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Abstract

The topic of early childhood development (ECD) and investment in ECD has come to the forefront recently, especially in the case of developing countries, and it is among the 2030 SDGs of the UN. Until recently, human capital has been associated with years of schooling. However, the latest studies show that brain development is fastest in the ECD period, which starts in the prenatal period and ends before formal schooling. Experiences during this period and even maternal health before pregnancy have persistent effects on an individual's human capital. Investing in human capital during the ECD period is more effective than investing later in life. In this paper, we develop a 9-period overlapping generations model examining the impact of parental human capital investment on economic growth. Using a multiperiod human capital formation technology with parental human capital and monetary input, we investigate the effects of alternative policies targeting the ECD period to reach the highest economic growth rate. We calibrate our model to 2019 Turkish data and find that mandatory and matching funds are more effective than lump-sum subsidies, which increase household income and leave the investment decision to parents. Also, ECD subsidies raise the investment made in the schooling period.

Keywords: early childhood development, human capital accumulation, overlapping generations modeling, general equilibrium, economic growth, policy simulation

JEL Codes: C61, J24, O11

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1. Introduction

Economic growth models have incorporated human capital accumulation for over half a century (see Nelson and Phelps, 1966; Mincer, 1984; Lucas, 1988). One of the pioneers of the studies on human capital theory, Theodore Schultz, argued that many paradoxes about economic growth can be resolved by taking human capital investment into account (Schultz, 1961). Human capital refers to the combined knowledge, skills, health and experiences of individuals in a society. Models that study the impact of human capital on economic growth suggest that individuals with better skills and health tend to be more productive (Lucas, 1988; Romer, 1990). This increased productivity is reflected in higher personal income and economic growth levels. Given the initial per capita gross domestic product , the growth rate is highly positively correlated with the initial human capital level (Barro, 1991).

Education and health outcomes are commonly used to analyze the effect of human capital on economic growth because they have quantifiable determinants. In the evaluation of the impact of health on economic growth, metrics such as adult survival rate, height, and mortality rate are utilized (Bhargava et al., 2001; Lorentzen et al., 2008; Weil, 2007). In education, the impact of schooling (Bils and Klenow, 2000; Hanushek and Kimko, 2000), school quality (Hanushek, 2013), and school expenses (Jackson et al., 2015; Dissou et al., 2016) is typically used to measure educational outcomes and its effect on economic growth. These studies show that most health and education indicators have a positive impact on economic growth. In order to optimize limited resources, investments should be prioritized in areas with the highest return on investment.

In this study, we explore intergenerational human capital investment and how the level of investment is affected by different policies that support families and the effect of selected policies on economic growth. We build a 9-period overlapping generations model in which parents invest in their children's human capital. We calibrated the steady state of the benchmark model to the 2019 Turkish economy and chose this year as the starting point for implementing the policies. We use data from TURKSTAT National Accounts, Household Budget Survey, and Budget Finance Statistics for the same year. This study examines the impact of two policies implemented for households with children during the early childhood development (ECD) period. The first policy

is a lump-sum subsidy that increases the household's income, while the second policy is a matching fund that directly increases the investment made into the child. The simulation results suggest that matching policies are more effective in achieving higher levels of steady-state consumption, human capital, physical capital, and output. We also find that ECD subsidies increase parental investment in the schooling period, resulting in increased impact of investments, and contribute to the country's human capital and growth in both models.

Research in neuroscience, psychology, and economics suggest that human capital accumulation begins in the early years of life, including prenatal period (Heckman, 2000; Campbell et al., 2001; Thompson and Nelson, 2001; Rolnick and Grunewald, 2003; Heckman, 2011; García et al., 2017). This period is defined as the ECD period and refers to the child's cognitive, physical, language, temperament, socio-emotional, and motor development process from conception to preschool age. Experiences during the early years have long-lasting effects on health, education, and economic outcomes, such as infant mortality, schooling, academic achievement, earnings and occupation, behavioral and emotional syndromes, as well as involvement in crime. Currie and Almond (2011) provide a comprehensive review of studies on the effects of early environments on adult outcomes.

Ensuring that children start life under equal conditions is advocated in terms of equality, but early intervention also provides high economic returns to the individual and society. García et al. (2017) explore the rate of return to two early childhood programs targeting disadvantaged children launched in the 1970s: the Carolina Approach to Responsive Education and the Carolina Abecedarian Project. Programs are evaluated by randomized control trials, and participants were included in the program from 8 weeks to 5 years of age in the study, followed up to their mid-30s. Results showed that programs have a 13.7% annual tax-adjusted internal rate of return and a 7.3 tax-adjusted benefit/cost ratio.

When examining the effects of the environment on a child, families or the primary caregivers, who constitute the child's closest environment, have the most crucial impact. There is a large body of literature attempting to assess the impact of family's socioeconomic status and the home environment on a child's motor, cognitive, linguistic, emotional, and social development (for

example Hauser 1994; Duncan et al. 1994; Blau 1999; Bradley and Corwyn 2002, Taylor et al. 2004; Lima et al. 2004; Noble et al. 2005; dos Santos et al. 2008; Santos et al. 2008; Hackman and Farah 2008; Maggi et al. 2010). The general consensus in the ECD literature is that young children from low-socioeconomic backgrounds are relatively more at risk of not successfully developing the necessary skills to subsequently succeed at school compared to those from higher socioeconomic backgrounds (Burger 2010).

Human capital accumulation is in fact a dynamic process, and the skills one acquires in the early years of life significantly affect their initial conditions and the technology of learning in the next stage. As a result, children from more privileged families and with higher abilities tend to benefit more from schooling. Consequently, the social and economic gap between children from different backgrounds persists (Carneiro and Heckman, 2003; Cunha et al., 2006) and even widens throughout their education (Carneiro et al., 2005). In other words, when children from disadvantaged backgrounds in the preschool period cannot catch up with their peers developmentally, they fall behind throughout their education and adulthood. These findings highlight the importance of early intervention to support development in children from lower-socio-economic status families.

Research shows that high quality early childhood education and care (ECEC) can lead to better school readiness (Magnuson et al., 2004; Hustedt et al., 2008), improved academic performance (Barnett, 1995; Campbell et al., 2001), higher rates of high school graduation (McCoy et al., 2017), greater participation in higher education (Garces et al., 2002; Anderson, 2008), lower rates of criminal activity (Garcia et al., 2019) and higher earnings in adulthood (Chetty et al., 2011). In that sense, early intervention not only ensures that children start life in equal footing, but it also provides high economic returns to the individual and society.

Research indicates that investing in ECD programs generates higher returns compared to investments made in later periods (Heckman, 2000; Cunha and Heckman, 2007). The high returns provided by early intervention programs for individuals and society require state intervention. State intervention eliminates moral hazard problems when society tries to compensate for poor outcomes due to insufficient investments. Furthermore, government interventions can help

address market failures like liquidity constraints, information gaps, and externalities (Currie, 2001). Investing in early childhood programs is a far more secure tool for economic development than other high-risk economic development programs (Rolnick and Grunewald, 2007). Failure to invest in children in their early years will lead to irreversible consequences for individuals, families and society in the long term (Denboba et al., 2014).

The rest of the paper is organized as follows: In Section 2, we present the current state of ECD in Türkiye, In Section 3, we present a brief review of the literature, the data and the model. Section 4 presents the policy simulation results. Section 5 concludes the study.

2. Early childhood development in Türkiye

In Türkiye, policies for ECD are included in top policy documents such as development plans and presidential annual programs. In addition, Strategic Plans of the Ministry of National Education (MoNE), the Ministry of Health (MoH), and the Ministry of Family and Social Services (MoFSS) also included ECD goals, targets, and strategies.

In the 11th Development Plan (2019-2023), the government aims to increase the number of institutions providing early childhood care and education services, diversify service delivery models, and increase inspections. Also, including early childhood education in compulsory education for 5-year-olds, creating flexible curricula and alternative education models are among the policies and measures. In the 2024 Presidential annual program, it is planned to make more systematic progress in the field of ECD with the adoption of the Draft National Early Childhood Strategy Document prepared under the coordination of the Presidential Strategy and Budget.

The MoNE aims to increase the quality and prevalence of early childhood education to ensure preschool education students' cognitive, emotional, and physical development. While expanding its services, the Ministry has developed strategies to create an integrated system and improve the quality of education for underprivileged groups. Making legislative arrangements to include 5-year-olds within the scope of compulsory education, increasing the number and experience of teachers required in this regard, and developing service models to meet the access and nutrition

needs of children in need are listed among the needs for disseminating these services. The Ministry has set a target to increase the enrollment rate of children aged 3-5 years old. The plan is to gradually increase the enrollment rate to reach 50% in 2022 and 55% in 2023, from the rate of 44.02% in 2018 when the plan was prepared. According to the most recent data from the World Bank, Türkiye's gross enrollment rate in preschool education has slightly increased in recent years, reaching 39.75% in 2020. However, this rate remains significantly lower than the global average of 60.86% and the OECD average of 80.78%.

The Turkish MoH suggests that raising awareness about risk factors associated with pregnancy and postpartum complications and improving the health systems are crucial to achieving a level of high-income countries in preventing maternal and infant deaths. The MoH aims to reduce the neonatal death rate from 9.2 to 8.5 and the under-five mortality rate from 11 to 10.6 per 1,000 live births. The infant and child mortality rate has been decreasing for a long time in Türkiye. The Ministry acknowledges that reducing mortality rates to the desired level in the future will be challenging, as they will have to deal with more complex causes of infant and child deaths.

The MoFSS set a target to improve protective and preventive services, to ensure that children are raised in the family environment, protected from all kinds of risks, in order to ensure the healthy development of children and to ensure equality of opportunity with their peers, and to create the necessary mechanisms for this. It aims to increase the service quality of specialized care institutions for children under protection by expanding the activities carried out to raise children in need of care with their families. According to the Ministry, the current number of children who are able to attend private nurseries, daycare centers, and children's clubs free of charge is not enough, and the Ministry aims to increase this number from 2599 to 2900.

According to the National Education Statistics of the MoNE, 39,826 schools and institutions provided preschool education and training across Türkiye in the 2022-23 academic year. 80 percent of these are public institutions, and 20 percent are private institutions. 83 percent of public institutions are affiliated with the MoNE, 54% of which are kindergartens, and 46% are reception classes. The majority of other public institutions that are not affiliated with the MoNE are nurseries opened by municipalities and associations, and community-based institıtions affiliated

with the Presidency of Religious Affairs. 71% of private institutions are kindergartens and reception classes affiliated with the MoNE, this rate has increased in recent years. On the other hand, it consists of private institutions that are not affiliated with the MoNE nurseries and daycare centers affiliated with the MoFSS, and nurseries opened in businesses in accordance with the Labor Law. Over the past year, there has been a notable rise in the number of schools and teachers. However, the most significant increase has occurred in kindergartens, which are present in both public and private institutions that are not associated to MoNE.

In the 2022-2023 academic year, 2,055,350 children are enrolled in public and private preschools in Türkiye. Among them, 82% continue their education in public institutions while the remaining 18% attend private institutions. Of the 1,681,705 children receiving education in public institutions, 51% attend kindergarten classes in schools that are affiliated with the MoNE. On the other hand, 77% of children attend kindergarten classes in private institutions that are affiliated with the MoNE. In recent years, there has been an increase in the rate of private educational institutions affiliated with MoNE.

In Türkiye, financial support is granted to preschool institutions based on the number of registered students, classrooms, and location. Within the framework of the state's budget possibilities, all schools receive the necessary share in line with these criteria. In addition to state resources, financial support is also provided to preschool education institutions from special provincial administration budgets, project funds and donations, municipalities, private individuals, institutions and organizations (European Commission Eurydice Preschool Education Financing Türkiye National Policy Document).

Although the amount spent per preschool student in TL has slightly increased in recent years, there has been a significant decline when measured in USD. In 2021, the expenditure per student has decreased by approximately 50% compared to 2016 in USD terms.

In the previous year, the private sector's share in the total expenditures made on preschool education by the state and the private sector increased from 16.4% to 24.7%. However, the households' share in the private sector decreased from 74.9% in 2012 to 51.8% in 2019. The households' share slightly increased to 54.5% in the last two years.

Table 1: Share of preschool education in total education expenditures by financial source (%)

		Share of preschool expenditures in total education expenditures						
	MoNE Budget/GDP	Total	Government			Private Sector		
			Total	Central	Local	Total	Households	Private entities
2011	2.6	5.3	5.0	4.9	9.7	5.6	6.5	4.1
2012	2.8	5.3	4.9	4.8	8.9	5.7	6.6	4.2
2013	3.0	5.0	4.6	4.5	7.9	5.5	6.5	3.8
2014	3.2	5.4	5.0	4.9	7.9	5.7	6.6	4.2
2015	2.7	5.3	5.1	5.1	8.3	5.1	5.9	3.9
2016	2.9	5.6	5.3	5.3	8.3	5.4	6.1	4.4
2017	2.8	5.9	5.6	5.6	9.4	5.7	6.2	5.1
2018	2.7	6.2	6.3	6.2	8.8	5.2	5.0	5.7
2019	2.6	6.1	6.9	6.8	10.5	3.8	3.0	5.5
2020	2.6	5.3	6.0	6.0	9.3	2.9	2.3	4.2
2021	2.6	5.0	5.3	5.3	11.8	3.9	3.1	5.6

Source: TURKSTAT, Education Expenditure Statistics, 2021

Table 1 presents the share of preschool education expenditures in total education expenditures according to financial sources. The share of the Ministry of National Education budget in GDP has decreased in recent years and reached 2.6% in 2021. Similarly, the share of preschool education expenditures in total education expenditures also decreased and reached 5% in 2021. While the share of the central government in state expenditures decreases, there has been an increase in the share of local governments. The share of the total expenditures by the private sector for preschool education had decreased until 2020, but it increased to 3.9% in 2021. Public spending on ECEC in Türkiye is 0.3%, while the OECD average is 0.8%, and the European Union is 0.07%. Nordic countries like Iceland, Sweden, and Norway, which have notable investments in ECEC, have 1.7%, 1.6%, and 1.4% shares, respectively (OECD Family Database, 2023).

Health is a critical factor in a child's development. Türkiye has significantly increased health spending with the Health Transformation Program (HTP) since 2003. However, compared to OECD countries, health expenditures in Türkiye remain relatively low. The implementation of

the HTP has led to significant improvements in the health of children in Türkiye. For instance, based on the data provided by the OECD, the child vaccination rate increased from 68% in 2003 to 96% in 2007 and has remained at this high rate since then. The MoFSS provides Conditional Health Benefits (CHB) to families who do not have social security and are in need. These benefits are available if they take their children aged 0-6 for a health check-up and if expectant mothers go for a health check-up during pregnancy and give birth in a hospital. The CHB Program provides financial assistance to children aged 0-6. They receive a monthly allowance of 100 TL for a maximum of 72 months. Pregnant women are entitled to receive 200 TL per month for up to 9 months, while postpartum women receive 300 TL per month for a maximum of 2 months. A one-time cash aid of 500 TL is also given to women who give birth in a hospital.[3]

Table 2: Early childhood development index in Türkiye

Developmental field	Percentage of children developmentally on track
ECD Index	73.7
Physical Development	97.9
Learning Readiness	95.7
Literacy/Numeracy	14.4
Socio-Emotional Development	73.3

Source: 2018 Türkiye Demographic and Health Survey

In 2018, for the first time in Türkiye, ECD indicators based on the Multiple Indicator Clustering Survey (MICS) methodology, developed by the United Nations Children's Fund (UNICEF) and used to measure the development of children in the ECD period, were included in the Türkiye Demographic and Health Survey (TDHS). This survey has been conducted every five years since 1968 and covers areas such as fertility, maternal and child health, and family planning. The availability of data at international standards in Türkiye will enable the investigation of the

[3] Legislation regarding examination and follow-up intervals for children and pregnant /postpartum women is determined by the MoH.

factors that determine ECD in the country and the development of policies that will improve ECD results. It will also enable comparison with countries using the same standards.

Table 2 reports the results of early childhood development index and its components. In Türkiye, 73.7% of children are developmentally on track. In the sub-indicators, a high percentage of children are developmentally on track in physical development and learning readiness and moderate level of children are on track in socio-emotional development. However, a small proportion of children are developmentally on track in the field of literacy numeracy.

3. The Model

3.1 Relevant literature

Economic models have studied intergenerational investment through the lens of human capital. The transmission of human capital from parents to children has been a key factor in exploring various issues within parental investment models. The structure of the model used in this study relates it to various strands of literature, such as family economics, intergenerational human capital transmission, intervention, and economic growth.

The concept of parental investment models dates back to the work of Becker and Tomes (1979). They present a dynastic model in which parents derive utility from their own consumption and income of their children. In their model, parents can invest in their children and their earning determined by parental investment and luck. Also, parental endowment passes down through families. They found that progressive and redistributive taxation could have unintended in long-run after-tax income inequality. In their following paper (Becker and Tomes, 1986) they investigate the speed of mean regression. They use a similar model but impose a barrowing constraint. Parents are not allowed to barrow against their children's future earnings to invest in their human capital. They find that earnings regress to the mean at a slower rate for poor families. Glomm and Ravikumar (1992) examine the effect of public and private schooling choice on growth and evolution of income inequality with a parental investment model. They build a two-period overlapping generations model in which generations are linked through parental human

capital. In the public school system, investment in schools is determined by majority voting, while in the private school system, each household chooses the quality of their children's education. The study concludes that public education reduces income inequality faster than private education. However, if initial income inequality is not very high, private education may provide higher per capita incomes. Solon (2004) employs a similar model to the one developed by Becker and Tomes (1979) to study the effect of change in earnings return to human capital and public investment in human capital. The results revealed that intergenerational mobility declines as earnings return to human capital increase, but increases with more progressive public investment in human capital.

Researchers have also examined family investment models with multiple children who have different initial resources to determine whether parental investments compensate for or reinforce differences between siblings. If one child has more genetic ability than the other, allocating more resources to increase the earnings of a child with a lower genetic ability is a compensating strategy. Giving more resources to the more able children to increase their earnings is a reinforcing strategy. Behrman et al. (1982) introduces two models to investigate the behavior of the parents in such a case. In their wealth model, the parent's behavior depends on the characteristics of the earnings function; if more genetic ability means more marginal returns to school, then parents adopt a reinforcing strategy. However, parents adopt a compensating strategy if it means a smaller marginal return. On the other hand, in the separable earnings-bequest model, attitudes towards inequality also influence parents' behavior. In the case of absolute inequality avoidance, parents adopt a compensatory strategy regardless of the characteristics of their earnings function. At lower degrees of inequality avoidance, characteristics of both welfare and earnings functions determine whether parents adopt reinforcing or compensatory strategies.

Benabou (2002) examines the effects of progressive income taxes and education financing on income distribution. They also investigate the tradeoffs between growth and efficiency from implementing these redistributive policies. The results show that the efficiency costs and benefits

of redistribution are generally balanced. Progressive education finance generates higher income growth than taxes and transfers but at the expense of lower insurance.

In all these intergenerational human capital investment studies, childhood is modeled as a single period. Thus, it is assumed that there is no difference between early and late investments in the child. However, this assumption contradicts empirical studies showing that the returns on investments made in the early period are much higher than those in later periods (Heckman and Mosso, 2014). Carneiro and Heckman (2003) presents evidence on earlier investments have higher returns and Knudsen et al. (2006) summarized the evidence that some skills or traits are more easily acquired in the earlier stages of childhood. In order to rationalize the effectiveness of programs aimed at promoting human capital and to understand investment dynamics, it is necessary to establish a model with multiple childhood periods. Therefore, we use human capital formation technology with multi-period childhood similar to Cunha and Heckman (2007) which is the first model that introduced multi-period human capital models to the literature. The multi period investment model is based on the sensitive and critical periods in a child's development. A structure that allocates varying efficiencies to inputs at different stages of development is designed to attain the maximum level of human capital in children by directing families' investment towards the periods with the highest productivity. After the multi-period human capital production function introduced to the literature, it is used to examine different research questions in family economics studies.

Del Boca et al. (2014) examined parents' time and financial investments in their children in a model where households also make the labor supply decision. According to their empirical findings, the amount of time parents spend with their children has a significant impact on their cognitive development, particularly when the child is young. However, the amount of monetary input is less productive on a child's quality. Policy analysis indicates that giving cash transfers to households with children has a relatively small effect on child outcomes. Because a significant portion of the transfer is often used for other household expenses and leisure activities. They also worked in households with one child as well as in households with two children. The results

were similar to the one-child situation. They stated that when the number of children in the household was initially decided, the birth order did not affect the development of the children.

Caucutt and Lochner (2020) develop a human capital investment framework that examines the intergenerational ability transmission process in determining human capital investments in children of different ages. They find that providing subsidies at a younger age has a greater impact on overall welfare and human capital compared to providing them at older ages. Gayle et al. (2015) develops the dynastic model of parental time and monetary inputs in early childhood to analyze the sources of racial difference in the intergenerational transmission of human capital. Reducing family structure and racial earnings disparities contribute to reducing racial achievement disparities. However, reducing assertive mating and divorce rates is much more important in closing racial achievement gaps. Lee and Seshadri (2019) develops a child investment model to explain intergenerational relationships. They show that education subsidies can significantly reduce intergenerational economic status persistence, especially when provided early on.

Although these models use multi-period human capital production technology, which is more consistent with empirical findings, to present more diverse findings from alternative policies to assist governments in making policy decisions. Recent studies mainly focused on the effects of early and late subsidies and different tax schemes. Therefore, this study aims to determine the most effective policy to maximize human capital accumulation and promote economic growth by simulating various policies for the ECD period, which is the period with the highest returns.

3.2 Economic environment

We build a 9-period OLG model where parents invest in their children's human capital. The economy is closed, and time is discrete, starting from 0 to infinity, but the people in the model have a finite lifespan. Each period is eight years, and people live for nine periods before death. Every period, a new generation is born, and the size of each generation is fixed and normalized to one, making the total measure of all generations equal to 9.

In Figure 1, we can see the sequence of life, starting with the ECD period comprising the pre-pregnancy and prenatal period[4], from two years before birth up to six years of age. The following two periods involve the individual completing K-12 and college education. During these initial three periods, the individual is a child of an adult parent and does not make any economic decisions but receives investments from their parent. Since the parent is assumed to be the decision-maker in the household, the child passively accepts investment, and her consumption is included in that of her parents[5] or ignored[6]. In the following period, the individual enters the workforce and has a child. In this period and the following two periods, the individual makes an investment in her child as a parent. After this period, the individual is in the post-parenthood period; the caregiving period ends, but she is still in the workforce. In the subsequent two periods, she is retired, and at the end of the ninth period, she dies right before her great-grandchild arrives.

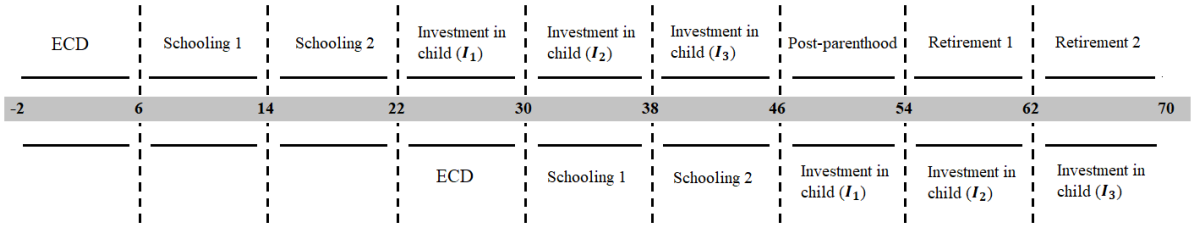

Figure 1: Sequence of events in the model

There is no physical bequest motive but bequest in the form of human capital is transmitted from generation to generation through the human capital accumulation function we employ.

Preferences:

When the economy starts at t=0, nine generations are alive. The one born at t = 0 will live for nine periods. There are also eight "old" generations, each endowed with a level of assets and human

[4] Importance of pre-and perinatal period documented by numerous studies (see, e.g., Gillberg and Cederlund 2005; Liu et al. 2016; Olds 2002).

[5]As suggested by De La Croix and Michel (2002)

[6]As is the study by Heckman and Mosso (2014)

capital. The generation born at time -8 reaches age nine at time 0. At the starting point, t=0, there will be initial conditions drawn from the data.

For an individual born at time t-3 (belonging to cohort t-3) who becomes economically active and becomes a parent of a child at time t, maximize following lifetime utility at time t:

$$U_t(c_{4,t}, c_{5,t+1}, \dots, c_{9,t+5}, h'_{3,t+5}) = log(c_{4,t}) + \beta log(c_{5,t+1}) + \beta^2 log(c_{6,t+2}) + \beta^3 log(c_{7,t+3}) + \beta^4 log(c_{8,t+4}) + \beta^5 log(c_{9,t+5}) + \varphi\beta^6 log(h'_{3,t+5}) \quad (1)$$

subject to budget constraints:

$$(1+\tau_c)c_{4,t} + (1+\tau_e)I_{4,t} + a_{5,t} = (1-\tau_w)\, w_t h_t \quad (2)$$

$$(1+\tau_c)c_{5,t+1} + (1+\tau_e)I_{5,t+1} + a_{6,t+1} = (1-\tau_w)\, w_{t+1} h_{t+1} + (1+r_{t+1})a_{5,t} \quad (3)$$

$$(1+\tau_c)c_{6,t+2} + (1+\tau_e)I_{6,t+2} + a_{7,t+2} = (1-\tau_w)\, w_{t+2} h_{t+2} + (1+r_{t+2})a_{6,t+1} \quad (4)$$

$$(1+\tau_c)c_{7,t+3} + a_{8,t+3} = (1-\tau_w)\, w_{t+3} h_3 + (1+r_{t+3})a_{7,t+2} \quad (5)$$

$$(1+\tau_c)c_{8,t+4} + a_{9,t+4} = (1+r_{t+4})a_{8,t+4} \quad (6)$$

$$(1+\tau_c)c_{9,t+5} = (1+r_{t+5})a_{9,t+5} \quad (7)$$

Parents derive utility from their consumption, discounted with a time preference parameter, and their children's human capital, based on their level of altruism. We assume that the utility function is logarithmic, so the effects of a change in the interest rate wealth and substitution cancel each other. The variable $c_{g,t}$ and $a_{g,t}$ represents the amount of consumption and savings respectively by the parent in the period g when the economy is at time t. Similarly, the investment made by parents in their child's human capital is represented with $I_{g,t}$. Since individuals have children when they are economically active, the ECD investment is represented by $I_{4,t}$ in the first budget constraint. The parameter φ represents altruism while β represents the time discount factor.

Human capital evolves according to:

$$h'_{3,t+3} = h'_{4,t+4} = h'_{5,t+5} = h'_{6,t+6} = \left[\gamma_1 (h_{t-3}{}^{\zeta_1} I_{4,t}{}^{1-\zeta_1})^{\theta_1} + (1-\gamma_1)\left[\gamma_2 (h_{t-3}{}^{\zeta_2} I_{5,t+1}{}^{1-\zeta_2})^{\theta_2} + (1-\gamma_2)(h_{t-3}{}^{\zeta_3} I_{6,t+2}{}^{1-\zeta_3})^{\theta_2}\right]^{\frac{\theta_1}{\theta_2}}\right]^{\frac{\eta}{\theta_1}}. \quad (8)$$

The level of human capital that individuals attain as a result of the investment they receive from their parents over three periods is represented by the $h'_{3,t+3}$. It is assumed that the labor force supplied to the economy is determined by the same level of human capital during their economically active periods ($h'_{3,t+3} = h'_{4,t+4} = h'_{5,t+5} = h'_{6,t+6}$). In other words, after an individual has completed their education, their human capital will remain constant - there will be no increase or depreciation over time. The share parameter in the constant elasticity of substitution (CES) function γ_1 is a skill multiplier. It shows the productivity of ECD investment in producing the ultimate level of human capital level through self-productivity. Additionally, it shows to what extent ECD investment increases the productivity of the investment made in the school period ($I_{5,t+1}$ and $I_{6,t+2}$) through dynamic complementarity. Similarly, γ_2 reveals the impact of investment made in the first part of the formal schooling period on human capital and to what extent it increases the productivity of the investment in the next period. Another CES parameter θ_1 is the substitution parameter, $1/1-\theta_1$ shows how easy it is to substitute between ECD investment and schooling period investment in producing human capital. Small levels of θ_1 indicates that low levels of ECD investments are not easily remediated by school investment. Another argument for a small level of θ_1 is that a high level of ECD investment should be sustained with a high level of school investment to get the highest return. Similarly, θ_2 represents the substitution parameter for child investment in the first and second schooling periods (child investment in periods two and three). The parent's human capital level, represented by h, is also included in the child's human capital production function. The positive effect of the parent's (generally mother's) human capital, typically measured by the level of education, on the child's outcomes has been shown by a bunch of studies. Cunha, Heckman, and Schennach (2010), Cunha

and Heckman (2008), Attanasio et al. (2020) and Attanasio, Meghir, and Nix (2020), Cuartas, (2022) shows that parental human capital is directly effects child's human capital level. Productivity of physical investment increases with the higher level of parental human capital. The final contribution of the physical investment and parental human capital in that period is determined by the Cobb-Douglas function. ζ_1, ζ_2 and ζ_3 show the human capital elasticities of parental human capital in ECD, first and second part of schooling respectively. τ_c is the consumption tax rate, τ_e is the tax rate on child development expenditures and τ_w is the income tax rate We follow the conventions in the literature and impose no taxes on assets.

Firm and production:

Individuals supply one unit of labor inelastically. Thus, labor supply in the economy equals four since there are four working-age adults at every period t. A representative firm uses a stock of physical capital (K_t) and a stock of effective labor (H_t) to produce Y_t according to the following constant returns to scale Cobb-Douglas technology:

$$Y_t = K_t^{\alpha}[H_t]^{1-\alpha}$$
$$H_t = \sum_{g=4}^{7} h_{g,t} l_{g,t} \tag{9}$$

where $\alpha \in (0,1)$ is the output elasticity with respect to capital. Aggregate human capital is as follows.

$$H_t = \sum_{i=0}^{3} \Big[\gamma_1 (h_{t-3}{}^{\zeta_1} I_{4,t-i-3}{}^{1-\zeta_1})^{\theta_1} + (1-\gamma_1)\big[\gamma_2 (h_{t-3}{}^{\zeta_2} I_{5,t-i-2}{}^{1-\zeta_2})^{\theta_2} + (1-\gamma_2)(h_{t-3}{}^{\zeta_3} I_{6,t-i-1}{}^{1-\zeta_3})^{\theta_2}\big]^{\frac{\theta_1}{\theta_2}}\Big]^{\frac{\eta}{\theta_1}} \tag{10}$$

Profit maximization of the firm implies the standard conditions where w is the wage rate per efficient labor unit, r is the interest rate and $\delta \in (0,1)$ is the depreciation rate. Details of the solution of firm's maximization problem are presented in the Appendix.

$$r_t = \alpha {k_t}^{1-\alpha} - \delta \quad (11)$$

$$w_t = (1-\alpha){k_t}^{\alpha} \quad (12)$$

Government:

In the base model we built above the government is assumed to finance the constant level of government spending and levies taxes on labor wage and consumption.

$$\tau_c\left(c_{4,t} + c_{5,t} + c_{6,t} + c_{7,t} + c_{8,t} + c_{9,t}\right) + \tau_e\left(I_{4,t} + I_{5,t} + I_{6,t}\right) + \tau_w(H_t w_t) = G_t \quad (13)$$

Economy is characterized by the time paths of consumption, physical capital, and human capital at each point in time[7].

Equilibrium:

A competitive equilibrium for this economy is a list of sequences of consumption plans $\left\{\left\{c_{g,t}\right\}_{g=4}^{9}\right\}_{t=0}^{\infty}$, child investment plans $\left\{\left\{I_{g,t}\right\}_{g=4}^{6}\right\}_{t=0}^{\infty}$, asset stock sequence $\left\{\left\{a_{g,t}\right\}_{g=4}^{9}\right\}_{t=0}^{\infty}$, factor prices $\{w_t, r_t\}_{t=0}^{\infty}$, production plans $\{Y_t\}_{t=0}^{\infty}$ such that:

i. Given the relative prices (w_t and r_t) and tax rates (τ_c, τ_e and τ_w) household chooses the consumption sequence ($c_{4,t}, c_{5,t+1}, c_{6,t+2}, c_{7,t+3}, c_{8,t+5}, c_{9,t+6}$), asset stock sequence ($a_{5,t}, a_{6,t+1}, a_{7,t+2}, a_{8,t+3}, a_{9,t+4}$) and human capital investment for their child ($I_{4,t}, I_{5,t+1}, I_{6,t+2}$) to maximize lifetime utility subject to the budget constraints

ii. Given the factor prices (w_t, r_t) the firm maximizes profits subject to a production technology.

iii. The goods market clears:

$$Y_t = C_t + I_{h_t} + I_{k_t} + G_t$$

where

$Y_t = K_t^{\alpha}[H_t]^{1-\alpha}$, $H_t = \sum_{g=4}^{7} h_{g,t} l_{g,t}$, $C_t = \sum_{g=4}^{9} c_{g,t}$, $K_t = \sum_{g=4}^{9} a_{g,t}$, $I_{h_t} = \sum_{g=4}^{6} I_{g,t}$ and

[7] The set of equilibrium conditions will be provided upon request.

$$I_{k_t} = K_{t+1} - (1 - \delta)K_t$$

iv. The government budget (13) is balanced.

4. The benchmark economy and policy simulations

In order to examine the impact of government subsidies on increasing household investment during the ECD period, various policy simulations will be analyzed. However, to compare the results, we first obtain the benchmark model results. This will help us understand the scenario where no incentives are provided to households, and they invest solely with their own resources. In multi-period OLG models, an analytical solution cannot be obtained due to the complex structure of the model, and a numerical solution is required. After all the equations necessary for the solution are obtained, the Gauss-Seidel Strategy adopted by Auerbach and Kotlikoff (1987) was used to solve the model.

4.1 Calibration

4.1.1 Data

In order to calibrate the model's parameters for the stationary equilibrium solution, a social accounts matrix (SAM) was created. The data used to create this matrix was obtained from various sources, including the 2019 Turkish Statistical Institute (TURKSTAT) National Accounts which provided information on payments made to employees, payments made to capital, individual consumption expenditures, and taxes on products. The 2019 TURKSTAT Household Budget Survey (HBA) was used to determine the share of investment expenditures on children in total expenditure, while the rate of indirect and direct taxes was obtained from the Budget Financing Statistics of the Ministry of Treasury and Finance for the same year.

4.1.2 Social accounting matrix

Gross Domestic Product (GDP) is derived from the sum of payments made to the workforce and net operating surplus (mixed income). The share of capital income in GDP (α) is obtained from the ratio of net operating surplus to GDP.

Government expenditures are calculated to be consistent with row and column balances. Since there is no detailed data on households' investments in early childhood development for Türkiye, this data was calibrated through the "preschool education expenditure" with code 10101 in the Household Budget Survey (HBA). The share of preschool expenditure in the total consumption expenditure of households was used to find the ratio of investment in children within the consumption value obtained from macroeconomic data. The altruism parameter (κ) is calibrated according to this ratio.

The discount rate (ρ), which reflects the household's time preference, is calibrated to be consistent with key macro indicators. Interest rate is calculated as the marginal product of capital, and wage per active labor force is calculated endogenously in the model as the marginal product of the active labor force.

While the tax on wage income in the model is a direct tax income, the tax on consumption and investment in children is an indirect tax. These tax rates are calibrated according to the ratio of indirect and direct tax revenues to each other and the ratio of total tax revenue to GDP in the 2019 Budget Financing Statistics of the Ministry of Treasury and Finance. The tax rate (τ_e) applied to investment expenditures on the child was calculated to be equal to the consumption tax (τ_c).

The behavioral and technical parameters in the human capital production function could not be calibrated due to lack of data, and the parameter values were taken from studies conducted in this field in the literature (Cunha and Heckman, 2007; Lee and Seshadri, 2019). Simulations will be conducted with different parameter values to check to what extent the policy result changes.

The social accounts matrix (SAM) is theoretically presented in Table 3 and numerical structure created according to Türkiye data for 2019 presented in Table 1A in the appendix. Parameter values calibrated using the SAM matrix are presented in Table 4.

Table 3: Theoretical structure of the Social Accounts Matrix

	Activities	Consumer	Child Investment (ECD period)	Child Investment (School period)	Labor	Capital	Government
Activities		Final consumption expenditures (Household)	Investment in the child in the ECD period	Investment in school age children			Final consumption expenditures (Government)
Consumer					Wage income	Savings	
Child Investment (ECD period)		Investment in the child in the ECD period					
Child Investment (School period)		Investment in school age children					
Labor	Payments to the workforce						
Capital	Operating surplus/mixed income; net						
Government		Taxes on wage income, consumption and investment in children					

Table 4: Calibrated parameters

Parameter	Definition	Value
α	Production elasticity of capital	0,5781
ρ	Discount rate	0,0417
γ_1	Skill multiplier of ECD period	0,8
γ_2	Skill multiplier of schooling period	0,7
θ_1	Elasticity parameter of ECD period	0,2
θ_2	Elasticity parameter of schooling period	0,1
η	CES parameter	0,7
κ	Altruism parameter	2,45
ζ_1	Parental contribution on child (ECD period)	0,9
ζ_2	Parental contribution on child (school period 1)	0,71
ζ_3	Parental contribution on child (school period 2)	0,68
σ	CRRA coefficient	1
t_c	Consumption tax rate	0,1835
t_w	Wage tax rate	0,2069
C/Y	Total consumption/GDP	0,7681
T/Y	Total tax income/GDP	0,2288
t_c(C+I4+I5+I6) / t_w(Hw)	Indirect taxes/direct taxes	1,6211
I4/C	ECD investments/Total consumption	0,0015

Source: Authors' calculations, Lee and Seshadri (2019) ve Cunha and Heckman (2007)

4.2 Implemented policies

4.2.1 Lump-sum subsidy

This policy involves the direct increase of household income by providing cash transfers to households with children during the ECD period. The aim is to encourage parents to invest more in their children's development. The assistance provided is not conditional, and households have the freedom to decide how much of the transfer will be spent on their child and how much will

be used for other expenses. Many studies have demonstrated the effects of the household income-increasing lump-sum subsidy in the United States (Dahl and Lochner, 2012; Duncan et al., 2014; Maxfield, 2013). This policy is implemented in Türkiye by Civil Servants Law No. 657, 202-206, which provides financial assistance to households with children. According to this law, in July 2023, households with children over six years old in Türkiye will be paid 127.45 lira, while those with children under six years old will be paid 254.89 lira.

In order to promote investing in ECD as part of its sustainable development goals (SDGs), the United Nations has encouraged governments to allocate at least 1% of their GDP towards ECD spending (Richter et al., 2018). Therefore, in the simulation, an ECD subsidy was chosen from the government to households, equivalent to one percent of the GDP in the benchmark model, which forms the starting point of the economy in which the policy is implemented.

4.2.2 Matching fund

Matching funds refer to funds that are paid in proportion to funds obtained from other sources. In this model, the investment for the child is provided by the state and the household.

Although this policy can be implemented in different ratios, we will examine the effects of 1:1 financing in this analysis, as it is the most common form of this practice. The grant is paid on the condition that the family contributes the same amount to the investment in their child. The government directly provides the expenditure to the child without transferring it to the household. Same as in the lump-sum model, the government subsidizes ECD equal to one percent of GDP in the benchmark model.

Ambler et al. (2015) show that matching funds increase education investment and reduce labor force participation among school-age youth. Moreover, it has been observed that it causes a crowd-in effect. In other words, government investment leads to an increase in household investment, although it is not conditional.

5 Results

Table 5 presents the results of the benchmark model, as well as the lump-sum and matching fund simulations, where the subsidy is equivalent to 1% of GDP of the benchmark model. We first present the steady-state results of the benchmark model to compare the policy simulation results and assess the impact of government incentives on variables. As previously mentioned, the three models are based on an economy where each generation's measure is normalized to one, resulting in the economically active population measuring at 4. These findings are consistent with the SAM matrix established for the steady-state equilibrium results of the benchmark model.

The human capital production function parameters were determined based on empirical evidence that the return on investment is highest for ECD and decreases for later schooling periods. Therefore, the amount of investment made by the parent in the child is higher in the period that provides the highest return. The interest rate obtained for an 8-year period of the model is presented by converting it into an annual interest rate. Since the government budget is assumed to be balanced, the state expenditure equals the total tax revenue from consumption and wage income in the benchmark model. In the lump-sum and matching fund models, government expenditure remains the same at the level in the benchmark model, and the fund required for the incentives is provided by generating extra revenue through consumption tax.

Initially, financing the ECD investment incentive requires an increase in the consumption tax rate. However, both policy simulations result in a decrease in the consumption tax rate. This is due to an increase in tax base led by economic growth. The tax rate to cover the constant government expenditures and ECD investment subsidies is lower than at the beginning.

The lump-sum subsidy model, which increased the total income of the family with children during the ECD period, increased output by 8,37% compared to the benchmark model. In the matching fund model, where the same amount of subsidy entered directly into the child's human capital production function with an equal amount of investment by the household resulting in a 52,48% boost in output. Similarly, while the lump-sum model leads to a 12.2% increase in physical capital, a 3.41% increase in human capital, and a 10.9% increase in total consumption, the

matching fund model leads to a significantly higher increase of 48.75% in physical capital, 57.91% in human capital, and 67% in total consumption. While the wage increases by 8.63% in the lump-sum model, it increases by 52.52% in the matching fund model.

Finally, as a result of the incentive given by the government to increase ECD investments, there is an increase in the investments made by the parents during the schooling period for the child in both models. Investment in the 8-year period, which constitutes the first school period after early childhood, increased by 14.53% in the lump-sum model and 12.6% in the second school period, while in the matching fund model, investment in the first school period increased by 46.37% and investment in the second school period increased by 48.3%.

Table 5: Results of benchmark economy and policy simulations

	Benchmark model	Lumpsum subsidy model	Matching fund model
Physical capital	0.1524	0.171	0.2267
Aggregate human capital	0.5595	0.5786	0.8835
Consumption	0.2027	0.2248	0.3393
Output	0.2639	0.286	0.4024
Government expenditure	0.0604	0.0604	0.0604
Wage	0.0278	0.0302	0.0424
Interest rate (annual)	0.0905	0.0882	0.0923
Consumption tax rate	0.1835	0.1686	0.0822
Wage tax rate	0.2069	0.2069	0.2069
Subsidy	0	0.002638	0.002638
ECD investment	0.0003139	0.0003644	0.002638
School 1 investment	0.0002478	0.0002838	0.0003627
School 2 investment	0.0002294	0.0002583	0.0003402

Source: Authors' calculations

6 Conclusion

The study analyzed the effects of two policies on households with children during the ECD period. The first policy is a lump-sum subsidy, which increases the household's income, while the second policy is the matching fund subsidy, which is granted on the condition that the household invests the same amount and it is a direct investment in the child. We find that in the

matching policy model, the steady state consumption, human capital, physical capital, and output levels are much higher compared to the lump-sum subsidy model.

Matching fund policy provides higher returns than lump-sum policy because it directly increases human capital, and it is given on the condition that the parent also makes the same investment. Therefore, we suggest providing in-kind payments in the form of early childhood education (ECE) services rather than cash payments when implementing a matching policy. Parents may lack knowledge about ECE and may not use cash incentives efficiently. However, by purchasing ECE services with the fund, an expert can better contribute to the child's human capital. Studies show that providing childcare assistance to families leads to increased utilization of center-based childcare services and has a positive effect on children's development in the US (Burchinal et al., 2000), in Canada (Crosby et al., 2005) and in Brazil (Leao et al., 2021). Given the relatively low impact of the lump-sum subsidy, Türkiye's current policy is unlikely to have a significant long-term effect. Furthermore, in both policy simulations, the increase in investment in early childhood development (ECD) leads to an increase in household investment in education at all levels. The total increase in education investments amplifies the impact of the incentive provided during the ECD period by contributing to the overall human capital of the economy.

Further study includes to expand policy simulations with the Child Tax Credit (as implemented in the US), universal child care (free ECE for every child), and direct unconditional cash transfers to the children. Our final task is to report and interpret the transitional path computations of the economy’s equilibrium values with respect to alternative policies.

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Appendix

Table 1A: Social Accounts Matrix (Thousand TL)

	Activities	Consumer	Child Investment (ECD period)	Child Investment (School period)	Labor	Capital	Government	Total
Activities		2.446.587.159,14	3.840.934,44	5.841.140,61			726.597.059,42	3.182.866.293,61
Consumer					1.342.907.498,40	1.839.958.795,21		3.182.866.293,61
Child Investment (ECD period)		3.840.934,44						3.840.934,44
Child Investment (School period)		5.841.140,61						5.841.140,61
Labor	1.342.907.498,40							1.342.907.498,40
Capital	1.839.958.795,21							1.839.958.795,21
Government		726.597.059,42						726.597.059,42
Total	3.182.866.293,61	3.182.866.293,61	3.840.934,44	5.841.140,61	1.342.907.498,40	1.839.958.795,21	726.597.059,42	

Sources: 2019 TurkStat National Accounts (payments to labor force, payments to capital and household's final consumption expenditures), 2019 Household Budget Survey (Share of early childhood development expenditures in total consumption), Ministry of Treasury and Finance 2019 Budget Finance Statistics (rate of direct and indirect taxes)), Lee and Seshadri (2019) (Behavioral parameters) and authors' calculations

Note: The tax revenues and expenditures of the government are calculated with SHM offsetting applications.

Firm maximization problem:

Firm maximize profit according to:

$$\max_{K_t, H_t} \Pi_t = K_t^{\alpha}[H_t]^{1-\alpha} - w_t H_t - r_t K_t - \delta K_t$$

Implying the first-order conditions

$$\frac{\partial \Pi_t}{\partial K_t} = \alpha K_t^{\alpha-1}(H_t)^{1-\alpha} - r_t - \delta = 0$$

$$\frac{\partial \Pi_t}{\partial H_t} = (1-\alpha)K_t^{\alpha}(H_t)^{-\alpha} - w_t = 0$$

$$r_t = \alpha {k_t}^{1-\alpha} - \delta$$

$$w_t = (1-\alpha){k_t}^{\alpha}$$