} \left(u_{cc} u_{nn} + \frac{2u_{cc} u_n}{n_i} - \frac{u_c^2}{n_i^2} \right) > 0$$

$$D_{35} = u_{q_g q_g} P_{q_h,i} P_{q_z,i} \left(u_{cc} u_{nn} + \frac{2u_{cc} u_n}{n_i} - \frac{u_c^2}{n_i^2} \right) < 0$$

$$D_{41} = -u_{q_h q_h} u_{q_z q_z} P_{q_g,i} \left(u_{nn} + \frac{u_n}{n_i} \right) > 0$$

$$D_{44} = -\left(u_{q_z q_z} P_{q_h,i}^2 + u_{q_h q_h} P_{q_z}^2 \right) \left(u_{cc} u_{nn} + \frac{2u_{cc} u_n}{n_i} - \frac{u_c^2}{n_i^2} \right) - u_{q_h q_h} u_{q_z q_z} \left(u_{nn} + u_{cc} {P_{n,i}}^2 \right) > 0$$

$$D_{45} = -u_{q_h q_h} P_{q_g,i} P_{q_z,i} \left(u_{cc} u_{nn} + \frac{2u_{cc} u_n}{n_i} - \frac{u_c^2}{n_i^2} \right) > 0$$

$$D_{61} = -u_{nn} u_{q_h q_h} u_{q_g q_g} u_{q_z q_z} + \frac{u_c^2}{n_i^2} \left(u_{q_g q_g} u_{q_z q_z} P_{q_h,i}^2 + u_{q_h q_h} u_{q_z q_z} P_{q_g,i}^2 + u_{q_h q_h} u_{q_g q_g} P_{q_z,i}^2 \right) < 0$$

$$D_{62} = u_{cc} \left[u_{q_h q_h} u_{q_g q_g} u_{q_z q_z} P_{n,i} + \frac{u_c}{n_i} \left(u_{q_g q_g} u_{q_z q_z} P_{q_h,i}^2 + u_{q_h q_h} u_{q_z q_z} P_{q_g,i}^2 + u_{q_h q_h} u_{q_g q_g} P_{q_z,i}^2 \right) \right] > 0$$

$$D_{63} = -u_{cc} u_{q_g q_g} u_{q_z q_z} P_{q_h,i} \left(u_{nn} + \frac{u_n}{n_i} \right) < 0$$

$$D_{64} = u_{cc} u_{q_h q_h} u_{q_z q_z} P_{q_g,i} \left(u_{nn} + \frac{u_n}{n_i} \right) > 0$$

$$D_{65} = -u_{cc} u_{q_h q_h} u_{q_g q_g} P_{q_z,i} \left(u_{nn} + \frac{u_n}{n_i} \right) < 0$$

From the second-order conditions for a utility maximum follows: $\left(u_{cc} u_{nn} + \frac{2u_{cc} u_n}{n_i} - \frac{u_c^2}{n_i^2} \right) > 0$ and $\left(u_{nn} + \frac{u_n}{n_i} \right) < 0$. The terms $\left(h_i u_{q_h q_h} + u_{q_h} \right) \gtreqless 0$ and $\left(g_i u_{q_g q_g} + u_{q_g} \right) \gtreqless 0$ have an indefinite sign.

As abbreviations for the substitution and income effects we use the following denotation:

$$s_{nc} \equiv \lambda \frac{D_{21}}{D_i},\ s_{nn} \equiv \lambda \frac{D_{22}}{D_i},\ s_{nq_h} \equiv \lambda \frac{D_{23}}{D_i},\ s_{nq_g} \equiv \lambda \frac{D_{24}}{D_i},\ s_{nq_z} \equiv \lambda \frac{D_{25}}{D_i},$$

$$s_{q_hc} \equiv \lambda \frac{D_{31}}{D_i},\ s_{q_hn} \equiv \lambda \frac{D_{32}}{D_i},\ s_{q_hq_h} \equiv \lambda \frac{D_{33}}{D_i},\ s_{q_hq_g} \equiv \lambda \frac{D_{34}}{D_i},\ s_{q_hq_z} \equiv \lambda \frac{D_{35}}{D_i},$$

$$s_{q_gc} \equiv \lambda \frac{D_{41}}{D_i},\ s_{q_gn} \equiv \lambda \frac{D_{42}}{D_i},\ s_{q_gq_h} \equiv \lambda \frac{D_{43}}{D_i},\ s_{q_gq_g} \equiv \lambda \frac{D_{44}}{D_i},\ s_{q_gq_z} \equiv \lambda \frac{D_{45}}{D_i},$$

$$i_c \equiv \frac{D_{61}}{D_i},\ i_n \equiv \frac{D_{62}}{D_i},\ i_{q_h} \equiv \frac{D_{63}}{D_i},\ i_{q_g} \equiv \frac{D_{64}}{D_i},\ i_{q_z} \equiv \frac{D_{65}}{D_i}.$$

From (2.A.2) to (2.A.6) the comparative static results in (2.9) – (2.17) follow. The effects for parental and child-specific consumption are the following

$$\frac{\partial c_i}{\partial \alpha} = s_{nc} + n_i i_c = -\frac{1}{D_i} u_{q_hq_h} u_{q_gq_g} u_{q_zq_z} (n_i u_{nn} + u_n) > 0 \tag{2.A.7}$$

$$q_z \frac{\partial z_i}{\partial \alpha} = s_{nq_z} + n_i i_{q_z} = -\frac{1}{D_i} u_{q_hq_h} u_{q_gq_g} P_{q_z,i} \left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i} \right) > 0 \tag{2.A.8}$$

$$\begin{aligned} \frac{\partial c_i}{\partial \beta} &= \pi \left(g_i s_{nc} + n_i s_{q_gc} + g_i n_i i_c \right) \\ &= -\frac{\pi}{D_i} u_{q_hq_h} u_{q_zq_z} \left(g_i u_{q_gq_g} + u_{q_g} \right) (n_i u_{nn} + u_n) \gtreqless 0 \end{aligned} \tag{2.A.9}$$

$$\begin{aligned} q_z \frac{\partial z_i}{\partial \beta} &= \pi \left(g_i s_{nq_z} + n_i s_{q_gq_z} + g_i n_i i_{q_z} \right) \\ &= -\frac{\pi}{D_i} u_{q_hq_h} P_{q_z,i} \left(g_i u_{q_gq_g} + u_{q_g} \right) \left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i} \right) \gtreqless 0 \end{aligned} \tag{2.A.10}$$

$$\begin{aligned} \frac{\partial c_i}{\partial \gamma} &= \widehat{w}_i \left(h_i s_{nc} - n_i s_{q_hc} + h_i n_i i_c \right) \\ &= -\frac{\widehat{w}_i}{D_i} u_{q_gq_g} u_{q_zq_z} \left(h_i u_{q_hq_h} + u_{q_h} \right) (n_i u_{nn} + u_n) \gtreqless 0 \end{aligned} \tag{2.A.11}$$

$$\begin{aligned} q_z \frac{\partial z_i}{\partial \gamma} &= \widehat{w}_i \left(h_i s_{nq_z} - n_i s_{q_hq_z} + h_i n_i i_{q_z} \right) \\ &= -\frac{\widehat{w}_i}{D_i} u_{q_gq_g} P_{q_z,i} \left(h_i u_{q_hq_h} + u_{q_h} \right) \left(n_i u_{cc} u_{nn} + 2u_n u_{cc} - \frac{u_c^2}{n_i} \right) \gtreqless 0 \end{aligned} \tag{2.A.12}$$

2.B: Differential effects on consumption

Using the absolute comparative static effects (2.9) to (2.17), we can derive the differential effects on consumption generated by the following policy changes.

For $d\gamma = 0$ the budget-neutral increase in β by $d\alpha = -\pi\bar{g}d\beta$ yields:

$$\begin{aligned} dc_i|_{d\alpha=-\pi\bar{g}d\beta} &= \frac{\partial c}{\partial \beta}d\beta + \frac{\partial c}{\partial \alpha}d\alpha = \pi\left[(s_{nc} + n_i i_c)(g_i - \bar{g}) + n_i s_{q_g c}\right] \\ &= -\frac{\pi}{D_i}(n_i u_{nn} + u_n)u_{q_h q_h}u_{q_z q_z}\left[(g_i - \bar{g})u_{q_g q_g} + u_{q_g}\right] \end{aligned} \tag{2.B.1}$$

$$\begin{aligned} dz_i|_{d\alpha=-\pi\bar{g}d\beta} &= \frac{\partial q_z}{\partial \beta}d\beta + \frac{\partial q_z}{\partial \alpha}d\alpha = \pi\left[(s_{nq_z} + n_i i_{q_z})(g_i - \bar{g}) + n_i s_{q_g q_z}\right] \\ &= -\frac{\pi}{D_i}\Bigg(n_i u_{cc}u_{nn} + 2u_n u_{cc} \\ &\quad -\frac{u_c^2}{n_i}\Bigg)u_{q_h q_h}P_{q_z,i}\left[(g_i - \bar{g})u_{q_g q_g} + u_{q_g}\right] \end{aligned} \tag{2.B.2}$$

For $d\beta = 0$ a budget-neutral increase in γ by $d\alpha = -\bar{\widehat{w}}\bar{h}d\gamma$ yields:

$$\begin{aligned} dc_i|_{d\alpha=-\bar{\widehat{w}}\bar{h}d\gamma} &= \frac{\partial c}{\partial \gamma}d\gamma + \frac{\partial c}{\partial \alpha}d\alpha = -\left(\bar{\widehat{w}}\bar{h} - \widehat{w}_i h_i\right)(s_{nc} + n_i i_c) - \widehat{w}_i n_i s_{q_h c} \\ &= \frac{1}{D_i}u_{q_g q_g}u_{q_z q_z}(n_i u_{nn} + u_n)\left[\left(\bar{\widehat{w}}\bar{h} - \widehat{w}_i h_i\right)u_{q_h q_h} - \widehat{w}_i u_{q_h}\right] \end{aligned} \tag{2.B.3}$$

$$\begin{aligned} dz_i|_{d\alpha=-\bar{\widehat{w}}hd\gamma} &= \frac{\partial q_z}{\partial \gamma}d\gamma + \frac{\partial q_z}{\partial \alpha}d\alpha \\ &= -\left(\bar{\widehat{w}}\bar{h} - \widehat{w}_i h_i\right)\left(s_{nq_z} + n_i i_{q_z}\right) - \widehat{w}_i n_i s_{q_h q_z} \\ &= \frac{1}{D_i}u_{q_g q_g}P_{q_z,i}\Bigg(n_i u_{cc}u_{nn} + 2u_n u_{cc} \\ &\quad -\frac{u_c^2}{n_i}\Bigg)\left[\left(\bar{\widehat{w}}\bar{h} - \widehat{w}_i h_i\right)u_{q_h q_h} - \widehat{w}_i u_{q_h}\right] \end{aligned} \tag{2.B.4}$$

For $d\alpha = 0$ the budget-neutral increase in β by $d\gamma = -\frac{\pi\bar{g}}{\bar{\hat{w}}\bar{h}}d\beta$ yields:

$$\begin{aligned} dc_i\big|_{d\gamma=-\frac{\pi\bar{g}}{\bar{\hat{w}}\bar{h}}d\beta} &= \frac{\partial c}{\partial \beta}d\beta + \frac{\partial c}{\partial \gamma}d\gamma \\ &= \pi\left(g_i - \frac{\hat{w}_i}{\bar{\hat{w}}}\frac{h_i}{\bar{h}}\bar{g}\right)(s_{nc} + n_i i_c) + \pi n_i\left(s_{q_g c} + \frac{\bar{g}}{\bar{h}}\frac{\hat{w}_i}{\bar{\hat{w}}}s_{q_h c}\right) \\ &= -\frac{\pi}{D_i}(n_i u_{nn} + u_n)u_{q_z q_z}\left[\left(g_i - \frac{\hat{w}_i}{\bar{\hat{w}}}\frac{h_i}{\bar{h}}\bar{g}\right)u_{q_h q_h}u_{q_g q_g}\right. \\ &\left. + u_c\left(u_{q_h q_h}P_{q_g,i} - \frac{\bar{g}}{\bar{h}}\frac{\hat{w}_i}{\bar{\hat{w}}}u_{q_g q_g}P_{q_h,i}\right)\right] \end{aligned} \tag{2.B.5}$$

$$\begin{aligned} dz_i\big|_{d\gamma=-\frac{\pi\bar{g}}{\bar{\hat{w}}\bar{h}}d\beta} &= \frac{\partial q_z}{\partial \beta}d\beta + \frac{\partial q_z}{\partial \gamma}d\gamma \\ &= \pi\left(g_i - \frac{\hat{w}_i}{\bar{\hat{w}}}\frac{h_i}{\bar{h}}\bar{g}\right)\left(s_{nq_z} + n_i i_{q_z}\right) + \pi n_i\left(s_{q_g q_z} + \frac{\bar{g}}{\bar{h}}\frac{\hat{w}_i}{\bar{\hat{w}}}s_{q_h q_z}\right) \\ &= -\frac{\pi}{D_i}\left(n_i u_{cc}u_{nn} + 2u_n u_{cc}\right. \\ &\left. - \frac{u_c^2}{n_i}\right)P_{q_z,i}\left[\left(g_i - \frac{\hat{w}_i}{\bar{\hat{w}}}\frac{h_i}{\bar{h}}\bar{g}\right)u_{q_h q_h}u_{q_g q_g}\right. \\ &\left. + u_c\left(u_{q_h q_h}P_{q_g,i} - \frac{\bar{g}}{\bar{h}}\frac{\hat{w}_i}{\bar{\hat{w}}}u_{q_g q_g}P_{q_h,i}\right)\right] \end{aligned} \tag{2.B.6}$$

Chapter 3

3 Public Provision versus Subsidization of Private External Child Care

3.1 Introduction

Recently, the provision of child care has received increased attention in most developed countries. Child care availability and affordability is a major concern for families and most OECD countries therefore aim to improve the provision and to reduce the price for child care. The main objectives of an improved availability of external child care are to fight family poverty by increasing mothers' participation in the labor market and to enhance both child development and equality of opportunities for children. Affordable and good-quality child care services may improve the reconciliation of work and family life and therefore foster labor market participation and gender equality. Generous child care policies are thus mostly viewed as a key determinant of the observed cross-country differences in maternal labor supply and the dramatic growth of female employment over the last decades (e.g. Jaumotte, 2003 and Attanasio et al., 2008).

The focus of this paper is to answer the question whether the provision of child care should be organized by the public or left to private forces and then be subsidized by the

state in order to improve the reconciliation of work and family life as well as to maximize welfare. Publicly provided child care in this context can either be provided by municipalities, churches or non-profit organizations while the carriers of privately provided child care include for-profit institutions, nannies, au-pairs, or babysitters. In this paper, we will mainly focus on the redistributive aspects of publicly provided versus subsidized child care. We analyze the households' preferences for public provision and a subsidy on private child care and compare the effects of both child care regimes on fertility, usage of external child care, the secondary earner's labor supply, and on welfare with respect to our baseline model without policy intervention.

The effects of public provision of private goods have been analyzed by several authors, e.g. Besley and Coate, 1991, Epple and Romano, 1996, Gouveia, 1997, and Blomquist and Christiansen, 1995 and 1999. There is also a large theoretical and empirical literature on child care, female labor supply and fertility. Much of this literature has examined the link between child care provision, fertility, and female labor supply (e.g. Apps and Rees, 2004, Lefebvre et al., 2009, and Haan and Wrohlich, 2011). Most papers have found positive effects of child care provision on both fertility and labor supply. In our model, we want to formally link these two strands of literature.

Previous theoretical studies on child goods such as child care and education often consider parental child care time exogenously given and do not analyze the time allocation decisions of parents. Kimura and Yasui (2009) analyze public provision of private goods for children in a politico-economic model with endogenous fertility but they concentrate on education - which, contrary to child care, is mandatory. De la Croix and Doepke (2004, 2009) also focus on education and analyze the differences between public and private schooling regimes. De la Croix and Doepke (2004) compare the implications of a public and private schooling regime for economic growth and inequality by assessing the merits of the different education systems in a framework that accounts for the joint decision problem of parents regarding fertility and education. In their second article, they analyze why different societies make different choices regarding the mix of private and public schooling (De la Croix and Doepke, 2009). Besides the fact that we focus on the effects of child care and not education, the main difference of those models to our model is that we additionally consider parental care and that the cost of child care is therefore not only a resource cost but also a time cost.

Borck and Wrohlich (2011) focus on child care and analyze the preferences for public or private provision of child care and child goods. They show that there exists a political conflict between different income groups and households with a different number of or preference for children. Our model is closely related to the model by Borck and Wrohlich (2011) but we put a stronger focus on the quality of children and the household's choice of parental and external child care. Additionally, we also analyze a child care regime with a subsidized private market. Borck (2014) studies the effect of preferences for child care provision, fertility, female labor supply and the gender wage gap. In this model, he also discusses the effects of a child care subsidy within a numerical simulation. Borck (2014) finds that as long as the subsidy is sufficiently high it has a positive effect both on fertility and on female labor supply.

There exist also many empirical papers on both public and subsidized private child care. Havnes and Mogstad (2011) evaluate the long-term effect of child care on labor supply in Norway using a 1975 reform. They find that a large-scale expansion of subsidized child care had little impact on maternal employment.[12] Instead, they find that the new subsidized child care mostly crowds out informal care arrangements implying a significant net cost of the child care arrangement. This result is similar to the findings of Lundin et al. (2008) who analyze the effects of a Swedish child care reform in 2002 that set a cap on the price that municipalities were allowed to charge parents and estimate the effects of reductions in child care costs on female labor supply. Their estimated effects of child care prices on labor supply are mostly statistically insignificant, but precisely estimated. Lundin et al. (2008) thus conclude that in countries with a well-developed and highly subsidized child care system, further reductions in the price of child care only have small effects on mothers' labor supply.

There are also various studies examining the effect of child care subsidies for privately provided child care. Viitanen (2007) estimates the impact of a voucher for private care within the Nordic system of universal provision of public care. He finds that the private daycare voucher increased the overall daycare provision in the municipalities participating in the experiment and had a significant, positive effect for the use of private daycare with zero to negligible effects on the use of public care and labor force participation. This result is contrary to a study by Haan and Wrohlich (2011) who evaluate the employment and fertility effects of policy reforms by simulating a reform of

[12] Subsidized child care in this case refers to public and private child care institutions, eligible for subsidies from the government because they satisfy federal quality requirements

child care subsidies for working mothers in Germany. Their results suggest that increasing child care subsidies, conditional on employment, increases the labor supply of all women as well as the fertility rates of the previously childless and highly educated women.

Our contribution to the existing literature is that we explicitly model the parents' preferences for parental child care, publicly provided child care, and privately provided external child care. We also add time restrictions regarding the usage of parental and external child care time. Our analysis shows that increasing publicly provided child care financed by an increase in the income tax leads to a decrease in fertility and the secondary earner's labor supply while it increases the children's quality for secondary earners with a relatively low wage rate. Regarding an increase in the subsidy for external child care, on the other hand, our results suggest that this instrument has a positive effect on both fertility and the secondary earner's labor supply. The effect on children's quality is in this case positive for secondary earners with a relatively high wage rate. Building upon these findings, we analyze the households' optimal choice of a child care regime depending on the parents' preferences. One of our main findings is that while richer households benefit the most from a small subsidy for external child care, poorer households either profit from publicly provided child care or from a full subsidy on external child care. By offering free child care provided by the private market the government could therefore both foster fertility and the secondary earner's labor supply as well as at the same time increase the households' welfare.

The paper is organized as follows. In section 3.2 we introduce the economic setup in the baseline model and present the comparative static results. The two different child care regimes are analyzed in section 3.3. Section 3.4 presents a comparison of preferences over the two child care regimes including a numerical simulation of the results. Section 3.5 concludes.

3.2 The baseline model

We use a static model of families with endogenous fertility and labor supply of a secondary earner. For simplicity, we divide the life cycle of each person into two phases of the same duration. During the first phase, a person entirely depends on parental

support, while in the second, the adult person allocates his or her time between working and thus contributing to family income and raising children. We consider an economy with a large number of households with identical preferences over consumption, the number of children and the children's quality. The population size is normalized to unity. A household i derives utility from own consumption, c_i, their number of children, n_i, and their children's quality, q_i. The household's preferences are represented by the following utility function

$$U_i = (1-\gamma)\ln c_i + \gamma \ln(n_i q_i) \tag{3.1}$$

where $\gamma \in \{0,1\}$ captures the relative weight given to their children and $i \in \{1, \dots, N\}$. Note that households care about both child quantity and child quality. Households are differentiated on the basis of the secondary earner's lifetime average wage rate w_i. This is the only source of heterogeneity in the model. The primary earner's income is thus assumed to be identical across households. We assume that wages across households are distributed according to the cumulative distribution function $F(\cdot)$ with finite mean. It is assumed that the support of $F(\cdot)$ is $\mathbb{R}^+$ and that $F(\cdot)$ is strictly increasing and twice continuously differentiable. Additionally, we assume the mean and variance of the wage rate to be finite and median income to be less than the mean income.

Based on the human capital function of de la Croix and Doepke (2004), the child's quality in our model increases in child specific consumption, z_i, parental time spend with the child, h_i, and external child care, s_i, bought on the market. The child's quality is represented by the following quasi-concave production function

$$q_i = \theta z_i^{\eta}(1+h_i)^{\rho}(1+s_i)^{(1-\rho)} \tag{3.2}$$

with $\theta > 0$, $\eta \in \{0,1\}$, and $\rho \in \{0,1\}$. The parameters η and ρ represent the parents' preferences for child-specific consumption and parental child care, respectively. This quality technology thus assumes diminishing returns to both child-specific consumption and parental child care time, but constant returns to scale in parental and external child care time. The terms $(1+h_i)$ and $(1+s_i)$ guarantee that the child's quality remains positive even if parents do not care for their child themselves or do not demand external child care. We thus do allow for corner solutions with respect to child care but not with respect to child-specific consumption.

Parents can care for their children themselves or buy external child care on the market. The preference parameter for child care time, ρ, may also be interpreted as to capture cultural differences in the attitude towards parental and external child care. The secondary earner allocates her time to working which yields wage at the rate w_i and to leisure time. We assume that child rearing is the only domestic time requiring parental time so that she spends her leisure time completely with the children. Through the endogeneity of n_i, the secondary earner's labor supply is also endogenous. If she has n_i children her parental time equals $h_i n_i$. The rest of the secondary earner's total time is working time and given by $L_i = 1 - h_i n_i$, her gross income therefore equals $w_i L_i$. Households carrying a larger wage rate w_i thus have higher opportunity costs of raising children. The primary earner allocates all her time to working and her gross salary is Y.

Thus, the household's budget constraint is given by

$$Y + w_i L_i = c_i + B z_i n_i + \pi s_i n_i \tag{3.3}$$

where B and π are the market prices for child specific consumption goods and external child care respectively.

The parents choose consumption, c_i, the number of children, n_i, child-specific consumption, z_i, the secondary earner's time spent with a child, h_i, and the amount of bought-in child care, s_i, so as to maximize their utility, $U_i(c_i, n_i, q_i)$, by taking account of the child's quality production and their budget constraint.

The household decision problem is given by:

$$\max_{c_i, n_i, q_i} U_i\big(c_i, n_i, q_i(z_i, h_i, s_i)\big) \;\; s.t. \; (3.3) \tag{3.4}$$

The solution to the household decision problem in (3.4) can either be interior, or at a corner where the household chooses either not to work and not to demand external child care or to work fulltime and to demand the maximum amount of private external child care. For households choosing an interior solution of parental and external child care time, the first-order conditions imply

$$n_i^* = \frac{\gamma\eta(Y + w_i)}{P_{n,i}} \tag{3.5}$$

$$h_i^* = \frac{\rho P_{n,i} - \eta w_i}{\eta w_i} \tag{3.6}$$

$$s_i^* = \frac{(1-\rho)P_{n,i} - \eta\pi}{\eta\pi} \tag{3.7}$$

$$z_i^* = \frac{P_{n,i}}{B} \tag{3.8}$$

$$q_i^* = \frac{\theta(1-\rho)P_{n,i}}{\eta\pi}\left(\frac{P_{n,i}}{B}\right)^{\eta}\left(\frac{\rho\pi}{(1-\rho)w_i}\right)^{\rho} \tag{3.9}$$

with $P_{n,i}$ as the price for child care, $P_{n,i} = w_i + \pi$. The price for child care increases in both the price for external child care and the secondary earner's wage rate. Note that the second-order conditions for a maximum are satisfied.

The effect of the secondary earner's wage rate on fertility in (3.5) is ambiguous and depends on the ratio of the price for external child care to the primary earner's income. Assuming that the primary earner's income is sufficient for financing external child care, that is $Y > \pi$, an increase in the wage rate of the secondary earner has a negative effect on fertility. The lowest and highest possible fertility rates are then given by $\lim_{w_i \to \infty} n_i^* = \gamma\eta$ and $\lim_{w_i \to 0} n_i^* = \frac{\gamma\eta Y}{\pi}$. In this case, we can depict the relationship between fertility and the secondary earner's wage rate as shown in Figure 3.1.

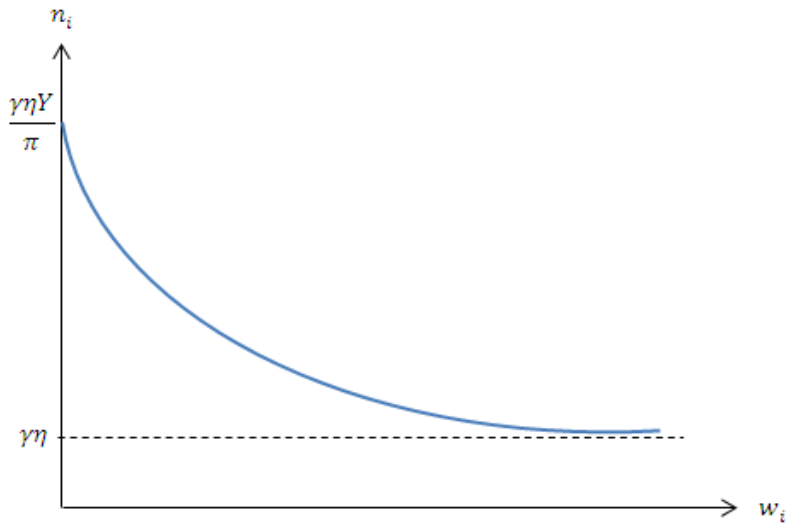


Figure 3.1: The relationship between fertility and the secondary earner's wage rate

For households whose primary earner cannot afford external child care, that is $Y < \pi$, an increase in the secondary earner's income leads to an increase in fertility. This is also the effect we would observe for single parent families.

Note that the demand for external child care in (3.7) increases while parental time in (3.6) decreases in the secondary earner's wage rate w_i. Depending on the size of ρ and η and assuming $\eta > \rho$, parents might decide for a corner solution of caring solely alone for their children or consuming the maximum amount of external child care. For households with a relatively high preference for parental child care, there is a threshold wage rate, $\widehat{w}_l^s$, below which secondary earners choose a corner solution of not buying external child care, $s_i^* = 0$. For households with a relatively small preference for parental child care, there is a threshold wage rate, $\widehat{w}_u^h$, above which secondary earners choose not to stay at home with the children such that $h_i^* = 0$. We additionally assume that the maximum demand for external child care time is one. Parents cannot buy more than one unit of external child care time per child. There is thus also a threshold wage rate, $\widehat{w}_u^s$, above which households cannot consume more external child care. We also assume that the demand for parental child care time is at maximum either $\frac{1}{n_i}$ if the family has more than one child or one in all other cases. The secondary earner's labor supply cannot be negative such that $h_i n_i \leq 1$ must hold true. Even though parents do not consume external child care below the threshold wage rate of $\widehat{w}_l^s$, they can still increase their number of children in our model. With an increasing fertility, the average maximum time the secondary earner can spend with each child decreases. Parental child care might therefore increase in the secondary earner's wage rate for households with a wage rate below $\widehat{w}_l^h$.[13]

The wage rate thresholds are:

$$\widehat{w}_l^s = \frac{(\eta + \rho - 1)\pi}{1 - \rho} \tag{3.10}$$

$$\widehat{w}_u^s = \frac{(2\eta + \rho - 1)\pi}{1 - \rho} \tag{3.11}$$

$$\widehat{w}_l^h = \frac{\rho\pi}{2\eta - \rho} \tag{3.12}$$

$$\widehat{w}_u^h = \frac{\rho\pi}{\eta - \rho} \tag{3.13}$$

Using the results described above, we can depict the relationship between the demand for both parental and external child care and the secondary earner's wage rate as shown in Figure 3.2.

[13] See Appendix 3.A for a detailed function of parental and external child care time.

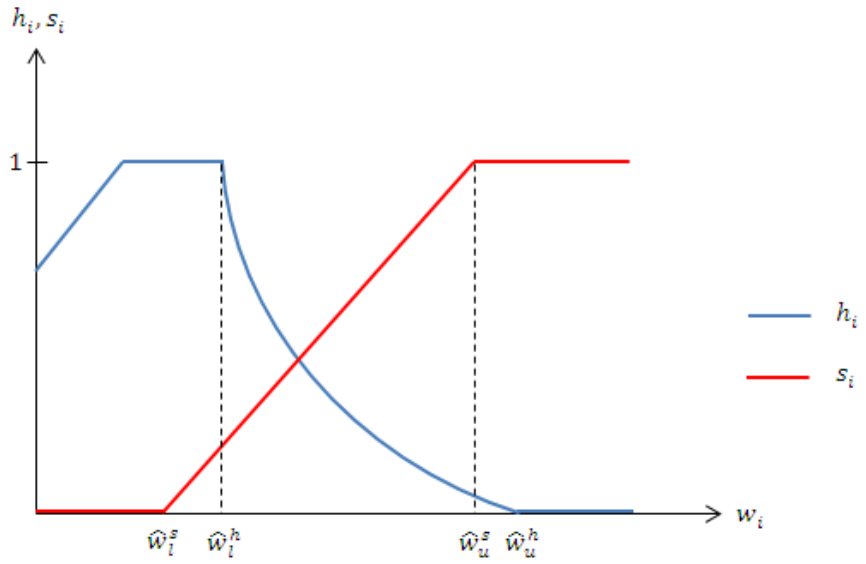


Figure 3.2: The relationship between the demand for parental and external child care and the secondary earner's wage rate

These relationships are consistent with the well-known evidence: high income households choose relatively low parental child care times with relatively high investments in external child care while low income households spend more time at home with their children. Note that we do not make an assumption on total child care time. Parental and external child care time can therefore be in sum smaller or larger than one.

Child specific consumption in (3.8) increases in the wage rate of the secondary earner. Due to the substitution effect, it also increases in the price for external child care. Having introduced the wage thresholds, our results show that the child's quality in (3.9) increases in the secondary earner's wage rate for all households.

The indirect utility function associated with the maximization problem is $V_i(w_i)$. Due to the additional time restrictions on parental and external child care time, the indirect utility function increases in the secondary earner's wage rate.

3.3 Child care regimes

Having introduced the baseline model, we now compare the effects of two different child care regimes financed by a proportional income tax: a public provision of external child care and a subsidization of external child care offered by the private market.

3.3.1 Publicly provided child care

At first, we analyze the effects of publicly provided external child care financed by an income tax. This setup mimics the system in the Scandinavian countries with universal public child care. The quality level of household i's children can in this case be obtained through child specific consumption, z_i, own parental time, h_i, private purchase of external child care, s_i, and governmental provision of external child care, g, with $g \in (0,1)$. Following Borck and Wrohlich (2011), we assume that all children receive the same quantity of public child care in this economy at no additional cost and that there is no possibility to opt out. On the other hand, households are allowed to supplement the publicly provided quantity, and the quantity of private purchase may differ across households. It should be noted that the fact that the quantity of public child care is common to all children does not mean that all households receive the same quantity of public services, because the number of children may differ across households. Household i's quality level for each child, q_i, is given by the following domestic production function:

$$q_i = \theta z_i^{\eta}(1 + h_i)^{\rho}(1 + s_i + g)^{(1-\rho)} \tag{3.14}$$

Based on the result of Blau and Currie (2008), we assume that privately and publicly provided child care have the same effect on the child's quality and that parents thus only differentiate between their preference for parental and external child care.[14] Public provision of external child care is financed by a proportional income tax t with $t \in (0,1)$. The household's budget constraint is therefore given by:

$$(Y + w_i L_i)(1 - t) = c_i + B z_i n_i + \pi s_i n_i \tag{3.15}$$

Following Kimura and Yasui (2009), we assume that the technology for converting expenditures into quantity of service is the same as that in the private sector. The government's budget constraint is given by

$$t\{Y + \int_0^{\infty}[1 - h(w)n(w)]w\, dF(w)\} = \pi g \int_0^{\infty} n(w)dF(w) \tag{3.16}$$

where $n(w)$ denotes the number of children and $h(w)$ the parental time spent with the children of a household with wage w. For simplification we denote $\bar{n}$ as the average number of children, $\int_0^{\infty} n(w)\mathrm{d}F(w)$, and $\bar{m}$ as the average labor income of a family in

[14] Blau and Currie (2008) conclude in their analysis on the provision of high-quality early childhood education that neither public nor private care is of uniformly higher quality than the other. We thus model public and private external child care as perfect substitutes.

the population, $Y + \int_0^\infty [1 - h(w)n(w)]w\, dF(w)$, of a household with an average wage rate $\bar{w}$. The government's budget constraint in (3.16) can thus be written as $t\bar{m} = \bar{n}\pi g$.

As in the baseline model, the solution to the household decision problem can either be interior, or at a corner where the household chooses either not to work and not to demand external child care or to work fulltime and to demand the maximum amount of private external child care. For households choosing an interior solution of parental and external child care time, the first-order conditions imply

$$n_{i,g}^* = \frac{\gamma\eta(Y + w_i)(1-t)}{P_{n,i,g}} \tag{3.17}$$

$$h_{i,g}^* = \frac{\rho P_{n,i,g} - \eta w_i(1-t)}{\eta w_i(1-t)} \tag{3.18}$$

$$s_{i,g}^* = \frac{(1-\rho)P_{n,i,g} - \eta(1+g)\pi}{\eta\pi} \tag{3.19}$$

$$z_{i,g}^* = \frac{P_{n,i,g}}{B} \tag{3.20}$$

$$q_{i,g}^* = \frac{\theta(1-\rho)P_{n,i,g}}{\eta\pi}\left(\frac{P_{n,i,g}}{B}\right)^{\eta}\left(\frac{\rho\pi}{(1-\rho)w_i(1-t)}\right)^{\rho} \tag{3.21}$$

with $P_{n,i,g}$ being the price for child care, $P_{n,i,g} = w_i(1-t) + (1+g)\pi$. An increase in publicly provided child care thus increases the price for child care as it effectively increases the price for private external child care for parents.

The effect of secondary earner i's wage rate on fertility in (3.17) is ambiguous. While an increase in the secondary earner's wage rate for families whose primary earner's income is relatively low, that is $[Y(1-t) < (1+g)\pi]$, has a positive effect on fertility, families whose primary earner's income is relatively high, that is $[Y(1-t) > (1+g)\pi]$, will decrease their demand for children. Assuming $[Y(1-t) > (1+g)\pi]$, the lowest and highest possible fertility rates are given by $\lim_{w_i\to\infty} n_{i,g}^* = \gamma\eta$ and $\lim_{w_i\to 0} n_{i,g}^* = \frac{\gamma\eta Y(1-t)}{(1+g)\pi}$. Comparing these results with our results of the baseline model in Figure 3.1, we find that the highest possible fertility rate decreases in the tax rate while the lowest possible fertility rate stays constant. An increase in publicly provided child care effectively increases the price for private external child care and therefore has a negative effect on the parents' demand for children. Supporting this result, we find that regarding

the tax rate, an increase in publicly provided child care financed by an increasing in the income tax leads to a decrease in fertility for all families.

Our results for households choosing an interior solution suggest that an increase in publicly provided child care financed by an increase in the income tax rate leads to an increase in parental time in (3.18) and a decrease in the demand for external child care in (3.19). Due to redistribution via the income tax, the negative effect on the demand for private external child care increases in the secondary earner's wage rate. The positive effect on parental child care, on the other hand, decreases in the secondary earner's wage rate. In this framework, an increase in publicly provided child care thus crowds out privately provided child care and at the same time does not have a positive effect on the secondary earner's labor supply due to the strong income effect.

As in the baseline model, there is a threshold wage rate, $\widehat{w}_{g,l}^{s}$, below which secondary earners choose a corner solution of not buying external child care, $s_{i,g}^{*} = 0$ and a threshold wage rate, $\widehat{w}_{g,u}^{h}$, above which secondary earners choose not to stay at home with the children such that $h_{i,g}^{*} = 0$. There is also a threshold wage rate, $\widehat{w}_{g,u}^{s}$, above which households cannot consume more external child care and a threshold wage rate, $\widehat{w}_{g,l}^{h}$, below which secondary earners cannot further decrease their labor supply. In case of publicly provided child care, the maximum demand for external child care time is $(1 - g)$.

The wage rate thresholds are:

$$\widehat{w}_{g,l}^{s} = \frac{(\eta + \rho - 1)(1 + g)\pi}{(1 - \rho)(1 - t)} \tag{3.22}$$

$$\widehat{w}_{g,u}^{s} = \frac{2\eta\pi - (1 - \rho)(1 + g)\pi}{(1 - \rho)(1 - t)} \tag{3.23}$$

$$\widehat{w}_{g,l}^{h} = \frac{\rho(1 + g)\pi}{(2\eta - \rho)(1 - t)} \tag{3.24}$$

$$\widehat{w}_{g,u}^{h} = \frac{\rho(1 + g)\pi}{(\eta - \rho)(1 - t)} \tag{3.25}$$

The thresholds in (3.22), (3.24), and (3.25) are larger than in the baseline model for all families. They exceed the levels of $\widehat{w}_{l}^{s}, \widehat{w}_{l}^{h}$ and $\widehat{w}_{u}^{h}$ by $\left(\frac{1+g}{1-t}\right)$ respectively (compare to Figure 3.2). Only $\widehat{w}_{g,u}^{s}$ in (3.23) is smaller than $\widehat{w}_{u}^{s}$. Fewer households will buy supplementary private external child care if the government offers publicly provided child

care. At the same time also fewer households will abstain from parental time. An increase in publicly provided external child care thus has a negative effect on the secondary earner's labor supply. These differences in the threshold wages increase in the income tax rate and therefore in the amount of publicly provided child care.

The effect of an increase in the income tax rate on child specific consumption in (3.20) is positive. Increasing publicly provided child care by increasing the income tax rate also has a positive effect on the child's quality in (3.21) for all families whose secondary earner's wage rate is smaller than the ratio of average household income to average number of children, that is $w_i < \frac{\bar{m}}{\bar{n}}$. These households benefit from redistribution vie the income tax. In this case the positive effects on parental child care and child-specific consumption dominate the negative effect on the demand for private external child care. For secondary earners with a higher wage rate the effect is ambiguous but also likely to be positive.[15]

Proposition 3.1: *Increasing publicly provided child care leads to a decrease in both fertility and the secondary earner's labor supply. At the same time, a family is likely to invest more in the quality of their children. We thus observe a quantity-quality trade-off with respect to public child care.*

3.3.2 Subsidy on external child care

In the following, we analyze the effects of a subsidization of external child care offered by the private market. We assume that there is no publicly provided child care available and households have to buy external child care on the private market. This setup mimics the system in the United States. If the government subsidizes privately provided external child care by β, parents face the following budget constraint:

$$(Y + w_i L_i)(1 - \tau) = c_i + B s_i n_i + \pi(1 - \beta) s_i n_i \qquad (3.26)$$

The subsidy for external child care is financed by the proportional income tax τ with $\tau \in (0,1)$. The government's budget constraint is then given by:

[15] The effect of an increase in the tax rate on the child's quality is positive as long as $\left[(1 + \eta)(\bar{m} - \bar{n} w_i)(1 - t) + \rho \bar{n} P_{n,i,g}\right] > 0$ holds.

$$\tau\left[Y + \int_0^\infty (1 - h(w)n(w))w\, dF(w)\right] = \beta\pi \int_0^\infty s(w)n(w)dF(w) \tag{3.27}$$

Using the same notation as in 3.3.1, the government's budget constraint in (3.27) can be written as $\beta\bar{n}\bar{s}\pi = \tau\bar{m}$, where $\bar{s}$ denotes the average time children spend in external child care. This implies that $\bar{n}\bar{s}\pi \geq \tau\bar{m}$ holds. For a tax rate $\tau = \frac{\bar{n}\bar{s}\pi}{\bar{m}}$ the subsidy β is equal to one and external child care is offered for free to the households.

As before, the solution to the household decision problem can either be interior, or at a corner where the household chooses either not to work and not to demand external child care or to work fulltime and to demand the maximum amount of private external child care. For households choosing an interior solution of parental and external child care time, the first-order conditions imply

$$n_{i,\beta}^* = \frac{\gamma\eta(Y + w_i)(1 - \tau)}{P_{n,i,\beta}} \tag{3.28}$$

$$h_{i,\beta}^* = \frac{\rho P_{n,i,\beta} - \eta w_i(1 - \tau)}{\eta w_i(1 - \tau)} \tag{3.29}$$

$$s_{i,\beta}^* = \frac{(1 - \rho)P_{n,i,\beta} - \eta\pi(1 - \beta)}{\eta\pi(1 - \beta)} \tag{3.30}$$

$$z_{i,\beta}^* = \frac{P_{n,i,\beta}}{B} \tag{3.31}$$

$$q_{i,\beta}^* = \theta\frac{(1 - \rho)P_{n,i,\beta}}{\eta\pi(1 - \beta)}\left(\frac{P_{n,i,\beta}}{B}\right)^\eta \left(\frac{\rho\pi(1 - \beta)}{(1 - \rho)w_i(1 - \tau)}\right)^\rho \tag{3.32}$$

with $P_{n,i,\beta}$ being the price for child care in case of a subsidy for external child care, $P_{n,i,\beta} = w_i(1 - \tau) + \pi(1 - \beta)$. An increase in the subsidy thus decreases the parent's costs for external child care and therefore the price for child care, $P_{n,i,\beta}$.

Fertility in (3.28) decreases in the secondary earner's wage rate for all families with $[Y(1 - \tau) > \pi(1 - \beta)]$. The lowest and highest possible fertility rates are given by $\lim_{w_i \to \infty} n_{i,\beta}^* = \gamma\eta$ and $\lim_{w_i \to 0} n_{i,\beta}^* = \frac{\gamma\eta Y(1-\tau)}{\pi(1-\beta)}$. The highest possible fertility rate thus increases in the subsidy for external child care. Households can afford more external child care and thus also more children. Regarding an increase in the income tax rate, we therefore observe an increase in fertility for all families. Hence, an increase in the subsidy for external child care leads to an increase in family i's quantity of children (compare to Figure 3.1).

For households choosing an interior solution, we find that an increase in both the wage rate of the secondary earner and in the subsidy for external child care financed by an increase in the income tax rate lead to a decrease in parental time in (3.29) and an increase in the demand for privately provided external child care in (3.30). Increasing the subsidy for external child care thus has a positive effect on the secondary earner's labor supply. These positive effects on labor supply and the demand for external child care increase in the secondary earner's wage rate.

As in the baseline model, there is a threshold wage rate, $\widehat{w}^{s}_{\beta,l}$, below which secondary earners choose a corner solution of not buying external child care, $s_i^* = 0$, and a threshold wage rate, $\widehat{w}^{h}_{\beta,u}$, above which parents decide not to stay at home, $h_i^* = 0$. There is also a threshold wage rate, $\widehat{w}^{s}_{\beta,u}$, above which households cannot consume more external child care and a threshold wage rate, $\widehat{w}^{h}_{\beta,l}$, below which secondary earners cannot further decrease their labor supply.

The wage rate thresholds are:

$$\widehat{w}^{s}_{\beta,l} = \frac{(\eta + \rho - 1)\pi(1-\beta)}{(1-\rho)(1-\tau)} \tag{3.33}$$

$$\widehat{w}^{s}_{\beta,u} = \frac{(2\eta + \rho - 1)\pi(1-\beta)}{(1-\rho)(1-\tau)} \tag{3.34}$$

$$\widehat{w}^{h}_{\beta,l} = \frac{\rho\pi(1-\beta)}{(2\eta - \rho)(1-\tau)} \tag{3.35}$$

$$\widehat{w}^{h}_{\beta,u} = \frac{\rho\pi(1-\beta)}{(\eta - \rho)(1-\tau)} \tag{3.36}$$

All wage thresholds are smaller than in the baseline model and thus also smaller than in the child care regime with publicly provided child care for all secondary earners (compare to Figure 3.2). More households will buy supplementary private external child care if the government subsidizes external child care. At the same time, more households will abstain from parental time.

Regarding child specific consumption in (3.31), an increase in the wage rate has a positive effect while an increase in the tax rate has a negative effect. Hence, households invest less in child-specific consumption in case of an increase in the subsidy for external child care. Concerning the child's quality in (3.32) we cannot determine which of the effects dominates: the negative effects with respect to parental time and child-specific

consumption or the positive effect on the demand for external child care. The effect depends on the household's preferences and is thus ambiguous.

Proposition 3.2: *Increasing the subsidy for external child care leads to an increase in both fertility and the secondary earner's labor supply. At the same time, family i may invest less in the quality of their child.*

3.4 Comparison of preferences over child care regimes

In this section, we compare households' preferences for the two child care regimes. We make the realistic assumption that the income distribution is skewed to the right and mean income thus exceeds median income. Assuming that median household income is below average household income implies that the median voter is effectively subsidized by both public provision of child care and by a subsidy for external child care. As the "tax price" under both child care regimes for the median income household is less than one, the chosen funding levels will be positive.

3.4.1 Preferences over child care regimes

Comparing the indirect utility levels of a household in a purely private child care regime to the case of publicly provided child care, allows us to determine the critical wage rate, $\widehat{w}_g$, for households who benefit from publicly provided child care and who do not. A household with a wage rate of the secondary earner w_i choses public child care if and only if

$$\mathrm{V}_{i,g}(w_i, t) \geq \mathrm{V}_i(w_i) \tag{3.37}$$

where $\mathrm{V}_{i,g}(w_i, t)$ is the indirect utility function associated with the maximization problem in section 3.2.1. The resulting critical value, $\widehat{w}_g$, separates the households who would choose publicly provided child care (those with a wage rate at or below $\widehat{w}_g$) from the households who would choose a purely private child care regime (those with a wage rate above $\widehat{w}_g$).

Comparing the indirect utility levels of a household in a purely private child care regime and in the case of a subsidy for external child care financed by the income tax, allows us to determine the critical wage rate, $\widehat{w}_\beta$, for households who benefit from the subsidy and who do not. A household with a wage rate of the secondary earner w_i choses a subsidy for external child care if and only if

$$\mathrm{V}_{i,\beta}(w_i, \tau) \geq \mathrm{V}_i(w_i) \tag{3.38}$$

where $\mathrm{V}_{i,\beta}(w_i, \tau)$ is the indirect utility function associated with the maximization problem in section 3.2.2. The resulting critical value, $\widehat{w}_\beta$, separates the households who would choose the subsidy from the households who would choose a purely private child care regime. In this case the relationship between the wage rate and the preference for a subsidy is not as straightforward. Low income households do not consume external child care (compare to Figure 3.2) and would therefore vote against a subsidy. Starting from the threshold wage rate, $\widehat{w}^s_{\beta,l}$, above which secondary earners choose to buy external child care, households can be differentiated between two groups: one group of households which benefits from the subsidy via redistribution and another group which would not vote for a subsidy.

To analyze how preferences for child care provision change with the secondary earner's wage rate, we follow Epple and Romano (1996a) and look at the households' indifference curves in both the (t, g) space and the (τ, β) space for some (indirect) utility level $\bar{V}$:

$$M_{i,g}(w_i, t, g) = \frac{dt}{dg}|_{\bar{V}} = -\frac{\frac{dV_{i,g}}{dg}}{\frac{dV_{i,g}}{dt}} \tag{3.39}$$

$$M_{i,\beta}(w_i, \tau, \beta) = \frac{d\tau}{d\beta}|_{\bar{V}} = -\frac{\frac{dV_{i,\beta}}{d\beta}}{\frac{dV_{i,\beta}}{d\tau}} \tag{3.40}$$

The slope of the indifference curves in (3.39) and (3.40) is positive. Due to the time restrictions on parental and external child care time, household preferences can in both cases not be ordered by household income. The households' indifference curves can thus cross more than once and an equilibrium may not exist. If we only considered interior solutions (that is without the time restrictions for corner solutions of parental and external child care time) household preferences could be ordered by household income and the slope of the indifference curves would decrease (increase) in the secondary earner's wage

rate for a child care regime with a public provision of (a subsidy on) external child care. The optimal tax rate would in this case equal the optimal tax rate of the median voter and our results would be closely linked to Borck and Wrohlich (2011). With the time restrictions, however, the median voter theorem does not hold.

In the case of publicly provided child care in (3.39), the slope of the indifference curves in the (t, g) space increases with the secondary earner's wage rate for low income earners and decreases for high income earners. Only low income earners benefit from publicly provided child care as rich households would choose to opt out and buy privately provided child care on the market.

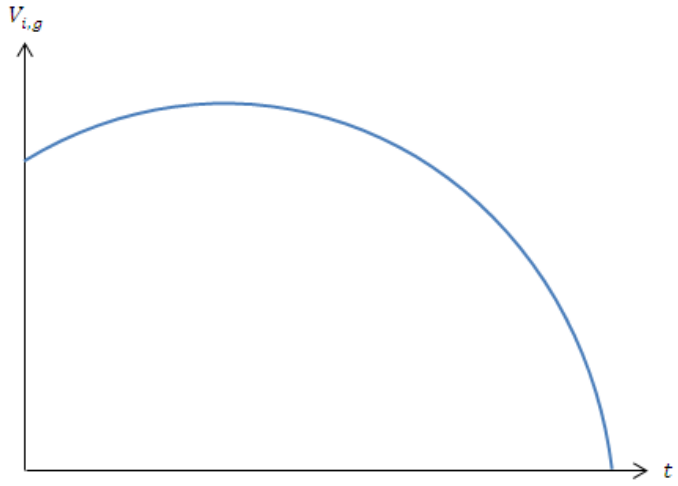


Figure 3.3: Indirect utility of a typical household dependent on the income tax

Figure 3.3 shows the indirect utility as a function of the tax rate for a household with a wage rate below $\widehat{w}_g$. This presents the household's preferences over taxes to finance publicly provided child care. The larger the household's wage rate, the more the peak of the curve shifts to the left and for all households with a wage rate above $\widehat{w}_g$ the optimal tax rate would be 0.

In case of a subsidy for external child care in (3.40), on the other hand, the slope of the indifference curves in the (τ, β) space decreases with the secondary earner's wage rate for both low and high income earners and increases for medium income earners.

This depicts the "ends against the middle" result of Epple and Romano (1996a): the middle class who wants high spending levels is opposed by the rich and poor who want low spending levels. Intuitively, this could occur for the following reason: A households'

choice of tax rate depends on whether, at a particular tax rate, the household demands external child care or not and on the households' fertility. Low income households are likely to have a higher number of children and therefore they profit more by the redistributive nature of the tax. However, households with a low income will not demand external child care and thus do not benefit from the subsidy. High income families, on the other hand, have a higher demand for external child care but they have a lower number of children and do not benefit from the redistribution via the tax rate. The middle class is the only group who benefits from both the redistribution via the number of children and the usage of external child care.

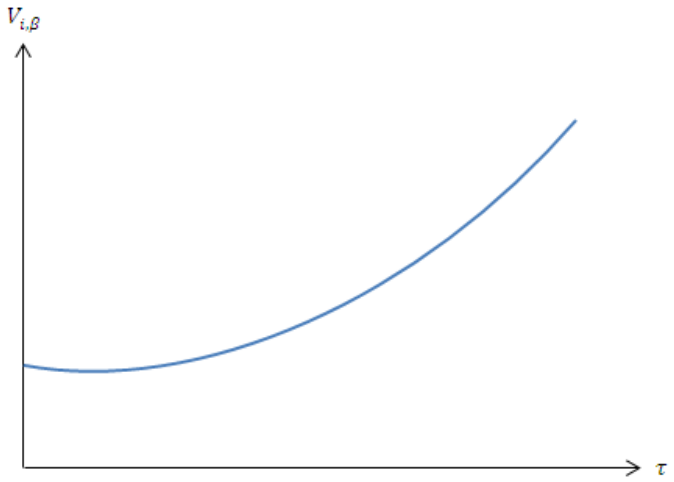


Figure 3.4: Indirect utility of a typical household dependent on the income tax

Nevertheless, if the preference parameter for parental child care, ρ, is relatively large, all households benefit the most from a full subsidy on external child care and would choose $\beta = 1$. In this case there is thus a unique equilibrium. Figure 3.4 shows a typical household's indirect utility as a function of the tax rate and presents the household's preferences over taxes for a child care subsidy. The optimal tax rate in a child care regime with a subsidy on external child care is therefore given by

$$\tau^* = \frac{\bar{n}\bar{s}\pi}{\bar{m}} \tag{3.41}$$

With decreasing ρ, the average demand for external child care increases and less households benefit from the redistributive nature of the child care regime with a subsidy on external child care. Thus, if households have a small preference for parental child care and the average demand for external child care is therefore large, high income households would prefer a tax rate of zero. Low and medium income households would still prefer a

full subsidy of external child care. Low income households usually do not demand external child care, but if it is provided for free, they will consume it and benefit the most from the redistribution via the number of children. Having assumed that the income distribution is skewed to the right and mean income thus exceeds median income, the decisive voter will vote for a full provision of the subsidy.

Proposition 3.3*: While richer households benefit the most from a subsidy for external child care, poorer households either prefer publicly provided child care or a full subsidy on external child care.*

3.4.2 Numerical simulation

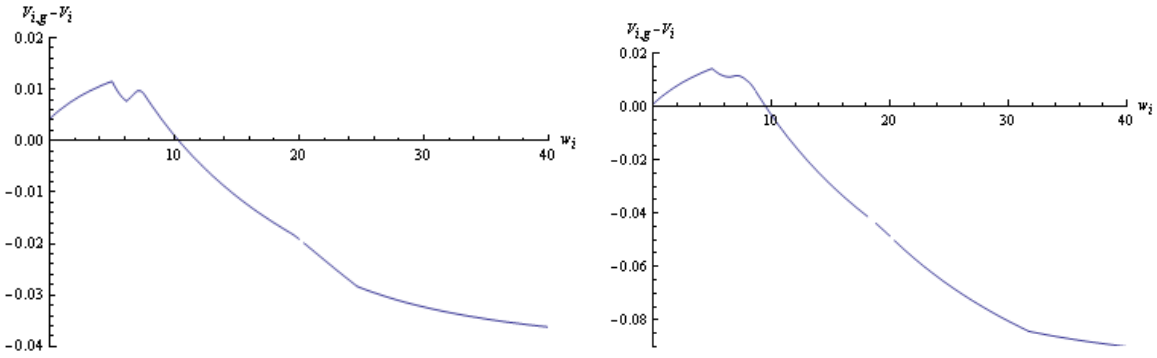
To illustrate our results, we now present a numerical simulation. We calibrate our numerical example to broadly fit relevant parameters for Germany. We assume that the household income is distributed according to a lognormal-distribution, $\ln(Y + w_i) \sim \mathcal{N}(\mu, \sigma)$ with $\mu = 3.74$ and $\sigma = 0.464$. This results in an average gross household income of $\overline{m} = 46.875$ [16] and median endowment of $m^M = 42.1$, with income measured in 1,000 Euros. We set the primary earner's income $Y = 40$, the yearly prices for external child care $\pi = 10$ and for child-specific consumption goods $B = 0.1$, and the following preference and productivity parameters $\gamma = 0.75$, $\eta = 0.75$, $\rho = 0.5$, $\theta = 0.05$. The resulting fertility and child care choices in the baseline model are $\bar{n} = 1.37$, $\bar{s} = 0.4$, and $\bar{h} = 0.3$. The average secondary earner's wage rate is $\overline{w} = 10.928$ and the median wage rate is $w^M = 8.058$.

In the following, we compare the indirect utility levels of households in the different child care regimes when either one of the two child care regimes is being implemented. In a first step, we compare the two child care regimes with the baseline model, namely a purely private regime without subsidization. Then, we also compare to utility levels for the households with respect to the different child care regimes.

[16] This equals the German average gross household income in 2011 (compare to Federal Statistical Office of Germany)

Setting $t_1 = \tau_1 = 0.05$ and $t_2 = \tau_2 = \frac{\bar{n}\bar{s}\pi}{\bar{m}} = 0.12$ we find the following utility differences for the child care regimes.

Figure 3.5 illustrates the utility differences for a regime with publicly provided child care and a purely private child care regime. We find that only households with low wages benefit from publicly provided child care. With an increasing income tax, less households benefit from publicly provided child care and the utility loss for high income households increases.



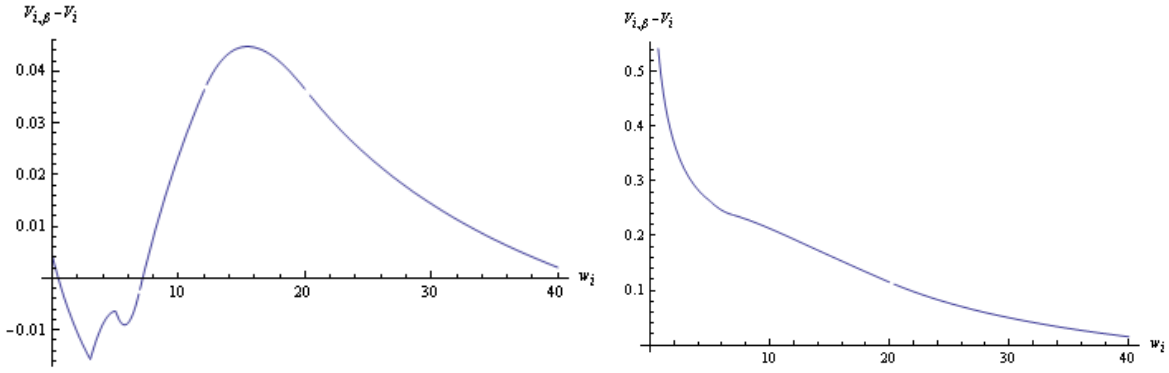
$t_1 = 0.05$ $t_2 = 0.12$

Figure 3.5: Preferences for publicly provided versus purely private child care

This result is similar to Borck and Wrohlich (2011) who also find that richer households clearly prefer market provision over pure government provision. Our results only differ with respect to low income households. By adding the time restrictions, we find that for low income households, the preference for publicly provided child care increases in the secondary earner's wage rate. The larger the preference parameter for parental child care, ρ, the further the curve shifts to the right and the utility loss for high income households decreases (compare to Figures 3.8 and 3.11 in Appendix 3.B). [17]

Figure 3.6 shows the utility differences of a child care regime with a subsidy for external child care and a purely private child care regime. In this case, we find that households with very low or high incomes benefit from the policy while households with low incomes would choose a purely private child care regime as long as the tax rate is relatively low.

[17] As we are considering an introduction of a child care regime, we have to take into account that changing the preference parameter ρ also affects average fertility and external child care time in the baseline model. See Appendix 3.B for the results for $\rho = 0.3$ and $\rho = 0.7$.

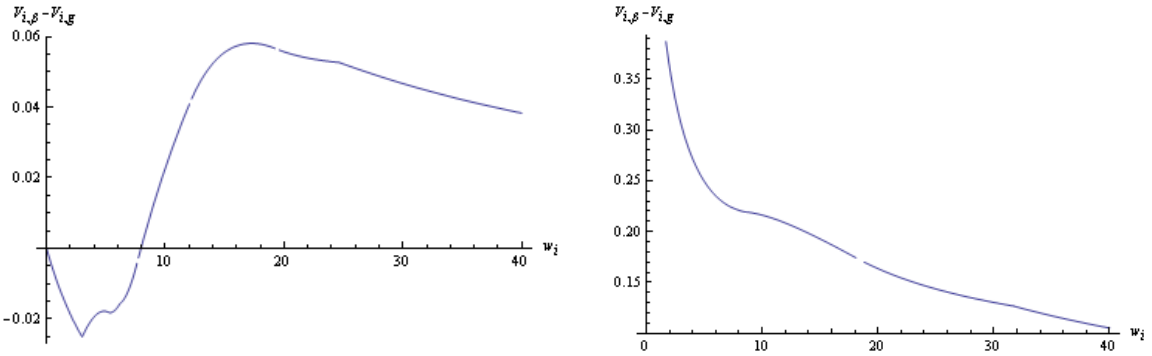


$\tau_1 = 0.05$ $\tau_2 = 0.12$

Figure 3.6: Preferences for subsidized versus purely private child care

In case of the optimal income tax (that is $\beta = 1$), all households benefit from the child care regime with a subsidy on external child care. In this case, external child care would be offered for free and all households would demand external child care. Low income households with many children benefit the most from the redistribution via the tax system and their utility gain in this case would thus be relatively large.

The larger the preference for parental child care, ρ, the smaller are both average fertility and demand for external child care and the smaller are thus also the utility gains for low and medium income households (compare to Figure 3.12 in Appendix 3.B). In this case, the necessary tax rate for a full subsidy decreases and high income households benefit more from the redistributive nature of the subsidy. The smaller the preference for parental child care, however, the more low and medium income households benefit from the subsidy while high income households would prefer a purely private child care regime (compare to Figure 3.9 in Appendix 3.B).



$t_1 = 0.05 = \tau_1$ $t_2 = 0.12 = \tau_2$

Figure 3.7: Preferences for subsidized versus publicly provided child care

In a final step, we compare the child care regime with public provision to the subsidized child care regime (Figure 3.7). We find that for a relatively low tax rate, only richer households prefer the subsidy over public provision while poorer households would favor public provision. In case of a full provision of the subsidy, all households prefer the child care regime with a subsidy over the one with publicly provided child care. For a decreasing preference for parental child care, the curve shifts upwards while for an increasing preference for parental child care, the curve shifts downwards (compare to Figures 3.10 and 3.13 in Appendix 3.B).

3.5 Conclusion

In this paper, we analyze households' preferences for public provision and a subsidy on private child care and compare the effects on fertility, use of external child care, the secondary earner's labor supply, and welfare. Our model predicts that publicly provided child care increases both the wage threshold for parents who do not buy additional external child care on the market and for parents who do not stay at home with their children. We thus observe a crowding out of privately provided child care while at the same time more parents stay at home with their children. Therefore, publicly provided child care in this framework has a negative effect on the secondary earner's labor supply. This result is similar to the findings of Havnes and Mogstad (2011) who analyze a staged expansion of subsidized child care in Norway. Their results suggest that there is little, if any, causal effect of subsidized child care on maternal employment. Instead, of increasing mothers' labor supply, they also find that the subsidized child care mostly crowds out informal child care arrangements. We also show that increasing publicly provided child care leads to a decrease in fertility while it increases the child's quality for secondary earners with a relatively low wage rate. Hence, we observe a quantity-quality trade-off in a child care regime with publicly provided child care.

A subsidy on privately provided external child care, on the other hand, decreases both the wage threshold for parents who do not demand external child care and for parents who abstain from parental child care. We find that an increase in the subsidy for external child care has both a positive effect on the secondary earner's labor supply and on the household's fertility. The effect on the child's quality is in this case positive for secondary

earners with a relatively high wage rate. In a child care regime with a subsidy on external child care, low income earners thus increase both their fertility and labor supply but at the same time invest less in their children's quality. This result is in line with several empirical findings (e.g. Lefebvre and Merrigan, 2008) which study the effect of child care subsidies on female labor market participation.

Regarding the households' preferences for the two different child care regimes, we find that while richer households benefit the most from a subsidy for external child care, poorer households either prefer publicly provided child care or a full subsidy on external child care. The larger the subsidy for privately provided external child care, the more households benefit as the wage threshold for parents who demand external child care decreases. In case of a full subsidy all households demand external child care and poor households benefit the most from the subsidy both through the redistribution via taxation and via the number of children. By offering free child care provided by the private market the government could therefore foster both fertility and the secondary earner's labor supply as well as at the same time increase the households' welfare.

Appendix

3.A: Demand functions

Demand function for parental child care in the baseline model:

$$h_i = \begin{cases} 1 & \text{if} \quad w_i < \widehat{w}_l^h \quad \text{and} \quad n_i < 1 \\ \dfrac{1}{n_i} & \text{if} \quad w_i < \widehat{w}_l^h \quad \text{and} \quad n_i \geq 1 \\ \dfrac{1}{n_i} & \text{if} \quad \widehat{w}_l^h \leq w_i \leq \widehat{w}_u^h \quad \text{and} \quad n_i\left(\dfrac{\rho(w_i+\pi)-\eta w_i}{\eta w_i}\right) \geq 1 \\ \dfrac{\rho(w_i+\pi)-\eta w_i}{\eta w_i} & \text{if} \quad \widehat{w}_l^h \leq w_i \leq \widehat{w}_u^h \quad \text{and} \quad n_i\left(\dfrac{\rho(w_i+\pi)-\eta w_i}{\eta w_i}\right) < 1 \\ 0 & \text{if} \quad w_i > \widehat{w}_u^h \end{cases} \tag{3.A.1}$$

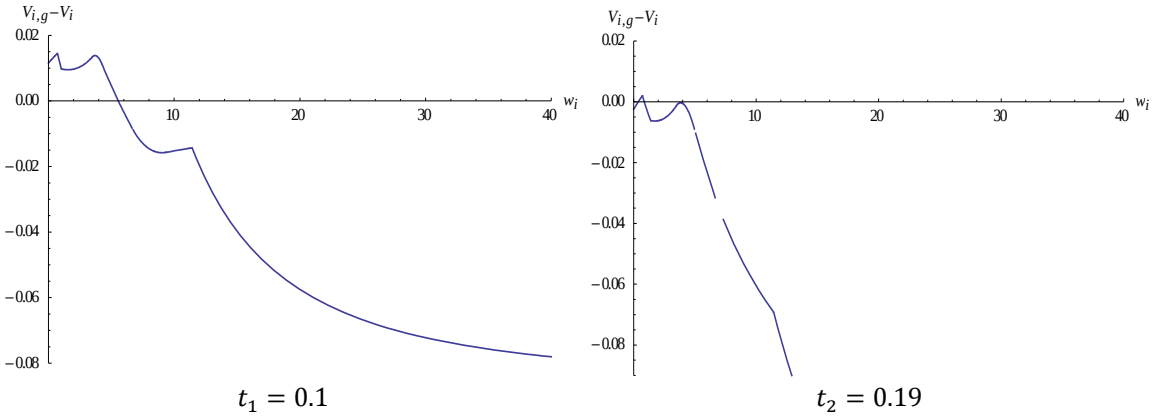
Demand function for external child care in the baseline model:

$$s_i = \begin{cases} 0 & \text{if} \quad w_i < \widehat{w}_l^s \\ \dfrac{(1-\rho)(w_i+\pi)-\eta\pi}{\eta\pi} & \text{if} \quad \widehat{w}_l^s \leq w_i \leq \widehat{w}_u^s \\ 1 & \text{if} \quad w_i > \widehat{w}_u^s \end{cases} \tag{3.A.2}$$

3.B: Results of the numerical simulation

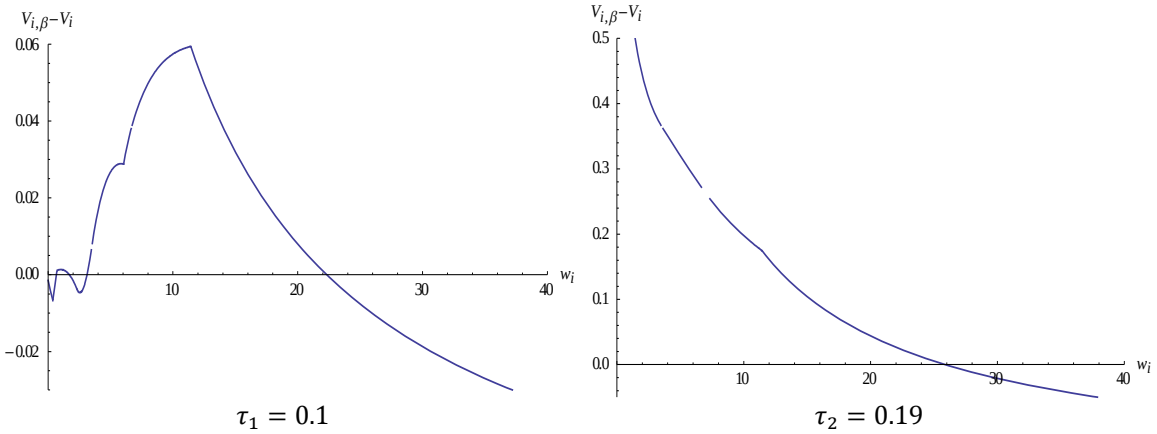
Setting $\rho = 0.3$, we find the following fertility and child care choices in the baseline model: $\bar{n} = 1.57$, $\bar{s} = 0.6$, and $\bar{h} = 0.1$. The average secondary earner's wage rate is $\overline{w} = 6.78$ and the median wage rate is $w^M = 4.43$. Parents in this case have a smaller preference for parental child care time and average fertility and external child care time are thus larger.

Setting $t_1 = \tau_1 = 0.1$ and $t_2 = \tau_2 = \frac{\bar{n}\bar{s}\pi}{\bar{m}} = 0.19$ we find the following utility differences for the child care regimes:



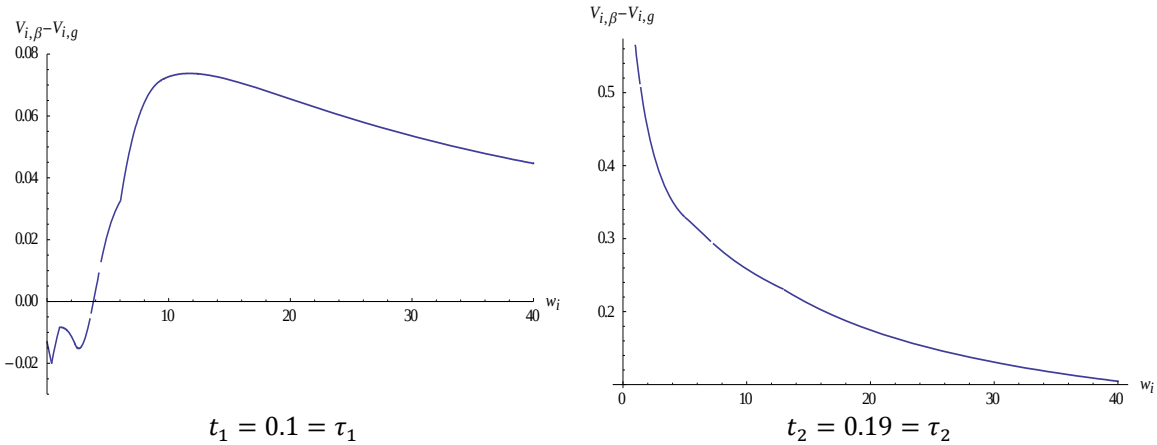
$t_1 = 0.1$ $t_2 = 0.19$

Figure 3.8: Preferences for publicly provided versus purely private child care



$\tau_1 = 0.1$ $\tau_2 = 0.19$

Figure 3.9: Preferences for subsidized versus purely private child care



$t_1 = 0.1 = \tau_1$ $t_2 = 0.19 = \tau_2$

Figure 3.10: Preferences for subsidized versus publicly provided child care

Setting $\rho = 0.7$, we find the following fertility and child care choices in the baseline model: $\bar{n} = 1.2$, $\bar{s} = 0.1$, and $\bar{h} = 0.5$. The average secondary earner's wage rate is $\bar{w} = 16.62$ and the median wage rate is $w^M = 13.05$. Parents in this case have a higher preference for parental child care time and average fertility and external child care time are thus smaller.

Setting $t_1 = \tau_1 = 0.01$ and $t_2 = \tau_2 = \frac{\bar{n}\bar{s}\pi}{\bar{m}} = 0.03$ we find the following utility differences for the child care regimes:

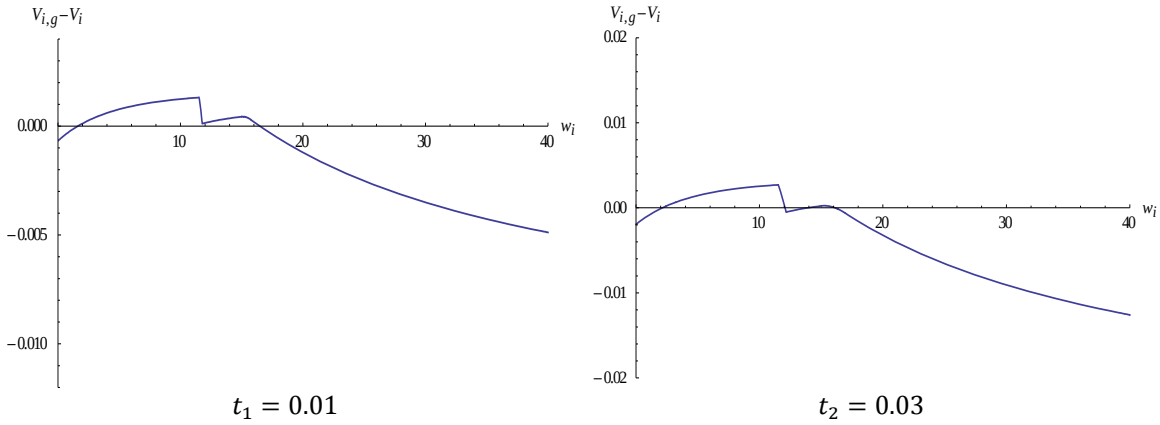


Figure 3.11: Preferences for publicly provided versus purely private child care

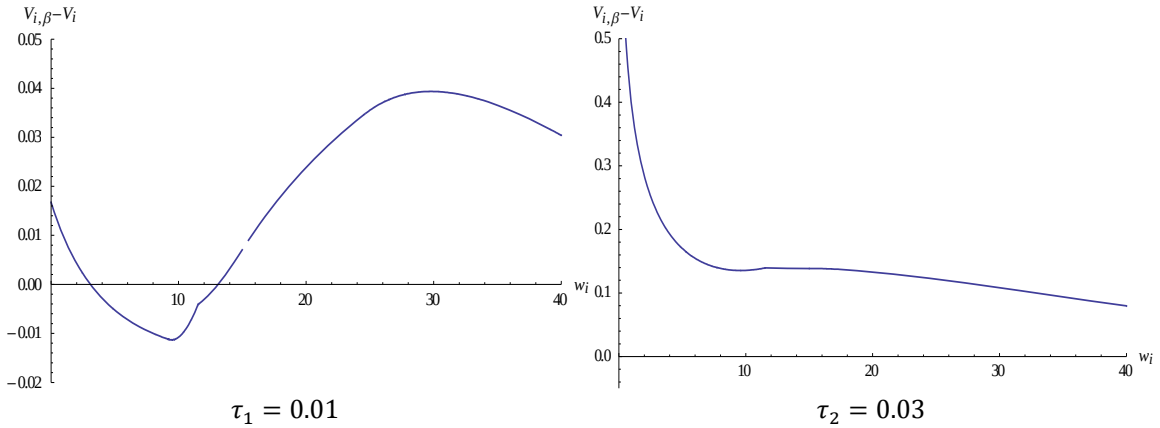


Figure 3.12: Preferences for subsidized versus purely private child care

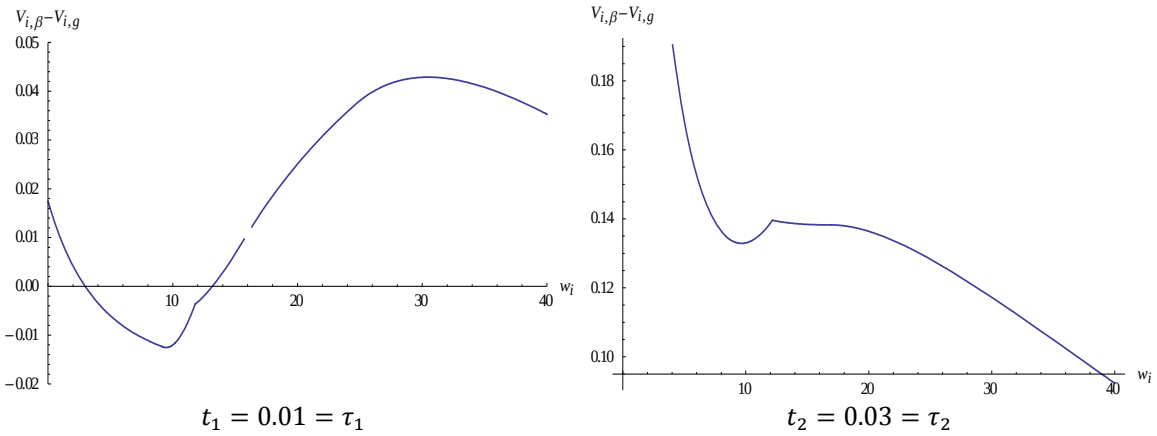


Figure 3.13: Preferences for subsidized versus publicly provided child care

Chapter 4

The Role of Government in Child Care Provision [18]

4.1 Introduction

All European countries are facing dilemmas and tensions related to the complex interaction between changes in the labor market, fertility trends, and children's opportunities. Social policy is therefore confronted with distinct policy objectives and instruments. In confronting the issue of low fertility levels and mothers labor market participation rates, policy makers have considered and tried a variety of options. One policy option that has received considerable attention is making high quality child care available and affordable (Attanasio et al., 2008).

In this paper, we present a theoretical model which analyzes preferences for parental and external child care and the effects of public policies on welfare, fertility and investments in quality of children within a model with endogenous fertility and labor supply of a secondary earner. We compare the households' preferences for quantity and quality of

[18] This chapter is based on joint work with Robert Fenge

publicly provided child care as well as for a price subsidy for publicly provided child care and a parental child care benefit. Publicly provided child care in this setting can either be provided by municipalities, churches or non-profit organizations while the carriers of privately provided external child care include for-profit institutions, child care by nannies, au-pairs or babysitters. Parents can opt for publicly provided child care or receive a parental child care benefit. This reflects the German system of parental child care benefits, the so called "Betreuungsgeld", that are only obtainable for parents who either care for their children themselves or demand only privately provided external child care.[19] Parental child care benefits are also established in Finland, Norway, and Sweden but we focus on the German system. We analyze how effectively the policy instruments are able to achieve a compatibility of family and work and model the parents' decision whether to demand publicly provided child care or receive a parental child care benefit.

The increased demand for child care accompanying the rise of two-earner couples has attracted the attention of policy makers and researchers alike. While the theoretical literature is relatively scarce, there exist various empirical studies on child care and maternal employment (see Blau and Currie (2006) for a survey).

Borck and Wrohlich (2011) analyze preferences for a public, private or mixed provision of child care both theoretically and empirically. Similar to our theoretical model, they model child care as a publicly provided private good. Their model builds on the redistributive aspect of public provision of private goods (see Besley and Coate, 1991; Epple and Romano, 1996a). They conclude that richer households should prefer market provision to purely public or mixed provision while preferences over public versus mixed provision depend on the redistributive effect of public provision. We extend their approach by additionally considering parental child care and adding differences in the qualities of the child care options. Furthermore, we also extend their analysis by considering price subsidies for public child care and a parental child care benefit.

The results of empirical studies on the effect of public child care on fertility and female labor supply are ambiguous. Havnes and Mogstad (2011) evaluate the effect of child care on labor supply using a 1975 reform. They find that a large-scale expansion of subsidized

[19] The "Betreuungsgeld" was introduced at the beginning of 2013 and is a monthly child care supplement for parents whose children aged three and under are not in a state-subsidized nursery. At the same time a spot in just such a nursery has become a legal entitlement for all children (Federal Ministry for Family Affairs, Senior Citizens, Women and Youth, 2013)

child care in Norway had little impact on maternal employment.[20] Instead, they found that the new subsidized child care mostly crowds out informal care arrangements implying a significant net cost of the child care arrangement. Previous research mostly came to the conclusion that affordable and readily available child care is a driving force both of cross-country differences in maternal employment and of its rapid growth over the last decades (see e.g. Jaumotte, 2003; Del Boca, 2002; Aaberge et al. 2005; Attanasio et al., 2008). Blau and Currie (2006) point out two fundamental problems of these studies: child care access and prices are endogenous to the work decision of mothers and the availability and cost of informal care is unobserved. Havnes and Mogstad (2011) conclude that the discrepancy between the estimates in the previous literature is likely to be explained by differences in biases owing to ignoring the substitution between subsidized and informal child care, misspecifications of functional forms for the employment and child care equations, and violations of the exclusion restriction.

There are also some empirical studies analyzing the effect of public child care on fertility. Rindfuss et al. (2010) examine a policy reform from the mid-1970s in Norway, which led to a substantial expansion of public child care. Their results suggest that moving from having no child care slots available for preschool children to having slots available for 60% of preschool children has a positive effect on fertility. Mörk et al. (2013) exploit the exogenous variation in parental fees caused by a Swedish child care reform in 2001 to identify the effect of child care costs on fertility. They find that the reduction in child care costs increased the number of first and higher order births, but only seemed to affect the timing of second births.

The second policy instrument we want to analyze is a parental child care benefit. Gathmann and Sass (2012) use a reform in East Germany that generated exogenous variation in child care prices to study the impact of child care costs on child care utilization, family labor supply and child well-being. In 2006, the government of Thuringia introduced a new family policy that provides generous subsidies to families who do not send their child to public child care. This family policy is very similar to the in 2013 introduced “Betreuungsgeld” in all German states which we formally analyze in our theoretical model. The specific structure of the subsidy in Thuringia is such that it declines linearly with the number of hours the eligible child attends public child care. As such, the subsidy is equivalent to an increase in the hourly price of public child care (fully

[20] Subsidized child care in this case refers to public and private child care institutions, eligible for subsidies from the government because they satisfy federal quality requirements

compensated by an income subsidy). Gathmann and Sass (2012) find that parents respond to those changes in the price for public child care by reducing both public and informal daycare and increasing parental child care. Declines in public daycare attendance are especially dramatic for children from low-skilled, single parents and low income families. Their results suggest that the decline in female labor force participation is strongest for single parents and low income households while they find no effect on fertility in eligible households.

Our main findings are the following. We find that for households opting for public child care, an increase in the quantity of publicly provided child care has a negative effect on both fertility and secondary earner's labor supply while the effects of an increase in its quality depend on the price effect and may be positive. Our results also suggest that both a price subsidy for publicly provided child care and the parental child care benefit has a negative effect on fertility and the secondary earner's labor supply for all households.

Regarding welfare, we find that for households choosing an interior solution of parental and external child care both policy instruments, a parental child care benefit and publicly provided child care, are equally effective. The household's decision which policy instrument to choose only depends on the relative benefit the household receives in total. This decision is independent of the household's income. For households choosing a corner solution, on the other hand, the decision depends on a variety of parameters: their income, their preferences for children, child care and consumption as well as on the policy parameters. Low income households choosing a corner solution of staying at home and not consuming external child care opt for a parental child care benefit if they have a small preference for children and their quality. For high income households, the decision depends on differences between the qualities of private and public external child care. If the relative benefit a household receives from the policy instruments is identical and the quality of private external child care is larger than the quality of publicly provided child care, a household in this corner solution also benefits more from the parental child care benefit than from publicly provided child care

The paper is organized as follows. In section 4.2 we introduce the economic setup. Section 4.3 presents the comparative static results for households choosing an interior solution of parental and external child care as well as for households choosing a corner solution. In section 4.4, we calculate the welfare effects of the parents' decision whether or not to demand publicly provided child care and section 4.5 concludes.

4.2 The model

We use a static model and allow for heterogeneity in the households' preferences with respect to consumption, fertility, and the child's quality. Family i's decisions are assumed to be taken by the parents who derive utility from their own consumption, c_i, their number of children, n_i, and their child's quality of life, q_i. The household's preferences are represented by the following utility function

$$U_i = (1 - \gamma_i) \ln c_i + \gamma_i \ln(n_i q_i) \tag{4.1}$$

with $\gamma_i \in \{0,1\}$ and $i \in \{1, \dots, N\}$. The parameter γ_i captures the family's relative weight given to their children. Note that households care about both child quantity and child quality. The quality per child, q_i, can be understood as a good produced domestically by the parents who use as inputs time spent with the child and a child-specific consumption good, z_i, bought on the market. For simplicity, we assume that only the secondary earner of family i spends time with the children. Time spent with a child can be divided into the secondary earner's own time, h_i, the time the child spends at privately provided external child care, s_i, and the time the child spends at publicly provided external child care, g. We assume that publicly provided child care in this setting can either be provided by municipalities, churches or non-profit organizations while the carriers of privately provided child care include for-profit institutions, child care by nannies, au-pairs or babysitters. Parents can decide whether they want to make demands on publicly provided child care or not and there is thus a possibility to opt out. If parents decide not to demand public child care, they are eligible for a parental child care benefit. In case parents opt for public child care, we assume that all children receive the same quantity of public child care in this economy. All households are allowed to supplement the publicly provided quantity and the quantity of private purchase may differ across households. It should be noted that the fact that the quantity of public child care is common to all children whose parents opt for public child care does not mean that all households receive the same quantity of public services, because the number of children may differ across households. The strictly concave domestic production function for a child's quality is given by

$$q_i = \theta(z_i)^{\eta_i}(1 + h_i q_h)^{\rho_i}\left(1 + \alpha_i g q_g + s_i q_s\right)^{(1-\rho_i)} \tag{4.2}$$

with $\theta > 0$, $\eta_i \in \{0,1\}$, and $\rho_i \in \{0,1\}$. The parameter ρ_i illustrates the household's preference for parental child care and $(1 - \rho_i)$ shows the household's preference for

external child care. η_i depicts the household's preference for child-specific consumption. This quality technology thus assumes diminishing returns to both child-specific consumption and parental child care time, but constant returns to scale in parental and external child care time. The parameter α_i represents the parents' decision regarding public child care. For $\alpha_i = 0$ the parents decide against while for $\alpha_i = 1$ they opt for publicly provided child care. The terms $(1 + h_i q_h)$ and $\left(1 + \alpha_i g q_g + s_i q_s\right)$ guarantee that the child's quality remains positive even if parents either do not care for their child themselves or do not demand external child care. Note that we allow for corner solutions regarding parental and external child care time but not regarding child-specific consumption. All forms of child care time are assumed to have different qualities: q_h describes the quality of the secondary earner to care for her child while q_g and q_s depict the quality of the public and private daycare teachers, respectively.

The secondary earner allocates her time to working which yields income at the rate w_i and to leisure time. We assume that child rearing is the only domestic time requiring parental time so that she spends her leisure time completely with the children. Through the endogeneity of n_i, the secondary earner's labor supply is also endogenous. If she has n_i children her parental time equals $h_i n_i$. The rest of secondary earner i's total time is working time and given by $L_i = 1 - h_i n_i$, her average lifetime gross income therefore equals $w_i L_i$. Secondary earners carrying a larger wage rate, w_i, thus have higher opportunity costs of both having and raising children. The primary earner allocates all her time to working and her average lifetime gross salary is Y_i. The market prices for privately provided child care, s_i, and publicly provided child care, g, are denoted by π_s and π_g, respectively. We assume that the government subsidizes the price for publicly provided child care by β. The price on the market for the child-specific consumption good, z_i, is denoted by B. Parents can choose whether they want to make demands on publicly provided child care or not. If they choose to opt out, they receive a parental child care benefit, σ, per child. The decision is denoted by the parameter α_i. For $\alpha_i = 0$ the family decides to take a parental child care benefit while for $\alpha_i = 1$ they opt for publicly provided child care. The family's budget constraint is thus given by:

$$(Y_i + w_i L_i)(1 - t) = c_i + \pi_s s_i n_i + \alpha_i \pi_g (1 - \beta) g n_i + B z_i n_i - (1 - \alpha_i)\sigma n_i \qquad (4.3)$$

Parents choose consumption, c_i, the number of children, n_i, the secondary earner's time spent with a child, h_i, the amount of bought-in child care, s_i, as well as child-specific

consumption, z_i, so as to maximize their utility, $U_i(c_i, n_i, q_i)$, by taking account of the child's quality production and their budget constraint.

The household decision problem is given by:

$$\max_{c_i, n_i, z_i, h_i, s_i} U_i\big(c_i, n_i, q_i(z_i, h_i, s_i, g)\big) \qquad s.t. \quad (4.3) \tag{4.4}$$

Following Kimura and Yasui (2009), we assume that the technology for converting expenditures into quantity of service is the same as that in the private sector. The government's budget constraint is

$$t\big[\bar{Y} + \bar{w}\big(1 - \bar{h}\bar{n}\big)\big] = \bar{\alpha}\beta\bar{n}g\pi_g + (1 - \bar{\alpha})\sigma\bar{n} \tag{4.5}$$

where $\bar{\alpha}$ denotes the average decision for publicly provided child care or the parental child care benefit, $\bar{n}$ the average number of children, $\bar{h}$ the average parental child care time, and $\bar{w}$ and $\bar{Y}$ the average secondary earner's wage rate and primary earner's income in the population, respectively. For simplification, we denote $\bar{m}$ as the average labor income of a family in the population, $\big[\bar{Y} + \bar{w}\big(1 - \bar{h}\bar{n}\big)\big]$. We assume that the government and the private market both set their prices for child care according to their marginal costs. The variable costs for providing one unit of external child care, $k(q_x)^{\kappa}x$, incur for employing additional daycare teachers and thus depend on the quality of the child care center, with $x \in \{s, g\}$. Hence, we assume that child care centers can increase their quality by recruiting additional daycare teachers. The prices for external child care are therefore given by

$$\pi_g = k\big(q_g\big)^{\kappa} \tag{4.6}$$

$$\pi_s = k(q_s)^{\kappa} \tag{4.7}$$

with $k > 0$ and $\kappa > 0$. The government's budget constraint in (4.5) can thus be written as $t\bar{m} = \bar{\alpha}\beta g\bar{n}k\big(q_g\big)^{\kappa} + (1 - \bar{\alpha})\sigma\bar{n}$.

Hence, in our analysis, the government has four instruments: the quantity and quality of publicly provided child care, the price subsidy as well as the parental child care benefit. In the following we will analyze the impact of the four instruments on fertility, the secondary earner's labor supply, the child's quality, and on welfare.

The solution to the household decision problem in (4.4) can either be interior, or at a corner where the household chooses either not to work and not to demand private external child care or to work fulltime and to demand the maximum amount of private external child care. For households choosing an interior solution of parental and external child care time, the first-order conditions imply[21]

$$n_i^* = \frac{\gamma\eta_i(Y_i + w_i)(1-t)}{P_{n,i}} \tag{4.8}$$

$$h_i^* = \frac{\rho_i P_{n,i} q_h - \eta_i w_i (1-t)}{\eta_i w_i (1-t) q_h} \tag{4.9}$$

$$s_i^* = \frac{(1-\rho_i)P_{n,i}q_s - \eta_i\pi_s\left(1+\alpha_i g q_g\right)}{\eta_i \pi_s q_s} \tag{4.10}$$

$$z_i^* = \frac{P_{n,i}}{B} \tag{4.11}$$

$$q_i^* = \frac{\theta(1-\rho_i)P_{n,i}q_s}{\eta_i\pi_s}\left(\frac{P_{n,i}}{B}\right)^{\eta_i}\left(\frac{\rho_i\pi_s q_h}{(1-\rho_i)w_i(1-t)q_s}\right)^{\rho_i} \tag{4.12}$$

where $P_{n,i}$ is the relative price for child care:

$$P_{n,i} \equiv \frac{w_i(1-t)}{q_h} + \frac{\pi_s}{q_s} + \frac{\alpha_i g\left[\pi_s q_g - \pi_g(1-\beta)q_s\right]}{q_s} + (1-\alpha_i)\sigma \tag{4.13}$$

As we assume private and public external child care to be substitutes, the household's benefit from public child care depends on the relative price difference. In the following, we assume that the government sets the price subsidy for publicly provided child care, β, such that $\left[\pi_s q_g > \pi_g(1-\beta)q_s\right]$ holds. This implies that the government always sets the subsidy such that $\left[\beta > 1 - \left(\frac{q_g}{q_s}\right)^{(1-\kappa)}\right]$ holds. The government therefore has to consider differences in the quality of private and public child care when setting the price for public child care. Hence, both publicly provided child care and a parental child care benefit increase the relative price for child care, $P_{n,i}$, in (4.13). The reason for this increase in the relative price is that public child care effectively increases the price of private external child care while the parental child care benefit effectively increases the price of public child care for parents.

The second-order conditions for a maximum in (4.8) – (4.11) are satisfied. Due to increasing opportunity costs of having children, parental child care decreases in the

[21] See Appendix 4.A for the derivations.

secondary earner's wage rate. The demand for external child care, on the other hand, increases in the secondary earner's wage rate due to the costs associated with buying external child care. Depending on the size of ρ_i and η_i, parents might decide for a corner solution of caring solely alone for their children or not at all. For households with a relatively high preference for parental child care, there is a threshold wage rate, $\widehat{w}_{i,l}^{s}$, below which secondary earners choose a corner solution of not buying external child care, $s_i^* = 0$. For households with a relatively small preference for parental child care, there is a threshold wage rate, $\widehat{w}_{i,u}^{h}$, above which secondary earners choose not to stay at home with the children such that $h_i^* = 0$. We additionally assume that the maximum demand for external child care time is one. Parents can neither buy more than one unit of external child care time per child nor spend more time at home with the child. There is thus also a threshold wage rate, $\widehat{w}_{i,u}^{s}$, above which households cannot consume more external child care. At maximum they can consume one unit of privately provided external child care. If the households additionally demand public child care, the maximum amount of private child care decreases to $(1-g)$. We furthermore assume that the demand for parental child care time is at maximum either $\frac{1}{n_i}$ or one depending on whether the family has more than one child or not. The secondary earner's labor supply cannot be negative, such that $h_i n_i \leq 1$ must hold true. There is thus a threshold wage rate, $\widehat{w}_{i,l}^{h}$, below which the secondary earner cannot spend more time with the child at home. Even though parents do not consume external child care below the threshold wage rate of $\widehat{w}_{i,l}^{s}$, they can still increase their number of children in our model. With an increasing fertility, the average maximum time the secondary earner can spend with each child decreases. Parental child care might therefore increase in the secondary earner's wage rate for households with a wage rate below $\widehat{w}_{i,l}^{h}$.[22]

The thresholds wage rates are

$$s_i^* = 0: \qquad \widehat{w}_{i,l}^{s} = \frac{q_h\left[\eta_i \pi_s\left(1+\alpha_i g q_g\right) - (1-\rho_i) P_{n,i_{|w_i=0}}\right]}{(1-\rho_i)(1-t)} \tag{4.14}$$

$$s_i^* = 1-\alpha_i g: \quad \widehat{w}_{i,u}^{s} = \frac{q_h\left\{\eta_i \pi_s\left[1+q_s+\alpha_i g\left(q_g-q_s\right)\right] - (1-\rho_i) P_{n,i_{|w_i=0}}\right\}}{(1-\rho_i)(1-t)} \tag{4.15}$$

$$h_i^* = 0: \qquad \widehat{w}_{i,u}^{h} = \frac{\rho_i P_{n,i_{|w_i=0}} q_h}{(\eta_i-\rho_i)(1-t)} \tag{4.16}$$

[22] See Appendix 4.B for a detailed demand function of parental and external child care time.

$$h_i^* = 1: \qquad \widehat{w}_{i,l}^h = \frac{\rho_i P_{n,i_{|w_i=0}} q_h}{[\eta_i(1+q_h) - \rho_i](1-t)} \tag{4.17}$$

with $P_{n,i_{|w_i=0}} \equiv \frac{\pi_s}{q_s} + \frac{\alpha_i g[\pi_s q_g - \pi_g(1-\beta)q_s]}{q_s} + (1-\alpha_i)\sigma$. The households' threshold levels thus depend critically on the decision whether to demand publicly provided child care or not as well as on the size of the family policy instruments and the household's preferences. Changes in the family policy instruments shift the threshold levels to the right or left and therefore influence the household's decision for labor supply.

Using the results described above, we can depict the relationship between the demand for parental as well as privately provided external child care and the secondary earner's wage rate as follows:

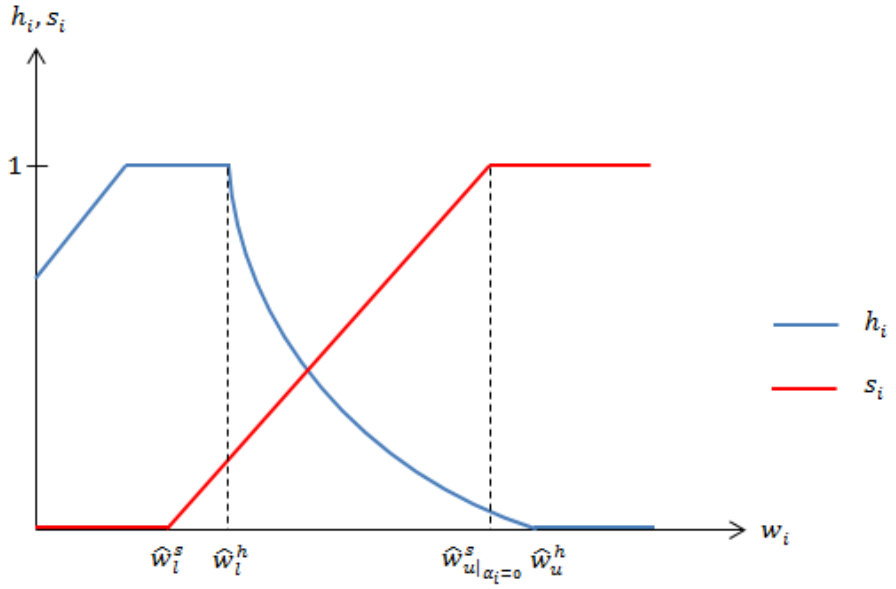


Figure 4.1: The relationship between the demand for parental and privately provided external child care and the secondary earner's wage rate (for $\alpha_i = 0$)

These relationships are consistent with the well-known evidence: high income households choose relatively low parental child care times with relatively high investments in external child care. Note that we do not make an assumption on total child care time. Parental and external child care time can therefore be in sum smaller or larger than one.

In case the household has more than one child, the threshold $\widehat{w}_{i,l}^h$ shifts to the right and the maximum amount of parental child care decreases to $\frac{1}{n_i}$. For households choosing public child care, the maximum amount of external child care they can demand decreases to $(1-g)$ and the threshold $\widehat{w}_{i,u}^s$ shifts to the left.

4.3 Comparative statics: The effects of changes in the family policy system

In the following, we analyze the comparative statics results for changes in the policy parameters for households choosing an interior solution as well as for households choosing a corner solution of parental and external child care.

4.3.1 Interior solution of parental and external child care

For households choosing an interior solution of parental and external child care, we find that fertility in (4.8) decreases in the secondary earner's wage rate as long as $\left\{\frac{Y_i(1-t)}{q_h} > \frac{\pi_s}{q_s} - \frac{\alpha_i g[\pi_s q_g - \pi_g(1-\beta)q_s]}{q_s} - (1-\alpha_i)\sigma\right\}$. That is if the relative income of the primary earner is larger than the relative costs for external child care.[23]

Assuming that the primary earner's income is sufficiently high, we can depict the relationship between fertility and the secondary earner's wage rate as shown in Figure 4.2:

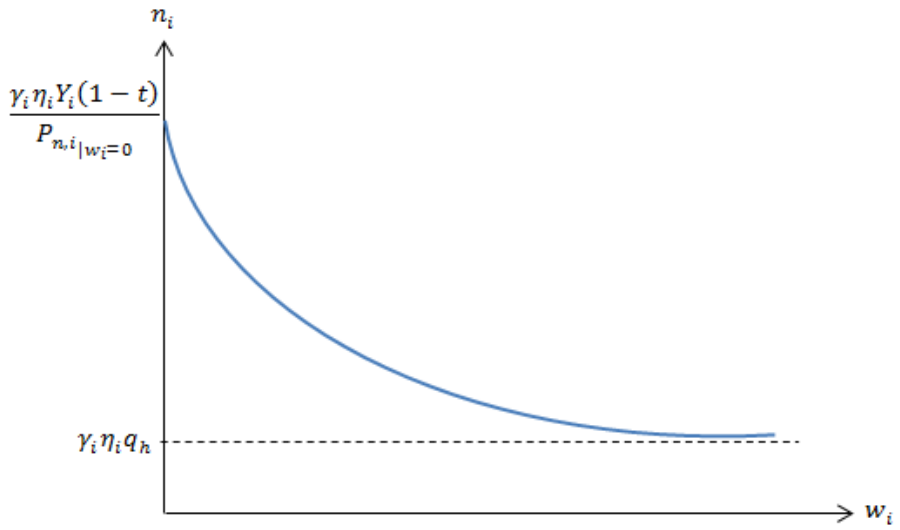


Figure 4.2: The relationship between fertility and the secondary earner's wage rate

The lowest and highest possible fertility rates in this case are given by $\lim_{w_i \to \infty} n_i^* = \gamma_i \eta_i q_h$ and $\lim_{w_i \to 0} n_i^* = \frac{\gamma_i \eta_i Y_i(1-t)}{P_{n,i|w_i=0}}$. In our model, families with a positive preference for

[23] See Appendix 4.C for the remaining derivations in this section.

children, γ_i, a positive parental child care quality, q_h, and a positive preference for child-specific-consumption, η_i, will thus always have children. In case of a single household, that is $Y_i = 0$, fertility would increase in the households' income.

An increase in the secondary earner's parental quality, q_h, on the other hand, always has a positive effect on fertility. Regarding the quality of external child care, we find that an increase in the quality of privately provided child care in (4.18) has a positive effect on fertility for $0 \leq \kappa \leq 1$:

$$\frac{\partial n_i^*}{\partial q_s} = \frac{\gamma_i \eta_i (1-\kappa)(Y_i + w_i)(1-t)\pi_s\left(1 + \alpha_i g q_g\right)}{\left(P_{n,i}\right)^2 (q_s)^2} \tag{4.18}$$

An increase in the quality of publicly provided child care as shown in (4.19), on the other hand, has an ambiguous effect on the number of family i's children. For a family choosing not to demand publicly provided child care, that is $\alpha_i = 0$, an increase in the quality of public child care always has a negative effect on fertility due to the tax increase. For a family choosing $\alpha_i = 1$, however, an increase in the quality of publicly provided child care might also have a positive effect on fertility depending on its impact on the price, that is on κ. For $0 \leq \kappa \leq 1$, the effect of an increase in the quality of publicly provided child care on fertility is also negative for households opting for public child care.

$$\frac{\partial n_i^*}{\partial q_g} = -\Lambda_i g \left\{ \alpha_i \overline{m}(1-t)\left[\frac{\pi_s}{q_s} - \frac{\kappa \pi_g (1-\beta)}{q_g}\right] + \frac{\kappa \bar{\alpha} \bar{n} \beta \pi_g}{q_g}\left[P_{n,i} - \frac{w_i(1-t)}{q_h}\right]\right\} \tag{4.19}$$

$$\frac{\partial n_i^*}{\partial g} = -\Lambda_i q_g \left\{ \alpha_i \overline{m}(1-t)\left[\frac{\pi_s}{q_s} - \frac{\pi_g (1-\beta)}{q_g}\right] + \frac{\bar{\alpha} \bar{n} \beta \pi_g}{q_g}\left[P_{n,i} - \frac{w_i(1-t)}{q_h}\right]\right\} \tag{4.20}$$

$$\frac{\partial n_i^*}{\partial \beta} = -\Lambda_i g \pi_g \left\{ \alpha_i \overline{m}(1-t) + \bar{\alpha} \bar{n}\left[P_{n,i} - \frac{w_i(1-t)}{q_h}\right]\right\} \tag{4.21}$$

$$\frac{\partial n_i^*}{\partial \sigma} = -\Lambda_i \left\{ (1-\alpha_i) \overline{m}(1-t) + (1-\bar{\alpha}) \bar{n}\left[P_{n,i} - \frac{w_i(1-t)}{q_h}\right]\right\} \tag{4.22}$$

with $\Lambda_i \equiv \frac{\gamma_i \eta_i (Y_i + w_i)}{\overline{m}\left(P_{n,i}\right)^2} > 0$.

Regarding an increase in the quantity of publicly provided child care in (4.20), the effect is negative for all households. For $\kappa = 1$, the effects of an increase in quality and in quantity on fertility only differ with respect to the initial level of g and q_g. The effects of

an increase in the price subsidy, β, in (4.21), and of an increase in parental child care benefit, σ, in (4.22), on fertility are also negative for all households. The reasons for these negative effects of the policy instruments on fertility are the following. Assuming $[\pi_s q_g > \pi_g(1-\beta)q_s]$, an increase in publicly provided child care effectively increases the price for private external child care and thus increases the parents relative price for child care. As shown in (4.13), the parental child care benefit also increases the household's relative price for child care and thus decreases the parent's demand for children.

Regarding parental time in (4.9), we find that an increase in the secondary earner's wage rate leads to a decrease in parental child care time for all families. Assuming $\eta_i > \rho_i$, an increase in parental child care quality, on the other hand, has a positive effect on parental child care. Concerning the quality of external child care, we find that an increase in the quality of privately provided child care leads to a decrease in parental child care time for $0 \leq \kappa \leq 1$ and thus increases the secondary earner's labor supply:

$$\frac{\partial h_i^*}{\partial q_s} = -\frac{\rho_i(1-\kappa)\pi_s\left(1+\alpha_i g q_g\right)}{\eta_i w_i (q_s)^2 (1-t)} \tag{4.23}$$

An increase in the quality of publicly provided child care as shown in (4.24), however, has a positive effect on parental child care for all families choosing $\alpha_i = 0$. For families choosing $\alpha_i = 1$, the impact is ambiguous and depends on price effect, that is on κ. For $0 \leq \kappa \leq 1$, the effect of an increase in the quality of publicly provided child care has a negative effect on the secondary earner's labor supply for all households.

$$\frac{\partial h_i^*}{\partial q_g} = \Gamma_i g \left\{\alpha_i \bar{m}(1-t)\left[\frac{\pi_s}{q_s} - \frac{\kappa\pi_g(1-\beta)}{q_g}\right] + \frac{\kappa\bar{\alpha}\bar{n}\beta\pi_g}{q_g}\left[P_{n,i} - \frac{w_i(1-t)}{q_h}\right]\right\} \tag{4.24}$$

$$\frac{\partial h_i^*}{\partial g} = \Gamma_i q_g \left\{\alpha_i \bar{m}(1-t)\left[\frac{\pi_s}{q_s} - \frac{\pi_g(1-\beta)}{q_g}\right] + \bar{\alpha}\bar{n}\beta\pi_g\left[P_{n,i} - \frac{w_i(1-t)}{q_h}\right]\right\} \tag{4.25}$$

$$\frac{\partial h_i^*}{\partial \beta} = \Gamma_i \left\{\alpha_i \bar{m}(1-t) + \bar{\alpha}\bar{n}\left[P_{n,i} - \frac{w_i(1-t)}{q_h}\right]\right\} \tag{4.26}$$

$$\frac{\partial h_i^*}{\partial \sigma} = \Gamma_i \left\{(1-\alpha_i)\bar{m}(1-t) + (1-\bar{\alpha})\bar{n}\left[P_{n,i} - \frac{w_i(1-t)}{q_h}\right]\right\} \tag{4.27}$$

with $\Gamma_i \equiv \frac{\rho_i}{\eta_i \bar{m} w_i (1-t)^2} > 0$.

An increase in the quantity of publicly provided child care in (4.25) has a positive effect on parental child care for all households and thus decreases the secondary earner's labor supply. As before, for $\kappa = 1$, the effects of an increase in quality and in quantity only differ with respect to the initial level of g and q_g. The same effect as for an increase in the quantity of publicly provided child care applies to an increase in the price subsidy, β, in (4.26) and an increase in the parental child care benefit, σ, in (4.27). Our model thus predicts that an increase in both the subsidy for publicly provided child care and the parental child care benefit has a negative effect on the secondary earner's labor supply for all households. Due to the negative income effect caused by the increase in the income tax, the secondary earner's opportunity costs of staying at home with the children and not working decrease and the secondary earner therefore increases her parental time. The size of the effects therefore decreases in the secondary earners wage rate (compare to Figure 4.1).

Summarizing our results with respect to the reconciliation of family and work for households choosing an interior solution of parental and external child care, we find that only an increase in the quality of privately provided external child care has a positive effect on both fertility and the secondary earner's labor supply for all households if $0 \leq \kappa \leq 1$ holds. Even though an increase in the quality of private external child care also leads to an increase in the price for child care, parents increase their demand for children and at the same time increase their labor supply. For households demanding public child care, that is $\alpha_i = 1$, an increase in both the quantity of publicly provided child care and the price subsidy for publicly provided child care has a negative effect on fertility and secondary earner's labor supply. The effect of an increase in the quality of publicly provided child care, however, depends on κ and is positive for $\kappa > 1$. Concerning the parental child care benefit, our model predicts a negative effect on both fertility and the secondary earner's labor supply for all households choosing an interior solution of parental and external child care.

Proposition 4.1: *An increase in the quantity of publicly provided child care, the subsidy for public child care as well as in the parental child care benefit has a negative effect on both fertility and the secondary earner's labor supply for all households. Increasing the quality of publicly provided child care, however, may increase both fertility and the secondary earner's labor supply for households opting for public child care depending on the price effect.*

Regarding the demand for privately provided external child care in (4.10), we find that an increase in the secondary earner's wage rate has a positive effect while an increase in parental child care quality has a negative impact. An increase in the quality of privately provided child care has an ambiguous effect on the demand for external child care and depends on the price effect of an increase in the quality, that is on κ, as well as on the household's preferences for parental child care and child-specific consumption:

$$\frac{\partial s_i^*}{\partial q_s} = -\frac{1}{\eta_i \pi_s q_s q_h}\left\{(1-\rho_i)\left[\kappa P_{n,i} + (1-\kappa)\frac{\pi_s}{q_s}\left(1+\alpha_i g q_g\right)\right] - \frac{\eta_i \pi_s}{q_s}\left(1+\alpha_i g q_g\right)\right\} \tag{4.28}$$

The same holds true for an increase in both the quality and quantity of publicly provided external child care as shown in (4.29) and (4.30) for families choosing $\alpha_i = 1$. In both cases, the effects are negative if $(\eta_i + \rho_i) > 1$ holds. Parents then use publicly provided child care as a substitution for private external child care. For families choosing $\alpha_i = 0$, the effects are in both cases negative due to the increase in the income tax. Therefore, an increase in both the quantity and the quality of publicly provided child care leads to a crowding-out of privately provided child care for households opting for the parental child care benefit and likely also for households opting for public child care.

$$\frac{\partial s_i^*}{\partial q_g} = \frac{(1-\rho_i) g\{\alpha_i \bar{m} q_h[\pi_s q_g - \kappa \pi_g (1-\beta) q_s] - \kappa \bar{\alpha} \beta \bar{n} w_i \pi_g q_s\} - \eta_i \alpha_i g \bar{m} \pi_s q_h q_g}{\eta_i \bar{m} \pi_s q_h q_s q_g} \tag{4.29}$$

$$\frac{\partial s_i^*}{\partial g} = \frac{(1-\rho_i)\{\alpha_i \bar{m} q_h[\pi_s q_g - \pi_g (1-\beta) q_s] - \bar{\alpha} \beta \bar{n} w_i \pi_g q_s\} - \eta_i \alpha_i \bar{m} \pi_s q_h q_g}{\eta_i \bar{m} \pi_s q_h q_s} \tag{4.30}$$

$$\frac{\partial s_i^*}{\partial \beta} = \frac{(1-\rho_i) g \pi_g (\alpha_i \bar{m} q_h - \bar{\alpha} \bar{n} w_i)}{\eta_i \bar{m} \pi_s q_h} \tag{4.31}$$

$$\frac{\partial s_i^*}{\partial \sigma} = \frac{(1-\rho_i)[(1-\alpha_i)\bar{m} q_h - (1-\bar{\alpha})\bar{n} w_i]}{\eta_i \bar{m} \pi_s q_h} \tag{4.32}$$

An increase in the subsidy for publicly provided external child care, β, in (4.31) has also an ambiguous effect on the demand for privately provided child care for families having decided to demand public child care, that is $\alpha_i = 1$. The income effect is positive for low income earners while it is negative for high income earners due to the associated increase in the income tax. The effect is thus more likely to be negative the larger the secondary earner's wage rate. The impact of an increase in β also depends on the average income,

the average demand for public child care, and the average number of children. For families opting for the parental child care benefit, that is $\alpha_i = 0$, the income effect is negative and households thus demand less privately provided external child care. In case of an increase in the parental child care benefit in (4.32), however, the effect is ambiguous for households choosing $\alpha_i = 0$ while the effect is negative for households choosing $\alpha_i = 1$. The effect for households opting for the parental child care benefit is more likely to be positive for households whose secondary earner carries a low wage rate as for them the income effect is again positive. For households who decided to demand publicly provided child care, we observe a decrease in the demand for privately provided child care due to the associated increase in the income tax. This negative effect therefore increases in the household's secondary earner's wage rate.

Summarizing our results for households choosing to demand publicly provided child care, that is $\alpha_i = 1$, we find that there is a crowding-out effect with respect to all policy instruments for secondary earners with a high wage rate due to the negative income effect. As shown before, only an increase in the quality of publicly provided child care may have a positive effect on the secondary earner's labor supply while for all other instruments the effect is negative. Parents thus do not use the publicly provided child care to increase their labor supply but rather substitute private external child care time.

For households choosing $\alpha_i = 0$, we also observe a crowding-out effect of private external child care for all three instruments influencing publicly provided child care due to the negative income effect. In this case, only an increase in the parental child care benefit may lead to a stronger demand for private external child care but at the same time it also has a negative effect on the secondary earner's labor supply. Both effects are stronger for low income households. Low income households opting for the parental child care benefit therefore use additional parental child care benefit payments to decrease their labor supply while they at the same time increase their demand for private external child care.

Proposition 4.2: *An increase in both the quantity and quality of publicly provided child care has a negative effect on the household's demand for private external child care. An increase in the subsidy for publicly provided child care (parental child care benefit) has a positive effect on the household's demand for private external child care for low income households opting for public child care (the parental child care benefit).*

Our model predicts that child-specific consumption in (4.11) increases in the secondary earner's wage rate and decreases in parental child care quality. An increase in the quality of privately provided child care has a negative effect on child-specific consumption due to the increased price for external child care. For families opting for the parental child care benefit, that is $\alpha_i = 0$, an increase in both the quantity and quality of publicly provided child care has a negative effect. For households choosing $\alpha_i = 1$, however, the effect is in both cases ambiguous but more likely to be positive for low income households due to the redistribution via the income tax. The same applies for an increase in the price subsidy for publicly provided child care. An increase in the parental child care benefit, on the other hand, has a negative effect on child-specific consumption for families choosing $\alpha_i = 1$ while the effect is ambiguous for families choosing $\alpha_i = 0$ and also depends on the secondary earners wage rate.

Regarding the child's quality in (4.12), we find that an increase in the secondary earner's wage rate has a positive effect. An increase in parental child care quality, on the other hand, has a negative effect on the child's quality. Concerning the quality of external child care in (4.33), we find that the impact of an increase depends crucially on the price effect, that is on κ, as well as on the household's preferences for parental and child-specific consumption. The effect of an increase in q_s is therefore ambiguous.

$$\frac{\partial q_i^*}{\partial q_s} = \frac{\phi_i(1-\kappa)}{q_s}\left\{(1-\rho_i)P_{n,i}q_s - (1+\eta_i)\pi_s\left(1+\alpha_i g q_g\right)\right\} \tag{4.33}$$

with $\phi_i \equiv \frac{\theta(1-\rho_i)}{\eta_i \pi_s}\left(\frac{P_{n,i}}{B}\right)^{\eta_i}\left(\frac{\rho_i \pi_s q_h}{(1-\rho_i)w_i(1-t)q_s}\right)^{\rho_i} > 0.$

An increase in the quality of public child care in (4.34), is more likely to have a positive impact on the child's quality for families demanding public child care, that is $\alpha_i = 1$. The same applies for the effects of an increase in the quantity of public child care in (4.35) and an increase in the price subsidy, β, in (4.36). All three effects are also more likely to be positive for secondary earners with a low wage rate due to the redistribution via the income tax and a large parental child care quality. As an increase in the policy instruments leads to an increase in parental child care, the quality of this care is crucial for the child's quality. The effects also depend on the average demand for public child care and the average fertility.

$$\frac{\partial q_i^*}{\partial q_g} = \frac{\phi_i g}{\bar{m} q_h q_g (1-t)} \{\rho_i \kappa \bar{\alpha} \beta \bar{n} P_{n,i} \pi_g q_h q_s + (1+\eta_i)[\alpha_i \bar{m} q_h [\pi_s q_g - \kappa \pi_g (1-\beta) q_s] - \kappa \bar{\alpha} \beta \bar{n} w_i \pi_g q_s](1-t)\} \tag{4.34}$$

$$\frac{\partial q_i^*}{\partial g} = \frac{\phi_i}{\bar{m} q_h (1-t)} \{\rho_i \bar{\alpha} \beta \bar{n} P_{n,i} \pi_g q_h q_s + (1+\eta_i)[\alpha_i \bar{m} q_h (\pi_s q_g - \pi_g (1-\beta) q_s) - \bar{\alpha} \beta \bar{n} w_i \pi_g q_s](1-t)\} \tag{4.35}$$

$$\frac{\partial q_i^*}{\partial \beta} = \frac{\phi_i g \pi_g q_s}{\bar{m} q_h (1-t)} \{\rho_i \bar{\alpha} \bar{n} P_{n,i} q_h + (1+\eta_i)(\alpha_i \bar{m} q_h - \bar{\alpha} \bar{n} w_i)(1-t)\} \tag{4.36}$$

$$\frac{\partial q_i^*}{\partial \sigma} = \frac{\phi_i q_s}{\bar{m} q_h (1-t)} \{\rho_i (1-\bar{\alpha}) \bar{n} P_{n,i} q_h + (1+\eta_i)[(1-\alpha_i) \bar{m} q_h - (1-\bar{\alpha}) \bar{n} w_i](1-t)\} \tag{4.37}$$

The effect of an increase in the parental child care benefit, σ, in (4.37), on the other hand, is more likely to be positive for households opting for a parental child care benefit, that is $\alpha_i = 0$. The impact in this case is more likely to be positive for secondary earners carrying a low wage rate and having a large parental child care quality. As before, the reason for this is the redistribution via the tax system and the importance of the parental child care quality considering the increase in parental child care.

Proposition 4.3: *For low income households with a large parental child care quality opting for public child care, an increase in both the quantity and quality of as well as in the subsidy for publicly provided child care is likely to have a positive effect on the child's quality. The same applies to households opting for a parental child care benefit with respect to an increase in the parental child care benefit.*

4.3.2 Corner solutions of parental and external child care

Next to the results for households choosing an interior solution of parental and external child care, we also analyze the effects with respect to the children's quality for households choosing a corner solution. We take two different cases into consideration: first, secondary earners who stay at home with their children and do not consume any private external child care; second, we also consider households who do not spend any

time with their children and consume the maximum amount of external child care. In the first case, we have to differentiate between two groups of households: those with one child at maximum and those with more than one child. In households with $n_i \leq 1$ the secondary earner can at most spend one unit of time at home, that is $h_i = 1$, while in households with $n_i > 1$ the secondary earner can only spend at most $\frac{1}{n_i}$ units of time per child at home. The crucial aspect is that in both cases the secondary earner's labor supply is zero, $L_i = 1 - h_i n_i = 0$, for the period of time she stays at home with her children. In the second case, the maximum amount of privately provided external child care the household can consume depends on the household's decision whether to demand public child care or not and is thus $(1 - \alpha_i g)$.

Choosing a corner solution for child care only affects the households' quality choice for their children. We assume that the fertility choice depends on the secondary earner's average lifetime wage rate and is therefore not affected by her decision for this specific period of time. The first-order conditions for the children's quality in the two cases imply

$$q_i^*{}_{|h_i=1,s_i=0} = \theta\big(1 + \alpha_i g q_g\big)\left(\frac{P_{n,i}}{B}\right)^{\eta_i}\left(\frac{1+q_h}{1+\alpha_i g q_g}\right)^{\rho_i} \tag{4.38}$$

$$q_i^*{}_{|h_i=\frac{1}{n_i},s_i=0} = \theta\big(1 + \alpha_i g q_g\big)\left(\frac{P_{n,i}}{B}\right)^{\eta_i}\left(\frac{\gamma_i\eta_i(Y_i+w_i)(1-t)+P_{n,i}q_h}{\gamma_i\eta_i\big(1+\alpha_i g q_g\big)(Y_i+w_i)(1-t)}\right)^{\rho_i} \tag{4.39}$$

$$q_i^*{}_{|h_i=0,s_i=1-\alpha_i g} = \theta\big[1 + q_s - \alpha_i g\big(q_s - q_g\big)\big]\left(\frac{P_{n,i}}{B}\right)^{\eta_i}\left(\frac{1}{1+q_s-\alpha_i g\big(q_s-q_g\big)}\right)^{\rho_i} \tag{4.40}$$

where $P_{n,i}$ is the relative price for child care as described in (4.13).

Regarding the child's quality for the case that a household decides to stay full-time at home in (4.38), we find that, in contrast to the case of the interior solution, the effect of an increase in parental child care quality is ambiguous as the household cannot further increase parental child care.[24] An increase in the quality of public child care in (4.41) has a negative effect for households opting for a parental child care benefit due to the increase in the income tax. The impact for households demanding public child care is likely to be positive for households choosing this corner solution as it depends on the secondary earner's wage rate and households choosing this corner solution usually carry a relatively small wage rate. The same applies to an increase in the quantity of publicly provided

[24] See Appendix 4.D for the remaining derivations in this section.

child care in (4.42). The effects also critically depend on the secondary earner's parental child care quality as in the case of households choosing an interior solution of parental and external child care.

$$\frac{\partial q_i^*{}_{|h_i=1,s_i=0}}{\partial q_g} = \phi_{i_{|h_i=1,s_i=0}} \Big\{ (1-\rho_i)\alpha_i g + \frac{\eta_i g}{\bar{m} P_{n,i} q_h q_s q_g} \big(1+\alpha_i g q_g\big) \big[\alpha_i \bar{m} q_h \big(\pi_s q_g - \kappa \pi_g (1-\beta) q_s\big) - \kappa \bar{\alpha} \beta \bar{n} w_i \pi_g q_s\big] \Big\} \tag{4.41}$$

$$\frac{\partial q_i^*{}_{|h_i=1,s_i=0}}{\partial g} = \phi_{i_{|h_i=1,s_i=0}} \Big\{ (1-\rho_i)\alpha_i g + \frac{\eta_i}{\bar{m} P_{n,i} q_h q_s} \big(1+\alpha_i g q_g\big) \big[\alpha_i \bar{m} q_h \big(\pi_s q_g - \pi_g (1-\beta) q_s\big) - \bar{\alpha} \beta \bar{n} w_i \pi_g q_s\big] \Big\} \tag{4.42}$$

$$\frac{\partial q_i^*{}_{|h_i=1,s_i=0}}{\partial \beta} = \frac{\eta_i \phi_{i_{|h_i=1,s_i=0}} g \pi_g}{\bar{m} P_{n,i} q_h} \big(1+\alpha_i g q_g\big)\big(\alpha_i \bar{m} q_h - \bar{\alpha} \bar{n} w_i\big) \tag{4.43}$$

$$\frac{\partial q_i^*{}_{|h_i=1,s_i=0}}{\partial \sigma} = \frac{\eta_i \phi_{i_{|h_i=1,s_i=0}}}{\bar{m} P_{n,i} q_h} \big(1+\alpha_i g q_g\big)\big[(1-\alpha_i)\bar{m} q_h - (1-\bar{\alpha})\bar{n} w_i\big] \tag{4.44}$$

with $\phi_{i_{|h_i=1,s_i=0}} \equiv \theta \left(\frac{P_{n,i}}{B}\right)^{\eta_i} \left(\frac{1+q_h}{1+\alpha_i g q_g}\right)^{\rho_i} > 0$.

An increase in the subsidy for public child care, β, in (4.43) is also likely to have a positive effect on the child's quality for households opting for public child care, while we observe a negative effect for households choosing a parental child care benefit. Increasing the parental child care benefit in (4.44), on the other hand, has a negative effect for households choosing $\alpha_i = 1$ while the effect is likely to be positive for households choosing $\alpha_i = 0$. Both effects are again likely to be positive as they depend on the secondary earners wage rate. As households in this corner solution choose the maximum amount of parental child care time, the effects also critically depend on the parental child care quality.

The results are very similar for the case of a household with more than one child in (4.39) and can be found in Appendix 4.D.

Proposition 4.4: *For a household choosing a corner solution of staying at home and opting for public child care, an increase in both the quantity and quality of as well as in the subsidy for publicly provided child care is likely to have a positive effect on the child's quality. For a household opting for a parental child care benefit, an increase in the parental child care benefit is in this corner solution likely to have a positive effect on the child's quality. In both cases the effects crucially depend on the secondary earner's parental child care quality.*

In case of secondary earners with a relatively high wage rate choosing a corner solution of consuming external child care and abstaining from parental child care in (4.40), we find that the child's quality increases in the secondary earner's wage rate. The impact of an increase in the quality of private external child care in (4.45) is positive for $\kappa \geq 1$ and otherwise depends on the household's preferences for parental child care and child-specific consumption.

$$\frac{\partial q_i^*{}_{|h_i=0,s_i=1-\alpha_i g}}{\partial q_s} = \phi_{i}{}_{|h_i=0,s_i=1-\alpha_i g} \left\{ (1-\rho_i)(1-\alpha_i g) - \frac{\eta_i (1-\kappa)\pi_s \left[1+q_s(1-\alpha_i g)+\alpha_i g q_g\right]\left(1+\alpha_i g q_g\right)}{P_{n,i}(q_s)^2} \right\} \tag{4.45}$$

with $\phi_{i}{}_{|h_i=0,s_i=1-\alpha_i g} \equiv \theta \left(\frac{P_{n,i}}{B}\right)^{\eta_i} \left(\frac{1}{1+q_s-\alpha_i g(q_s-q_g)}\right)^{\rho_i}$.

An increase in the quality of public child care in (4.46) has a negative effect for households opting for the parental child care benefit due to the increase in the tax rate. The effect for households demanding public child care is ambiguous and also depends on the price effect as well as on the households' preferences for child-specific consumption and parental child care. The same applies to an increase in the quantity of public child care in (4.47). For households with a small preference for parental child care - this should be the case for households choosing this corner solution - opting for publicly provided child care, the effect with respect to the quantity is likely to be negative if $q_g < q_s$. In this case, an increase in the quantity of publicly provided child care decreases the maximum amount of private child care the households can consume and the total quality of external child care therefore decreases.

$$\frac{\partial q_i^*{}_{|h_i=0,s_i=1-\alpha_i g}}{\partial q_g} = \phi_{i_{|h_i=0,s_i=1-\alpha_i g}} \Bigg\{(1-\rho_i)\alpha_i g + \frac{\eta_i g}{\bar{m}P_{n,i_{|h_i=0,s_i=1}} q_h q_s q_g}\big[1+q_s(1-\alpha_i g) + \alpha_i g q_g\big]\big[\alpha_i \bar{m} q_h\big(\pi_s q_g - \kappa\pi_g(1-\beta)q_s\big) - \kappa\bar{\alpha}\beta\bar{n}w_i\pi_g q_s\big]\Bigg\} \tag{4.46}$$

$$\frac{\partial q_i^*{}_{|h_i=0,s_i=1-\alpha_i g}}{\partial g} = \phi_{i_{|h_i=0,s_i=1-\alpha_i g}} \Bigg\{(1-\rho_i)\alpha_i\big(q_g - q_s\big) + \frac{\eta_i}{\bar{m}P_{n,i} q_h q_s q_g}\big[1+q_s(1-\alpha_i g) + \alpha_i g q_g\big]\big[\alpha_i \bar{m} q_h\big(\pi_s q_g - \pi_g(1-\beta)q_s\big) - \bar{\alpha}\beta\bar{n}w_i\pi_g q_s\big]\Bigg\} \tag{4.47}$$

$$\frac{\partial q_i^*{}_{|h_i=0,s_i=1-\alpha_i g}}{\partial \beta} = \frac{\eta_i \phi_{i_{|h_i=0,s_i=1-\alpha_i g}}}{\bar{m}P_{n,i} q_h}\big[1+q_s(1-\alpha_i g)+\alpha_i g q_g\big] g\pi_g(\alpha_i \bar{m} q_h - \bar{\alpha}\bar{n}w_i) \tag{4.48}$$

$$\frac{\partial q_i^*{}_{|h_i=0,s_i=1-\alpha_i g}}{\partial \sigma} = \frac{\eta_i \phi_{i_{|h_i=0,s_i=1-\alpha_i g}}}{\bar{m}P_{n,i} q_h}\big[1+q_s(1-\alpha_i g)+\alpha_i g q_g\big][(1-\alpha_i)\bar{m} q_h - (1-\bar{\alpha})\bar{n}w_i] \tag{4.49}$$

One main difference in the results for this corner solution compared to the one where households do not consume external child care is that increases in both the subsidy for public child care (see (4.48)) and the parental child care benefit (see (4.49)) are likely to have a negative effect on the child's quality for all households. Secondary earners choosing this corner solution of abstaining from parental child care carry relatively high wage rates and thus do not benefit from the redistribution via the income tax. Hence, they do not benefit from increasing subsidies or parental child care benefits. Both results also depend on the secondary earner's parental child care quality. The larger the secondary earner's parental child care quality, the smaller is the negative effect on the child's quality. This relationship can be explained by the effect of the policy instruments on fertility. The more children a family has, the more it benefits from redistribution via the number of children.

Proposition 4.5: *For a household choosing a corner solution of consuming the maximum amount of private external child care and working full-time, an increase in both the subsidy for publicly provided child care and the parental child care benefit is likely to have a negative effect on the child's quality. For a household opting for publicly provided child care, the effect of an increase in the quantity of public child care in this corner solution depends on the qualitative differences between public and private child care.*

4.4 Welfare analysis

In the welfare analysis, we analyze the redistribution effects of the four policy instruments on households with different incomes and preferences. We assume that the benevolent government maximizes the household's indirect utility function $V_i(g, q_g, \beta, \sigma)$ subject to the government's budget constraint in (4.5). For households choosing an interior solution of parental and external child care time, we find the following indirect utility levels for the two options of choosing publicly provided child care or a parental child care benefit:

$$\begin{aligned} V_{i|_{\alpha_i=0}} = {} & (1-\gamma_i)\ln[(1-\gamma_i)(Y_i+w_i)(1-t)] \\ & + \gamma_i \ln\left[\frac{\gamma_i\theta(1-\rho_i)}{\pi_s}(Y_i+w_i)(1\right. \\ & \left. - t)q_s\left(\frac{P_{n,i|_{\alpha_i=0}}}{B}\right)^{\eta_i}\left(\frac{\rho_i\pi_s q_h}{(1-\rho_i)w_i(1-t)q_s}\right)^{\rho_i}\right] \end{aligned} \tag{4.50}$$

$$\begin{aligned} V_{i|_{\alpha_i=1}} = {} & (1-\gamma_i)\ln[(1-\gamma_i)(Y_i+w_i)(1-t)] \\ & + \gamma_i \ln\left[\frac{\gamma_i\theta(1-\rho_i)}{\pi_s}(Y_i+w_i)(1\right. \\ & \left. - t)q_s\left(\frac{P_{n,i|_{\alpha_i=1}}}{B}\right)^{\eta_i}\left(\frac{\rho_i\pi_s q_h}{(1-\rho_i)w_i(1-t)q_s}\right)^{\rho_i}\right] \end{aligned} \tag{4.51}$$

The policy parameters do not influence the parent's own consumption but only their child-specific consumption choices. Households always adjust child care time such that there is no difference in the two scenarios in (4.50) and (4.51) with this respect. Due to the income effect, the households' endogenous decision on α influences their decision concerning child-specific consumption. We thus find that for a household choosing an

interior solution of parental and external child care the only crucial factor is the size of the respective policy instrument and therefore the relative price for child care, $P_{n,i}$. Household i's indirect utility is identical in both situations as long as the parental child care benefit equals the relative benefit from publicly provided child care:

$$V_{i|_{\alpha_i=0}} = V_{i|_{\alpha_i=1}} \quad \Leftrightarrow \quad \sigma = \frac{g\left[\pi_s q_g - \pi_g(1-\beta)q_s\right]}{q_s} \tag{4.52}$$

For households choosing an interior solution of parental and external child care, both policy instruments, the parental child care benefit and publicly provided child care, are thus equally effective with respect to welfare and their decision which instrument to choose only depends on the relative benefit the household receives in total. Households choosing an interior solution of parental and external child care will thus opt for public child care as long as $\left\{g\left[\pi_s q_g - \pi_g(1-\beta)q_s\right] > \sigma q_s\right\}$ holds independent of their income.

Proposition 4.6: *For a household choosing an interior solution of parental and external child care time, publicly provided child care and the parental child care benefit are equally effective with respect to welfare. The household's decision for a policy instrument in this case only depends on the relative benefit the household receives from the policy instrument in total.*

For households choosing a corner solution, changes in the policy parameters do not only influence the parents' child-specific consumption choices but also child care options and their own consumption possibilities in this period. In case of secondary earners choosing a corner solution of not consuming private external child care and not working, the household's consumption possibilities in this period are decreased as the secondary earner's labor supply is zero. Thus, the only source of income is the primary earner's net income. Next to the parents' preference for children and their quality, γ_i, parental consumption in this case also depends on their preference for child-specific consumption, η_i, and the relative price for child care, $P_{n,i}$. We find the following indirect utility levels for the first case with $h_i = 1$ and $s_i = 0$ for the two scenarios:

$$V_i|_{\alpha_i=0,h_i=1,s_i=0} = (1-\gamma_i)\ln\left\{Y_i(1-t) - \frac{\gamma_i\eta_i(Y_i+w_i)(1-t)}{P_{n,i_{|\alpha_i=0}}}\left[\frac{w_i(1-t)}{q_h}+\frac{\pi_s}{q_s}\right]\right\} + \gamma_i\ln\left[\frac{\gamma_i\eta_i\theta}{P_{n,i_{|\alpha_i=0}}}(Y_i+w_i)(1-t)\left(\frac{P_{n,i_{|\alpha_i=0}}}{B}\right)^{\eta_i}(1+q_h)^{\rho_i}\right] \tag{4.53}$$

$$V_i|_{\alpha_i=1,h_i=1,s_i=0} = (1-\gamma_i)\ln\left\{Y_i(1-t) - \frac{\gamma_i\eta_i}{P_{n,i_{|\alpha_i=1}}}(Y_i+w_i)(1-t)\left[\frac{w_i(1-t)}{q_h}+\frac{\pi_s(1+gq_g)}{q_s}\right]\right\} + \gamma_i\ln\left[\frac{\gamma_i\eta_i\theta(1+gq_g)}{P_{n,i_{|\alpha_i=1}}}(Y_i+w_i)(1-t)\left(\frac{P_{n,i_{|\alpha_i=1}}}{B}\right)^{\eta_i}\left(\frac{1+q_h}{1+gq_g}\right)^{\rho_i}\right] \tag{4.54}$$

For households with $n_i > 1$ who are therefore choosing a corner solution with $h_i = \frac{1}{n_i}$ and $s_i = 0$, we find the following indirect utility functions for the two scenarios:

$$V_i|_{\alpha_i=0,h_i=\frac{1}{n_i},s_i=0} = (1-\gamma_i)\ln\left\{Y_i(1-t) - \frac{\gamma_i\eta_i(Y_i+w_i)(1-t)}{P_{n,i_{|\alpha_i=0}}}\left[\frac{w_i(1-t)}{q_h}+\frac{\pi_s}{q_s}\right]\right\} + \gamma_i\ln\left[\frac{\gamma_i\eta_i\theta}{P_{n,i_{|\alpha_i=0}}}(Y_i+w_i)(1-t)\left(\frac{P_{n,i_{|\alpha_i=0}}}{B}\right)^{\eta_i}\left(\frac{\gamma_i\eta_i(Y_i+w_i)(1-t)+P_{n,i_{|\alpha_i=0}}q_h}{\gamma_i\eta_i(Y_i+w_i)(1-t)}\right)^{\rho_i}\right] \tag{4.55}$$

$$V_i|_{\alpha_i=1,h_i=\frac{1}{n_i},s_i=0} = (1-\gamma_i)\ln\left\{Y_i(1-t) - \frac{\gamma_i\eta_i(Y_i+w_i)(1-t)}{P_{n,i_{|\alpha_i=1}}}\left[\frac{w_i(1-t)}{q_h}+\frac{\pi_s(1+gq_g)}{q_s}\right]\right\} + \gamma_i\ln\left[\frac{\gamma_i\eta_i\theta(1+gq_g)}{P_{n,i_{|\alpha_i=1}}}(Y_i+w_i)(1-t)\left(\frac{P_{n,i_{|\alpha_i=1}}}{B}\right)^{\eta_i}\left(\frac{\gamma_i\eta_i(Y_i+w_i)(1-t)+P_{n,i_{|\alpha_i=1}}q_h}{\gamma_i\eta_i(1+gq_g)(Y_i+w_i)(1-t)}\right)^{\rho_i}\right] \tag{4.56}$$

Note that the consumption possibilities of the parents are identical for the two cases in (4.53) and (4.55) as well as in (4.54) and (4.56). The only difference is the child care time which depends on the maximum amount of parental child care time available to the parents. The parents' decision whether to opt for the parental child care benefit or public child care in these scenarios not only depends on the relative benefit they receive but also on their preferences and their income. Parental consumption in this corner solution is always larger in case the household opts for the parental child care benefit as this policy is a direct payment which increases parental income. Households with a low preference for children and their quality, γ_i, therefore benefit more from a parental child care benefit than from publicly provided child care. For households with a relatively large preference for children and their quality, γ_i, the decision also depends on the household's preference for parental child care.

Proposition 7: *A household with a large preference for parental consumption choosing a corner solution of not consuming private external child care and not working benefits more from a parental child care benefit than from additional publicly provided child care.*

In case parents choose a corner solution of abstaining from parental child care and consuming the maximum amount of external child care, their consumption possibilities are also influenced in this period due to the time restrictions.

$$
\begin{aligned}
V_i|_{\alpha_i=0,h_i=0,s_i=1} &= (1 \\
&- \gamma_i) \ln \Bigg\{ (Y_i + w_i)(1-t) \\
&- \frac{\gamma_i \eta_i (Y_i + w_i)(1-t)}{P_{n,i_{|\alpha_i=0}}} \left[\frac{w_i(1-t)}{q_h} + \frac{\pi_s(1+q_s)}{q_s} \right] \Bigg\} \\
&+ \gamma_i \ln \left[\frac{\gamma_i \eta_i \theta (1+q_s)}{P_{n,i_{|\alpha_i=0}}} (Y_i + w_i)(1-t) \left(\frac{P_{n,i_{|\alpha_i=0}}}{B} \right)^{\eta_i} \left(\frac{1}{1+q_s} \right)^{\rho_i} \right]
\end{aligned}
\tag{4.57}
$$

$$
\begin{aligned}
V_i|_{\alpha_i=1,h_i=0,s_i=1-g} &= (1 \\
&- \gamma_i) \ln \left\{ (Y_i + w_i)(1-t) \right. \\
&\left. - \frac{\gamma_i \eta_i (Y_i + w_i)(1-t)}{P_{n,i_{|\alpha_i=1}}} \left[\frac{w_i(1-t)}{q_h} + \frac{\pi_s \left[1 + q_s + g\left(q_g - q_s\right)\right]}{q_s} \right] \right\} \\
&+ \gamma_i \ln \left\{ \frac{\gamma_i \eta_i \theta \left[1 + q_s + g\left(q_g - q_s\right)\right]}{P_{n,i_{|\alpha_i=1}}} (Y_i + w_i)(1 \right. \\
&\left. - t) \left(\frac{P_{n,i_{|\alpha_i=1}}}{B} \right)^{\eta_i} \left(\frac{1}{1 + q_s + g\left(q_g - q_s\right)} \right)^{\rho_i} \right\}
\end{aligned}
\tag{4.58}
$$

Whether parental consumption is increased or decreased depends on the parents' preference for (child-specific) consumption. Parental consumption in (4.57) and (4.58) therefore also depends on the parents' preference for children and child-specific consumption as well as on the relative price for child care.

Contrary to the circumstances before, the secondary earner in this case does work full-time and therefore her wage rate is relevant for parental consumption. Hence, the parents' decision whether to opt for a parental child care benefit or publicly provided child care in this corner solution also not only depends on the relative benefit they receive but also on their preferences and their income. As opposed to the scenarios discussed before, parental consumption in this corner solution is not always larger in case the household opts for a parental child care benefit. In this case, the household's decision for a policy option depends on the qualitative differences between private and public external child care. In all three corner solutions, welfare in the two scenarios is not equal if the relative benefits from the parental child care benefit and public child care are identical, that is if $\left\{ g\left[\pi_s q_g - \pi_g (1-\beta) q_s\right] = \sigma q_s \right\}$ holds. This condition is not sufficient for households choosing a corner solution of parental and external child care. For households choosing a corner solution of abstaining from parental child care and consuming the maximum amount of external child care, the two scenarios are equal if the relative benefits from the parental child care benefit and public child care are identical and at the same time $q_s = q_g$ holds. As long as $q_s > q_g$, the households always benefits more from the parental child care benefit than from publicly provided child care.

Proposition 4.8: *For a household choosing a corner solution of consuming the maximum amount of private external child care and working full-time, the decision whether to opt for a parental child care benefit or publicly provided child care depends on the qualitative differences between private and public external child care. If the relative benefit the household receives from the policy instruments in total is identical and* $q_s > q_g$ *holds, the household prefers the parental child care benefit to publicly provided child care.*

We can therefore conclude that while for households choosing an interior solution the decision whether to opt for the parental child care benefit or public child care only depends on the relative benefit the households receives from the policy option, the decision is much more complex for households choosing a corner solution. In case of corner solutions, the household's decision depends not only on the relative benefit but also on the household's income and her preferences for children as well as for consumption and child care.

4.5 Conclusion

Summarizing our comparative statics results regarding the reconciliation of family and work for households choosing an interior solution of parental and external child care, we find that for households opting for public child care, an increase in the quantity of publicly provided child care has a negative effect on both fertility and secondary earner's labor supply, while the effects of an increase in its quality depend on the price effect and may be positive. For households opting out of publicly provided child care and thus demanding a parental child care benefit, increases in both the quantity and the quality of public child care have negative effects on fertility and the secondary earner's labor supply because of the increase in the income tax. Our results suggest that both a price subsidy for publicly provided child care and the parental child care benefit has a negative effect on fertility and the secondary earner's labor supply for all households.

Our finding with respect to the parental child care benefit is similar to Apps and Rees (2004) and Gathmann and Sass (2012). Apps and Rees (2004) show that a parental child care benefit – or in their case a child benefit - may have a negative effect on fertility.

Gathmann and Sass (2012) find that an increase in the parental child care benefit has a negative effect on female labor force participation and that the decline is strongest for single parents and low income households.

Our results suggest that only an increase in the quality of privately provided external child care may have a positive effect on both fertility and the secondary earner's labor supply for all households. Even though an increase in the quality of private external child care also leads to an increase in the price for child care, parents will increase their demand for children and at the same time increase their labor supply if the price effect is not too large.

Regarding privately provided external child care, our results for households opting for publicly provided child care predict that there is a crowding-out effect with respect to all policy instruments for secondary earners with a relatively high wage rate. As mentioned above, only an increase in the quality of publicly provided child care may have a positive effect on the secondary earner's labor supply while for all other instruments the effect is negative. Parents thus do not use the publicly provided child care to substitute parental child care time but rather substitute private external child care time. For households opting for a parental child care benefit, we observer a crowding-out effect of private external child care for all three instruments influencing publicly provided child care. For these households, only an increase in the parental child care benefit may lead to a stronger demand for private external child care but at the same time it has a negative effect on the secondary earner's labor supply. This result is similar to Havnes and Mogstad (2011) who evaluate the effect of new subsidized child care on labor supply. They find that the subsidized child care mostly crowds out informal care arrangements implying a significant net cost of the child care arrangement.

Our results with respect to the child's quality suggest that for low income households with a large parental child care quality opting for public child care, an increase in both the quantity and quality of as well as in the subsidy for publicly provided child care is likely to have a positive effect. These households benefit from redistribution via the income tax. The same applies to households opting for a parental child care benefit with respect to an increase in the parental child care benefit. For high income households, however, the impact of the policy instruments is likely to be negative due to the negative income effect.

In case of households choosing an interior solution of parental and external child care, we find that both policy instruments, a parental child care benefit and publicly provided child care, are equally effective with respect to welfare and the household's decision which instrument to choose only depends on the relative benefit the household receives in total. This decision is independent of the household's income. For households choosing a corner solution, on the other hand, the decision depends on a variety of parameters: their income, their preferences for children, child care and consumption as well as on the policy parameters. Low income households choosing a corner solution of staying at home and not consuming external child care opt for a parental child care benefit if they have a small preference for children and their quality. For high income households, the decision depends on qualitative differences between private and public external child care. If the relative benefit the households receive from the policy instruments is identical and the quality of private external child care is larger than the quality of publicly provided child care, households in this corner solution also benefit more from the parental child care benefit than from publicly provided child care.

Appendix

4.A: First-order conditions of the maximization problem

The first-order conditions of the household's maximization problem in (4.4) are the following:

$$\frac{\partial U_i}{\partial n_i} = \frac{\Psi_i - \gamma_i(Y_i + w_i)(1-t)}{n\{\Psi_i - (Y_i + w_i)(1-t)\}} \tag{4.A.1}$$

$$\frac{\partial U_i}{\partial h_i} = \frac{\gamma_i \rho_i q_h}{1 + h_i q_h} - \frac{(1-\gamma_i) n_i w_i (1-t)}{(Y_i + w_i)(1-t) - \Psi_i} \tag{4.A.2}$$

$$\frac{\partial U_i}{\partial s_i} = \frac{\gamma_i (1-\rho_i) q_s}{1 + s_i q_s + \alpha_i g q_g} - \frac{(1-\gamma_i) n_i \pi_s}{(Y_i + w_i)(1-t) - \Psi_i} \tag{4.A.3}$$

$$\frac{\partial U_i}{\partial z_i} = \frac{\gamma_i \eta_i}{z_i} - \frac{(1-\gamma_i) n_i B}{(Y_i + w_i)(1-t) - \Psi_i} \tag{4.A.4}$$

with $\Psi_i \equiv n\left[s_i \pi_s + h_i w_i (1-t) + z_i B + \alpha_i g \pi_g (1-\beta) - (1-\alpha_i)\sigma\right]$

4.B: Demand functions

Demand function for parental child care in the model:

$$h_i^* = \begin{cases} 1 & \text{if} \quad w_i < \hat{w}_l^h \quad \text{and} \quad n_i < 1 \\ \dfrac{1}{n_i} & \text{if} \quad w_i < \hat{w}_l^h \quad \text{and} \quad n_i \geq 1 \\ \dfrac{1}{n_i} & \text{if} \quad \hat{w}_l^h \leq w_i \leq \hat{w}_u^h \quad \text{and} \quad n_i \left(\dfrac{\rho_i P_{n,i} q_h - \eta_i w_i (1-t)}{\eta_i w_i q_h (1-t)}\right) \geq 1 \\ \dfrac{\rho_i P_{n,i} q_h - \eta_i w_i (1-t)}{\eta_i w_i q_h (1-t)} & \text{if} \quad \hat{w}_l^h \leq w_i \leq \hat{w}_u^h \quad \text{and} \quad n_i \left(\dfrac{\rho_i P_{n,i} q_h - \eta_i w_i (1-t)}{\eta_i w_i q_h (1-t)}\right) < 1 \\ 0 & \text{if} \quad w_i > \hat{w}_u^h \end{cases} \tag{4.B.1}$$

Demand function for external child care in the model:

$$s_i^* = \begin{cases} 0 & \text{if} \quad w_i < \widehat{w}_l^s \\ \dfrac{(1-\rho_i)P_{n,i}q_s - \eta_i\pi_s\left(1+\alpha_i g q_g\right)}{\eta_i \bar{m}\pi_s q_s} & \text{if} \quad \widehat{w}_l^s \le w_i \le \widehat{w}_u^s \\ 1-\alpha_i g & \text{if} \quad w_i > \widehat{w}_u^s \end{cases} \tag{4.B.2}$$

4.C: Comparative statics results: Interior solution

The results for changes in the secondary earner's wage rate, parental child care quality and the quality of privately provided external child care on fertility, parental child care, the demand for private external child care and the child's quality are the following:

$$\frac{\partial n_i^*}{\partial w_i} = -\frac{\gamma_i\eta_i(1-t)}{\left(P_{n,i}\right)^2}\left\{\frac{Y_i(1-t)}{q_h} - \frac{\pi_s}{q_s} - \frac{\alpha_i g\left[\pi_s q_g - \pi_g(1-\beta)q_s\right]}{q_s} - (1-\alpha_i)\sigma\right\} \tag{4.C.1}$$

$$\frac{\partial n_i^*}{\partial q_h} = \frac{\gamma_i\eta_i(Y_i+w_i)w_i(1-t)^2}{\left(P_{n,i}\right)^2(q_h)^2} \tag{4.C.2}$$

$$\frac{\partial h_i^*}{\partial w_i} = -\frac{\rho_i\left[P_{n,i} - \dfrac{w_i(1-t)}{q_h}\pi_s\right]}{\eta_i(w_i)^2(1-t)} \tag{4.C.3}$$

$$\frac{\partial h_i^*}{\partial q_h} = \frac{\eta_i - \rho_i}{\eta_i(q_h)^2} \tag{4.C.4}$$

$$\frac{\partial s_i^*}{\partial w_i} = \frac{(1-\rho_i)(1-t)}{\eta_i\pi_s q_h} \tag{4.C.5}$$

$$\frac{\partial s_i^*}{\partial q_h} = -\frac{(1-\rho_i)w_i(1-t)}{\eta_i\pi_s(q_h)^2} \tag{4.C.6}$$

$$\frac{\partial q_i^*}{\partial w_i} = \frac{\phi_i q_s}{w_i q_h}\left[\rho_i P_{n,i}q_h + (1+\eta_i)w_i(1-t)\right] \tag{4.C.7}$$

$$\frac{\partial q_i^*}{\partial q_h} = -\frac{\phi_i q_s}{(q_h)^2}\left[\rho_i P_{n,i}q_h + (1+\eta_i)w_i(1-t)\right] \tag{4.C.8}$$

The results for the comparative statics analysis for child-specific consumption are the following:

$$\frac{\partial z_i^*}{\partial w_i} = \frac{(1-t)}{Bq_h} \tag{4.C.9}$$

$$\frac{\partial z_i^*}{\partial q_h} = -\frac{w_i(1-t)}{B(q_h)^2} \tag{4.C.10}$$

$$\frac{\partial z_i^*}{\partial q_s} = -\frac{(1-\kappa)\pi_s\left(1+\alpha_i g q_g\right)}{B(q_s)^2} \tag{4.C.11}$$

$$\frac{\partial z_i^*}{\partial q_g} = \frac{g\left\{\alpha_i \bar{m} q_h\left[\pi_s q_g - \kappa\pi_g(1-\beta)q_s\right] - \kappa\bar{\alpha}\beta\bar{n}w_i\pi_g q_s\right\}}{\bar{m}Bq_h q_s q_g} \tag{4.C.12}$$

$$\frac{\partial z_i^*}{\partial g} = \frac{\alpha_i \bar{m} q_h\left[\pi_s q_g - \pi_g(1-\beta)q_s\right] - \bar{\alpha}\beta\bar{n}w_i\pi_g q_s}{\bar{m}Bq_h q_s} \tag{4.C.13}$$

$$\frac{\partial z_i^*}{\partial \beta} = \frac{g\pi_g(\alpha_i \bar{m} q_h - \bar{\alpha}\bar{n}w_i)}{\bar{m}Bq_h} \tag{4.C.14}$$

$$\frac{\partial z_i^*}{\partial \sigma} = \frac{(1-\alpha_i)\bar{m}q_h - (1-\bar{\alpha})\bar{n}w_i}{\bar{m}Bq_h} \tag{4.C.15}$$

4.D: Comparative statics results: Corner solutions

The results for changes in the secondary earner's wage rate and parental child care on the child's quality for the corner solutions are the following:

$$\frac{\partial q_i^*{}_{|h_i=1,s_i=0}}{\partial q_h} = -\frac{\phi_{i|_{h_i=1,s_i=0}}\left(1+\alpha_i g q_g\right)}{P_{n,i}(q_h)^2(1+q_h)}\left[\eta_i w_i(1-t)(1+q_h) - \rho_i P_{n,i}(q_h)^2\right] \tag{4.D.1}$$

$$\frac{\partial q_i^*{}_{|h_i=0,s_i=1-\alpha_i g}}{\partial w_i} = \frac{\eta_i \phi_{i|_{h_i=0,s_i=1-\alpha_i g}}}{P_{n,i}q_h}\left[1+q_s(1-\alpha_i g)+\alpha_i g q_g\right](1-t) \tag{4.D.2}$$

The results for the comparative statics analysis for the corner solution where the secondary earner decides to stay at home full-time with the children with $n_i > 1$ are the following:

$$\frac{\partial q_i^*{}_{|h_i=\frac{1}{n_i},s_i=0}}{\partial q_g} = \phi_{i_{|h_i=\frac{1}{n_i},s_i=0}} g \left\{ \alpha_i(1-\rho_i) + \frac{\eta_i(1+\alpha_i g q_g)[\alpha_i \bar{m} q_h(\pi_s q_g - \kappa\pi_g(1-\beta)q_s) - \kappa\bar{\alpha}\beta\bar{n}w_i\pi_g q_s]}{\bar{m}P_{n,i}q_h q_s q_g} + \frac{\rho_i(1+\alpha_i g q_g)\{\alpha_i\bar{m}[\pi_s q_g - \kappa\pi_g(1-\beta)q_s] + \beta\bar{n}\pi_g[\bar{\alpha}g\pi_s(\kappa-(1-\kappa)\alpha_i q_g) + \kappa\sigma q_s(\bar{\alpha}-\alpha_i)] - (1-\bar{\alpha})\alpha_i\sigma\bar{n}(\pi_s q_g - \kappa\pi_g q_s)\}}{[P_{n,i}q_h + \gamma_i\eta_i(Y_i+w_i)(1-t)](1-t)q_s q_g} \right\} \tag{4.D.3}$$

$$\frac{\partial q_i^*{}_{|h_i=\frac{1}{n_i},s_i=0}}{\partial g} = \phi_{i_{|h_i=\frac{1}{n_i},s_i=0}} q_g \left\{ \alpha_i(1-\rho_i) + \frac{\eta_i(1+\alpha_i g q_g)[\alpha_i \bar{m} q_h(\pi_s q_g - \pi_g(1-\beta)q_s) - \beta\bar{n}w_i\pi_g q_s]}{\bar{m}P_{n,i}q_h q_s q_g} + \frac{\rho_i(1+\alpha_i g q_g)\{\alpha_i\bar{m}[\pi_s q_g - \pi_g(1-\beta)q_s] + \beta\bar{n}\pi_g(\bar{\alpha}g\pi_s + \bar{\alpha}\sigma q_s + \alpha_i\sigma q_s) - (1-\bar{\alpha})\alpha_i\sigma\bar{n}(\pi_s q_g - \pi_g q_s)\}}{[P_{n,i}q_h + \gamma_i\eta_i(Y_i+w_i)(1-t)](1-t)q_s q_g} \right\} \tag{4.D.4}$$

$$\frac{\partial q_i^*{}_{|h_i=\frac{1}{n_i},s_i=0}}{\partial \beta} = \phi_{i_{|h_i=\frac{1}{n_i},s_i=0}} (1+\alpha_i g q_g) g\pi_g \left\{ \frac{\eta_i(\alpha_i\bar{m}q_h - \bar{\alpha}\bar{n}w_i)}{\bar{m}P_{n,i}q_h} + \frac{\rho_i\{\alpha_i q_s(\bar{m} - \sigma\bar{n}q_s) + \bar{\alpha}\bar{n}[\pi_s + \alpha_i g[\pi_s q_g - \pi_g(1-\beta)q_s] + \sigma q_s]\}}{[P_{n,i}q_h + \gamma_i\eta_i(Y_i+w_i)(1-t)](1-t)q_s} \right\} \tag{4.D.5}$$

$$\frac{\partial q_i^*{}_{|h_i=\frac{1}{n_i},s_i=0}}{\partial \sigma} = \phi_{i_{|h_i=\frac{1}{n_i},s_i=0}} (1+\alpha_i g q_g) \left\{ \frac{\eta_i[(1-\alpha_i)\bar{m}q_h - (1-\bar{\alpha})\bar{n}w_i]}{\bar{m}P_{n,i}q_h} + \frac{\rho_i\{\bar{m}q_s(1-\alpha_i) + \bar{n}[\pi_s(1-\bar{\alpha}) + \alpha_i g[\pi_s q_g - \pi_g(1-\beta)q_s - \bar{\alpha}(\pi_s q_g - \pi_g q_s)] - \bar{\alpha}\beta g\pi_g q_s]\}}{[P_{n,i}q_h + \gamma_i\eta_i(Y_i+w_i)(1-t)](1-t)q_s} \right\} \tag{4.D.6}$$

with $\phi_{i_{|h_i=\frac{1}{n_i},s_i=0}} \equiv \theta \left(\frac{P_{n,i}}{B}\right)^{\eta_i} \left(\frac{\gamma_i\eta_i(Y_i+w_i)(1-t)+P_{n,i}q_h}{\gamma_i\eta_i(1+\alpha_i g q_g)(Y_i+w_i)(1-t)}\right)^{\rho_i}$.

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