Optimal Policy for Investment in Human Capital in the Light of Optimal Tax Theory[1]

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The increasing amount of student loan is becoming a pressing issue for the US economy, as it exceeds 1.4 trillion dollars (or 7.2% of GDP), thus requiring a policy change. This paper presents economic literature on optimal taxation with human capital, which provides foundations for evaluating the long-run effects of taxation and endogenous investment in skills. I review insights from the dynamic models. The literature in the field considers two instruments: turning repayments income-contingent and providing subsidies to education costs. I summarize the results from theoretical and simulation studies. Income-contingent repayment schemes can improve welfare, whereas the effects of education subsidies may be positive only under some assumptions.

Inwestycje w kapitał ludzki w świetle optymalnej teorii podatkowej

Rosnąca wielkość kredytu studenckiego staje się istotną kwestią dla gospodarki USA, ponieważ przekracza już 1,4 biliona dolarów (7,2% PKB) i wymaga zmiany polityki. Niniejszy artykuł prezentuje literaturę ekonomiczną poruszającą temat optymalnego opodatkowania kapitału ludzkiego, która stanowi podstawę do oceny długoterminowych skutków opodatkowania i endogenicznych inwestycji w kapitał ludzki. W artykule przedstawiono spostrzeżenia z modeli dynamicznych. W literaturze przedmiotu omawiane są dwa instrumenty: raty kredytu studenckiego uzależnione od dochodów i zapewnianie dotacji pokrywających całkowite lub częściowe koszty edukacji. Podsumowanie wyników badań teoretycznych i symulacyjnych ukazało, że programy spłat uzależnione od dochodu mogą poprawić dobrobyt, podczas gdy efekty subsydiów edukacyjnych mogą być pozytywne tylko przy pewnych założeniach.

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1. Introduction

Benefits from higher education accrue to individuals, and policy makers should take it into account when they design the financing of the education system (OECD, 2012). There are pronounced differences in how education systems are financed around 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. Since human capital is the key determinant of economic growth in the long run (Lucas, 1988), optimal educational choices accrue to general equilibrium effects on top of individual benefits.

The investment in human capital formation should be considered in a life-cycle framework (e.g. Ben-Porath, 1967). This kind of model allows for showing the trade-offs faced by the agents at different stages of their life (young vs. working vs. old) and analyzing the impact of introducing government interventions such as taxes, education subsidies, etc. In such models, individuals plan their consumption and savings over the entire life cycle and therefore imposing a new tax or education subsidies may change welfare.

There exist two main strands in literature considering the coexistence of education and work. In the first strand, coined as *learning or doing*, the agents are obliged to choose whether they spend time on education or on working. In the second strand, coined as *learning and doing*, the agents at each period of their life can spend time on both – work and education (Stancheva, 2015a). The life-cycle perspective and the two approaches to modeling choice of investment in human capital motivate the use of a dynamic model.

Stancheva (2015b), as well as Koeniger and Prat (2018), emphasize the dynastic aspect of modeling investment in human capital: it can be viewed as a transfer from parents to children (in parallel to other types of transfers, e.g. financial bequests). Therefore, the choice of optimal taxation and investment in human capital should concern not only the individuals within their life but also the dynasties.

The problem of financing the educational system seems to be crucial for all economies. There exist two approaches to financing education: from taxation or from private funds. The main issue involved in the former is that access to education is financed through an intergenerational transfer, while the tax system may provide disincentives to invest in human capital when individual productivity is unobservable and subject to idiosyncratic income shocks. The main issue with the latter is that liquidity constraints force some individuals to take up loans to finance investment in human capital: with inefficient financial markets, not all individuals invest sufficiently in human capital and, with idiosyncratic income shocks, the outstanding loans for investment in human capital may generate systemic risk for the financial system (e.g., in the US, student loans exceed 1.4 trillion dollars currently, with a high fraction of defaults). The main goal of the article is to review the research findings in the optimal taxation literature from the perspective of investment in human capital. The research question in this review article may be stated as follows: is there an optimal way to finance education through taxation. Optimality is operationalized as the benevolent social planner's dynamic choice in the overlapping generations context.

My study reviews the findings of the literature focusing on the tradition of optimal taxation and New Dynamic Public Finance in the context of endogenous human capital investment in the overlapping generation framework (OLG hereafter), with dynastic families. Such models allow for analyzing the role of parents in the educational choices of their offspring. They permit a welfare analysis by comparing the utility of agents between two simulated worlds: with and without certain instruments. Since these are general equilibrium models, they allow for identifying the total effects of instruments: fiscal, change in economic structures and change in optimal choices by households.

The goal of this article is to discuss the trade-offs between the centralized and decentralized equilibrium. To this aim, I analyze if the instruments discussed in the existing literature can result in first-best outcomes, or only second-best policies exist.

Whether the social planner (the centralized economy) setting the optimal taxation and education policy may increase social welfare and decrease inequality. Investment in human capital generates a positive externality, hence causing underinvestment in most conventional frameworks. I pursue with the review of the literature with the underlying hypothesis that education policy and tax policy generate spillovers between one another.

This study is structured as follows. First, I present the motivation for analyzing the policies fostering investment in human capital. Then, I present economic literature which focuses on optimal taxation in a wider context, not only strictly connected with human capital investment. I show the potential consequences of laissez-faire policies and discuss the current situation in countries with alternative schemes for financing higher education. While my moti-vation focuses on tertiary education, the same reasoning may be applied to countries where secondary school attainment is not universal. I then move on to discuss the state-of-the-art literature in the field, 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 the 1980s, Romer (1989) indicated a positive correlation between education of people and economic growth. Similar results were obtain by Pelinescu (2015), who highlighted a positive impact of human capital on growth expressed as gross domestic product per capita. In the US, the number of people who enroll in degree-granting postsecondary institutions in years 1990–2015 increased by 44% (Figure 1).

Figure 1. Enrollment in degree-granting postsecondary institutions in 1990–2015 and forecast to 2027
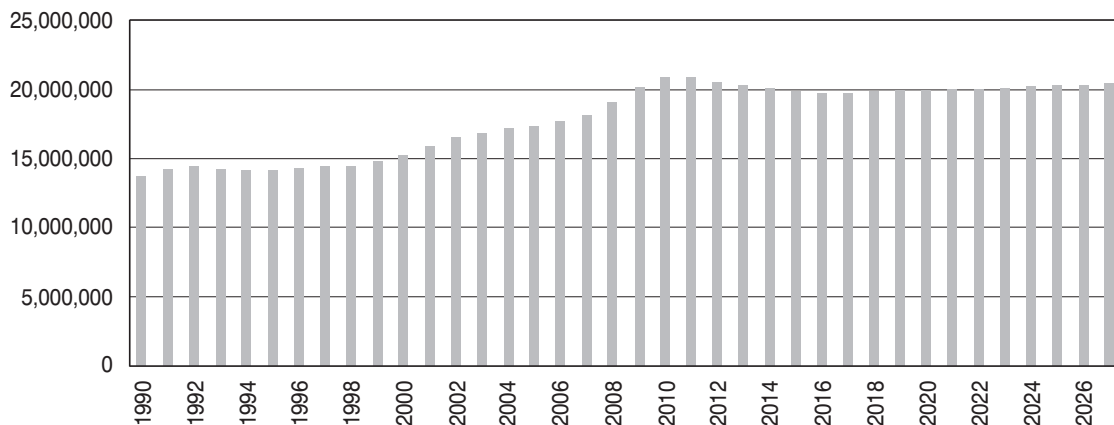

Source: U.S. Department of Education, National Center for Education Statistics, Annual Report of the Commissioner of Education.

The current situation of higher educa-tion system financing is affected by the three main economic trends: "rising costs of post-secondary education, rising average returns to schooling in the labor market and increasing labor market risk" (Lochner & Mange-Naranjo, 2015, p. 4). The aver-age tuition, fees, room and board (TFDB) costs in the US doubled at four-year public schools and increased by 65% at four-year private colleges from 1990–91 to 2012–13 (at constant 2013 prices). Although in recent years the costs of education have risen, the number of students who enroll in degree-granting institutions also increased almost to 20 million in 2015.

Figure 2. Percent of student loan debt in default or with 90+ days of delay in payment and amount of student loan debt in million $ in the USA
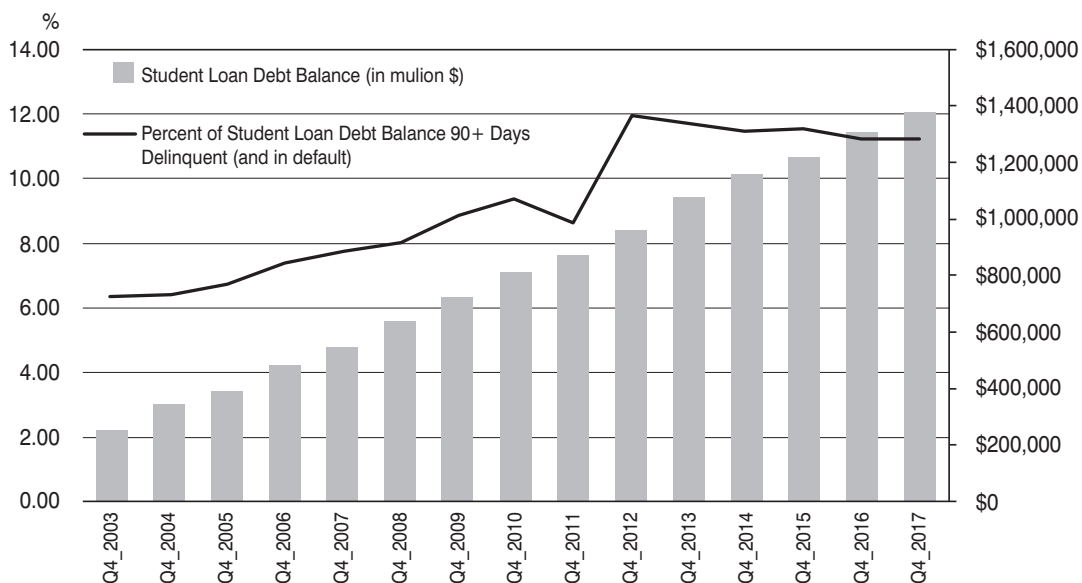
Source: Center for Microeconomic Data – Federal Reserve Bank of New York.

One of the reasons why people care about higher education is the fact that between 1979 and 2005 the weekly earnings for college graduates increased by 25%, whereas they declined by 4% among workers with a high-school diploma (Autor et al., 2008). Avey and Turner (2012) calculated that even after taking into account the rising costs of education, it is still more beneficial for individuals to graduate from college. The difference in discounted lifetime earnings rose (between 1980 and 2008) by more than 300,000$ for men and 200,000$ for women who graduated from college compared to agents who graduated only from high school. There are many empirical studies indicating that highly educated people earn more comparing to people without higher education (e.g., Oreopoulos & Petronijevic, 2013). The skill premium can be one of the main incentives that motivate people to graduate from universities.

Meanwhile, the increasing labor market uncertainty leads to the situation where the level of debt has significantly risen in recent years. More and more students have difficulties with finding their first job after graduating from college, which makes them unable to repay their debts. These problems were strikingly evident during the Great Recession, when unemployment rates significantly rose for young people regardless of their educational background (Hoynes et al., 2012).

In the US, individuals are obligated to pay for college. This paid education system has made the amount of students' debt increase very fast recently and may affect the economic situation of the US and the whole world. As shown in Figure 2, student debt was almost equal to $1.4 trillion in 2017 and has increased steadily. Because of the enormous growth of student debt, some economists have warned that the situation looks really similar to the expansion of mortgage borrowing in the years before the financial crisis in 2008 (Glater, 2016).

Figure 2 shows that the percent of student loan debt in default or with 90+ days of delay in payment almost doubled between 2003 and 2017. The problem of student debt and high default rates has triggered an adjustment in policy in the US. In 2009, the Obama administration allocated additional public funds to increase the number of grant programs for students, reducing the loans take up rate. Subsequently, in 2011, an income-based repayment program was introduced, which encouraged debtors to consolidate student loans. As a consequence, the number of student loans in default has declined, but the outstanding debt in default remained constant (Figure 2). The report presented by Scott-Clayton (2017) suggests that

nearly 40 percent of borrowers may default on their student loans in the nearest future. Therefore, the analysis of American education system financing seems to be crucial not only for the US but also for the rest of the world.

The current economic problem with enormous students' debt is even compared with the financial mortgage crisis (Glater, 2016). Therefore, the analysis of optimal taxation, concerning investment in human capital, seems to be one of the most natural ways of reducing the more and more serious problem of students' loans. Imposing optimal taxation with human capital, policy makers should take into consideration the citizens' opinion about financing the higher education system. A questionnaire recently conducted by Drenzer et al. (2018) indicates that public expenditures on higher education in the US are believed to be a good or excellent investment for over three quarters of American adults (76%). Moreover, every forth American (83% of respondents) judge that higher education institutions contribute to scientific advances that benefit the American society. These observations confirm that an analysis of optimal taxation with human capital, an optimal repayment scheme for student loans and an analysis of the possible effects of introducing subsidies for higher education on student debt have become more and more important and still remain seriously unexplored areas.

In this article, I review the economic literature on *optimal taxation with human capital* in life-cycle and OLG models. The education system and tax policies both influence inequality and intergenerational redistribution, hence analyzing them together provides novel insights (Findeisen & Sachs, 2016). Koeniger and Prat (2018) demonstrate that taxes on labor income and on bequests introduce a distortion to the decisions about human capital investment. Therefore, abstracting from the educational system in designing the tax policy, one omits an important externality.

In fact, the tax system discriminates against human capital (Schulz, 1961). There exists a two-way interaction between the tax system and investments in human capital. On the one hand, imposing progressive taxes on labor income captures parts of the returns from human capital investment for individuals. On the other hand,

tax progressivity provides insurance against earnings risk. Finally, investment in human capital directly influences the tax base and therefore affects the pretax income distribution (Stancheva, 2017). Optimal income taxation models contain, as one of the crucial inputs, the skill distribution of workers which is mainly shaped by human capital investment. Given the interdependence of the optimal tax system and human capital investment, life-cycle dynamic models seem particularly suitable. It was demonstrated in the past in a model of taxation that optimal tax rates differ between setups with infinitely lived agents and the setups with finitely lived agents over the life cycle.

In the literature, economic agents are rational and make decisions (inter alia about human capital investment) in order to maximize lifetime utility. The objective of the social planner is to maximize social welfare and especially in the OLG model the social planer wants to treat all generations alike. Because the objectives of the social planer are different from preferences of individuals, the optimal education level differs between the *laissez faire* and the social optimum. For example, if human capital can be inherited in parallel to physical capital, then agents underinvest in human capital when maximizing utility within one lifetime horizon (Del Rey & Lopez-Garcia, 2013).

Such models permit the identification of the socially optimal investment in human capital as well as the evaluation of the effects of instruments aimed at bringing the economy to the social optimum. My review of the literature reveals that two policies are most frequently analyzed: education subsidies and repayment schemes. Hence, I discuss the modeling and policy implications of these two instruments at length.

3. Optimal Taxation in a Life-Cycle Model With Human Capital

The optimal taxation theory is the study of designing and implementing the tax system which "*should be chosen to maximize a social welfare function subject to a set of constraints*" (Mankiw, Weinzierl, & Yagan, 2009). If abilities or skills remain unobservable to the government, the challenge lies in making the tax scheme incentive compatible (see Mirelees, 1971, 1976, 1986 for a deterministic setup; Kocherlakota, 2010

provides a setup for idiosyncratic income shocks). In this article, I focus my attention on the studies of the implications of optimal tax policies on the endogenous education decision. The impact of taxation on human capital in the optimal taxation framework was analyzed in several recent papers. The proposed models differed with many important features such as heterogeneity of agents, external shocks, dynasty structure, the way in which investment in human capital occurs, etc. Each of these assumptions is relevant for the final policy recommendations (see, for example, Del Rey & Lopez-Garcia, 2016).

In literature, there exist two main approaches to financing the education system. On the one hand, investment in human capital could be funded privately, but in order to reach the social optimum, dedicated lending is provided. The key feature of these designs is the repayment schemes. On the other hand, the state can raise taxation in order to subsidize education per se. I discuss the literature on these two instruments below.

3.1. Optimal Repayment Scheme

If returns to human capital investment are known and all agents are alike in terms of skill acquisition and productivity, then the only source of discrepancy between social optimum and individual optimum is related to the access to financing for human capital investment. Given that in the steady state human capital and physical capital should both grow at the same rate, they should also bring the same return (adjusted for depreciation), hence agents could in principle borrow in financial markets to fund their education in the same way as firms borrow physical capital. If financial markets are efficient (i.e. no uncertainty and no information asymmetry), financing human capital through borrowing is efficient. However, with intra-cohort heterogeneity in skills, assets at birth and information asymmetry, financing human capital through borrowing is no longer optimal. Moreover, if returns to human capital are unknown and earnings are subject to idiosyncratic productivity shocks, then *laissez faire* cannot provide social optimum.

This problem is well identified in the literature. In the full information scenario, Friedman (1955) proposes income-contingent repayment of debt, i.e. a repayment scheme which allows for realigning social and private incentives to invest in human capital. Naturally, this setup does not allow for overcoming inequality in assets at birth, nor is it a solution to information asymmetry, but it is possible to extend the framework by Friedman to account for those features. Andenberg (2009) shows that the education premium (positive or negative) depends on the properties of human capital investments – whether they increase or decrease idiosyncratic income uncertainty. Since the social planner cannot observe productivity shocks experienced by the agents, the efficient allocation is be constrained, but it can be implemented using a mix of education policy with the tax system. Grochulski and Piskorski (2010) provide a dynamic setup (labor supply is spread over a larger number of life periods) and characterize the optimal tax policy following NDPF. The optimal tax system consists of taxes deferred until all shocks are realized. Consequently, the marginal tax rate should be history-dependent. This result can be easily translated to the income-contingent repayment scheme: payment for human capital is deferred to the future and dependent upon actual shocks to earnings experienced throughout the working period.

A further extension to this setup focuses on innate differences in abilities. The ability affects the education outcomes – some individuals are more talented and therefore observe higher return from investment in education. Both ex-ante and ex-post heterogeneity (i.e. innate differences in abilities and idiosyncratic shocks to individual productivity) is present in a framework proposed by Findeisen and Sachs (2016). Here, heterogeneous agents acquire universal high school education early in their life; they subsequently decide to enter the market directly after high school or go to college and finally they all choose labor supply. They propose an income-contingent repayment schedule that linearly increases income up to a threshold and constantly onwards. The key result in that study is that although optimum repayment schemes may have a complex non-linear schedule, it can be well approximated by a linear schedule, which depends solely on income. They also demonstrate Pareto optimality of the integrated tax and education system in which the government pre-finances educa-

tion and the repayment scheme is income-contingent following their proposed linear schedule.

Further, the idea that human capital investment occurs before engagement in the labor market is overly simplistic: learning actually occurs in every life period. Stancheva (2017) examines the optimal taxation and education policy in the framework with ex-ante (innate abilities) and ex-post intra-cohort heterogeneity (due to health shocks and income shocks), and with per period human capital investment. She compares income-contingent loan to a deferred deductibility scheme. In such a setup, optimal taxation will depend on the extent to which insurance against shocks may be provided through progressive income taxation. She considers two cases. In the first case, high-ability agents benefit from investments in human capital proportionately (the investment in human capital decreases the elasticity of the wage with respect to ability). Then, the optimal taxation policy is based on an income-contingent repayment scheme, encompassing the history of human capital investments and earnings. In the second case, the benefits from human capital investments are disproportionate across abilities. If this is the case, the optimal taxation policy allows for deducting current investment in human capital from current and future incomes.

In the above setups, intergenerational transfers occur only via the state. Note that an overlapping generations setup gives a new meaning to the terms "taxation" and "repayment". In order to lend money to currently young agents, the government needs to tax the currently working agents (a transfer between generations). When repayment occurs (whether through loan repayments or through taxation), the current working population is additionally taxed to pre-finance the education of the new generation of young agents. Introducing such a system imposes transition costs, but its functioning is not neutral to the intergenerational redistribution.

Intergenerational transfers may also occur within families, via dynasties. The inheritance aspect of the overlapping generations setup has been thoroughly analyzed in the context of physical capital (e.g. Farhi & Werning, 2010), but human capital actually exhibits many similarities. Namely, a parent with higher educational attainment is more likely to transmit their human capital to their offspring than a parent with lower attainment (Solon, 1999). This evidence suggests that the impact of parental factors on children's human capital is considerable and educational investments are an important form of giving by parents (beyond the bequest motive).

Formally, Koeniger and Prat (2018) introduce dynasties to models of optimal taxation with endogenous human capital investment. They focus mainly on transmission of financial and human capital from parents to children and study the limitations to optimal taxation of intergenerational transfers. Clearly, such taxes reduce inequality (provide equal chances to ever next generation), but they also weaken the bequeathing motives in both physical and human capital investments. The social optimum can be implemented by loans with income-contingent repayment.

The large-scale dynamic models discussed above make no provisions for information asymmetry in the process of human capital investment. Namely, taxes have to be incentive compatible, but human capital investment decisions are taken with benevolence. This assumption is necessary for computational and analytical reasons in large-scale dynamic models, but does not need to hold. A formal verification was proposed by Gary-Bobo and Trannoy (2015), who develop a static model, but introduce risky labor-market outcomes, adverse selection, moral hazard and risk aversion. In this setup, they study optimal taxation with student loans and show that the conclusions are not altered by the introduction of information asymmetry: optimal taxation is only feasible with income-contingent repayments.

There are few countries where most of the differentiating human capital investment is financed through borrowing (e.g. student loans). Among them, the United States has the highest per capita outstanding student debt, amounting currently to 7.2% of GDP. This debt raises concern about the systemic risk in the financial sector, as currently 11% of the loans are in default. Financing tertiary education through debt is also popular in England and Australia. None of these countries implemented universal income-contingent repayment schemes: neither in tax schedules nor in the contracts between the stu-

dent and the debtor. In fact, the majority of loans are repaid as a sequence of fixed monthly installments over a fixed period of time.

Given the unequivocally clear insights from theoretical modeling, a stark conflict between theoretically optimal outcomes and actually implemented outcomes exists for further research. First, it would be valuable to study the political economy of introducing the income-contingent repayment schemes. Even if optimal, income-contingent repayments may reduce welfare for too many of the living agents. If that is the case, without an effective inter-generational redistribution scheme, the current suboptimal outcome is likely to prevail.

Second, to the best of my knowledge, a high fraction of education fees is borne by the generation of parents (pre-funding) rather than by the generation of children (repayment). If that is the case, depending on the particularities of the pre-funding scheme, it may well be the case that payment for education becomes contingent on the incomes of the "wrong" generation, while fixed repayment schemes additionally limit access to human capital investment for young cohorts born to poor households (educationally and assets-wise). This type of situation is a greater departure from socially optimal outcomes than that studied so far in the literature. Also, it is not clear if and to what extent income-contingent payments by the "wrong" generation improve in the fixed payment scheme of the "right" generation.

3.2. Education Subsidies

High prevalence of delinquency in student loans in the US calls for further analysis of education subsidies as a policy alternative to borrowing against future earnings. Education subsidies have totally different economic consequences than student loans. Education subsidies are effectively a redistribution tool, because they allow all agents to graduate from university, regardless of their parents' wealth (within cohort redistribution). They may also be viewed as an instrument which deepens inequality, because taxes raised to finance education reduce welfare of all agents, while benefits accrue only to young agents (between cohort redistribution). The overall welfare effects and changes in inequality depend on the efficiency gains from higher human

capital investment and distortion introduced by taxation. Therefore, the results in this strand of literature are bound to be ambiguous.

In static models, the financing of education subsidies is typically through income taxes. In the static taxation model with a progressive, optimal tax system and endogenous human capital formation, Bovenberg and Jacobs (2005) show that the social optimum may be achieved by fiscally neutral subsidies (i.e. fully financed from income taxation). However, with heterogeneity of innate ability and subsequent productivity, this result no longer generally holds (Bovenberg & Jacobs, 2011). If the elasticity of earnings with respect to education depends more on labor supply than on ability, then the optimal education policy should contain education subsidies. Education subsidies are not a good redistributive tool in a situation when there is a strong complementarity between education and innate ability. Moreover, Bovenberg and Jacobs (2011) emphasize that subsidizing education contributes to greater productivity dispersion and thus progressive taxation is necessary to raise the sufficient funds to continue providing education to the subsequent cohorts. This instrument effectively redistributes from high-ability working individuals to lower-ability learning individuals (otherwise, the funds for education subsidization would be insufficient).

The pioneer of using the dynamic model with a heterogeneous agent in order to analyze the optimal redistributive taxation and education policy is Benabou (2002). He examines the impact of progressive income taxation and education subsidies on the level and distribution of income in an economy where agents live infinitely and are exposed to productivity shocks. In this setup, taxation efficiency is maximized with relatively high education subsidies, e.g. 10–15% of GDP for a broad range of plausible calibrations. In fact, positive education subsidies are consistent also with a setup where returns to education are known and heterogeneous 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 gains from the introduction of education subsidies are higher if income taxes are

not set optimally comparing to the situation when income taxes are set optimally. In a dynastic setup, education should be taxed similarly to bequests (Farhi & Werning, 2010).

A further extension to this setup focuses on introducing overlapping generations. Education subsidies are financed by income taxes which are paid by currently working agents. Therefore, similarly to previous instruments (repayment scheme), intergenerational transfers occur. These intergenerational transfers may occur within dynasties (altruistic parents care about the human capital and welfare of their children) or through public policies. Increasing the educational spending may lead to higher inequality when we assume that heterogeneous agents can invest in their human capital in every period of life and are altruistic (Glomm & Kaganovich, 2003).

The overlapping generations model allows for analyzing positive effects of investment in human capital of parents on their children. Del Rey and Lopez-Garcia (2013) make simplifications of reality and assume that children are born with knowledge endowment equal to the level of human capital of their parents and borrow money (in a perfect credit market) to invest in education only in the first period of life. In such a world, optimal policy (to decentralize the golden rule balanced growth path) involves education taxes.

Further, the analysis of innate ability of agents sheds a new light on the sense of combining education subsidies with progressive income tax. Introducing progressive income tax, on the one hand, provides social insurance against idiosyncratic wage risk but, on the other, distorts investment in human capital (education decision of households). Krueger and Ludwig (2016) showed that education subsidies can mitigate these distortions and reduce relative wages of skilled and unskilled workers; therefore, increasing the expenditures on education may be seen as a redistributive tool. This positive redistribution effect of education subsidies implies that optimal education policies are always characterized by generous subsidies.

Beyond the innate ability, the motivation to learn and work may also have impact on return to investment in human capital. Koeniger and Prat (2018) noticed that, on the one hand, if children inherit a higher bequest, their labor effort is smaller comparing to children who inherit a relatively small bequest. On the other hand, higher labor income is positively correlated with ability, which implies that the expectations about children's abilities rise proportionally to parents' wages. Therefore, children of richer parents are more attractive for the planner to invest in their human capital. Investment in children's human capital by the social planner depends positively on parental income and negatively on parental wealth. Investment in human capital is risky and parents cannot diversify their children's ability risk. Consequently, the social planner does not have to discourage human capital investments as much as bequests. The optimal policy will contain a positive implicit tax on bequests and subsidize human capital (Koeniger & Prat, 2018).

An increasing number of students graduating from college prove that investment in human capital has become a more important aspect for Americans. Because a high fraction of fees is borne by parents rather than children, an analysis of the impact of education subsidies on fertility may change the optimal policy. Yew and Zhang (2009) investigate the dependence between fertility and optimal pay-as-you-go social security. They showed that if fertility is exogenous, the welfare effect of social security is negative, whereas for endogenous fertility it is beneficial to reduce fertility and raise investments in human capital (per child) in order to enhance the social security welfare. To the best of my knowledge, there is no literature which analyzes the impact of education subsidies on fertility in US. This analysis seems to be important in the light of the decreasing fertility rate, which is currently below the level needed for replacement-level fertility (Mathews & Hamilton, 2019).

4. Conclusions and Direction for Future Research

The optimal taxation with human capital is a relatively new strand in literature, especially in the life-cycle framework. In terms of policies across countries, there exist countries with large education subsidies financed through progressive income taxation, flat income taxation as well as

countries that effectively entirely use private investment (possibly financed through debt). This 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. For example, the US has very low tertiary enrollment levels (relative to its GDP per capita) and at the same time struggles with a large outstanding balance of student loans (7.2% of GDP), with as much as 11% of nonperforming loans. Dynamic macroeconomic models with heterogeneous agents and income uncertainty permit the evaluation of 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, student loans should be repaid with income-contingent schemes rather than through regular installments. Such a 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 the theoretical setups and calibrated macroeconomic simulations.

Meanwhile, education subsidies are much more controversial in the literature. The overall welfare effects and changes in inequality depend on the efficiency gains from higher human capital investment and distortion introduced by taxation. Therefore, the results in this strand of the literature are bound to be ambiguous. In conventional models, even with agents heterogeneity, education should be subsidized (potentially, hand in hand with progressive income taxation). However, in dynastic setups, parents' decision to invest in human capital of the children may be suboptimal from a social perspective, necessitating actual taxation rather than subsidization of education. This potentially counterintuitive result follows from the fact that income of parents and innate abilities of children are not perfectly correlated (and financial markets are imperfect, not providing sufficient financing).

Importantly, with income uncertainty, investment in education can be depressed whereas instruments such as income-contingent repayment schemes or education subsidies can be a powerful redistribution tool. While some types of education subsidies actually contribute to greater inequality when coupled with progressive income taxation, they may realign the incentives and make education available to individuals with high innate abilities rather than those with high bequests from the parents' generation. Naturally, financing of the education system necessitates between-cohort redistribution.

There are many remaining research challenges for optimal taxation with human capital. One example is to analyze the investment in risky human capital within the family (similarly to the analysis conducted by Koeniger and Prat (2018)). In the model with the family structure, members of the household make joint decisions regarding consumption, labor supply and investments in human capital of offspring. This means that there is risk sharing within the family. Moreover, altruistic parents are more likely to finance education for low-ability children comparing to the social planner. Therefore, future research should examine the differences between the *laissez faire* and the social optimum in the economy where innate abilities are not the same within one family.

A broader challenge for future work is to combine the optimal education policy with endogenous fertility. To the best of my knowledge, a high fraction of education fees is borne by the generation of parents (pre-funding) rather than by the generation of children (repayment). In the US, the number of graduates from college is constantly growing and education is perceived as an important form of giving from parents to children. Introducing education subsidies may have a positive effect on the parent's decision concerning the number of children, because the cost of providing for children's education disincentivizes higher fertility. In the US, there is an observable trend of decreasing the number of children and currently the fertility rate is below the level needed to replace the population (Mathews & Hamilton, 2019). The literature quantifying the full effects of educational subsidies on fertility is yet to emerge.

Future research should focus on examining the impact of investments in human capital (especially two instruments discussed above) on demographic change (ageing society) and on the level of student debt. Because people live longer, the

returns to human capital will increase; therefore, the impact of education subsidies is not so obvious. Ludwig et al. (2012) showed that adding endogenous human capital accumulation (to the standard OLG model) dampens the negative effect of demographic change on welfare. It would be fruitful to examine the optimal education and tax policies in the light of ageing society.

Endnotes

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