

Optimal Tax Theory for Investment in Human Capital and the Role of Family

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Purpose: Parents spend more than half of all education expenditures on children's education, thus the role of the family cannot be omitted in determining the optimal educational policy. The main aim of the article is to present economic literature on optimal taxation with human capital, focusing on studies concerning the impact of the family (parents) on the investment in children's human capital.

Design/Methodology/Approach: Insights from two workhorses are reviewed: the RAMSEY approach and the MIRRLEES approach. The literature in the field considers two instruments: Income-Contingent Loans (ICL) and Education Subsidies (ES). Results from theoretical and simulation studies are summarized.

Findings: Income-contingent repayment loans can improve welfare, whereas the effects of education subsidies may be positive only under some assumptions.

Research limitations/Implications: The MIRRLEES approach is a relatively new strand of literature and due to numerical complexity all researches analyze only partial-equilibrium models with simple set-up (without altruistic families/ fertility decisions/ pension systems).

Originality/value: The article provides guidance for policymaker and decision-makers regarding optimal higher education systems and financial support systems for students.

Keywords: optimal taxation with human capital, income-contingent repayment, education subsidies.

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Optymalna teoria opodatkowania inwestycji w kapitał ludzki i rola rodziny

Cel: ponad połowę wszystkich wydatków na edukację dzieci pokrywają rodzice, dlatego też nie można pominąć roli rodziny w ustalaniu optymalnej polityki edukacyjnej. W artykule przedstawiono literaturę dotyczącą optymalnego opodatkowania kapitału ludzkiego, skupiając się na badaniach dotyczących wpływu rodziny (rodziców) na inwestycje w kapitał ludzki dzieci.

Metodologia: w artykule przedstawiono artykuły dotyczące dwóch głównych podejść podatkowych: podejścia RAMSEY'A i podejścia MIRRLEES'A. W literaturze przedmiotu rozważa się dwa instrumenty: pożyczki uzależnione od dochodu (ICL) i subsydia edukacyjne (ES). Przeanalizowano wyniki badań teoretycznych i symulacyjnych.

Wyniki: pożyczki uzależnione od dochodów mogą poprawić dobrobyt, podczas gdy skutki subsydów edukacyjnych mogą być pozytywne tylko przy pewnych założeniach.

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Ograniczenia/implikacje badawcze: *podjęcie MIRRLEES'A jest stosunkowo nowym nurtem literatury i ze względu na złożoność numeryczną wszystkie badania analizują jedynie uproszczone modele częściowej równowagi (bez rodzin altruistycznych/decyzji o dzietności/systemów emerytalnych).*

Oryginalność/wartość: *artykuł dostarcza wskazówki dla decydentów i polityków w zakresie ustalania optymalnych systemów edukacji wyższej i systemów wsparcia finansowego dla studentów.*

Słowa kluczowe: optymalne opodatkowanie kapitału ludzkiego, pożyczki ze spłatą zależną od dochodów, subsydia edukacyjne.

JEL: H21, H52, I22, J24

1. Introduction

There are different education funding systems across the world. In most European countries, such as Poland, Germany, Denmark etc., universities charge low or no tuition fees because higher education institutions are funded from general taxation. In contrast, in the United States and in the United Kingdom students pay for education. In the countries with paid education, parents educational spending covers a significant fraction of all college costs (including, i.e., tuition fees and living expenses). Empirical evidence – both micro and macro-economic – indicates that parents have a significant influence on the children's educational choices. Parents have the greatest influence on students' educational aspirations even after controlling for socioeconomic status. Both the non-financial support (i.e., parental involvement in child's activities, children-parent relationship, family structure) (Chapman, 1981; Perna et al., 2010; Cabrera & LaNasa, 2000; Butterbaugh, 2013) and the financial support (Butterbaugh, 2013; Haider & McGarry, 2018; Sallie Mae, 2021) impact the young's educational decisions. The dynastic aspect of modelling investment in human capital allows for the incorporation of the parent's financial support: it can be viewed as a transfer from parents to children (in parallel to other types of transfers, e.g. financial bequests) (Stantcheva, 2015b; Koeniger & Prat, 2018). Therefore, the choice of optimal taxation and investment in human capital should concern not only the individuals in their life but also the role of families. In the analysis, focus was on the education spending on the tertiary level of education (higher education),

because there exists a consensus regarding the primary education finance system – in most countries, lower education is funded by the government.

In general, in the economic literature, there exist two main approaches that allow analyzing dynamic taxation: the dynamic MIRRLEES¹ and the parametric RAMSEY. This Chapter presents the literature overview for the approaches regarding the optimal education finance system, emphasizing the studies including the family role in the investment in human capital. The main difference between the two approaches is that in the dynamic MIRRLEES approach there is incomplete information – the social planner does not know all about agents (more precisely, they do not know their abilities and labor effort).

In literature there exist two main policy instruments of incentivizing investment in human capital: **Education Subsidies (ES)** and **Income-Contingent Loans (ICL)**. **ES** are the government financial aid financed from general taxation, they most often cover the cost of tuition fees, in some cases also the living expenses, and, therefore, provide free access to higher education. They are effectively a redistribution tool because they eliminate barriers to acquiring education (within cohort redistribution). However, they also deepen inequality because taxes raised to finance education reduce welfare of all agents, while benefits accrue only to young agents (between cohort redistribution). **ICL** keep investment in human capital as a private decision, but repayment of student loans is contingent on borrowers' current income. In the UK, for example, student loan repayment programs stipulate income thresholds below which repayments are not required.

Similar solutions exist in the USA, though they are much less popular. Due to risky aspects of investment in human capital, **ICL** are good instruments for insuring against negative shocks. Arranging the reimbursement that depends on the borrower's current income is beneficial for young people, especially during unemployment or at the beginning of their careers. The existing macroeconomic literature indicates positive aspects of **ICL** (Gary-Bobo & Trannoy, 2015; Findeisen & Sachs, 2016; Stantcheva, 2017; Radomska, 2019).

Given the insights from the literature, this article will review the findings of the studies which analyze optimal taxation in the context of endogenous human capital investment in models with (dynasties) families. Such models allow to analyze the role of parents in children's educational choices. They permit welfare analysis by comparing the utility of agents between two simulated worlds: with and without certain instruments. The goal of the article is to present the trade-offs between centralized and decentralized equilibrium. To this aim, the instruments in the existing literature (**ES** and **ICL**) are discussed as they can result in first-best outcomes or only second-best policies. Whether there exists the optimal taxation and education policy that may increase social welfare and decrease inequality. Investment in human capital generates positive externalities, hence causing underinvestment in most conventional frameworks. The review of the literature is pursued with the underlying hypothesis that education policy and tax policy generate spillovers between one another.

This study is structured as follows. First, motivation for analyzing the role of parents in the process of investment in human capital is presented. Then, economic literature regarding optimal taxation in two main strands of literature: **RAMSEY** and **MIRRLEES** is presented, focusing on the studies that take into account the role of family in the human capital acquisition process. Results are discussed focusing on the instruments incentivizing the investment in human capital (**ES** and **ICL**). Then, discussing the state of the art literature in the field takes place, showing the advances of some of the modeling paths and identifying the research gaps. The

paper concludes with directions for future research.

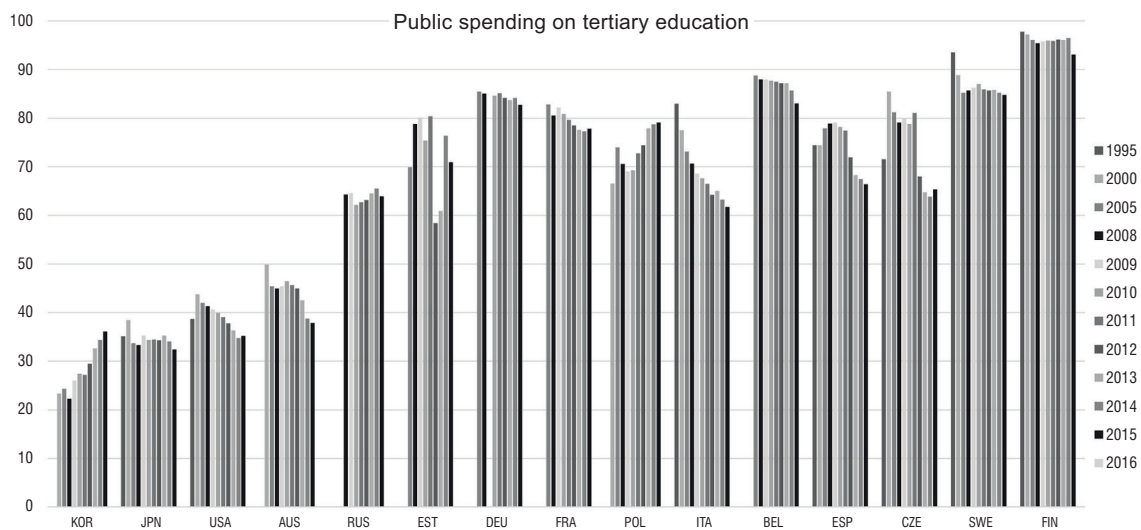
2. Motivation

In most countries in North America and Europe, the government tertiary education expenses account for at least 2%. This amount covers all or almost all tuition fees at the universities in many European countries. In the countries, the main source of financing higher education is a public expenditure, as shown in Figure 1a and Figure 1b. Figure 1a and Figure 1b present the division of education expenses into two main sources: public and private in selected countries in the years 1995–2016. The countries with the highest public education expenditures are on the right side of Figure 1a. In the countries private education spending covers only a small part of education expenditures, as presented in Figure 1b. The order of countries in all Figures in the article starts from the countries with the lowest public education expenditures to countries that cover almost all education expenditures (i.e. Finland).

Public expenses are various types of scholarship programs, grants or loans that are offered by the government for the most talented students (Academic or Athletic Scholarships) or most needy students (Need-Based Scholarships). Private expenses are the other financial resources that are used to finance higher education, i.e., students' and families' savings or loans, expenditures made by private businesses and non-profit organizations, such as religious organizations, charitable organizations, and business and labor associations. In some countries, public subsidies cover less than half of all education spending, i.e., in the USA, South Korea or Austria and the rest is covered by private resources.

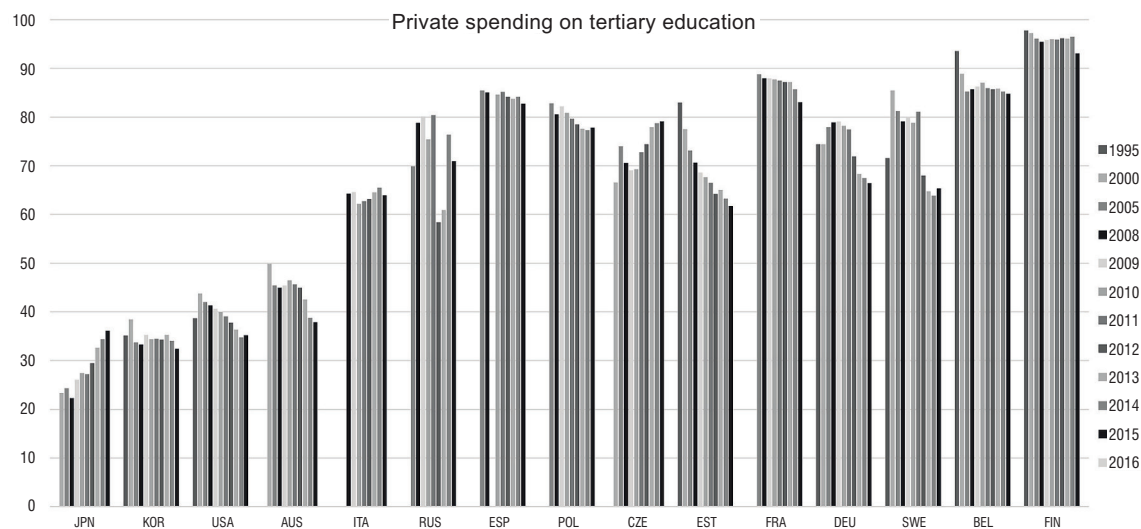
Parents play a crucial role in the process of education of their children by spending tangible (money) and intangible (time, care) resources. At the preliminary and secondary education levels, parents impact children's education by parenting style (parent's involvement and behavior) and the financial resources spent on additional extracurricular activities. At the later stage of education, students need parents' financial help to cover their college costs, especially in countries where there is minor

Figure 1a. Public tertiary education expenditures in selected countries in years 1995–2016



Source: Own calculation based on OECD (2020), Spending on tertiary education (indicator).

Figure 1b. Private tertiary education expenditures in selected countries in years 1995–2016



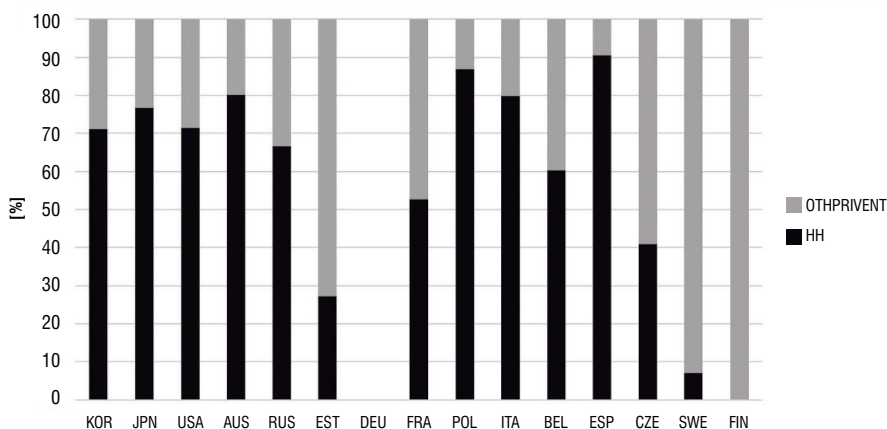
Source: Own calculation based on OECD (2020), Spending on tertiary education (indicator).

or any public education spending on tertiary education (Galmath & Lahiri, 2018). Figure 2 presents the proportion between the division of private education expenses into two sources: households spendings and other private expenditures. As presented in Figure 2, in most cases more than half of all private expenditures are financed

by households (parents). The order of countries starts from the countries with the lowest public education expenditures to countries that cover almost all education expenditures (the same order as in Figure 1a).

Parent's willingness to pay for their children's higher education has been analyzed

Figure 2. The sources of private funding in 2015 in selected countries



Source: Own calculation based on OECD (2020), *Spending on tertiary education (indicator)*.

for many years. The two main determinants of the willingness of the parent to pay for college of children are the total income and the number of children in the family (Steelman & Powell, 1991; Rauscher, 2016). Moreover, if parents themselves receive financial help to pay for tuition, they are more likely to help their children, implying the continuity of altruism towards children's education over generations (Steelman & Powell, 1991). What is interesting – if children's test scores were low, parents were more likely to go into debt to finance children's education. In other words, parents sacrifice for their children when children cannot receive scholarships due to low test scores or grades. The empirical evidence implies that if only parents have the financial possibility to finance their child's education, they invest in the child's human capital, regardless of the child's ability. Therefore parental altruism, understood as a willingness of parents to finance their children's education, should be taken into account in the designing the optimal policy for investment in human capital.

Summarizing, the role of family in the process of acquisition of human capital is crucial, especially when it comes to financing higher education. Therefore, the article reviews the economic literature on *optimal taxation with human capital* in macroeconomic models, focusing on the life cycle and overlapping generation (OLG) models that consider the family (dynasty) role in the human capital acquisition process. The education system and tax policies

both influence inequality and intergenerational redistribution, hence analyzing them together provides novel insights (Findeisen & Sachs, 2016). Taxes on labor income and on bequests introduce a distortion to the decision about human capital investment (Koeniger & Prat, 2018). Therefore, abstracting from the educational system in designing the tax policy, one omits an important externality.

3. Optimal Taxation Theory

The optimal taxation theory is the study of designing and implementing the tax system that “should be chosen to maximize a social welfare function subject to a set of constraints” (Mankiw, Weinzierl & Yagan, 2009). A typical citizen pays many taxes, i.e., on labor earnings, interest income, consumption, etc. As many economists indicate, taxes may distort agents' decisions (i.e. labor taxes demotivate from work). Therefore the problem of designing a good tax system is not trivial.

In general, in the literature, there exist two main approaches that allow analyzing optimal taxation: the dynamic MIRREES and the parametric RAMSEY. In the RAMSEY approach, the type of tax instruments is specified (parametrically) ex-ante. Therefore, this approach is most often used to assess optimal policies quantitatively, and it is also called a quantitative Ramsey approach (Stantcheva, 2020). In the approach, it is possible to analyze how the introduction of the tax system affects

(labor/consumption/education, etc.) decisions of different types of agents, because the social planner knows all about the agent types. The main result of the RAMSEY approach implies that the social planner should be allowed to use all possible tax structures to reduce the utility of agents at a minimum. Moreover, if the social welfare function is based on the maximin principle (focuses on the reduction of inequalities) progressive taxation of labor income is optimal.

Building on the RAMSEY taxation, the MIRRLEES approach was proposed by introducing incomplete information – the social planner does not know all about agents. In the RAMSEY approach, the benevolent government sets taxes so as to finance its expenditures and maximize the representative agent's utility. The main aim of the MIRRLEES approach is to choose the tax system to minimize distortions associated with taxation. Because agents have different (unobservable) ability types to earn income they react differently to the tax system. As a result, the social planner only observes the produced output and cannot observe how the taxes distort the agent's labor decision. Moreover agents can misreport their ability type (i.e. in order to be taxed on the lower level). Therefore, the social planner sets the taxation system to be incentive-compatible² to encourage the agent to truthfully report their types. Therefore, generally, the taxes are not ex-ante specified in the MIRRLEES approach.

The focus is on two policy instruments of subsidizing investment in human capital studied in the literature: **education subsidies** and **income-contingent loans**. The **ES** are the government financial aid financed from general taxation, which most often covers the cost of tuition fees, in some cases also living expenses, and therefore provides free access to higher education. There exist countries with fully functional **education subsidies** where students pay no tuition fees, such as Germany, Denmark, Finland and Norway. In the countries, education expenses constitute high direct public cost, financed from, i.e. labor taxes. In the standard macroeconomic approaches (both the RAMSEY and MIRRLEES), labor taxes distort agents' labor decisions. Therefore the introduction of **education subsidies** is associated with the introduc-

tion of some taxation and affects the agent labor decisions.

ICL were theoretically introduced by Friedman (1955), he proposes **income-contingent repayment of the debt**, i.e. a repayment scheme which allows realigning social and private incentives to invest in human capital. He underlines the risky aspects of investment in human capital. The practical implementation of this kind of repayment scheme has its origins in Australia where there was the Higher Education Contribution Scheme (HECS) introduced in 1989. The scheme is based on the collection of tuition fees from domestic students, with repayment starting when the debtor's income has risen above the given threshold, and the amount of the repayment depends on income – it cannot be higher than 4% or 8% of annual personal income (Chapman, 2016). Since that time, more and more countries have introduced a similar scheme of repayment of students debt, i.e., New Zealand (1991); South Africa (1991); United Kingdom (1998); Hungary (2001); Chile (2006); Thailand (for 2006 only); and Malaysia (2019). The hybrid system (both income-contingent and mortgage-style loans) is being introduced by Japan, South Korea and the Netherlands (OECD, 2019).

In the following sections, literature overview regarding the optimal taxation of labor and human capital investments is presented. The focus is on studies that analyze the impact of family roles, distinguished by the proposed instruments incentivizing investment in human capital: **ICL** and **ES**. The macroeconomic literature is divided into two approaches: RAMSEY and MIRRLEES, because they differ in important assumptions (asymmetry information), leading to different policy recommendations.

3.1. Parametric RAMSEY Approach

Last century, many macroeconomists solving the problem of designing the tax system made two main strong assumptions: taxes have to be linear, and agents in the economy are identical (representative agent models) (see the pioneer Chamley, 1986). The simple assumptions were extended, i.e. in the very long-standing RAMSEY tax literature. The idea of finding the optimal tax system in the RAMSEY approach can be summarized by the two following dual questions: “What tax sys-

tem makes the agent *the happiest* (allow to derive the higher utility), assuming a given amount of revenue (amount of taxes) to be extracted from an agent?" and "Assuming a given level of an agent's *happiness* (utility), how can we extract the highest amount of taxes (the most revenue) from an agent?". The problems can be expressed mathematically as follow:

$$\begin{aligned} \max_{\tau_1, \tau_2, \dots, \tau_N} \sum_{i=1}^N U_i \quad s.t. \quad \sum_{i=1}^N T_i &\geq G \\ \max_{\tau_1, \tau_2, \dots, \tau_N} \sum_{i=1}^N T_i \quad s.t. \quad \sum_{i=1}^N U_i &\geq U \end{aligned}$$

Where $\tau_1, \tau_2, \dots, \tau_N$ denotes the tax system, U_i is the utility of agent i , T_i is the tax revenue from agent i , and G and U are the exogenously given levels of the amount of revenue to be extracted from all agents and the level of an agent's *happiness*, respectively.

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In the approach, types of tax instruments are specified parametrically³ ex-ante, and in the further extensions, they can take many forms, not necessarily linear. Thanks to the ex-ante restrictions on tax instruments, it is possible to analyze more complex and realistic economies than in the MIRRLEES approach, i.e. incorporating overlapping generations, public goods, credit constraints and incomplete markets or open economies. Therefore the approach is most often used to assess optimal policies quantitatively. Furthermore, most researchers try to set the optimal taxes that capture current tax system characteristics, i.e., the level and the progressivity. Their main findings imply that the average marginal income tax should be increasing and concave in age. The key result of most research using the RAMSEY approach is that capital taxes are optimal if it is not feasible to introduce age-dependent labor income taxes.

The RAMSEY tax literature is very long-standing, and therefore it is impossible to present all the papers studying either

a tax reform or an optimal tax policy in very different settings. However, one interesting observation that I should underline is that in recent years many publications analyze the optimal taxation of capital, labor or human capital in the RAMSEY spirit using the overlapping generations model. This type of model allows taking into account the role of the family because agents of different ages are observable at one time, and allows for modelling the structure of the family by incorporating the child's utility, expected child's earnings or human capital in the utility function. The next section presents articles that analyze the optimal policy for investment in human capital, focusing on research that incorporates the family structure into the model. The incorporation of the family structure reflects the fact that most investments in human capital are made before and during college (before labor participation) and are primarily paid by parents.

3.1.1. Optimal Taxation in a Life Cycle Model with Human Capital and Family Structure

The literature concerning the optimal investment in human capital in the RAMSEY approach is very rich. In this section, the focus is on the models in which the decision units are families (households) because parents play an important role in the process of acquiring human capital. Moreover, they also finance a significant part of all education costs for youth. The selected literature concerning investment in human capital with the family structure is presented, with the description of model features, in Table 1.

Several model features that differ from the selected studies are distinguished. First, the focus is mainly on the research that proposes **education subsidies** (black in Table 1) or **income-contingent loans** (grey in Table 1) as instruments for improving welfare and decreasing inequality. Several studies propose neither instrument and are marked with light grey. Second, it is analyzed what inputs form the human capital of the next generation (public spending, private spending, parent's human capital). Third, studies with the model in which the utility function of the family contains the human capital of children are marked. Fourth, it is checked whether there exists some heterogeneity (ex-ante or ex-post)

Table 1. Optimal taxation and education policies in recent macroeconomic literature: RAMSEY approach

Authors	Year	Utility function contain HC	Human capital formation			Heterogeneity		Main result
			public spending	private spending	paren human capital	ex-ante	ex-post	
De la Croix & Doepke	2004						Comparison of public and private education system and the fertility choice	
De la Croix & Doepke	2003						An increase in inequality lowers average education and growth	
Glomm & Kaganovich	2008						An increase in the level public education expenditures leads to similar growth-inequality relationships	
Ono & Uchida	2018						The growth rate in debt financing is lower than in tax financing	
Gamlaith & Lahiri	2018						Improving substitutability between public and private education expenditures improves long run macroeconomic outcomes	
Caucutt, Imrohoroğlu & Kumar	2003						Changes in the progressivity of tax rates can have positive growth effects	
Benabou	2002						Progressive education finance always leads to higher income growth than taxes transfer, but at the cost of lower insurance	
Kruger & Ludwig	2013						The welfare-maximizing fiscal policy is characterized by a progressive labor income tax code and a positive subsidy for education	
Kruger & Ludwig	2016						Subsidizing higher education reduces the college wage premium which has important redistributive benefits	
Del Rey & Lopez-Garcia	2020						First-best "Golden Rule" balanced growth path requires a government loan system optimal investments in education	
Del Rey & Lopez-Garcia	2016						Pay-as-you-go social security always increase welfare	
Del Rey & Lopez-Garcia	2019						Devoting more resources to public education does not always increase welfare	
Del Rey & Lopez-Garcia	2013						When the government subsidizes the repayment of education loans, optimal pensions are positive	
Glomm & Kaganovich	2003						Increased spending on public education may lead to higher inequality	
Glomm & Kaganovich	1992						We find income inequality declines more quickly under public education	
Boldrin & Montes	2005						Public financing of education and public pensions can be designed to implement an intergenerational transfer scheme support	

Notes: The colors in the boxes show that the model has the specific characteristics. Grey refers to income-contingent loans, black to education subsidies, light grey to no instrument. Please note, that if the feature is contained in the model, it is specifically marked with light grey of the cell in Table 1. If the cell has no background color it means that the model does not include the specific feature.

between the families. The last column of Table 1 presents the main policy recommendation concerning the optimal human capital policy.

The studies presented in Table 1 analyze the optimal education policies. The main question is whether education should be privately or publicly financed. The answer on this question depends on inequality. In general, in an economy with a public education system income, inequality declines more quickly, and if the majority of agents have income below average, the whole society will prefer a public education system (Glomm & Ravikumar, 1992). If inequality is sufficiently low, the private education system yields higher per capita income.

As the microeconomic data indicates, the choice of education system (private or public) impacts parents' decision regarding the number of children and, as a result, the economic growth (de la Croix & Doepke, 2004). Taking into account fertility choices of families, the results regarding the optimal education system are similar. If inequality in human capital endowments across families is high, a public education system leads to higher economic growth. In contrast, in a situation with low inequality, it is more beneficial for society to have a private education system growth (de la Croix & Doepke, 2004).

There are both private and public universities all over the world, and young people decide about their studies. The quality of public and private schools may differ, especially in the USA private universities outperform public universities. Economic studies argue that higher substitutability between public and private education expenditures yields better long-run economic outcomes (Gamlath & Lahiri, 2018). Therefore, the quality of schools should be similar in both education systems (private and public).

The next question regarding the public education system is how governments should finance the it. To finance a public education system, governments may tax the agents (families) or finance education from debt. Both possible solutions (debt and taxation) affect the economic growth and welfare across generations, as well as fiscal stance favored by voters (Radomska, 2023). The growth rate in the case of debt financing education is lower than that in tax financing. Moreover, financing educa-

tion from debt creates a trade-off between present and future generations. Summarizing, it is optimal to finance education through taxation (Ono & Uchida, 2018). Income tax is one of the most common taxes worldwide. The tax distorts people's decisions regarding the labor supply, savings (Benabou, 2002) and education decisions (Krueger & Ludwig, 2013, 2016). Progressive financing of education always leads to higher income growth (Benabou, 2002). Because agents' labor and education decisions are distorted through taxation, optimal fiscal policy should consist of progressive income taxes and education subsidies to a substantially larger degree than the current US system (Krueger & Ludwig, 2013). Moreover, education subsidies allow more people to graduate from universities, increasing the number of skilled people and, as a result, reducing the college wage premium.

Both education and social security transfers are financed through taxation and have redistributive consequences (affect inequality and human capital distribution in the economy), although they appear at different stages of life. Therefore, the public education and the pension system should be established together to maximize social welfare. If the government offers **education loans** (and subsidizes repayment), the optimal pension should be positive (Del Rey & Lopez-Garcia, 2013, 2016, 2020). Instruments incentivizing human capital (**education subsidies**) do not always increase welfare (Del Rey & Lopez-Garcia, 2019). But if the government subsidizes education (through the introduction of **ES** or **ICL**), public pensions should be positive to increase welfare (Del Rey & Lopez-Garcia, 2013, 2016; Boldrin & Montes, 2005). Public education and social security reduce income inequality and have a non-monotonic effect on economic growth – the social programs enhance growth in most poor countries (when the initial level of funding is low) but slow down growth in developed countries with a high level of public funding (Glomm & Kaganovich, 2008).

The public education spending impact parental education expenditures, because they lower the student's cost of human capital investment. Both instruments (**ES** and **ICL**) promote college participation and have a significant impact on the equi-

librium effects. The USA government programs crowd out parental transfer, but they are valuable: removal of loans or education subsidies reduces both output and welfare in the long run (Abbott et al., 2019). Moreover, it is better to give aid (ES) to able children than to give student loans or cut labor tax for all students.

In summary, public education systems have an impact both on economic growth and inequality. Generally, it is beneficial for society to have a public education system, especially when there is high inequality across families. Government programs incentivizing investment in human capital, such as **education subsidies** or **income-contingent loans**, provide children from low-income families with access to education. Moreover, the introduction of **education subsidy** partially mitigates the negative effect of the introduction of income taxation. The most optimal education policy requires the government to give aid to able children rather than to give student loans or cut labor tax for all students.

3.2. Dynamic MIRRLEES Approach

The RAMSEY approach was the most popular approach to dynamic taxation in the late twentieth century. But its most important problem is the fact that **optimal taxes need to be specified ex-ante**, which is helpful in analyzing welfare gains from the change of the existing tax system but imposes the distortionary features of the taxation system. Primarily, the optimal taxation analysis assumed that a benevolent government sets taxes so as to finance its expenditures and maximize the representative agent's utility. The further approach posits that the government's goal is to choose the tax system to minimize distortions associated with taxation. If lump-sum taxes were allowed, then the first welfare theorem would apply, and the unconstrained optimum would be achieved. Therefore the main criticism of the RAMSEY approach is that the main goal of the government is to mimic lump-sum taxes with an imperfect set of instruments. However, very little is usually said about why tax instruments are restricted and why they take such a particular form. As such, it is often recognized that RAMSEY representative agent models do not deliver a theoretical foundation for distortionary taxation. Distortions are assumed, and their overall

level is largely determined exogenously by the level of government expenditure.

In response to the conceptual problem, James MIRRLEES (1971) proposes a new approach assuming informational asymmetry and arguing that the set of taxes that implement the optimal allocation is endogenously restricted. In the approach, **taxes do not have to be ex-ante specified**, and people in the economy are heterogeneous, which is **private information**. This heterogeneity comes from natural sources: in the real world, people differ in many ways and in general, governments do not observe the individual features (ability, intelligence, diligence etc.). In the traditional MIRRLEES approach, people differ ex-ante in their skills or productivity – more precisely, how much labor input they need to generate a given level of labor income. The extension of the traditional approach, the so-called dynamic MIRRLEES approach⁴ assumes that skills evolve over time stochastically in the meaning that people may gain or lose skills over time because of health shocks, shocks to human capital, labor market shocks or luck. The agents can differ ex-ante (due to differences in ability) and ex-post (due to shocks). Worker skills and work effort are not observed by the government. Private information creates a trade-off between insurance and incentives.

Because the government does not know the agents' skills, it can only impose taxes on the produced output (which is the outcome of the two variables: labor effort and skill). Therefore the social planner does not know if the low output is due to the agent's low ability or the low effort. This restriction translates into the trade-off that the government faces when designing the optimal tax schedule. On the one hand, the benevolent social planner wants to provide insurance for agents against the skill risk, and thus it favors the high taxes on income. On the other hand, high taxes may disincentivize highly skilled people to produce more income than low-skilled people. Therefore, the main goal of setting the taxation system is to solve for the optimal constrained efficient allocations and find a possible decentralized implementation subject to the informational constraints.

Even when tax instruments are not unduly constrained, distortions generally arise as a solution to the planning problem. Since tax instruments are not restricted, it

would be possible to achieve the first-best (without agent's heterogeneity). It means that if everyone shared the same skills, it would be optimal to impose a simple lump-sum tax— an income tax with no slope. The planning problem is thus equivalent to the first-best problem of maximizing utility subject only to the economy's resource constraints. This extreme case emphasizes the more general point that the desire to redistribute or ensure skill draws is the key determinant of marginal tax rates. Thus, taxes are affected by the distribution of skills and risk aversion, among other things.

To summarize, the two main goals of the introduction of dynamic optimal taxation are to redistribute across agents and to ensure (smooth) consumption over life. In the dynamic MIRRLEES approach, firstly, the aim is to solve the problem of optimal constrained efficient allocation and then to find possible decentralized tax implementations. That implies that tax instruments are not restricted a priori. The main result coming from the literature regarding the dynamic MIRRLEES approach assumes that the optimal capital taxes should be deferred till the realization of uncertainty (Grochulski & Piskorski, 2010). The taxes should be smoothed over the life cycle and include two components: the persistent component that will depend on the last period's tax and a drift component that capture the insurance motive (Stantcheva, 2020).

3.2.1. Optimal Taxation in a Life Cycle Model with Human Capital

Most dynamic MIRRLEES models with human capital accumulation assume that wages depend on the agent's ability and the human capital. The agent cannot change their ability type, but they can invest in human capital through money, time or a mix of both. Therefore, an investment in human capital is the key role in shaping the distributions of skill and income. The main aim of the introduction of the taxation system is to redistribute resources between agents and ensure smooth consumption. However, the introduction of the tax and transfer system affects the size of investments in human capital because it changes the net rate of return. Therefore, the problem of optimal labor and human capital taxation is analyzed along with the trade-offs between the centralized and decentralized economy.

The optimal tax system should consist of taxes that depend on the history of incomes and human capital levels each period. The key role in setting the optimal education and tax policy plays the risk properties of education (Anderberg, 2009). The sign of the optimal education premium (whether it is positive or negative) depends on whether education increases or decreases wage risk. Because it is hard to guess, how agents will benefit from the investment in human capital, the income taxes should be deferred until later years in the life cycle model when all uncertainty is resolved (Grochulski & Piskorski, 2010). Consequently, the marginal tax rate should be history-dependent. This result can be easily translated to the **income-contingent loans**: payment for human capital is deferred to the future and dependent upon actual shocks to earnings experienced throughout the working period.

Although optimal repayment schemes may have a complex non-linear schedule, they can be well approximated by a linear schedule, which depends solely on income (Findeisen & Sachs, 2016). In other words, the optimal **income-contingent loans** are linearly increasing in income up to a threshold and constant onwards. However, it is not always optimal to make education expenses fully tax deductible. The amount of deductibility of education expenditures depends on the wage elasticity concerning ability and human capital (Stantcheva, 2015a, 2015b, 2017). The extension of the standard dynamic MIRRLEES approach with the unobservable human capital shows features of the optimal taxation system: the optimal marginal income taxes should decrease with age (Kapicka, 2015).

In the standard static MIRRLEES model a social optimum may be achieved by fiscally neutral **education subsidies** (i.e. education fully financed from income taxation) (Bovenberg & Jacobs, 2005). However, with the heterogeneity of innate ability and subsequent productivity, this result no longer generally holds (Bovenberg & Jacobs, 2011). If the elasticity of earnings for education depends more on labor supply than on ability, then optimal education policy should contain positive **education subsidies**. Taxation efficiency is maximized with relatively high education subsidies, e.g. 10–15% of GDP, for a broad range of plausible calibrations (Benabou, 2002). Positive **education subsidies** are

consistent also with a setup where returns to education are known and heteroge-

Table 2. Optimal taxation and education policies in recent macroeconomic literature: MIRRLEES approach

Authors	Year	Finite-lives	Education observed by government	Heterogeneity		Main result
				ex-ante	ex-post	
Anderberg	2009					Show how optimal education and tax policy depends on the risk properties of human capital
Bovenberg &	2011					Education should be subsidized to offset tax distortions on labor supply
Bovenberg & Jacobs	2005					Optimal subsidies on education ensure efficiency in human capital accumulation
Jacobs	2013					Education subsidies should not be used for distributional reasons
Jacobs & Yang	2016					Education subsidies help to reduce distortions from explicit and implicit taxes on human capital formation
Jacobs, Schindler & Yang	2012					Education subsidies internalize a positive (negative) fiscal externality if there is underinvestment (overinvestment) in education
Bohacek & Kapicka	2008					Presented conditions for which schooling subsidies should be positive
Kapicka & Neira	2015					Presented the optimal policy that balances redistribution across agents, insures against human capital shocks, & incentivizes to learn & work
DaCosta & Maestri	2007					Savings should be discouraged, human capital investments encouraged
Fahri & Werning	2010					Human capital should be subsidized
Findeisen & Sachs	2015					Marginal increase in college subsidies in the US is at least 70 percent self-financing through the net-present value increase in future tax revenue
Findeisen & Sachs	2016					Presented optimal design of integrated education finance and tax system
Gary-Bobo, Tranny	2015					Second-best optimal loan repayments are always income-contingent
Grochulski & Piskorski	2010					Optimal linear capital taxes should be deferred till the realization of uncertainty
Koeniger & Prat	2018					Human capital investments should increase in parental income, but decrease in inherited assets
Maldonado	2008					Education should be subsidized if the education elasticity of wage decreases with ability
Stantcheva	2015					The subsidy should be set to balance the total labor supply effect of the subsidy and its distribution consequences
Stantcheva	2015					Presented optimal linear formulas for income, education and bequest taxes
Stantcheva	2018					Full deductibility of expenses is close to optimal and that simple linear age-dependent policies perform very well

Notes: The colors in the boxes show that the model has the specific characteristics. Grey refers to income-contingent loans, black to education subsidies, light grey to no instrument. Please note, that if the feature is contained in the model, it is marked with a special background (light grey) of the cell in Table 2. If the cell is with no background (not colored) it means that the model does not include the specific feature.

neous agents invest in human capital in each period of life. The social optimum may consist of positive **education subsidies**, even if the social planner does not know the innate ability of agents (Bohacek & Kapicka, 2008). The welfare gain from the introduction of **ES** is higher, if income taxes are not set optimally (compared to the situation when income taxes are set optimally). In summary, the introduction of positive **education subsidies** generally improves welfare, if earnings depend more on education than on (innate) ability.

ES are not a good redistributive tool in when there is a strong complementarity between education and innate ability. Subsidizing education contributes to greater productivity dispersion. Therefore, progressive taxation is necessary to raise sufficient funds to continue providing education to the subsequent cohorts (Bovenberg & Jacobs, 2011). The instrument effectively redistributes from high-ability working individuals to low-ability learning individuals (otherwise, funds for education subsidization would be insufficient).

Table 2 presents the selected literature concerning investment in human capital in the MIRRLEES approach. Several model features that differ the selected studies are distinguished. First, the focus is mainly on the research that proposes **education subsidies** (black in Table 2) or **income-contingent loans** (grey in Table 2) as instruments for improving social welfare and decreasing inequality. Several studies propose neither of both instruments and are marked with light grey green. Second, it is distinguished whether the agent has a finite or infinite planning horizon. Third, it is marked whether the social planner observes the years of education (by definition the government does not observe the ability and labor effort). Fourth, it is checked whether there is any heterogeneity (ex-ante or ex-post) between families. The last column of Table 2 presents the main policy recommendation concerning an optimal human capital policy.

Summarizing, the existing literature shows that recommendation for an optimal taxation policy depends on the assumption about the model (Radomska, 2019). But generally, in the dynamic MIRRLEES economy with the heterogeneous agents who invest in their human capital, there exists a place for improving the aggre-

gate welfare through the social planner intervention, such as the **introduction of income-contingent loans and/or education subsidies**. One important fact needs to be stressed: there is no research analyzing the optimal investment in human capital in the model with altruistic parents toward the children's human capital. The utility function of the model does not contain the next generation's human capital.

3.2.2. Optimal Taxation in a Life Cycle Model with Human Capital and Family Structure

All the studies mentioned in section 2.2.1 consider models in which units of analysis are agents. The incorporation of family (dynasty) structure into the dynamic MIRRLEES model with human capital is still at the initial stage of research. The very first research analyzing the dynamic MIRRLEES model with human capital and family presents that it is optimal to subsidize education in the case when the redistributive effect of education is larger relative to its efficiency cost (Stantcheva, 2015b). Otherwise, **education subsidies** should be tax-deductible so that they can interfere with the income-contingent repayment scheme. Moreover, the optimal **education subsidy** should depend on income tax and bequest tax. Introducing an overlapping generations scheme, in which each generation lives three periods, into the dynamic MIRRLEES model indicates that optimal **ES** should be higher, optimal labor taxes lower, and the optimal bequest tax unchanged in the set-up with credit constraints (Stantcheva, 2015b).

The introduction of dynasties in the optimal MIRRLEES approach implies that the size of **education subsidies** should be positively correlated to output produced by parents and negatively correlated to bequests (Koeniger & Prat, 2018). As abilities of parents and children are correlated, the social planner who does not see the ability, only the produced output, should invest more in children who are likely to benefit most from education. At the same time, a high amount of inherited assets demotivates the agents (children) to work; therefore, it is not worth investing in their education.

The analysis of parental income and the largest USA need-based program Pell Grant in the process of child's human capi-

tal acquisition implies that optimal **education subsidy** should be declining in parental income even without distributional concerns (Colas, Findeisen & Sachs, 2021). **ES** for children from poor families promote intergenerational mobility and equality of opportunity. Moreover, it is cheaper for society to subsidize the higher education of children from poor families than subsidizing children from “average” income families. In summary, optimal parental income should be considered in setting the optimal financial education aid (**ICL** and **ES**).

Summarizing, the introduction of family structure to the dynamic **MIRRLEESIAN** economy implies that setting an optimal education policy requires analysis of parents’ earnings, welfare and redistributive consequences of the introduction of education financing instruments. The results of the dynamic **MIRRLEESIAN** model with human capital can be summarized as follows: “it is optimal to subsidize human capital investments on the net if and only if they do not benefit high-ability agents disproportionately; if human capital investments disproportionately benefit the already high-ability agents, they increase post-tax inequality and tighten high-ability agents’ incentive constraints and should be taxed on the net. When human capital investments take the form of time (training) rather than resource (money) investments, the key parameter is how substitutable or complementary they are to labor effort, i.e., whether there is learning and doing or rather learning-or-doing.” (Stantcheva, 2020).

4. Conclusions and Direction for Future Research

The optimal taxation with human capital is a relatively new strand in literature, especially in dynasty framework (Radomska, 2023). In terms of policies across countries, there exist different financing education approaches: financed through income taxation using **education subsidies**, financially supported by government by using **income-contingent loans** or entirely financed through a private investment. The multiplicity of policy options is accompanied by a growing recognition that decisions about investment in human capital are strategic both at a family level and at a country level. Macroeconomic models with family structure and income

uncertainty permit to evaluate the extent to which the observed policies and their outcomes are optimal and help to identify policies which can improve welfare as well as educational attainments.

The existing literature indicates that, regardless of the assumptions in the model and the approach: **RAMSEY** or **MIRRLEES**, student loans should be repaid with income-contingent schemes rather than through regular instalments. **ICLs** provide insurance for agents against the skill risk, i.e. health shocks or unemployment. Such reform should be relatively easy to implement, as it does not require changes to the tax system in the countries which extensively rely on student loans. This result is quite universal across theoretical setups and calibrated macroeconomic simulations. Although the formula for an optimal **income-contingent loan** is complicated, it can be well approximated by a simple linear schedule (Findeisen & Sachs, 2016).

The impact of **education subsidies** on welfare and inequality is ambiguous and depends on efficiency gains from higher human capital investment and distortion introduced by taxation. In conventional models, even with agents heterogeneity, education should be subsidized and **ES** should be settled together with income taxation. However, in dynastic setups, the amount of **education subsidies** should depend also on the parent’s income and welfare (Radomska, 2023). This result follows from the fact that a parent’s income and innate child’s abilities are somehow correlated and rich parents’ children have a lower motivation to learn and work, reducing the future benefits from investment in human capital. Finally, **ES** are social transfers and should be settled together with the pension system (Del Rey & Lopez-Garcia, 2013).

There are many remaining research challenges for optimal taxation with human capital. One example is to analyze investing in risky human capital with altruistic parents in the **MIRRLEES** approach. In the model with the family structure, household’s members make joint decisions regarding consumption, labor supply and investments in the human capital of offspring. It means that there is risk-sharing within the family. Moreover, altruistic parents are more likely to finance education for low-ability children, as compared to the

social planner. One of the possible directions for future research is the analysis of the economy with different levels of parents' altruism. Most studies assume that all parents are equally altruistic toward their children. The introduction of heterogeneity in parental altruism will allow replicating the fact that some parents care more about their children's education than others. Therefore, analysis of several family types regarding parental altruism may allow a more precise formulation of educational policy recommendations. Parental altruism can be analyzed as a function of other variables (such as labor output or family wealth highlighting the fact that wealthy parents invest more in children's education).

It is a broader challenge for future work to combine optimal education policy with endogenous fertility in the MIRRLEES approach. Introducing **ES** may have a positive effect on a parent's decision concerning the number of children, because no longer the cost of providing children with education will discourage parents from having more children. Therefore analysis of the impact of **education subsidies** on fertility may be deemed crucial. Fertility decisions are important for human capital investment, which has been studied in the parametric RAMSEY approach (De la Croix & Doepke, 2004). To the best of my knowledge, there is no analysis in the dynamic MIRRLEES approach that analyzes the impact of fertility on the optimal taxation of human capital.

Future research should focus on examining the impact of investments in human capital (especially **ICL** and **ES**) on demographic change (ageing society) in the MIRRLEES approach. Because people live longer, returns to human capital will increase. The addition of endogenous human capital accumulation dampens the negative effect of demographic change on welfare (Ludwig et al., 2012). **Education subsidies** should also be settled taking into account the pension system (Del Rey & Lopez-Garcia, 2013). It would be fruitful to examine the optimal education, tax policies and pension system in the light of an ageing society.

An analysis of the optimal education system in the MIRRLEES approach in the general equilibrium model is the biggest challenge for future research. Most studies focus on the partial equilibrium analysis due to numerical complexity. Analysis

of general equilibrium enables quantifying the optimal level of the education subsidy that allows a balanced budget. Moreover, general equilibrium models allow an analysis of the impact of instruments (education subsidies and income-contingent loans) on the education premium due to endogenously settled wages. Finally, there are still few studies that analyze the transitory path, which is needed to evaluate the public costs of a given policy reform. Comparing only a steady-state (with and without instruments) is common in the literature on optimal taxation due to numerical complexity, especially in the MIRRLEES approach, but does not enable evaluating a policy reform over time (for specified generations).

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Endnotes

- ¹ The term "dynamic Mirrlees" is introduced, consisting with Stefanie Stantcheva (2020) to underline that the traditional (static) James Mirrlees (1971) approach to a dynamic set-up is assumed.
- ² Meaning that the truth-telling strategy should yield at least weakly higher expected agent utility than any other strategy. oecd
- ³ Because this approach assumes that the taxes are ex-ante parametrically specified, I name this approach as parametric RAMSEY consistent with Stefanie Stantcheva (2020).
- ⁴ The analysis of optimal taxation in the dynamic MIRRLEES approach is present, among others, in Kocherlakota, 2005 (with aggregate shocks); Farhi & Werning, 2010, 2013; Stantcheva (2017) (with the persistence of types); Golosov et al., 2006; Kapicka, 2013 (with the Markov skill process).

Bibliography

- Abbott, B., Gallipoli, G., Meghir, C., & Violante, G.L. (2019). Education policy and intergenerational transfers in equilibrium. *Journal of Political Economy*, 127(6), 2569–2624.
- Anderberg, D. (2009). Optimal policy and the risk properties of human capital reconsidered. *Journal of Public Economics*, 93(9–10), 1017–1026.
- Benabou, R. (2002). Tax and education policy in a heterogeneous-agent economy: What lev-

- els of redistribution maximize growth and efficiency? *Econometrica*, 70(2), 481–517.
- Bohacek, R., & Kapicka, M. (2008). Optimal human capital policies. *Journal of Monetary Economics*, 55(1), 1–16.
- Boldrin, M., & Montes, A. (2005). The intergenerational state education and pensions. *The Review of Economic Studies*, 72(3), 651–664.
- Bovenberg, A.L., & Jacobs, B. (2005). Redistribution and education subsidies are Siamese twins. *Journal of Public Economics*, 89(11–12).
- Bovenberg, A.L., & Jacobs, B. (2011). Optimal taxation of human capital and the earnings function. *Journal of Public Economic Theory*, 13(6), 957–971.
- Butterbaugh, S. (2013). The Parental Influences on a Student's Undergraduate Collegiate Choices. University of Minnesota Digital Conservancy, <https://hdl.handle.net/11299/155295>.
- Cabrera, A.F., & La Nasa, S.M. (2000). Understanding the college-choice process. *New directions for institutional research*, 2000 (107), 5–22.
- Chamley, C. (1986). Optimal taxation of capital income in general equilibrium with infinite lives. *Econometrica: Journal of the Econometric Society*, 607–622.
- Chapman, D.W. (1981). A model of student college choice. *The Journal of Higher Education*, 52(5), 490–505.
- Chapman, B. (2016). Income contingent loans in higher education financing. *IZA World of Labor*.
- Colas, M., Findeisen, S., & Sachs, D. (2021). Optimal need-based financial aid. *Journal of Political Economy*, 129(2), 492–533.
- De la Croix, D., & Doepke, M. (2004). Public versus private education when differential fertility matters. *Journal of Development Economics*, 73(2), 607–629.
- Del Rey, E., & Lopez-Garcia, M.A. (2013). Optimal education and pensions in an endogenous growth model. *Journal of Economic Theory*, 148(4), 1737–1750.
- Del Rey, E., & Lopez-Garcia, M.A. (2016). Endogenous growth and welfare effects of education subsidies and intergenerational transfers. *Economic Modelling*, 52, 531–539.
- Del Rey, E., & Lopez-Garcia, M.A. (2019). Public education, intergenerational transfers, and fertility. *Economics Letters*, 179, 78–82.
- Del Rey, E., & Lopez-Garcia, M.A. (2020). On government-created credit markets for education and endogenous growth. *Economic Modelling*, 92, 170–179.
- Farhi, E., & Werning, I. (2010). Progressive estate taxation. *The Quarterly Journal of Economics*, 125(2), 635–673.
- Farhi, E., & Werning, I. (2013). Insurance and taxation over the life cycle. *Review of Economic Studies*, 80(2), 596–635.
- Findeisen, S., & Sachs, D. (2016). Education and optimal dynamic taxation: The role of income-contingent student loans. *Journal of Public Economics*, 138, 1–21.
- Friedman, M. (1955). The role of government in education. In *Economics and the Public Interest* (pp. 123–144). Rutgers University Press.
- Gamlath, S., & Lahiri, R. (2018). Public and private education expenditures, variable elasticity of substitution and economic growth. *Economic Modelling*, 70, 1–14.
- Gary-Bobo, R. J., & Trannoy, A. (2015). Optimal student loans and graduate tax under moral hazard and adverse selection. *The RAND Journal of Economics*, 46(3), 546–576.
- Glomm, G., & Ravikumar, B. (1992). Public versus private investment in human capital: endogenous growth and income inequality. *Journal of Political Economy*, 100(4), 818–834.
- Glomm, G., & Kaganovich, M. (2003). Distributional effects of public education in an economy with public pensions. *International Economic Review*, 44(3), 917–937.
- Glomm, G., & Kaganovich, M. (2008). Social security, public education and the growth–inequality relationship. *European Economic Review*, 52(6), 1009–1034.
- Grochulski, B., & Piskorski, T. (2010). Risky human capital and deferred capital income taxation. *Journal of Economic Theory*, 145(3), 908–943.
- Haider, S.J., & McGarry, K. (2018). Parental investments in college and later cash transfers. *Demography*, 55(5), 1705–1725.
- Kapicka, M. (2015). Optimal Mirrleesian taxation in a Ben-Porath economy. *American Economic Journal: Macroeconomics*, 7(2), 219–248.
- Kocherlakota, N.R. (2005). Zero expected wealth taxes: A Mirrlees approach to dynamic optimal taxation. *Econometrica*, 73(5), 1587–1621.
- Kocherlakota, N.R. (2010). *The new dynamic public finance*. Princeton University Press.
- Koeniger, W., & Prat, J. (2018). Human capital and optimal redistribution. *Review of Economic Dynamics*, 27, 1–26.
- Krueger, D., & Ludwig, A. (2013). Optimal progressive labor income taxation and education subsidies when education decisions and intergenerational transfers are endogenous. *American Economic Review*, 103(3), 496–501.
- Krueger, D., & Ludwig, A. (2016). On the optimal provision of social insurance: Progressive taxation versus education subsidies in general equilibrium. *Journal of Monetary Economics*, 77, 72–98.

- Ludwig, A., Schelkle, T., & Vogel, E. (2012). Demographic change, human capital and welfare. *Review of Economic Dynamics*, 15(1), 94–107.
- Mae, S. (2012). How America pays for college. *Newark*. DE: Report.
- Mankiw, N. G., Weinzierl, M., & Yagan, D. (2009). Optimal taxation in theory and practice. *Journal of Economic Perspectives*, 23(4), 147–174.
- Mirrlees, J.A. (1971). An exploration in the theory of optimum income taxation. *The Review of Economic Studies*, 38(2), 175–208.
- Mirrlees, J.A. (1976). The optimal structure of incentives and authority within an organization. *The Bell Journal of Economics*, 105–131.
- Mirrlees, J.A. (1986). The theory of optimal taxation. *Handbook of Mathematical Economics*, 3, 1197–1249.
- OECD, (2019). *Education at a glance: OECD indicators*. Paris
- Ono, T., & Uchida, Y. (2018). Human capital, public debt, and economic growth: A political economy analysis. *Journal of Macroeconomics*, 57, 1–14.
- Perna, L., Fester, R., & Walsh, E. (2010). Exploring the college enrollment of parents: A descriptive analysis. *Journal of Student Financial Aid*, 40(1), 1.
- Radomska, S. (2019). Optimal Policy for Investment in Human Capital in the Light of Optimal Tax Theory. *Studies and Materials*, 30(1), 34–42.
- Radomska, S. (2023). *Investment in human capital: an optimal taxation approach* [Doctoral dissertation, University of Warsaw]. Repository of the University of Warsaw. <https://depotuw.ceon.pl/handle/item/4710>.
- Rauscher, E. (2016). Passing it on: Parent-to-adult child financial transfers for school and socioeconomic attainment. *RSF: The Russell Sage Foundation Journal of the Social Sciences*, 2(6), 172–196.
- Stantcheva, S. (2015a). *Learning and (or) doing: Human capital investments and optimal taxation* (No. w21381). National Bureau of Economic Research.
- Stantcheva, S. (2015b). *Optimal Income, Education, and Bequest Taxes in an Intergenerational Model* (No. w21177). National Bureau of Economic Research.
- Stantcheva, S. (2017). Optimal taxation and human capital policies over the life cycle. *Journal of Political Economy*, 125(6), 1931–1990.
- Stantcheva, S. (2020). Dynamic taxation. *Annual Review of Economics*, 12, 801–831.
- Steelman, L.C., & Powell, B. (1991). Sponsoring the next generation: Parental willingness to pay for higher education. *American Journal of Sociology*, 96(6), 1505–1529.