Taxation and parental time allocation under different assumptions on altruism*

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This version of the article has been accepted for publication, after peer review and is subject to Springer Nature's AM terms of use, but is not the Version of Record and does not reflect post-acceptance improvements, or any corrections. The Version of Record is available online at: https://doi.org/10.1007/s10797-017-9447-2

Abstract

This paper examines the effects of labor income taxation on parental time allocation in an OLG model in which child care arrangements, that is the combination of parental and non-parental time, matter for human capital accumulation. We show that the sign of the impact of labor income taxation on parental time with children and on growth critically depends on the assumption on the altruistic motives behind the choice of devoting time to children.

Keywords: early childhood environment, child care, labor supply, paternalism, full altruism

JEL Classification: J13, J22, J24.

1 Introduction

This paper examines the effects of labor income taxation on parental time allocation in an overlapping generations (OLG) model in which child care arrangements, that is the combination of parental and non-parental time, matter for

*We thank for their insightful comments the editor and two anonymous referees, as well as seminar participants at the PET conference in Lisbon, at the IIPF conference in Taormina, at the SIEP meeting in Pavia, at the University of Oslo and at the OLG days conference at the Paris School of Economics. The usual disclaimers apply. Part of the paper was written while Alessandra Casarico was visiting Oslo Fiscal Studies, which she thanks for hospitality. Alessandra Casarico acknowledges financial support from MIUR within a PRIN project. Alessandro Sommacal acknowledges financial support from MIUR within the FIRB project RBFR0873ZM 001.

human capital accumulation, and parents can be either paternalistic or fully altruistic.

The issue of how taxation affects labor supply is a long standing one and it is at the core of the policy debate on how to support macroeconomic development. In models in which time allocation is limited to the choice between labor and leisure, reductions in the tax rate are shown to be an effective tool to increase labor supply (Prescott 2004, Ohanian et al 2008, Berger and Heylen 2011). Time allocation is however more complex and the literature accounts for time devoted to home production, in addition to market work and leisure (e.g Gronau 1977). Models with home production are fruitfully used to study business cycle fluctuations (e.g Benhabib et al 1991) and the increase in female labor force participation (Olivetti 2006 and Greenwood et al 2005). They are also applied to analyze the impact of labor taxation on time allocation: the relationship found between labor taxation and market work is negative, whereas the link between the former and time devoted to home production is positive (Ragan 2013 and Rogerson 2007). A reduction in the tax rate on labor income raises labor supply and, at the same time, reduces time devoted to home production. These models often interpret time devoted to home production as child care, but they do not include the latter in the process of human capital accumulation. Since recent research finds that parental time and non-parental time are important inputs for the human capital accumulation of children,[1] it could be appropriate to incorporate them in the production of human capital. This choice calls for an explicit assumption on the motivations behind the choice of time inputs by parents. Full altruism and paternalism are the main assumptions adopted in the literature to describe parental attitudes towards children (Heckman and Mosso 2014). A fully altruistic parent cares about the utility of the child, whereas paternalistic parental preferences are defined over a specific child's outcome, namely her human capital, and not over the adult utility of the child.[2] Casarico and Sommacal (2012) investigate the impact of labor income taxation on time allocation and growth in a model in which child care affects the process of human capital formation, parental preferences are paternalistic, and revenues finance a

[1] For example, Del Boca et al (2014) stress that parental time is more important for the cognitive development of children than money expenditure. Bernal and Keane (2010, 2011) find that, on average, the substitution of maternal time with other sources of care produces negative and rather sizable effects on children's skills; however, they also stress that this effect is driven by the substitution of maternal time of highly educated mothers with low quality child care. This is also documented by Heckman and Masterov (2007), who review the evidence supporting the idea that high-quality preschool centers available to disadvantaged children are highly effective in promoting achievement. The review of the literature in Almond and Currie (2011) points in the same direction. We also remark that the Europe 2020 strategy has forcefully highlighted the importance of the availability of quality day care services not just as a tool that complements parental labor, but as a means to develop future cohorts' human capital and to promote equality of opportunities.

[2] Note that what we label here "paternalism" (i.e., the fact that parental preferences are defined over the human capital of the child and not over her utility) is sometimes called "warm glow" or "joy of giving". We deem it more appropriate to use the term "paternalism" because "warm glow" or "joy of giving" are used by many scholars to refer to a situation in which parental preferences are defined over a specific action of the parent (e.g., time devoted to children), rather than over the outcome of such an action (e.g., the level of human capital).

lump-sum transfer. In this paper we build on Casarico and Sommacal (2012), but we consider fully altruistic parents. In addition, we allow revenues from taxation to finance both a lump-sum transfer, and a subsidy to day care, to investigate how alternative usages of revenues affect the link between taxation, time allocation and growth. Prior research has examined public subsidies to day care (e.g. Rosen 1997, Blomquist et al 2010 and Domeij and Klein 2013), but has not accounted for the role of child care in human capital accumulation.

We construct an OLG model in which an agent lives for three periods: childhood, parenthood and retirement. In the first period, the agent only receives care. In the second period, she has one child and she determines how much to consume and save, and how much time to devote to labor, leisure and her child. In the third period, the agent retires and consumes all her income.

We assume that the child requires a certain care time and that time not supplied by the parent is covered by non-parental time, i.e. day care services which the parent buys on the market. Child care arrangements, that is the combination of parental and non-parental time, influence the human capital of the child. We maintain that parents do not overprovide time to the child, which means that a one to one substitution between parental time and time spent in day care services always reduces the child's human capital. In addition, we assume that the growth rate of the economy only depends on child care arrangements. In particular, we abstract from the role of formal schooling on the accumulation of human capital, because we want to study the repercussions of labor taxation on growth, focusing on the allocation of parental time as the main transmission mechanism, an issue which is largely unexplored in the theoretical literature.[3]

In a first formulation of the model, for which we provide analytical results, revenues are used to finance a lump-sum transfer, and all the time that the parent devotes to the child directly contributes to the offspring's human capital. In this set-up we show that the relationship between taxation and time allocation critically depends on the assumption on parental altruism. If the parent is paternalistic, we replicate the standard result in the literature on taxation and time allocation: when the tax rate declines, labor supply increases and parental time devoted to the child goes down. The reduction in parental time happens because its opportunity cost (i.e., net foregone earnings) increases when taxation declines. Clearly, time spent in day care centers increases. If the parent is fully altruistic, we show that lowering taxation has an ambiguous impact on parental time, and we identify a threshold level of the elasticity of the labor supply at which the sign of the effect of taxation on parental time changes. Beyond that threshold, reducing taxation grants both higher labor supply and higher parental time with the child, with time spent in day care centers decreasing to meet the time constraint. Thus, the assumption of full altruism can challenge the conventional wisdom according to which a decline in taxes decreases parental time with children. The possibility of a negative relationship

[3]One should bear in mind that the effects working via the child care channel we look at should be combined with those operating via e.g. formal schooling, to obtain the overall impact of taxation on growth.

between taxation and parental time can be explained as follows: when taxation goes down, the returns to parental investment in the child's human capital are higher because the child will work more. The more elastic the response of labor supply is to changes in taxation, the more likely it is that the higher returns offset the increase in the opportunity cost of parental time. The changes in time allocation have repercussions on human capital accumulation and growth. Under paternalism, a reduction in taxation is always associated with a decline in the growth rate because of the decrease in parental time; under full altruism, the growth rate decreases if and only if the elasticity of the labor supply is low, because only in this instance, parental time goes down.

In a second formulation of the model, we remove the restriction that all parental time spent with the child is productive and develop a (more general and more realistic) model, in which parental time can be of two types: productive and unproductive in terms of human capital. In addition, we let revenues finance a subsidy to day care services. We solve this version of the model numerically and we perform two policy experiments. In the first policy experiment, we assume that the reduction in the tax rate is matched by a change in the lump-sum transfer to keep the budget balanced. This experiment captures the purely distortionary effects of taxation on time allocation and growth. In the second policy experiment, we assume that all the adjustment is borne by the subsidy so that we can investigate the impact of changes in it on time allocation and growth. When we perform the first policy experiment, we find that unproductive time declines under both paternalism and full altruism. All the other variables behave as in the analytical model, with the important exception concerning day care services under full altruism. In particular, we show that time spent in day care centers always rises, even when productive parental time increases. The result depends on the rise in productive time being smaller than the decrease in unproductive time, and thus day care time compensating for the difference. When we perform the second policy experiment, qualitatively, the impact of a reduction in taxation on the labor supply, productive parental time and time in day care is the same, irrespective of the assumption on altruism. The labor supply increases and so does productive parental time. Time in day care centers declines. The assumption on altruism becomes salient when assessing the effects of taxation on unproductive time, and then growth. Unproductive time always increases under paternalism; howver, the same does not apply under full altruism when the wage elasticity of the labor supply is high. In most cases, the impact on growth is positive: this is due to the decline in day care time being almost matched one to one by an increase in productive (rather than unproductive) time with children, which is more beneficial human capital accumulation-wise, compared to time in day care centers. However the impact is negative under paternalism when the wage elasticity of labor supply is high enough. In this instance, the decrease in time spent in day care centers is offset by a larger increase in unproductive, rather than productive parental time, with negative repercussion on growth.

The paper is organized as follows: in Section 2 we describe the building blocks of the model in which parental time is only of the productive type and

revenues finance only a lump-sum transfer. We discuss the impact of taxation on time allocation, human capital accumulation and growth, comparing the case in which the agent is paternalistic with the one in which she is fully altruistic. In Section 3 we introduce and solve numerically the model in which parental time is of two types — productive and unproductive — and we introduce a subsidy on child care expenditure. We reassess the impact of changes in labor income taxation on all the variables of interest. Section 4 concludes.

2 Basic set-up

The model we introduce draws on the OLG endogenous growth model of Casarico and Sommacal (2012) but allows for different assumptions on altruism, rather than focusing only on paternalism. Agents live for three periods — childhood, parenthood and retirement — and have one child in the second period of life. The population is constant, and the size of each generation is equal to N. Agents have perfect foresight about future variables.

In the first period, the agent receives care. In the second period she has one child and decides how much to consume and save, and how much time to devote to labor, leisure and the child. The child requires a given care time: the time not supplied by the parent is covered by non-parental time, i.e. day care services, that the parent buys on the market. In the third period, the agent retires and consumes her income.

Production

In each period, output Y_t of a physical good evolves from using capital and labor measured in efficiency units:

$$Y_t = K_t^{\alpha} {L_t^y}^{1-\alpha}, \tag{1}$$

where K_t is the capital stock; $L_t^y = N l_t^y h_t$ is the aggregate labor supply in efficiency units in sector y producing the physical good, with l_t^y indicating the individual labor supply in this sector, and h_t the individual human capital. The share of capital income in output is $0 < \alpha < 1$. The physical good can be used for consumption and for investment in physical capital; we choose it as the numeraire.

Non-parental care is derived from using a constant return to scale technology, which employs only labor as input. Because teachers can oversee more than one child at the same time, we follow Lundholm and Ohlsson (1998) and assume that one hour of work in the day care sector produces $\chi > 1$ hours of non-parental care.

We assume perfect labor mobility, which guarantees that the wages equalize across the sector producing the physical good and the sector producing non-parental care; thus, there is only one wage per efficiency unit w_t. Moreover, the zero profit condition implied by perfect competition indicates that the price per hour of non-parental care is $w_t h_t / \chi$.

Preferences

The following utility function describes preferences of an agent born in period $t-1$:

$$U_t = \log c_t^m + \beta \frac{(z_t)^\kappa}{\kappa} + \theta \log c_{t+1}^o + \gamma^p \log h_{t+1} + \gamma^{fa} U_{t+1}, \tag{2}$$

where c_t^m and c_{t+1}^o denote consumption during parenthood/middle age and retirement/old age, respectively (no consumption takes place during childhood); z_t stands for leisure time and $\kappa \leq 1$; h_{t+1} is the human capital of the child born at time t and U_{t+1} indicates her utility; β and θ are non-negative parameters determining the weight of leisure and consumption during old age, respectively; γ^p is the weight of the human capital of the child and γ^{fa} is the weight of her utility. We consider two alternative environments: the utility function (2) incorporates paternalism when $\gamma^p > 0$ and $\gamma^{fa} = 0$, whereas it incorporates full altruism when $\gamma^p = 0$ and $0 < \gamma^{fa} < 1$.

Human capital production function

We assume that human capital h_{t+1} linearly depends on the quality of the early childhood environment x_t:

$$h_{t+1} = q x_t, \tag{3}$$

where $q > 0$. This is the simplest way to formalize the idea that the early childhood environment matters for human capital accumulation.[4]

Child care and the quality of the early childhood environment

A child requires an exogenous constant care time a, which can be covered either by parental time n_t or by non-parental time d_t. That is:

$$d_t + n_t = a. \tag{4}$$

Child care (both parental time and non-parental time) produces the quality of the early childhood environment x_t according to the following technology:

$$x_t = \left[\sigma (d_t h_t)^\nu + (1-\sigma)(n_t h_t)^\nu\right]^{\frac{1}{\nu}}. \tag{5}$$

The quality of the early childhood environment is a function of parental and non-parental time in efficiency units. Note that all the time the parent spends with her child contributes to human capital accumulation. This assumption will be relaxed in Section 3. The parameter $0 < \sigma < 1$ determines the weight of non-parental time in the production of the quality of the early childhood environment. The parameter ν governs the elasticity of substitution between $d_t h_t$ and $n_t h_t$, $\zeta_\nu = 1/(1-\nu)$, and determines how easy it is to substitute parental time with non-parental time. We assume $\nu < 1$ and focus on the case of imperfect substitutability between parental time and non-parental time. The production function (5) captures the idea that though parents and non-parental

[4] Casarico and Sommacal (2012) focus on the growth impact of taxation in a model in which the human capital production function features both early childhood environments and formal schooling as inputs. Here, we abstract from the role of formal schooling, because we focus on the study of the impact of labor taxation on growth, using the allocation of parental time as the main transmission mechanism.

care givers have the same level of human capital, the value of being alone with a parent differs from the value of being in a group of peers under teachers' supervision. Therefore, the productivity of parental and non-parental time also differ. For example, the productivity of non-parental time is influenced by the educational content of day care services, which depends not only on the level of human capital of non-parental care givers but also on how a day care center is organized and on its educational policies.

Government budget constraint

The government budget constraint at t is the following:

$$\tau N w_t h_t l_t = N T_t, \tag{6}$$

where τ is the tax rate on labor income, $l_t = l_t^d + l_t^y$ is the total number of hours each person works both as an employee in the day care sector (l_t^d) and as an employee in the final good sector (l_t^y), and T_t is the lump-sum transfer paid back to agents. We take the tax rate τ as the exogenous policy variable, and we endogenously determine the lump-sum transfer T_t to fulfil the budget constraint.

Following some of the existing literature (e.g., King and Rebelo 1990, Stokey and Rebelo 1995, Ihori 2001), we assume that tax proceeds are returned to the same individual as lump-sum transfers; this assumption allows to separate the effects of taxation from those of government expenditure.

Individual budget constraints

The time and budget constraints are as follows:

$$l_t + z_t + n_t = 1 \tag{7}$$

$$c_t^m = w_t h_t l_t (1 - \tau) + T_t - s_t - \frac{w_t h_t}{\chi} d_t \tag{8}$$

$$c_{t+1}^o = (1 + r_{t+1}) s_t, \tag{9}$$

where s_t denotes savings. Equation (7) indicates that during parenthood, agents have one unit of time to devote to labor supply, leisure and parental time with the child. Equation (8) is the budget constraint during parenthood: net earnings plus the lump-sum transfer received can be allocated to consumption, savings, and the purchase of non-parental time. Equation (9) is the budget constraint during retirement: the income of the second period, which is given by savings plus the interests earned on them, goes to consumption.

2.1 First-order conditions

Firm's optimization problem

In the final good sector, profit maximizing behavior of the competitive firms implies the following conditions:

$$\psi + r_{t+1} = \alpha \left(\frac{K_{t+1}}{L_{t+1}^y} \right)^{\alpha - 1} \tag{10}$$

$$w_{t+1} = (1-\alpha)\left(\frac{K_{t+1}}{L^y_{t+1}}\right)^{\alpha}, \tag{11}$$

which are standard. Equation (10) states that the interest rate r_{t+1} is equal to the marginal productivity of capital minus the depreciation rate ψ. Equation (11) requires that the wage per efficiency unit w_{t+1} is equal to the marginal productivity of aggregate labor in efficiency units.

Consumers' optimization problem

Agents choose parental time n_t, labor supply l_t and savings s_t to maximize the utility function (2), subject to the time constraints (4) and (7), the budget constraints (8) and (9), the production function of the quality of the early childhood environment (5), and the technology of skill formation (3).

The first-order conditions for an interior solution on the choices of s_t, l_t, and n_t can be written as follows:

$$s_t : \frac{1}{c^m_t} = (1+r_{t+1})\theta\frac{1}{c^o_{t+1}} \tag{12}$$

$$l_t : \beta(z_t)^{\kappa-1} = \frac{1}{c^m_t} w_t h_t (1-\tau) \tag{13}$$

$$n_t : \frac{1}{c^m_t} w_t h_t \left[(1-\tau) - \frac{1}{\chi}\right] = \frac{dx_t}{dn_t}\frac{1}{x_t}\left(\gamma^p + \gamma^{fa} q x_t \frac{1}{c^m_{t+1}} w_{t+1} l_{t+1}(1-\tau)\right), \tag{14}$$

where $\frac{dx_t}{dn_t}\frac{1}{x_t} = \frac{\left[-\sigma(a-n_t)^{\nu-1} + (1-\sigma)n_t^{\nu-1}\right]h_t^{\nu}}{x_t^{\nu}}$ is the total impact of parental time on the quality of the early childhood environment.

The first-order conditions for savings and labor supply are standard. Equation (12) requires that the marginal rate of substitution between consumption during parenthood and retirement is equal to one plus the interest rate. Equation (13) requires that the marginal rate of substitution between consumption during parenthood and leisure is equal to the net wage.

Equation (14) reflects the choice of parental time. Parental time affects utility both through consumption and through the quality of the early childhood environment. The impact of a change in parental time n_t on the utility from consumption appears on the left-hand side of equation (14), where $1/c^m_{t+1}$ is the marginal utility of consumption and $w_t h_t \left[(1-\tau) - 1/\chi\right]$ is the change in consumption. The change in consumption delivered by one additional unit of parental time is given by net forgone wages $w_t h_t(1-\tau)$, (i.e., the price of parental time), less the price of non-parental care $w_t h_t/\chi$. The right-hand side of equation (14) measures the effect of a change in parental time n_t on utility through human capital. In the case of paternalism, the right hand side reduces to $\frac{dx_t}{dn_t}\frac{1}{x_t}\gamma^p$. In the case of full altruism, the right hand side is equal to $\frac{dx_t}{dn_t}\gamma^{fa} q \frac{1}{c^m_{t+1}} w_{t+1} l_{t+1}(1-\tau)$.

We point out that, at an interior solution, if $w_t h_t \left[(1-\tau) - 1/\chi\right] > (<) 0$, then $\frac{dx_t}{dn_t}\frac{1}{x_t} > (<) 0$, which means that a marginal increase in parental time devoted to the child improves (worsens) the quality of early childhood environments. As long as the cost of child care in terms of foregone earnings is higher

than the cost of child care bought on the market ($w_t h_t [(1-\tau) - 1/\chi] > 0$), a parent is willing to spend time with the child only if this is beneficial for the human capital of the child herself ($\frac{dx_t}{dn_t}\frac{1}{x_t} > 0$).

2.2 Equilibrium

An intertemporal equilibrium is defined as a vector of quantities $\left\{l_t^y, l_t^d, z_t, n_t, d_t, c_t^m, s_t, c_t^o, h_t, x_t, K_t, T_t\right\}$ and of prices $\{w_t, r_t\}$ such that the following equations are satisfied: the first order conditions for consumers (12)-(14) and for firms (10) and (11); the time constraints (4) and (7); the budget constraints (8) and (9) for consumers; the budget constraint for the government (6) and the capital market equilibrium condition

$$K_{t+1} = N s_t.$$

We focus on a balanced growth path along which $\left\{l_t^y, l_t^d, z_t, n_t, d_t\right\}$ are constant and $\{c_t^m, s_t, c_t^o, h_t, x_t, K_t, T_t\}$ increase at a constant common rate $g_{t+1} = g = h_{t+1}/h_t - 1$, where

$$g = q\left[\sigma d_t^{\nu} + (1-\sigma) n_t^{\nu}\right]^{\frac{1}{\nu}} - 1. \tag{15}$$

2.3 The effects of taxation on time allocation and growth

In this section we analyze how, in equilibrium, changes to taxation affect time allocation, distinguishing between a set-up with paternalism and one in which the parent is fully altruistic towards the child. We can state the following propositions.

Proposition 1 *When $\gamma^{fa} = 0$ and $\gamma^p > 0$ (paternalism), provided that $1 - \tau - \frac{1}{\chi} > 0$, it holds that $\frac{\partial l}{\partial \tau} < 0$ and $\frac{\partial n}{\partial \tau} > 0$.*

Proof. See Appendix A. ■

A reduction in taxation increases the net wage, thereby pushing the labor supply up. As the increase in the net wage raises the opportunity cost of parental time provided to the child, parents supply less of it: as a result, a higher labor supply is combined with a lower parental time with the child. Thus, when the parent is paternalistic, the model delivers the same relationship between taxation and parental time with children found in the literature on home production mentioned in Section 1.

Proposition 2 *When $0 < \gamma^{fa} < 1$ and $\gamma^p = 0$ (full altruism), provided that $1 - \tau - \frac{1}{\chi} > 0$, it holds that $\frac{\partial l}{\partial \tau} < 0$. Moreover, $\frac{\partial n}{\partial \tau} > 0$ if and only if*

$$|\epsilon_{l\tau}| < \frac{\tau}{1-\tau}\frac{1}{\chi(1-\tau-1/\chi)} \equiv \bar{\epsilon}_{l\tau}, \tag{16}$$

where $\epsilon_{l\tau} = \frac{\partial l}{\partial \tau}\frac{\tau}{l} < 0$ is the elasticity of labor supply with respect to the tax rate and $\bar{\epsilon}_{l\tau}$ is the threshold level of $|\epsilon_{l\tau}|$ below which the relationship between parental time and the tax rate is positive.

Proof. See Appendix A. ■

As in the case of paternalism, a reduction in the tax rate increases the labor supply and it raises the opportunity cost of parental time, i.e. the left hand side of equation (14). Besides this change, under full altruism there is an additional effect to take into account, which depends on the presence of τ and l on the right hand side of equation (14): the return to parental investment in the child's human capital, which is positive when $(1-\tau-1/\chi) > 0$, is higher when taxation is lower because the child will work more and will receive higher net wages; these higher returns may offset the increase in the opportunity cost of parental time and thus, the impact of taxation on time devoted to the child has an ambiguous sign. The strength of the reaction of the child's labor supply to changes in taxation is critical to assess the overall impact of taxation on parental time. When the elasticity of labor supply with respect to taxation is high enough in absolute value, a higher labor supply brought about by a decrease in taxation is combined with higher parental time, i.e. $\frac{\partial n}{\partial \tau} < 0$. Changes in labor supply are absorbed by changes in leisure rather than by changes in parental time with the child. Note that the value of the threshold $\bar{\epsilon}_{l\tau}$ for the elasticity of labor supply depends negatively on the parameter χ and positively on the policy variable τ. Once the effects of taxation on parental time n are understood, the effects on day care services d can be easily derived, using equation (4): whenever n increases (decreases), d declines (rises).

After the discussion of the effects of taxation on time allocation, we analyse its impact on growth, and we state the following

Proposition 3 *Provided that* $1 - \tau - \frac{1}{\chi} > 0$,

when $\gamma^{fa} = 0$ *and* $\gamma^{p} > 0$ *(paternalism), or when* $0 < \gamma^{fa} < 1$ *and* $\gamma^{p} = 0$ *(full altruism) and* $|\epsilon_{l\tau}| < \bar{\epsilon}_{l\tau}$, *then* $\frac{\partial g}{\partial \tau} > 0$.

when $0 < \gamma^{fa} < 1$ *and* $\gamma^{p} = 0$ *(full altruism) and* $|\epsilon_{l\tau}| \geq \bar{\epsilon}_{l\tau}$, *then* $\frac{\partial g}{\partial \tau} \leq 0$.

Proof. Follows immediately from Proposition 1 and 2, which describe the impact of taxation on time allocation, from equation (5) which says that the quality of early childhood environment is a function of the allocation of time, from equation (3), which links human capital to the quality of early childhood environment, and from taking into account that, as pointed out at the end of Section 2.1, at an interior solution for parental time the substitution of parental time with non-parental time has a negative impact on the level of human capital, provided that $1 - \tau - \frac{1}{\chi} > 0$. ■

When preferences are fully altruistic and the elasticity of labor supply with respect to taxation is high enough in absolute value, a reduction in taxation increases labor supply and parental time devoted to the child, and it fosters the accumulation of human capital and growth. On the other hand, when the elasticity of labor supply is low in absolute value or if parental preferences are paternalistic, the reduction in taxation negatively impacts on human capital accumulation and growth.

3 A general set-up

In the previous section we showed that an increase in labor supply is not necessarily accompanied by a reduction of parental time devoted to human capital-enhancing care. Indeed, if parents are fully altruistic and the elasticity of labor supply with respect to taxation is sufficiently high in absolute value, a reduction of the tax rate on labor income induces an increase of both labor supply and parental time devoted to the child, and a reduction in leisure and in the use of day care services. One may wonder how the parent can work more and, at the same time, reduce the use of non-parental care. Obviously, this can only happen if the parent buys day care services also to enjoy leisure time; thus, in response to a reduction of the tax rate, she can reduce the hours of leisure and the amount of day care services, and increase parental care and labor supply at the same time. However, the idea of the parent buying day care services to increase the amount of leisure time enjoyed might not be fully realistic.[5] In addition, not all parental time with children necessarily contributes to the accumulation of human capital, as we have assumed so far. The parent can spend time reading to the child or playing with her, but she could also cover the care time required by the child simply by being around in the house without any interaction with the child herself.

To take these aspects into account, in this section we allow for two types of parental time spent with the child: productive, and unproductive time; in addition, we include subsidies to daycare in the government budget constraint to investigate how alternative usages of revenues influence the relationship between labor taxation, time allocation, and growth.[6]

We assume that

$$n_t = n_t^1 + n_t^2 \tag{17}$$

i.e., total time spent with the child is the sum of productive time n_t^1 and unproductive time n_t^2, and that

$$x_t = \left[\sigma(d_t h_t)^\nu + (1-\sigma)(n_t^1 h_t)^\nu\right]^{\frac{1}{\nu}}. \tag{18}$$

Since the term n_t^1 represents productive time, it enters the quality of the early childhood environment (and therefore the human capital of the child), whereas n_t^2 does not. In all the equations of the model developed in Section 2 in which n_t appears, it is replaced by $n_t = n_t^1 + n_t^2$. In particular, equation (4) now reads as:

$$d_t + n_t^1 + n_t^2 = a. \tag{19}$$

Therefore, though unproductive time n_t^2 does not directly affect the human capital of the child, it has an indirect impact on it: given the constraint (19), an

[5] Kornstad and Thoresen (2007) assume, for instance, a fixed link between market work and day care time, i.e. the parents buys day care only for each hour of market work. Of course, the parent can *per se* buy day care services also to cover the leisure time. The price of day care is crucial to determine whether she will do so or not.

[6] We have also explored the consequences of introducing a bequest motive into the model. We found that, qualitatively, the results of the policy experiments we focus on are unaffected. Further details are available from the authors upon request.

increase in unproductive time always reduces productive time n_t^1 and/or the use of day care services d_t. Since both n_t^1 and d_t enter the quality of the early childhood environment, we can conclude that increasing unproductive time always has an indirect negative impact on the child's human capital accumulation.[7] Since n_t^2 has a negative impact on the utility function of the parent through the human capital of the child, to have an interior solution for the choice of n_t^2 it is necessary to assume that unproductive time positively affects the utility function of the parent through a different channel. Accordingly, we assume that the utility function of the parent is given by:

$$U_t = \log c_t^m + \beta \frac{(z_t)^\kappa}{\kappa} + \delta \frac{(n_t^2)^\kappa}{\kappa} + \theta \log c_{t+1}^o + \gamma^p \log h_{t+1} + \gamma^{fa} U_{t+1} \tag{20}$$

The difference between equation (20) and (2) is given by the term $\delta \frac{(n_t^2)^\kappa}{\kappa}$, which represents how the parent evaluates unproductive time spent with the child. A possible interpretation of this term is that unproductive time spent with the child is one kind of leisure time: z_t is leisure time enjoyed without the child, whereas n_t^2 is leisure time enjoyed while the child is present in the house (e.g., watching TV while the child is playing alone in another room). This justifies the choice of using the same functional form for n_t^2 and z_t.

To allow for subsidies on day care, the individual budget constraint during parenthood and the government budget constraint become:

$$c_t^m = w_t h_t l_t (1-\tau) + T_t - s_t - (1-\xi)\frac{w_t h_t}{\chi} d_t \tag{21}$$

$$\tau N w_t h_t l_t = N T_t + N \xi \frac{w_t h_t}{\chi} d_t, \tag{22}$$

respectively, with $\xi < 1$ denoting the subsidy rate.

For each assumption on altruism, we perform two policy experiments: in the first one, we assume that the reduction in the tax rate is matched by a change in the lump-sum transfer to keep the budget balanced. This experiment captures the purely distortionary effects of taxation on time allocation and growth. In the second one, we assume that all the adjustment is borne by the subsidy in order to investigate the impact of changes in it on time allocation and growth.

Given the richer time allocation, we cannot provide an analytical solution, and therefore we solve the model numerically. To this end, we have to assign a value to the parameters of the model: Appendix B presents the details of the calibration procedure; Table 1 provides a summary of the values assigned to some parameters and of the methodology adopted to set the others.

As shown in the previous section, the elasticity of the labor supply with respect to taxation $\epsilon_{l\tau}$ is a salient factor to determine the sign of the relationship between taxation and parental time: since $\epsilon_{l\tau}$ depends on the elasticity with

[7] Note also that, differently from the model we solve analytically, here an increase in day care services does not necessarily imply a one to one reduction in productive parental time, and therefore a decline in the growth rate.

respect to the net wage, which we denote by ϵ, we choose the parameter κ in the utility function (20) to obtain different values for ϵ, i.e. $\epsilon = 0.1$, 0.2, 0.3, 0.4, 0.5.[8] While the elasticity of the labor supply with respect to taxation depends on how revenues are used, and will therefore be different in the two policy experiments, the elasticity with respect to the net wage is defined abstracting from the expenditure side of the government budget constraint. Clearly, the two elasticities are intertwined: in commenting the results, we will refer interchangeably to either one or the other, rather than referring to the exogenous parameter κ which drives them.

Table 2 shows the results under the assumptions of paternalism, and of full altruism for the first policy experiment. Table 3 does the same for the second policy experiment. In the first row of Table 2 and Table 3, we report the values of the elasticity of the labor supply with respect to the net wage. For each of these values, we compute the elasticities with respect to taxation of the labor supply, productive and unproductive parental time devoted to the child, the use of day care services, and the growth rate.

[8] One may think that the upper bound of the values of ϵ we use in the calibration is high compared to the available microeconometric estimates (e.g. Evers et al 2008 and Meghir and Phillips 2008). However, in this paper we are not distinguishing across gender, and it is well known that the wage elasticity for women is higher than that of men. In addition, macro elasticities and micro elasticities need not be the same, and the former can be much higher than the latter (e.g. Keane and Rogerson 2015).

Table 1: Parameters

		Value or calibration strategy
a	care requirement	0.24
τ	tax rate	0.39
ξ	daycare subsidy	calibrated to match a ratio of public expenditure on childcare and preschool to GDP equal to 0.009
χ	productivity of the day care sector	5
β, δ, σ	parameters of the utility function and of the early childhood quality function	calibrated to get the following allocation of time: $l = 0.32$; $n^1 = 0.04$; $n^2 = 0.03$ (therefore: $d = a - n^1 - n^2 = 0.17$; $z = 1 - l - n^1 - n^2 = 0.61$)
ν	parameter of the early childhood quality function	0.5
α	share of capital income in national product	0.33
ψ	depreciation rate	1
q	parameter of the human capital production function	calibrated to get an annual growth rate of GDP per capita equal to 2%
θ	parameter of the utility function	calibrated to get a ratio of gross savings to GDP equal to 0.23
γ^p	parameter of the utility function	equal to 0 in the case of full altruism; equal to θ in the case of paternalism
γ^{fa}	parameter of the utility function	equal to 0 in the case of paternalism; equal to θ in the case of full altruism
κ	parameter of the utility function	calibrated to get the values of the wage elasticity of labor supply reported in the first row of Tables 2 and 3

Note: for details see Appendix B.

Table 2: Policy experiment 1: the change in taxes is matched by a change in the lump-sum transfer

Wage elasticity of labor supply (l)	0.1	0.2	0.3	0.4	0.5
Tax elasticity of:	Panel A: Paternalism				
labor supply (l)	-0.137	-0.289	-0.410	-0.506	-0.581
productive parental time (n_1)	0.631	0.486	0.371	0.278	0.202
unproductive parental time (n_2)	0.021	0.096	0.189	0.361	0.963
time spent in day care centers (d)	-0.152	-0.131	-0.121	-0.129	-0.218
growth rate (g)	0.250	0.168	0.093	0.002	-0.214
Tax elasticity of:	Panel B: Full altruism				
labor supply (l)	-0.142	-0.292	-0.411	-0.507	-0.586
productive parental time (n_1)	0.087	-0.036	-0.137	-0.228	-0.332
unproductive parental time (n_2)	0.089	0.258	0.519	1.046	2.396
time spent in day care centers (d)	-0.036	-0.037	-0.059	-0.131	-0.345
growth rate (g)	0.004	-0.094	-0.213	-0.412	-0.873

Notes: for different values of the elasticity of labor supply with respect to the net wage (first row of the table), we compute the elasticity with respect to taxation of productive parental time, unproductive parental time, time spent in day care centers and growth under the assumption of paternalism (Panel A) and full altruism (Panel B). To generate the values of the wage elasticity of the labor supply reported in the first row of table, we calibrate the parameter κ in the utility function (20). For details see Appendix B.

3.1 First policy experiment

We first devote our attention to the impact of taxation on time allocation, and then we discuss the effect of taxation on the growth rate.

3.1.1 The effects of taxation on time allocation

We begin by looking at changes in time allocation under the assumption of paternalistic preferences. Panel A of Table 2 shows that, when taxes are reduced, labor supply increases, whereas both productive and unproductive parental time devoted to the child decrease. Therefore, according to equation (19), time spent in day care centers rises. These results are in line with Proposition 1.

Looking at Panel B of Table 2, we note that for a fully altruistic parent the effects of a reduction in the tax rate on time spent with the child depend on the type of parental time we focus on. The elasticity of productive time with respect to taxation is positive when the absolute value of the elasticity of the labor supply with respect to taxation is low, and it is negative when the latter elasticity is high enough in absolute value. This is consistent with the analytical results established in the previous section: productive time may increase or decrease, depending on how sensitive the labor supply is to changes in the tax rate. Unproductive time, which is not included in the analytical

model, always declines. Finally, the elasticity of time spent in day care centers with respect to taxation is always negative. We point out that, differently from the results of the model developed in Section 2, time spent in day care centers increases even when productive parental time rises: the result depends on the increase in productive time being smaller than the decrease in unproductive time. To sum up, if a parent is fully altruistic and the elasticity of the labor supply with respect to taxation is sufficiently high in absolute value, a reduction of the tax rate induces an increase of labor supply and productive parental time devoted to the child. In addition, it determines a higher demand for day care services. Leisure and unproductive time spent with the child, instead, decline.

The intuition behind the effects of taxation on time with the child under paternalism and full altruism can be explained as follows. When a parent chooses unproductive and productive parental time, she equates marginal cost and marginal benefit associated with the choice.

On the cost side, the distinction between unproductive and productive parental time, and between paternalism and full altruism is immaterial. The marginal cost is always represented by net foregone earnings evaluated using the marginal utility of consumption: when (productive and/or unproductive) parental time increases, labor supply is reduced, and consumption of the parent declines by an amount equal to net foregone earnings. When taxes are reduced, net foregone earnings rise, and so does the marginal cost of both unproductive and productive parental time.

On the benefit side, the distinction between unproductive and productive parental time, and between paternalism and full altruism is important. Since unproductive parental time can be viewed as leisure time with the child, it directly enters the utility function (20) and it has no direct impact on the human capital accumulation process (18). Accordingly, the marginal benefit of unproductive parental time is given by the marginal change in the utility function, i.e. $\delta(n_t^2)^{\kappa-1}$: such a marginal benefit is not directly affected by changes in taxation and does not depend on the type of parental altruism. The type of parental preferences becomes salient when we look at productive time, which enters as an input in the quality of the early childhood environment equation (18). A paternalistic parent enjoys utility directly from the level of human capital of the child. Accordingly, the marginal benefit of productive parental time for a paternalistic parent simply depends on the marginal impact that such time has on the level of human capital, i.e. on its marginal productivity in terms of human capital; this productivity is not directly affected by changes in taxation. A fully altruistic parent cares about the utility of the child; the utility of the child is, in turn, affected by her net earnings, which depend on her human capital, her labor supply and the tax rate. Thus, for a fully altruistic parent, the marginal benefit of productive parental time is also affected by changes in taxation. More precisely, changes in taxation have a double impact on the marginal benefit of productive parental time: a direct impact for a given level of labor supply, and an indirect impact through changes in labor supply.

Keeping in mind the marginal cost and the marginal benefit of the different time usages, and knowing if and how they are affected by taxation, it is now

possible to have a clearer understanding of the results in Table 2. A reduction in the tax rate raises the marginal cost of unproductive parental time irrespective of the assumption on altruism and it does not generate any direct impact on its marginal benefit: as a consequence, since marginal cost is increasing (because the marginal utility of consumption is decreasing), unproductive parental time is reduced to maintain the equality between its marginal cost and its marginal benefit. As to productive parental time, its marginal cost also rises when taxes are reduced. What happens to the marginal benefit depends on the assumption on parental preferences. For a paternalistic parent, the marginal benefit is not directly affected by taxation. Therefore, the behavior of productive parental time for this parent mimics that of unproductive parental time: it declines when taxes are reduced. For a fully altruistic parent, a reduction in the tax rate raises the marginal benefit of productive parental time: such an impact is stronger, the stronger the response of labor supply to taxation. Therefore, the optimal choice of productive time by a fully altruistic parent in response to a change in taxation balances two contrasting effects: the increase in the marginal cost pushes towards a reduction of productive parental time; the increase in the marginal benefit, on the other hand, calls for a rise in such a time use. For low in absolute value elasticity of labor supply with respect to taxation, the increase in the marginal benefit is low and the effect related to the marginal cost dominates: accordingly, productive parental time declines. When labor supply is more sensitive to changes in the tax rate, the increase in the marginal benefit is high enough to more than offset the increase in the marginal cost: in such a case, productive parental time rises.

3.1.2 The effects of taxation on growth

Having spelled out the effects of taxation on time allocation, we now comment on the resulting impact on growth, which in our model is entirely determined by human capital accumulation during childhood, and therefore by productive parental time and by day care services. Table 2 shows that, under paternalism, the elasticity of the growth rate with respect to taxation is positive, unless the elasticity of labor supply with respect to taxation is high. With full altruism, a tax cut always boosts the process of skill formation and the growth rate, with the exception of the case in which the elasticity of labor supply is low.

The impact of taxation on the process of human capital accumulation can be understood if we take into account the effect of taxation on time allocation and the link between time allocation and the technology of skill formation (18). When taxation induces an increase of both productive parental time and day care services, human capital accumulation is obviously strengthened: this happens when parents are fully altruistic and the elasticity of labor supply with respect to taxation is not too low in absolute value. However, when this elasticity is low in absolute value or parents are paternalistic, taxation substitutes productive parental time with day care services. In this case, the effect on the skill formation process is theoretically ambiguous: it depends on the relative productivity of productive parental time and day care services, and on the mag-

nitude of the changes in the two inputs. As to the relative productivity of the two inputs, we recall our assumption that parents do not overprovide time to the child, which means that a one to one substitution of parental time with time spent in day care services always reduces the child's human capital. As to the magnitude of the change in productive parental time and day care services, the increase of the latter is stronger than the decrease of the former. However, when preferences are paternalistic, such an increase is not strong enough to compensate for the higher productivity of parental time, unless the elasticity of the labor supply with respect to taxation is high in absolute value.[9]

3.2 Second policy experiment

Results for this experiment are reported in Table 3, Panel A for paternalism and Panel B for full altruism. In this policy experiment, a reduction in the tax rate is accompanied by a reduction in the subsidy rate: thus, the policy change involves both an increase in the price of parental time, i.e. net foregone earnings, and in the price of day care services, with the latter change being larger than the former.[10] Qualitatively, the impact of taxation on the labor supply, productive parental time and time in day care is the same irrespective of the assumption on altruism and of the magnitude of the wage elasticity of the labor supply: the labor supply increases[11] and there is a substitution of day care time with productive parental time. The assumptions on altruism and the vaue of the wage elasticity of the labor supply become important when assessing the impact of taxation on unproductive time. The latter always increases under paternalism; the more so, if the wage elasticity of the labor supply is high. Since the functional form for leisure time and unproductive time is the same, a high value of the parameter κ makes both labor supply and unproductive time very sensitive to changes in taxation. Under full altruism, unproductive parental time increases, unless the wage elasticity of the labor supply is high enough. The intuition for the asymmetric impact of high values of the wage elasticity on the behavior of unproductive time across paternalism and full altruism is the following: only with fully altruistic preferences, when taxes are cut, the

[9] From Table 2, it is not possible to directly appreciate the magnitude of the marginal change in productive parental time n^1 relative to that in day care services d: indeed, the table reports information on the elasticities of d and n^1 with respect to taxation and not on their marginal changes, i.e. on derivatives of d and n^1. However, to recover such a relative change it is enough to multiply by n^1/d the ratio between the tax elasticity of n^1 and the tax elasticity of d (where $n^1 = 0.04$ and $d = 0.17$, as specified in Table 1); in other terms: $\left(\frac{\partial n^1}{\partial \tau}\right) / \left(\frac{\partial d}{\partial \tau}\right) = \frac{n^1}{d}\left(\frac{\partial n^1}{\partial \tau}\frac{\tau}{n^1}\right) / \left(\frac{\partial d}{\partial \tau}\frac{\tau}{d}\right)$.

[10] We can solve the government budget constraint in (22) with respect to the subsidy rate ξ. We then take the derivative of ξ with respect to τ, keeping the lump-sum transfer T, the labor supply l and time in day care centers d constant. We find: $\left.\frac{\partial \xi}{\partial \tau}\right|_{T=\overline{T}} = \frac{l}{d}\chi > 1$. Thus, the change of the subsidy rate (and therefore of the price of day care services) is higher than the change of the tax rate (and therefore of the price of parental time).

[11] We point out that the impact on the labor supply that we measure is the average impact during the parenthood period, which lasts for 25 years in our calibration. If we split parenthood in sub-periods, the labor supply would likely decrease in the first sub-period, when the child demands care, and increase in the following periods.

return to investment in the human capital of the child increases; the more so, if the wage elasticity of the labor supply is high. In this case, the increase in productive parental time more than compensates the decrease in time in day care centers, and unproductive parental time declines to match the care time constraint.

As to the impact of a reduction in the tax rate on growth, as we discussed in section 3.1.2, its sign depends on the productivity of parental time and of time in day care centers, where the former is higher than the latter by assumption, and on the magnitude of the changes in the two inputs. Results in Table 3 show that the impact on growth is positive, with the exception of the model with paternalistic preferences and high wage elasticity of the labor supply. In this case, the decrease in time in day care centers is offset by an increase in unproductive time, which is larger than the one in productive parental time, with negative consequences on growth.

In summary, under full altruism a reduction in the subsidy on day care always increases growth, whereas such a reduction may be detrimental to growth under paternalism, as long as the wage elasticity of the labor supply is high enough.[12]

Table 3: Policy experiment 2: the change in taxes is matched by a change in the day care subsidy

Wage elasticity of labor supply (l)	0.1	0.2	0.3	0.4	0.5
Tax elasticity of:			Panel A: Paternalism		
labor supply (l)	0.023	-0.187	-0.340	-0.453	-0.522
productive parental time (n_1)	-0.740	-0.600	-0.491	-0.391	-0.260
unproductive parental time (n_2)	-0.025	-0.119	-0.250	-0.506	-1.236
time spent in day care centers (d)	0.178	0.162	0.160	0.181	0.279
growth rate (g)	-0.293	-0.207	-0.122	-0.003	0.275
Tax elasticity of:			Panel B: Full altruism		
labor supply (l)	-0.003	-0.198	-0.343	-0.451	-0.522
productive parental time (n_1)	-1.191	-1.063	-0.972	-0.912	-0.891
unproductive parental time (n_2)	-0.010	-0.009	0.016	0.092	0.278
time spent in day care centers (d)	0.282	0.252	0.226	0.198	0.161
growth rate (g)	-0.433	-0.386	-0.361	-0.363	-0.414

Notes: see the notes to Table 2

4 Conclusions

In a model in which child care affects the human capital accumulation process, we investigate how changes in labor income taxation influence time allocation

[12]The literature shows mixed results on public financing of day care services. Rosen (1997) shows that a subsidy to day care is likely to reduce GDP, whereas Blomquist et al (2010) and Domeij and Klein (2013) argue in favor of subsidizing day care. These papers, as mentioned in the Introduction, abstract from the impact of child care on human capital accumulation.

between labor, leisure, productive and unproductive time with children. The key idea behind the results of the paper is that a reduction in taxation under full altruism directly affects the marginal benefits of productive parental time, whereas it only influences the cost side under paternalism.[13] We perform two policy experiments: in the first, a reduction in taxation is borne by a reduction in a lump-sum transfer. We show that if the parent is paternalistic, lowering the tax rate reduces parental time devoted to the child. If the parent is fully altruistic, a lower taxation may go together with higher or lower productive parental time devoted to children, depending on the value of the wage elasticity of the labor supply. In particular, when the latter is high enough, reducing taxation may grant both higher labor supply and higher productive parental time with children, with positive repercussions on human capital accumulation and growth. In the second policy experiment, a reduction in taxation is associated with a decline in the subsidy on the purchase of day care. In this case, productive parental time increases also under paternalism, though by less than under full altruism. As to the impact on growth, the reduction in taxation always increases growth under full altruism. With paternalism, the results depend on the wage elasticity of the labor supply. When it is high enough, a reduction in taxation and thus in the subsidy can have negative repercussions on growth.

The discussion on the effects of taxation has been qualitative. As to the *quantitative* assessment of the effects of taxation on time allocation, and on human capital accumulation, we leave it for future research. We are aware that such an assessment would require a large scale, fully fledged OLG model with intragenerational heterogeneity and a more complete description of the process of human capital accumulation than the one adopted in this paper, which, in particular, abstracts from schooling in later periods of life.

Our analysis of the effects of taxation does not aim at determining the optimal public policy. Under the assumption of paternalism and intragenerational heterogeneity, Casarico et al (2015) characterize the optimal tax policy and quality of day care services in a model in which, similarly to the present paper, child care matters for human capital accumulation. The distinctive feature of the analysis there is the presence of an intergenerational externality, which modifies the standard results of the optimal taxation literature, where parental time is not an input of the human capital production function. If we allow for full altruism, we expect the intergenerational externality to disappear and the optimal public policy to replicate the results of standard models.

We think that investigating theoretically the relationship between taxation and parental time allocation both under the case of paternalism and of full altruism is important since, to the best of our knowledge, no direct empirical

[13] We also explored the case in which the utility function of the parent depends (through a logarithmic function) on the net income of the child or directly on the time devoted to him. In both cases, the marginal utility of parental time is not affected by taxation and we obtain the same results as under paternalism, in which preferences depends on the human capital of the child. In general, we argue that every choice on the modelling of altruism such that the marginal utility of parental time is (not) directly affected by taxation will deliver results which mimic those under full altruism (paternalism).

test exists on the type of altruism involved in parental decision to devote time to children. The result according to which paternalism and full altruism may have different implications in terms of the relationship between taxation and time allocation could guide empirical analysis. Indeed, it provides a tool to identify the type of parental preferences behind the choice of time investment: for instance, if the empirical analysis shows that a reduction in taxation (keeping the day care subsidy constant) does not decrease productive time devoted to children, the result could be interpreted as evidence in favor of fully altruistic parental preferences. One can find a similar result in Gelber and Mitchell (2012) that, to the best of our knowledge, is the only empirical analysis on the effects of taxation on broad time allocation. Using a repeated cross-section of time diary data for the US, they show that time devoted to child care is not significantly affected by changes in the net-of-tax wage. The analysis of Gelber and Mitchell (2012) focuses on the US and on a sample of single males and females. Further work is needed to understand more in depth the relationship between taxation and broad time allocation: our paper could provide the empirical analysis a useful theoretical guide.

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Appendix A Proof of Propositions 1 and 2

We stationarize equations (6), (8), (9) and (12)-(14) and focus on a balanced growth path. We denote a stationarized variable with a $\widetilde{}$. After few manipulations it is possible to show that the equilibrium can be expressed as a function of l and n only, and it is characterized by the following system of equations:

$$\varphi_1(l,n,\tau) \equiv \frac{1+\theta}{l-\frac{a-n}{\chi}}(1-\tau) - \beta(z)^{\kappa-1} = 0 \tag{23}$$

$$\varphi_2(l,n,\tau) \equiv \frac{1+\theta}{l-\frac{a-n}{\chi}}\left(1-\tau-\frac{1}{\chi}\right) - \frac{d\widetilde{x}}{dn}\frac{1}{\widetilde{x}}\left(\gamma^p + \gamma^{fa}\frac{1+\theta}{l-\frac{a-n}{\chi}}l(1-\tau)\right) = 0 \tag{24}$$

where $\frac{d\widetilde{x}}{dn}\frac{1}{\widetilde{x}} = \frac{-\sigma(a-n)^{\nu-1}+(1-\sigma)n^{\nu-1}}{\sigma(a-n)^{\nu}+(1-\sigma)n^{\nu}}$.

We apply the implicit function theorem to the system of equations (23)-(24), and we obtain:

$$\frac{\partial l}{\partial \tau} = -\frac{\begin{vmatrix} \frac{\partial \varphi_1}{\partial \tau} & \frac{\partial \varphi_1}{\partial n} \\ \frac{\partial \varphi_2}{\partial \tau} & \frac{\partial \varphi_2}{\partial n} \end{vmatrix}}{\begin{vmatrix} \frac{\partial \varphi_1}{\partial l} & \frac{\partial \varphi_1}{\partial n} \\ \frac{\partial \varphi_2}{\partial l} & \frac{\partial \varphi_2}{\partial n} \end{vmatrix}} = -\frac{\frac{\partial \varphi_1}{\partial \tau}\frac{\partial \varphi_2}{\partial n} - \frac{\partial \varphi_2}{\partial \tau}\frac{\partial \varphi_1}{\partial n}}{\frac{\partial \varphi_1}{\partial l}\frac{\partial \varphi_2}{\partial n} - \frac{\partial \varphi_2}{\partial l}\frac{\partial \varphi_1}{\partial n}} \tag{25}$$

and

$$\frac{\partial n}{\partial \tau} = -\frac{\begin{vmatrix} \frac{\partial \varphi_1}{\partial l} & \frac{\partial \varphi_1}{\partial \tau} \\ \frac{\partial \varphi_2}{\partial l} & \frac{\partial \varphi_2}{\partial \tau} \end{vmatrix}}{\begin{vmatrix} \frac{\partial \varphi_1}{\partial l} & \frac{\partial \varphi_1}{\partial n} \\ \frac{\partial \varphi_2}{\partial l} & \frac{\partial \varphi_2}{\partial n} \end{vmatrix}} - \frac{\frac{\partial \varphi_1}{\partial l}\frac{\partial \varphi_2}{\partial \tau} - \frac{\partial \varphi_2}{\partial l}\frac{\partial \varphi_1}{\partial \tau}}{\frac{\partial \varphi_1}{\partial l}\frac{\partial \varphi_2}{\partial n} - \frac{\partial \varphi_2}{\partial l}\frac{\partial \varphi_1}{\partial n}}. \tag{26}$$

In the case of paternalism (Proposition 1), we have:

$$\frac{\partial \varphi_1}{\partial \tau} = -\frac{1+\theta}{l-\frac{a-n}{\chi}} \tag{27}$$

$$\frac{\partial \varphi_1}{\partial n} = -\frac{1+\theta}{\chi\left(l-\frac{a-n}{\chi}\right)^2}(1-\tau) - \beta(1-\kappa)z^{\kappa-2} \tag{28}$$

$$\frac{\partial \varphi_1}{\partial l} = -\frac{1+\theta}{\left(l-\frac{a-n}{\chi}\right)^2}(1-\tau) - \beta(1-\kappa)z^{\kappa-2} \tag{29}$$

$$\frac{\partial \varphi_2}{\partial \tau} = -\frac{1+\theta}{l-\frac{a-n}{\chi}} \tag{30}$$

$$\frac{\partial \varphi_2}{\partial n} = -\frac{1+\theta}{\chi\left(l-\frac{a-n}{\chi}\right)^2}(1-\tau-\frac{1}{\chi}) - \gamma^p \frac{d}{dn}\left(\frac{d\widetilde{x}}{dn}\frac{1}{\widetilde{x}}\right) \tag{31}$$

$$\frac{\partial \varphi_2}{\partial l} = -\frac{1+\theta}{\left(l-\frac{a-n}{\chi}\right)^2}(1-\tau-\frac{1}{\chi}) \tag{32}$$

where:

$$\frac{d}{dn}\left(\frac{d\widetilde{x}}{dn}\frac{1}{\widetilde{x}}\right) = \frac{\left[\sigma(\nu-1)(a-n)^{\nu-2} + (1-\sigma)(\nu-1)n^{\nu-2}\right]\widetilde{x} - \nu\left[-\sigma(a-n)^{\nu-1} + (1-\sigma)n^{\nu-1}\right]^2}{\widetilde{x}^{2\nu}} \tag{33}$$

with $\widetilde{x} = [\sigma(a-n)^{\nu} + (1-\sigma)(n_t)^{\nu}]^{\frac{1}{\nu}}$. Note that $\frac{d}{dn}\left(\frac{d\widetilde{x}}{dn}\frac{1}{\widetilde{x}}\right) < 0$ (recall that $\nu < 1$).

After a few manipulations, we can write $\frac{\partial l}{\partial \tau}$ in (25) as follows:

$$\frac{\partial l}{\partial \tau} = -\frac{-\frac{(1+\theta)^2}{\chi^2\left(l-\frac{a-n}{\chi}\right)^3} + \gamma^p(1+\theta)\frac{\frac{d}{dn}\left(\frac{d\widetilde{x}}{dn}\frac{1}{\widetilde{x}}\right)}{\left(l-\frac{a-n}{\chi}\right)} - \frac{1+\theta}{\left(l-\frac{a-n}{\chi}\right)}\beta(1-\kappa)z^{\kappa-2}}{\gamma^p\frac{d}{dn}\left(\frac{d\widetilde{x}}{dn}\frac{1}{\widetilde{x}}\right)\left[\frac{1+\theta}{\left(l-\frac{a-n}{\chi}\right)^2}(1-\tau)\gamma^p + \beta(1-\kappa)z^{\kappa-2}\right] - \frac{\chi-1}{\chi}\beta(1-\kappa)z^{\kappa-2}\frac{1+\theta}{\left(l-\frac{a-n}{\chi}\right)^2}\left(1-\tau-\frac{1}{\chi}\right)} \tag{34}$$

Since both the numerator and the denominator of equation (34) are negative, we get $\frac{\partial l}{\partial \tau} < 0$.

As to $\frac{\partial n}{\partial \tau}$, after a few calculations we can write it as

$$\frac{\partial n}{\partial \tau} = -\frac{\frac{(1+\theta)^2}{\chi\left(l-\frac{a-n}{\chi}\right)^3} + \beta(1-\kappa)z^{\kappa-2}\frac{(1+\theta)}{\left(l-\frac{a-n}{\chi}\right)}}{\gamma^p\frac{d}{dn}\left(\frac{d\widetilde{x}}{dn}\frac{1}{\widetilde{x}}\right)\left[\frac{1+\theta}{\left(l-\frac{a-n}{\chi}\right)^2}(1-\tau)\gamma^p + \beta(1-\kappa)z^{\kappa-2}\right] - \frac{\chi-1}{\chi}\beta(1-\kappa)z^{\kappa-2}\frac{1+\theta}{\left(l-\frac{a-n}{\chi}\right)^2}\left(1-\tau-\frac{1}{\chi}\right)}. \tag{35}$$

The denominator of (35) corresponds to the one in equation (34) and it is negative, whereas the numerator is positive; thus, $\frac{\partial n}{\partial \tau} > 0$.

We now focus on the case of full altruism (Proposition 2). Equations (27), (28) and (29) still hold, whereas equations (30), (31) and (32) read as

$$\frac{\partial \varphi_2}{\partial \tau} = -\frac{1}{\chi l(1-\tau)^2} \tag{36}$$

$$\frac{\partial \varphi_2}{\partial n} = -\gamma^{fa}\frac{d}{dn}\left(\frac{d\widetilde{x}}{dn}\frac{1}{\widetilde{x}}\right) \tag{37}$$

$$\frac{\partial \varphi_2}{\partial l} = -\frac{1-\tau-\frac{1}{\chi}}{l^2(1-\tau)}. \tag{38}$$

Starting from $\frac{\partial l}{\partial \tau}$, it is straightforward to see that both the numerator and the denominator of (25) are negative and thus $\frac{\partial l}{\partial \tau} < 0$. The sign of $\frac{\partial n}{\partial \tau}$ is instead ambiguous. To identify a condition such that $\frac{\partial n}{\partial \tau}$ is positive or negative, we first note that $\frac{\partial n}{\partial \tau}$ can be written as follows:[14]

$$\frac{\partial n}{\partial \tau} = -\frac{\frac{\partial \varphi_2}{\partial \tau} + \frac{\partial \varphi_2}{\partial l}\frac{\partial l}{\partial \tau}}{\frac{\partial \varphi_2}{\partial n}}. \tag{39}$$

The denominator of (39) is positive. As to the numerator, we substitute from (36) and from (38); rearranging terms we obtain $\frac{\partial n}{\partial \tau} > 0$ if and only if:

$$|\epsilon_{l\tau}| < \frac{\tau}{1-\tau}\frac{1}{\chi\,(1-\tau-1/\chi)} \equiv \bar{\epsilon}_{l\tau}, \tag{40}$$

which is condition (16) in the main text.

Appendix B Calibration

The calibration follows Casarico and Sommacal (2012).

We interpret each period as having a length of 25 years. We set the time span over which child care is provided to 6 years; thus, $a = 6/25 = 0.24$. This means that 24% of the first period of life is spent receiving child care. Because population is constant, we normalize its size N at 1.

To choose the productivity parameter of the day care sector χ we look at the child to staff ratio. According to the OECD family database,[15] this ratio changes depending on the country considered and on the age range of the children, being lower for children between 0 and 3 and higher for children between 3 and 5. We set χ equal to 5, which is at the lower bound of the child to staff ratio in the data mentioned above.[16]

We choose the parameters β and δ in the utility function (20) and the parameter σ in the production function of the quality of child care (18) to generate a realistic allocation of time between labor l, productive parental time with the child n^1 and unproductive parental time with the child n^2. Leisure z is residually

[14] This can be verified substituting (25) in (39) and rearranging terms: the resulting expression corresponds to (26).

[15] http://www.oecd.org/els/family/database.htm

[16] A sensitivity analysis on χ is available upon request. Qualitatively, the results of policy experiments 1 and 2 are not affected by the choice of a higher value of χ. Quantitatively, for higher values of χ, namely for $\chi = 10$, in policy experiment 1 fully altruistic parents increase productive parental time for all the values of the wage elasticity of labor supply we consider. Indeed, we point out that, in the basic model of Section 2, χ is one of the parameters affecting the threshold elasticity of labor supply $\epsilon_{l\tau}$ (see Proposition 2): the higher χ, the lower $\bar{\epsilon}_{l\tau}$. Thus, the choice of $\chi = 5$ is somehow conservative.

determined using the time constraint (7).[17] In line with previous research (e.g., Juster 1985; Cardia and Ng 2003; Ragan 2013), we assume that non-personal time available for discretionary use amounts to 100 hours per week. We use the Harmonized European Time Use Survey (HETUS).[18] As a proxy of productive time with the child we use child care performed by parents as a primary activity and as a proxy of unproductive time we use child care performed as a secondary activity, plus the time spent transporting children.[19] The data show that on average 32% of the time endowment is devoted to work, 4% to productive time with the child and 3% to unproductive time with the child.

As to the parameter ν which governs the elasticity of substitution between $d_t h_t$ and $n_t^1 h_t$, $\zeta_\nu = 1/(1-\nu)$, see equation (18), the existing estimates refer to the elasticity of substitution between inputs in the production of the general category of home-produced goods. We use a value of $\nu = 0.5$, giving an elasticity $\zeta_\nu = 2$ which belongs to the range of available estimates (see Aguiar et al 2012).[20]

With regard to the choice of τ, we use Eurostat data to compute the average of the implicit tax rates [21] on labor income for the set of countries we mention in footnote 18 and set the policy parameter τ to 39%.

The day care subsidy is set in order to match a ratio of public expenditure on childcare and preschool to GDP equal to 0.9%, which is the average value for the countries mentioned in footnote 18, according to OECD data.

The intertemporal discount factor θ is chosen in order to have a ratio of gross savings to GDP equal to 0.23. We choose α, that is the share of capital income in national product, equal to 0.33. The depreciation rate is set equal

[17] Note that leisure is therefore defined as the time not spent either working or providing productive and unproductive time to the child: thus, it is not a measure of leisure only, because it also includes, for example, housework.

[18] The countries we consider are: Belgium, Finland, France, Germany, Italy, Norway, Spain, Sweden and the United Kingdom. Data refer to people in the 25-50 age group, which corresponds in our three-period OLG model to the second period of life. The period we consider is 1999-2004. This is the reference period for all the average data we use in the calibration.

[19] In Time Use surveys activities taking place at the same time are divided into primary/main activities and secondary/parallel activities.

[20] To the best of our knowledge, direct estimates of the elasticity of substitution between non-parental time and parental time in the production of the quality of the early childhood environment are not available. Therefore, we also perform a sensitivity analysis on ν, which is available upon request. From a qualitative point of view, results are unaffected by changes in ν. From a quantitative point of view, the higher is ν the higher the wage elasticity of labor supply should be, in order to have fully altruistic parents increasing productive parental time when taxes are reduced under policy experiment 1 (e.g. for $\nu = 0.8$ this happens for a wage elasticity of labor supply greater than 0.2). As to policy experiment 2, it is more likely to deliver positive tax elasticity of the growth rate under paternalism the lower ν is (e.g. for $\nu = 0.2$, this happens not only when the wage elasticity is equal to 0.5 but also when it is equal to 0.4).

[21] The implicit tax rate is an average effective tax burden indicator that also includes social security contributions. We choose such a comprehensive indicator because the distortionary effects of taxation on time allocation depend on the overall tax burden. The choice of an indicator capturing the average tax burden is consistent with a homogeneous agent model and with the proportional tax schedule we assume herein.

to 1, which is a quite common assumption in two-period OLG models.[22] We choose the parameter q of the human capital production function to obtain an annual growth rate of GDP per capita $((1+g)^{\frac{1}{25}}-1)$ equal to 2% which is the average value for the set of countries we consider.

The parameter characterizing the degree of paternalism γ^p is set equal to the intertemporal discount factor θ when the case of paternalism is considered (i.e., we assume that the parent gives the same weight to her own consumption and to the human capital of the child), whereas it is set to 0 when we consider the case in which parental child care is motivated by fully altruistic preferences. By the same token we set the parameter characterizing the degree of full altruism γ^{fa} equal to θ when the case of full altruism is analyzed, whereas it is 0 when we consider the case of paternalistic parental preferences.

We finally choose the parameter κ in the utility function (20) to obtain different values for the wage elasticity of labor supply, namely 0.1, 0.2, 0.3, 0.4, 0.5.

The values of all the parameters calibrated according to the procedure specified above, are reported in Table A1.

Table A1: Values of the calibrated parameters (for different values of the wage elasticity of labor supply)

Changing target: Wage elasticity of labor supply	0.1	0.2	0.3	0.4	0.5
			Panel A: Paternalism		
κ	-16.1011	-1.8728	-0.0788	0.6132	0.9384
β	0.0007	0.8370	2.0317	2.8603	3.3592
δ	4.5020E-26	0.0002	0.1131	1.2803	4.0050
σ	0.5090	0.5090	0.5090	0.5090	0.5090
q	17.2875	17.2875	17.2875	17.2875	17.2875
θ	0.6236	0.6236	0.6236	0.6236	0.6236
γ^p	0.6236	0.6236	0.6236	0.6236	0.6236
ξ	0.1264	0.1264	0.1264	0.1264	0.1264
			Panel B: Full altruism		
κ	-6.5468	-1.2235	0.0596	0.6176	0.8857
β	0.0831	1.1538	2.1755	2.8665	3.2727
δ	1.7013E-11	0.0022	0.1956	1.3842	3.5435
σ	0.5235	0.5235	0.5235	0.5235	0.5235
q	16.9458	16.9458	16.9458	16.9458	16.9458
θ	0.6236	0.6236	0.6236	0.6236	0.6236
γ^f	0.6236	0.6236	0.6236	0.6236	0.6236
ξ	0.1264	0.1264	0.1264	0.1264	0.1264

[22] As stressed by de la Croix and Michel (2002), even a rather low annual depreciation rate (e.g. 5%), can produce a large depreciation of the capital stock in a two period OLG model: in particular, in our setup in which a model period is equal to 25 years, an annual depreciation rate of 5%, generates a per period depreciation of the capital stock of 72%.