



UNIVERSITA' DEGLI STUDI DI PADOVA

**DIPARTIMENTO DI SCIENZE ECONOMICHE ED AZIENDALI
"M.FANNO"**

CORSO DI LAUREA MAGISTRALE IN ECONOMICS AND FINANCE

TESI DI LAUREA

**"EDUCATION POLICIES WITH UNOBSERVABLE
HUMAN CAPITAL INVESTMENT"**

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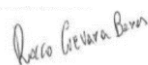
ANNO ACCADEMICO 2020 – 2021

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A handwritten signature in black ink, reading "Riccardo Crestani". The signature is written in a cursive style and is positioned below the printed text "Firma dello studente".

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1. Introduction

Human capital is one of the most important determinants of the lives of people and communities. At this very moment, human capital is being produced and transmitted through this work, the conclusion of a rich process of accumulation of human capital.

The acquisition of knowledge, experience and skills through educational investments is probably one of the main reasons for the global economic growth of recent centuries and the flight of millions of people from absolute poverty. The diffusion of literacy and knowledge has allowed those who have benefited from it to jump on the running train of technological progress and globalization. Technological progress too has certainly resulted from the increase and diffusion of knowledge that has allowed scientific discoveries and improvements in technique.

Going up the thread of history, human capital is decisive for the development of civilizations and cultures. Botticini and Eckstein (2007) claim that the history of the Jewish people was decisively influenced by the rule imposed in the first centuries after Christ which obliged families to educate their children to read the sacred scriptures. This had a significant effect from a demographic and economic point of view. In fact, the cost of educating children drove many Jews living in agricultural communities to conversion, causing a dizzying fall in the number of Jews in the world; on the other hand, it allowed families that complied with this norm to gain a valuable competitive advantage in terms of knowledge. In fact, since they were educated in a world where illiteracy was still the norm, they were encouraged to abandon agricultural work for high skill occupations such as trade.

Looking at more recent times, studies such as that of Varvarigos (2017) ascribe to human capital a fundamental role in relation to economic cycles. In fact, according to the author the accumulation of human capital increases in times of crisis because the opportunity cost of dedicating time to educational programs decreases. This, however, can also cause an increase in human capital that, by acting on labor productivity, allows to push the economic recovery, leading to an increase in the opportunity cost of acquiring human capital and thus to reopen a new cycle. In this sense, human

capital responds to the economic cycle in a countercyclical manner, but also helps to strengthen and consolidate the effects of cycles.

So we can argue that human capital determines behavior, opportunities, careers at the individual level and production, knowledge and distribution of wealth at the social level.

Nowadays a significant part of life is spent acquiring human capital and the rest of life is strongly influenced by human capital investment decisions.

The production of human capital is usually delegated to educational institutions (schools, universities, etc.), but it may also be useful to consider extracurricular experiences or the possibility of learning by doing.

Just as it is useful to analyze the various dynamics that influence or are influenced by the accumulation of human capital. These dynamics can act within the educational processes, for example think about all the indicators regarding the quality of education (educational programs, number of teachers per student, test results) that various international organizations monitor each year, but they can also act in the life of individuals and in particular in the moments of their choices.

First of all it is necessary to point out that human capital is usually an expensive investment in terms of time and money. The opportunities to study are not equally distributed among people and countries. On the contrary, the process of human capital accumulation can be responsible for the transmission of inequalities. In fact, there are many empirical studies that show how there is a relationship between the level of income and education of parents and children: this is due both to the greater availability of wealth to invest and the environment in which children grow up. In addition, education is a risky investment because it is not possible to resell; in the event of difficulties during studies or a negative shock in the labor market, the investment loses value that cannot be recovered.

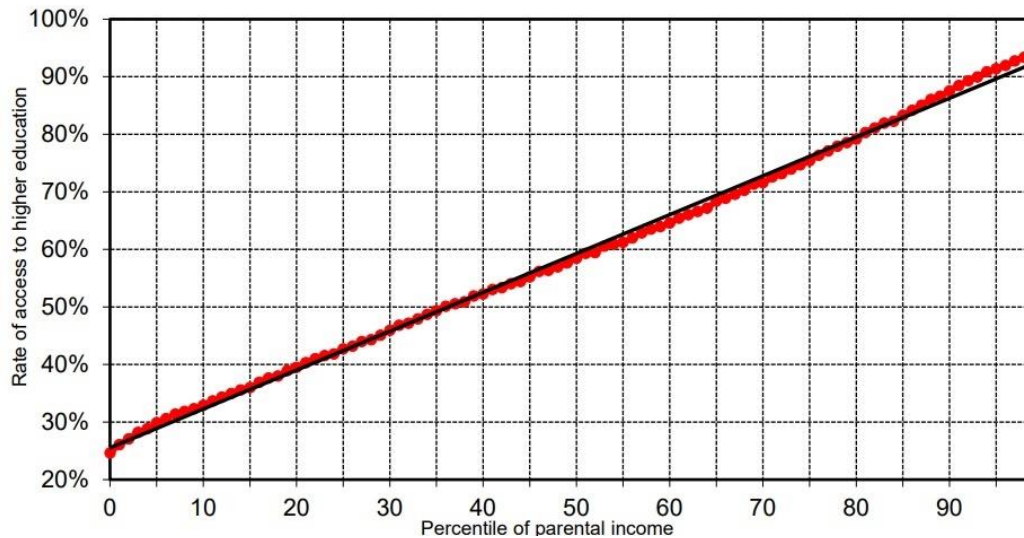
As figure 1.1 shows, in 2014 in the U.S. the rate of access to university was barely 30% among the bottom 10% poorest children, and over 90% among the 10% richest children.

The acquisition of human capital enriches the individual both personally and at work. In economic theory, it helps to increase productivity or signal the high productivity of the individual. So investing in human capital affect the possibility to enter easily in the labor market and to earn higher wages. For this reason it can be considered as a transfer of wealth between generations.

In aggregate, however, the quantity and distribution of human capital also characterize the development of a country. In the most recent models of economic growth, human capital is

considered one of the driving variables of economic growth. And if economic growth means additional income, the distribution of human capital affects the distribution of the additional income produced.

Figure 1.1 Parental income and university access (U.S. 2014)



Source: Piketty 2020

It can, therefore, be argued that the creation of human capital generates positive social externalities and also for this reason must be stimulated by governments. In fact, the private benefit of acquiring education is less than the social benefit, and this leads to a demand for human capital that is less than socially desirable.

The government can then intervene in different ways. Compulsory education is a widespread institution in many countries of the world, although the age limit may vary. Just as the presence of public schools open to all students regardless of income is widespread. However, these measures mainly concern the first years of education and become infrequent when the level of education increases. There are few countries in the world that guarantee free academic studies or specialized courses. On the contrary, a significant monetary investment is often required to access. Investment that, if it cannot be supported by the savings of parents, or by the salary of a working student, can enter into the design of public policies or be delegated to market practices. There are in fact education grants or scholarships, as well as university loans to try to ensure free access to higher levels of education.

Obviously, governments must plan their policies taking into account their budget constraints and bearing in mind that taxation design can also have an effect on human capital decisions. For

example taxation on labor income can affect investment in human capital because it affects its return; taxation on capital or wealth affect the human capital decisions because it affects an alternative form of wealth transfer.

Thus the literature on taxation, starting with Mirrlees (1971), is enriched by including the theories about human capital. Several useful concepts are introduced to become aware of how public policies can act on the creation and distribution of human capital.

This branch of literature manifests the need to know how much of the labor income is determined by human capital and how expensive it is to acquire it, both in monetary terms and in terms of efforts, to understand how to represent the intertemporal function of the individual at the time of the investment decision.

It is also necessary to understand how exogenous skills or opportunities guaranteed by the family influence the accumulation of human capital. So many studies investigate the dynamics of complementarity that the acquisition of human capital can present with other factors such as skill, wealth, other educational stages.

Furthermore, it is possible to analyze situations in which the structure of the markets interferes with investment decisions. For example, the case of imperfect capital markets, where credit constraints do not allow free access to the liquidity needed to finance investments. Or the case of unstable labor markets that are subject to frequent shocks, which cause a higher risk of investing in education that affects investment decisions.

Once these concepts are incorporated, it becomes possible to analyze programs of taxation and public investment that correctly stimulate the acquisition of human capital. The results obtained in the literature allow both to highlight relationships between policies and individual or aggregate variables, and to establish links between the policies.

This work aims to offer an overview of the literature about human capital to facilitate future research. The utility of investigating human capital accumulation and human capital policies is highlighted through a description of actual education characteristics, trends and distribution. To stimulate the investigation about higher education policy, an explanation of the principal policy tools actually implemented around the world is provided.

Empirical data, policy information and theoretical analysis are jointly collected to produce a compendious useful to understand the importance of human capital and of education policies and to tackle easily the education policies design.

Investigating data and theoretical model makes it possible to think about the link between hypothesis sustaining the models and the policy instruments actually used. This lead to be aware for example that observability of human capital expenses in the models is a key element to implement policies like subsidies or loans; or that actual policies are not sufficient to promote an equal distribution of education opportunities.

This work proceeds with section 2 in which a review of institutional literature, data and public policies illustration are exposed; in section 3 a review of human capital in economic theory literature and human capital taxation literature is presented. Finally, section 4 is a conclusion to summarize and open questions for future research.

2. Higher education and public intervention

The importance of education for the life of the individual and for society has drawn the attention of international institutions and organizations to this topic and of the governments to intervene in the education system.

Therefore, a rich collection of reports and publications that analyze the state and development of the educational system in the world is available. Both the inputs of the educational system (level of expenditure, number of teachers, quality of structures) and the outputs (school results, distribution of knowledge and income) are analyzed.

It is clear that there are large disparities between countries of the world or between students from different social class families. This fact is a crucial point of the analysis, moreover because equity is taken as a fundamental value for the social development of the future in many of these reports.

This implies that the average values of education are taken into account in describing the actual scenario but also its distribution is carefully considered.

For that reason all governments intervene by financing educational services, because there is no guarantee that the market ensures fair access to educational opportunities.

A fair distribution of educational opportunities is based both on human rights theory, which recognizes the right of individuals to have reasonable opportunities to develop their person and skills, and on social science theories. The latter emphasize how unfair distribution of opportunities can lead to underutilization of talents, which are assumed to be normally distributed. Moreover, since higher levels of education are associated with better life outcomes, not only employment and income but also health or political participation, societies that do not invest sufficiently in education will find themselves with higher social costs for health care or income support. Finally, the spread of education has a positive impact on social cohesion, a fundamental factor for a successful country.

These are some of the reasons that highlight the need for a meticulous and careful design of policies to be implemented regarding education and human capital.

Of course, the design and implementation of these policies must overcome some obstacles typical of the complexity of creating public policies. It is therefore necessary to recognize and disarticulate the problem of the distribution of human capital so as to understand it deeply and clearly; public opinion can intervene by modifying the process of policy formation; a reasonable amount of time may be necessary to evaluate the effect of the actions taken.

In addition to this, there is a variety of tools available to policy-makers to intervene directly or indirectly: it is possible to act at the regulatory level by promulgating laws and regulations, provide a service directly, allocate funds for services provided by third parties or act on the system of incentives, for example with tax benefits.

From a legislative point of view, for example, in most countries there is compulsory schooling up to a certain age. In many countries the primary schooling service is provided directly by the state or both by the state and private entities. But for higher level of education, the public intervention decrease, both in terms of laws and investments; on the other hand the private investment gain importance.

Focusing for a moment on Italy, last data suggest the need to improve the education policy scheme for higher education. In 2019 the share of tertiary educated people was 19.6%, compared with the EU average of 33,2% (ISTAT data).

In this section it is presented a review of reports and data representing the state of education among countries and periods to highlight the need of a public intervention. In addition an explanation of the public role affecting the higher education investment is provided; OECD and World Bank are the main sources used.

2.1 The spread of higher education

After World War II, the opportunities that education offers in terms of economic and social results have become clear.

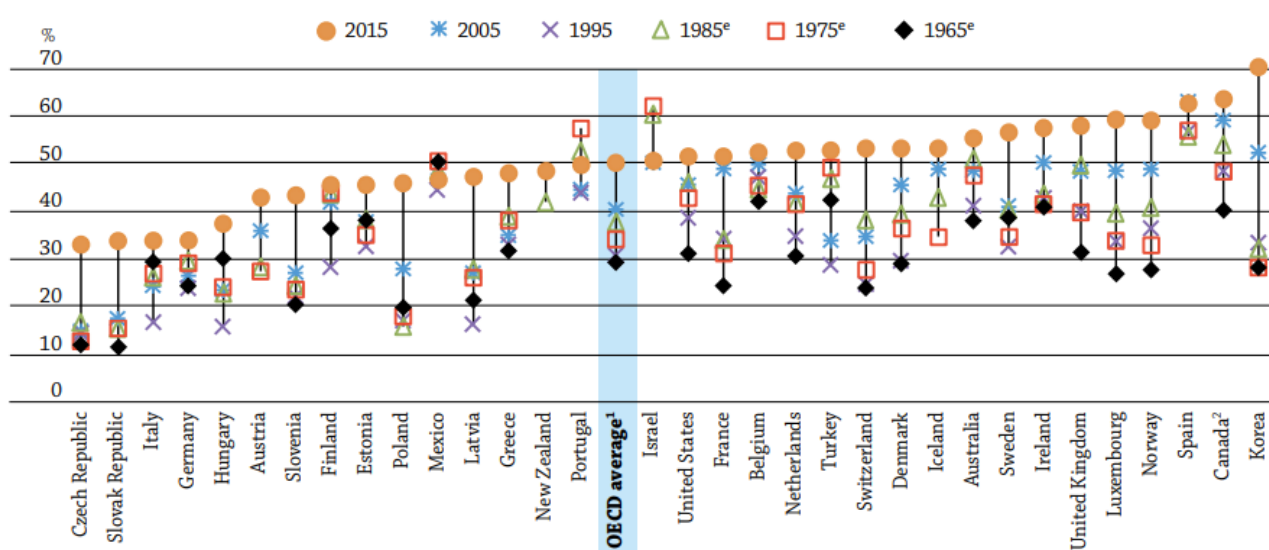
In order to respond to the growing demand for education, countries have equipped themselves to expand the supply of higher education for the majority of the population.

Thus, from 1965, when the share of population that had achieved at least upper secondary education was 43%, to 2015, fifty years later, it almost doubled to 84%.

The expansion of upper secondary education has generated a consequent expansion of tertiary education. If in 2015 half of those completing upper secondary education achieved a tertiary education qualification, in 1965 only 30% did so. Italy does not represent a virtuous example maintaining a level close to 30%.

Following this trend, nowadays in a large part of OECD countries the share of young adults with tertiary education exceeds that with upper secondary education.

Fig. 2.1 Percentage of 25-34 year-old adults with tertiary education among those with upper secondary education or higher (1965-2015)



Source: OECD (2017)

Figure 2.1, describing the percentage of young adults with tertiary education among that with upper secondary education, helps us to note that countries have followed very different paths of educational policies to respond to the growing demand. Some have decided to expand initially only the opportunity to access to upper secondary education and then to tertiary education, while others have simultaneously expanded both. Some have experienced constant expansion, while others have slowed and accelerated in different decades.

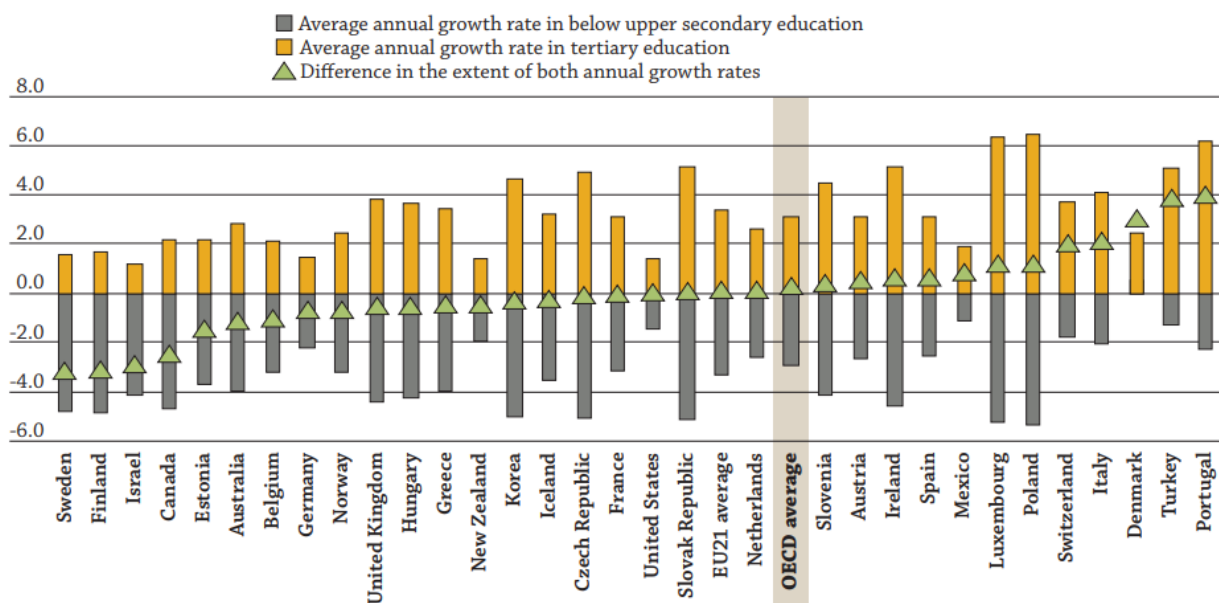
It is true, however, that not all have benefited from the spread of education in the same way, particularly in recent decades. Moreover, if the growth of the last fifty years is remarkable, the new millennium has brought a society in which upper secondary education has become not a privilege, but almost a basic condition to participate in economic and social life (some reports named it

knowledge economy). This is reflected by the data about Human Capital Index¹ presented by the World Bank, which show that human capital stock is still growing in almost all the countries in the last decade.

Therefore, we cannot limit to looking at the trend of the highest steps of the educational ladder, such as the growth of 3.1% of those with tertiary education between 2000 and 2013, but also look at the lowest levels. It is possible to note that during the same period there was a 2.9% decrease in those without upper secondary education. Despite this, five OECD countries, including Italy, maintain a share of individuals without upper secondary education close to 40%.

Furthermore, looking at the average growth rates, it can be seen that some countries are simultaneously expanding access and completion of upper secondary and tertiary education, while others seem to be favoring tertiary education at the expense of upper secondary education.

Fig. 2.2 Average annual growth rates in below upper secondary and tertiary education (2013)



Source: OECD (2014)

Looking at the Figure 2.2, in the left side are represented countries such as Sweden, Finland, Canada, which have experienced growth rates of tertiary educated people lower than those of the decrease in below upper secondary educated people. While on the right side of the figure there are countries such as Portugal, Turkey and Italy that see tertiary educated growing faster than the fall in low educated.

¹ Human Capital Index is built by the World Bank to describe the state of human capital. Education is one of the most important determinants of the index.

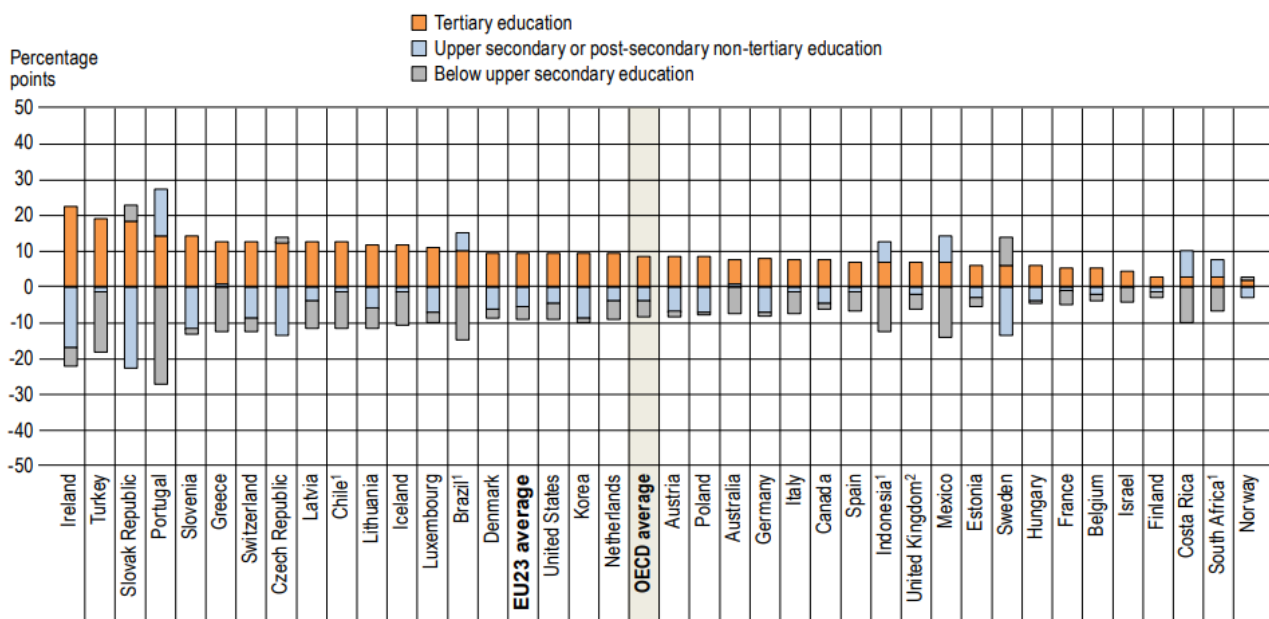
2.2 Participation in education

To design education policies it is first of all necessary to understand who are the individuals participating (or not participating) in educational programs.

It is also useful to try to identify the trends in recent years with respect to the demand and supply of education and to grasp its meaning and motivation.

Focusing on tertiary education, it is immediately apparent that in the last decade there has been a significant increase in all OECD countries in the proportion of young adults reaching tertiary education. Figure 2.3 helps us to verify that trend from 2009 and to identify the countries like Ireland or Turkey which experienced the larger growth and the countries like Norway or South Africa which experienced the lower growth. This trend will drive us also to analyze the return on education in terms of income and social indicators.

Fig. 2.3 Changes in educational attainment of 25-34 year-olds between 2009 and 2019



Source: OECD (2020)

Looking not at the variation over time, but at the most recent static data reported in Figure 2.4, it should be considered that the share of young adults with a tertiary degree varies widely between OECD countries, from 24% in Mexico to 70% in Ireland.

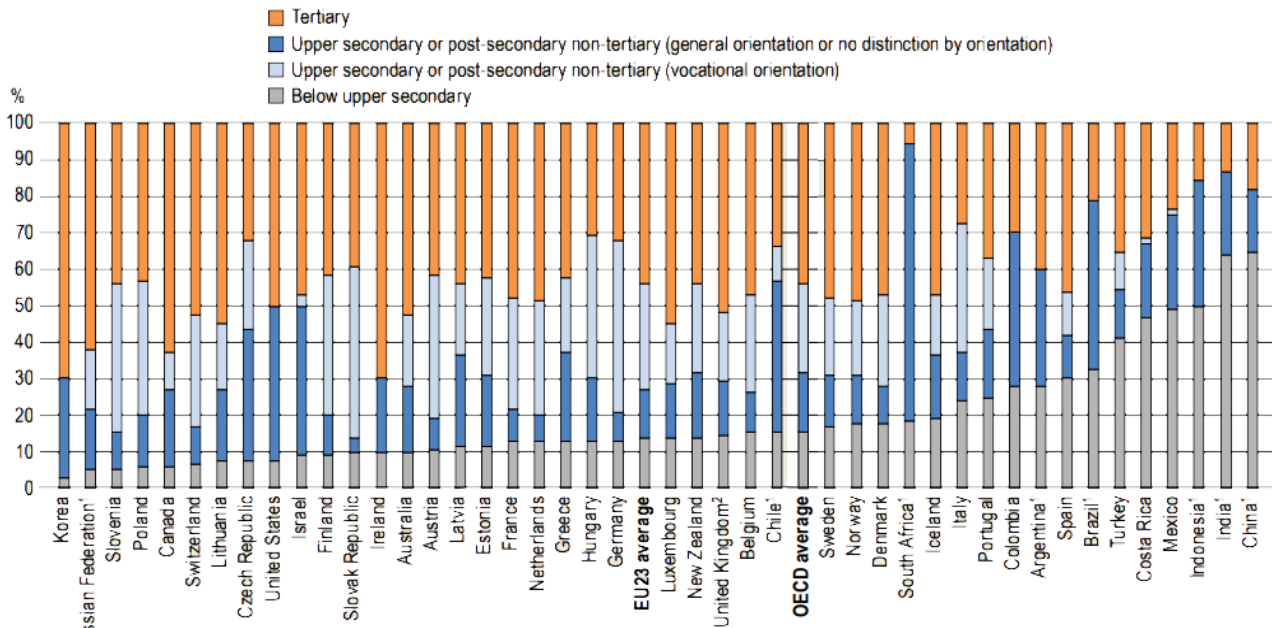
These data reflects dynamics typical of our century. Globalization and technological progress determine a substantial change in the labor market, in which the condition of low-skilled workers worsen creating a strong incentive to undertake higher education. Inequality remains as a chronic

disease and it is mirrored also in educational attainments.

This is also evident from the PISA (Program for International Student Assessment)² tests, which show that 70% of young people when they are fifteen are willing to complete tertiary education.

These expectations, however, are not in all cases met as can be deduced from the gap with the real share of individuals who reach that level of education.

Fig. 2.4 Educational attainment of 25-34 year-olds (2019)



Source: OECD (2020)

2.3 Education opportunities

The spread of tertiary education has therefore been remarkable but inevitably not accessible to all.

However, this would be interesting because education plays an important role in terms of social mobility, acting on the earnings and general well-being of the person.

But have the opportunities for access to education been the same for all?

In reality, access and completion of education are probably part of the mechanism of transmission of inequalities.

² The PISA-based Test for Schools provides school-level estimates of performance and information about the learning environment and students' attitudes gathered from student questionnaires.

The social background of the family is in fact one of the determinants of educational attainments.

Data from 2015 report that more than half of young adults with high education have at least one parent with the same qualification. Almost one third of young adults has at least one parent with a secondary school qualification. Only one in ten comes from a family with parents with lower educational levels.

In order to evaluate the different opportunities for access to higher education a necessary measure is the odds ratio. It compares the relative probability of individuals to have a higher education degree if their parents have a tertiary or upper secondary education degree with individuals whose parents have below secondary education attainment.

The data show that the odds ratio is on average twice as great if a parent has an upper secondary education and 4.5 times greater if he or she has a tertiary education degree.

Again, the magnitude of this effect varies among countries as Figure 2.5 shows. For example, in Italy those with high educated parents are almost 10 times more likely to achieve higher education than those who have low educated parents. Instead, in Korea the probability is distributed almost independently of parental education.

It may be thought that the inequalities regarding higher education are the result of the accumulation of inequalities in the previous levels.

During secondary school, PISA tests show that students from disadvantaged socio-economic situations have lower performances. This reduces both motivation and likelihood to access to higher education.

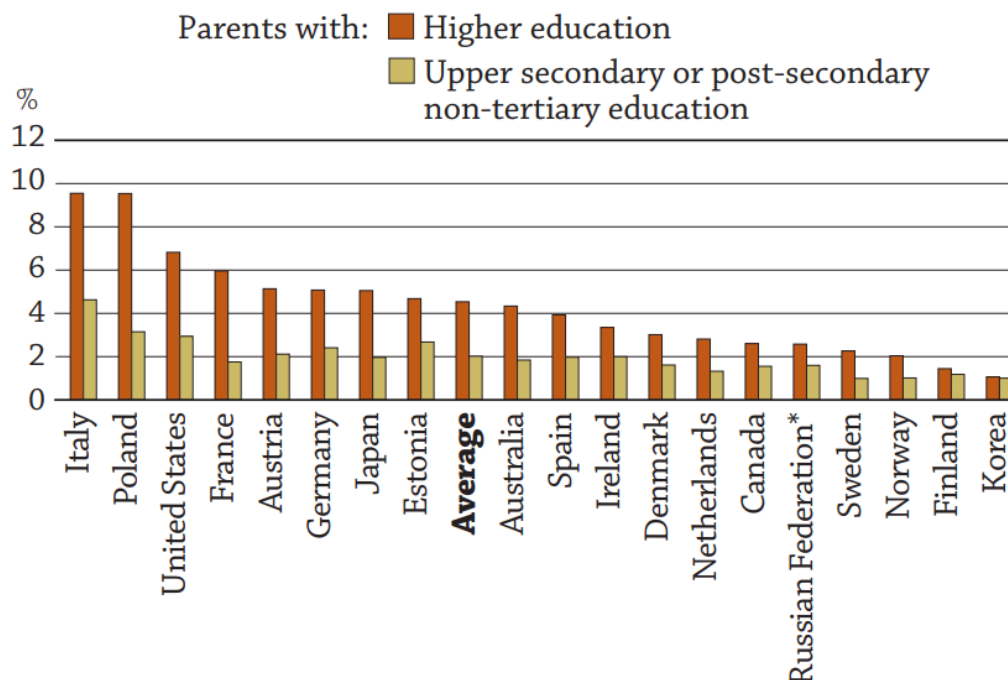
Furthermore, disadvantaged students are more likely to drop out before completing secondary school, thus making impossible to access to tertiary education.

Finally, students from disadvantaged backgrounds have lower expectations at the age of 15. In fact, students from the bottom third of the *PISA economic, social and cultural status*³ are 37% less likely to aspire to complete a tertiary degree with respect to those in the top third. This relation remain significant even controlling for performances in cognitive tests.

³ The Programme for International Student Assessment (PISA) index of economic, social and cultural status was created on the basis of the following variables: the International Socio-Economic Index of Occupational Status (ISEI); the highest level of education of the student's parents, converted into years of schooling; the PISA index of family wealth; the PISA index of home educational resources; and the PISA index of possessions related to "classical" culture in the family home.

Fig. 2.5. Likelihood of being a tertiary-educated young adult, by parents' educational attainment

20-34 year-olds; odds ratio compared with that of people whose parents have below upper secondary education



Source: Survey of Adult Skills (PIAAC) (2012)

2.4 Economic return on education

The choice regarding the investment in education is influenced by its relationship with the labor market. A longer and more prestigious path of education acts on the entry into the labor market. The conditions of the labor market are therefore an important determinant of individuals' choices in education: in periods of unfavorable conditions, in fact, young people tend to stay longer in education, as the opportunity cost of education decreases and the investment in human capital can be crucial to find a job.

In addition, a higher level of education is usually related to higher employability and consequently a lower probability of being unemployed or inactive. This is reflected in the number of NEETs (neither employed nor in education or training) which decreases as the level of education achieved increases. In fact, if the latest data report a generalized decrease of NEETs in the last two decades (with few exceptions including Italy), they show also that among the holders of a tertiary education

qualification the share of NEETs is 6% lower with respect to those with a upper secondary education qualification and 29% lower with respect to those with a lower qualification.

Consequently, it can be observed that high levels of education increase the probability of being employed. On average in OECD countries for individuals between 24 and 35 years old the employment rate is 85% for those with tertiary education, 78% for those with a upper secondary education and 61% for those with lower qualifications. Higher education programs such as masters and doctorates are associated with an employment rate higher than 90%.

This mirrors the transformation of the economies of the OECD countries, characterized by an increased demand for high-skilled workers. The low-skilled workers retain opportunities to be employed, but under more unfavorable conditions and in routine jobs associated with a high risk of automation.

This is reflected in higher unemployment associated with lower educational levels. For young adults, the unemployment rate goes from 5% for those with tertiary education, 7% for those with upper secondary education, to 13% for those with lower qualifications. The same inverse relationship applies between educational attainment and inactivity.

In addition to the degree of employability, education also has strong effects on the job position and the remuneration of work. The return on education properly takes the character of a higher salary recognized to workers with higher educational attainments.

On average, in OECD countries this premium is 23% for those who have a upper secondary qualification compared to those who do not and 54% for those who have a tertiary qualification compared to those who do not.

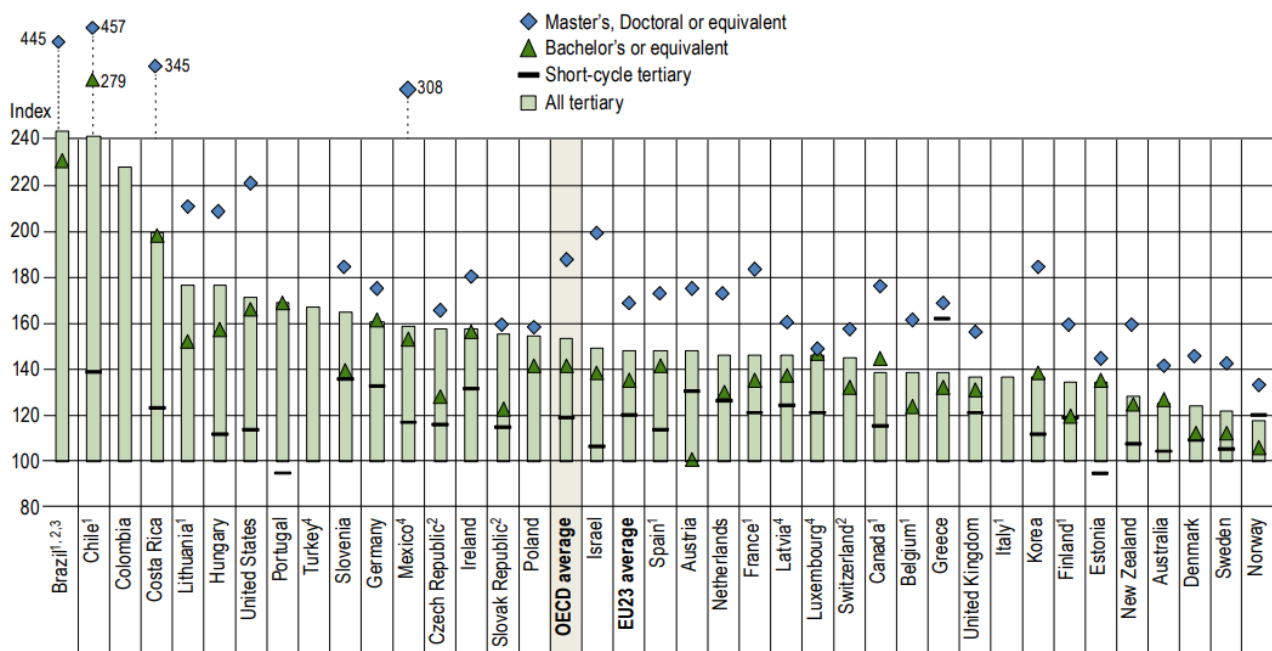
Figure 2.6 shows the premium for tertiary-educated adults in OECD countries with respect to adults with upper secondary education. It clarifies that the difference in earnings for different types of tertiary degrees is also considerable: short-cycle tertiary degrees involve a lower premium than master programs or doctorates.

In countries such as Brazil, Chile and Costa Rica, where the share of individuals with tertiary education is among the lowest in OECD countries, the advantage of higher education is even greater and around 100% compared to those with upper secondary education. The limited supply of high educated people makes its price higher. In reverse, in countries like Denmark, Sweden and Norway where tertiary education is accessible and widespread among people, the premium is lower.

The premium varies according to age, gender, field of study, and quality of the course. In addition, the benefit of studying is usually increasing in working life: on average, those with a tertiary degree between 45 and 54 years old earn 50% more than their peers between 25 and 34, while those with an upper secondary degree 20% more and those with lower degrees 10% more. It is true that the higher wages with increasing age may also reflect the effect of a decline in wages for the younger generation, or a combination of the experience effect and the decline in wages effect. Although the available data show that the latter is very slight, especially for those with tertiary qualifications.

Fig. 2.6 Relative earnings of tertiary-educated adults compared to earnings of adults with an upper secondary education (2018)

25-64 year-old workers (full-time full-year workers); upper secondary education = 100



Source: OECD/UIS/Eurostat (2020)

As is well known, investing in education not only brings benefits, but also costs. It is therefore necessary to evaluate the relationship between investment and benefit for the individual and society.

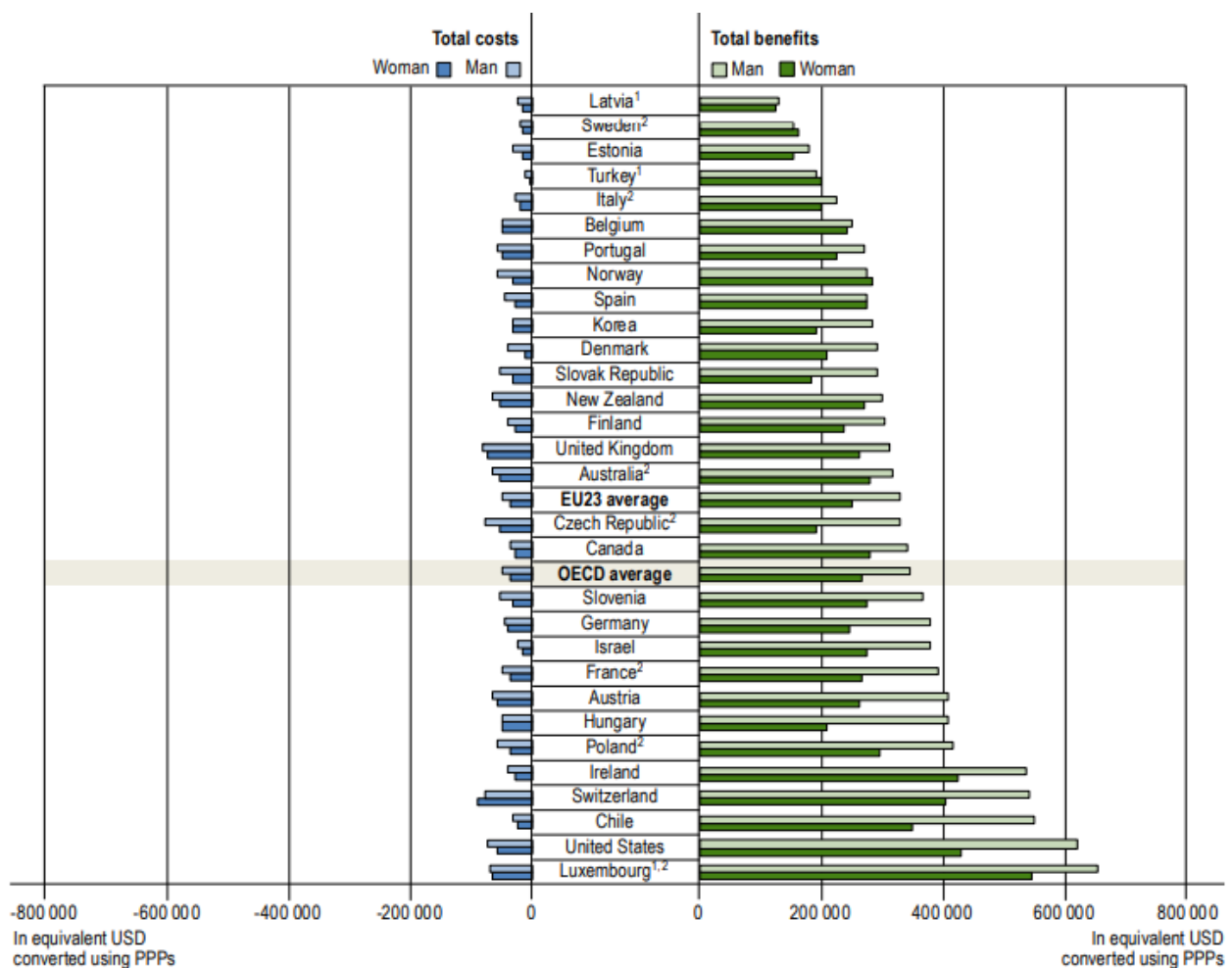
For the individual, the benefit is measurable as the greater probability of finding a job and the higher salary perceived; for society as higher income from taxes and social security contributions (without considering social externalities). On the other hand, costs include both direct investment by individuals and the government, but also indirect costs such as the cost of living during studies and, above all, postponing earnings and tax revenues.

Focusing on tertiary education and its positive effects during working life, on average in OECD countries the net private financial return⁴ is 1.5 times greater than the effect of upper secondary education, estimated at an average of USD 186 100 for men and USD 150 400 for women, as Figure 2.7 shows.

It can be noted immediately that the return for women is lower than for men, although women are more likely to complete tertiary education than men.

Fig. 2.7 Private costs and benefits for a man or a woman attaining tertiary education (2017)

As compared with returns to upper secondary education, in equivalent USD converted using PPPs for GDP; future costs and benefits are discounted at a rate of 2%



Source: OECD (2020)

⁴ Net financial returns are the net present value of the financial investment in education, the difference between the discounted financial benefits and the discounted financial cost of education, representing the additional value that education produces over and above the 2% real interest that is charged on these cash flows.

Calculating the internal private rate of return⁵ for tertiary education the result is 16% for men and 19% for women⁶. This result shows that the internal rate of return for tertiary education is lower than that for upper secondary education (25% for men and 32% for women) and this is due to the high costs required to achieve a tertiary qualification.

The benefits also affect the public sector which decide to invest in education. Considering the benefit net of investment costs, it is estimated that the average net public benefit in OECD countries is USD 137 700 for men and USD 67 900 for women, with an internal rate of return of 6% for men and 8% for women.

This relatively lower return for the public sector than the private sector reflects the fact that the total costs of education are generally higher for the government than for individuals, while individuals get the majority of the economic benefits.

However, it remains a positive return for both individuals and the government, which encourages to invest in education and human capital and call to make an effort to eliminate the gender differences that disadvantages women and causes a loss to the public sector.

2.5 Social return on education

As anticipated, education is positively associated not only with economic indicators such as income, but also with social indicators.

First of all, there exist a relationship between high levels of education and skills, and health. The PIAAC (Program for the International Assessment of Adult Competencies) reports analysis regarding educational qualifications and skills, considered as different indicators even if related, and self-reported health by individuals.

From these data, exhibited in Figure 2.8, we can see the positive relationship between these variables that can be explained in different ways. First of all, social and emotional skills that are acquired during formal training courses can affect the psycho-physical state even more than

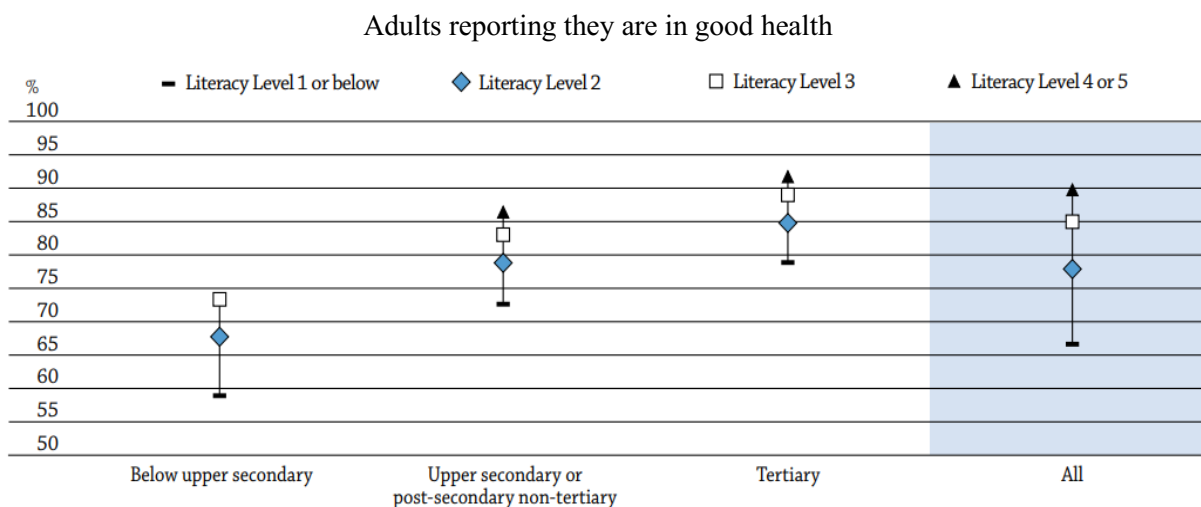
⁵ The internal rate of return is the (hypothetical) real interest rate equalizing the costs and benefits related to the educational investment. It can be interpreted as the interest rate an individual can expect to receive every year during a working-age life on the investment made on a higher level of education.

⁶ The internal rate of return is influenced by the difference in private benefit but also in foregone earnings between man and women

cognitive skills. More knowledge and cognitive skills can instead generating a greater predisposition to prevention.

Other OECD data on fifteen countries show how life expectancy changes as the level of education achieved varies: a man with tertiary education has a longer life expectancy than one who has not completed upper secondary education. This relation exists but it is less pronounced for women. In addition, the difference varies depending on the country taken into analysis: in the Czech Republic the difference is seventeen years, while in Portugal only three years.

Fig. 2.8 Self-reported health, by educational attainment and literacy proficiency (2012 or 2015)



Source: OECD Survey of Adult Skills (PIAAC)(2012,2015)

It can also be thought that these effects are influenced by a selection bias because serious health problems can affect the choice to continue or not to invest in education.

OECD reports add to the effects on self-reported health and life expectancy, the effects on life satisfaction.

Data collected by the Gallup World Pool show that adults with tertiary education qualifications are those who are most satisfied with their lives (Figure 2.9).

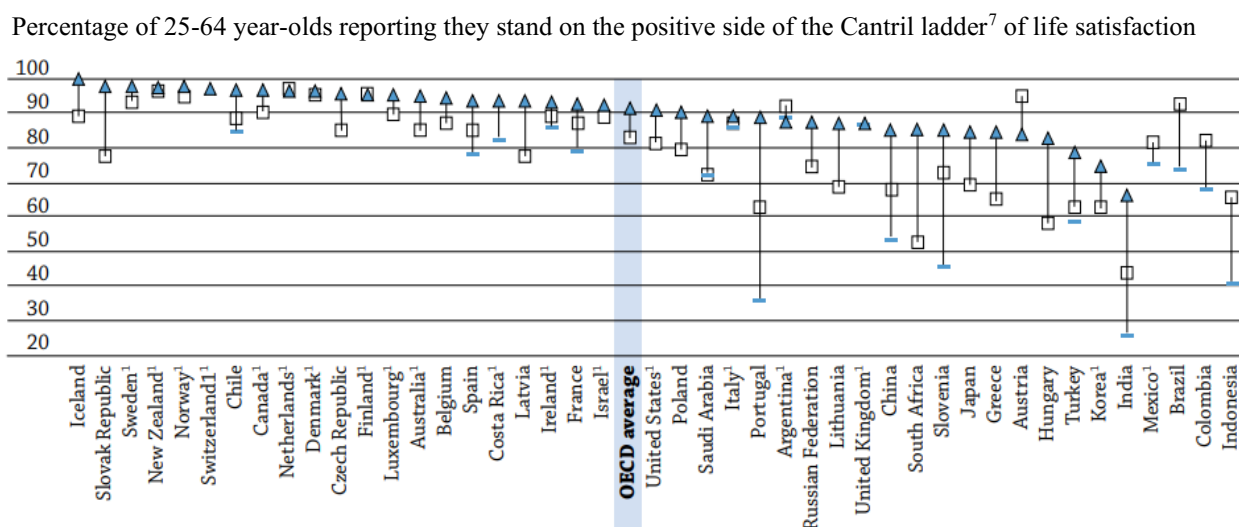
In this case it is possible to explain this relationship both by means of the economic dynamics analyzed previously (effects of education on employability or income) and again by means of those socio-emotional skills that affect people's life prospects and ability to be included in the social networks.

It is necessary to specify that in some of the countries analyzed the level of education does not statistically significantly affect the self-reported satisfaction indicated by individuals, especially in those countries with a high level of general satisfaction (such as Denmark and Norway, but also in

Italy the difference is not significant). This may suggest that these countries reach a level of inclusiveness due to their economic and social structure that allows individuals to participate in economic and social life regardless of their educational level.

In other countries, such as India or Turkey, despite the wide difference between satisfaction reported by high educated and non-educated people, a tertiary degree does not guarantee a percentage of satisfied person above 80%.

Fig. 2.9 Life satisfaction, by educational attainment (2015)



Source: OECD European Union Statistics on Income and Living Conditions (EU-SILC) and other national surveys

In addition, there is evidence of a link between education and participation in civic life. The data collected by the OECD show that high educated individuals are more likely to engage in public life, in terms of voting, volunteering, political interest and interpersonal trust.

For example, in terms of voting, in twenty-five OECD countries the difference in the self-declared voting rate is 15% between adults with high and low education.

It may be argued that education acts on these variables through its effect on income, but generally the effect remains significant after controlling for income.

⁷ The Cantril ladder as adopted in the Gallup World Poll:

Please imagine a ladder with steps numbered from zero at the bottom to ten at the top. Suppose we say that the top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you.

If the top step is 10 and the bottom step is 0, on which step of the ladder do you feel you personally stand at the present time?

Therefore it can be stated that income is one of the channels through which education brings benefits, but not the only one. In fact, education can help individuals to acquire cognitive and non-cognitive skills, to improve their social status and to have access to social networks that can affect their lives.

And this should be considered both at the individual level, in terms of choice of investment in human capital, and at the social level, in terms of choice of public investment and educational policies that guarantee access to education.

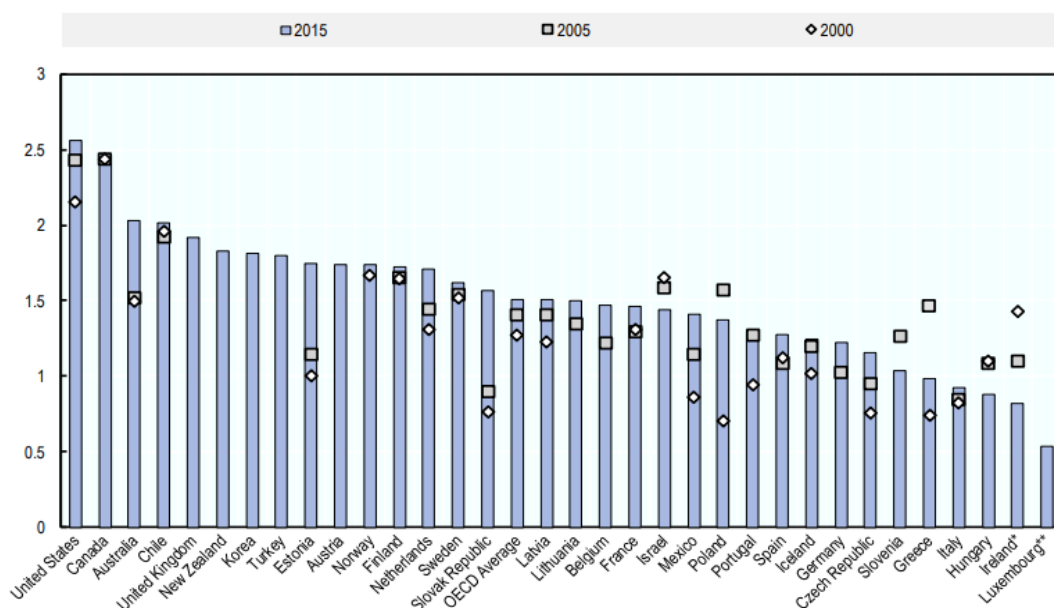
2.6 Education expenditure

In 2017 the OECD countries' average spending on education was 4.9% of GDP and represented 11% of total public spending.

As shown in Figure 2.10 there are large differences between OECD countries and in the last decades countries follow different paths.

It is clear, looking at Figure 2.11 and 2.12, that the majority of expenditure is directed to primary, upper secondary and post-upper secondary education (on average 3.5% of GDP), while a smaller portion to tertiary education (on average 1.4% of GDP).

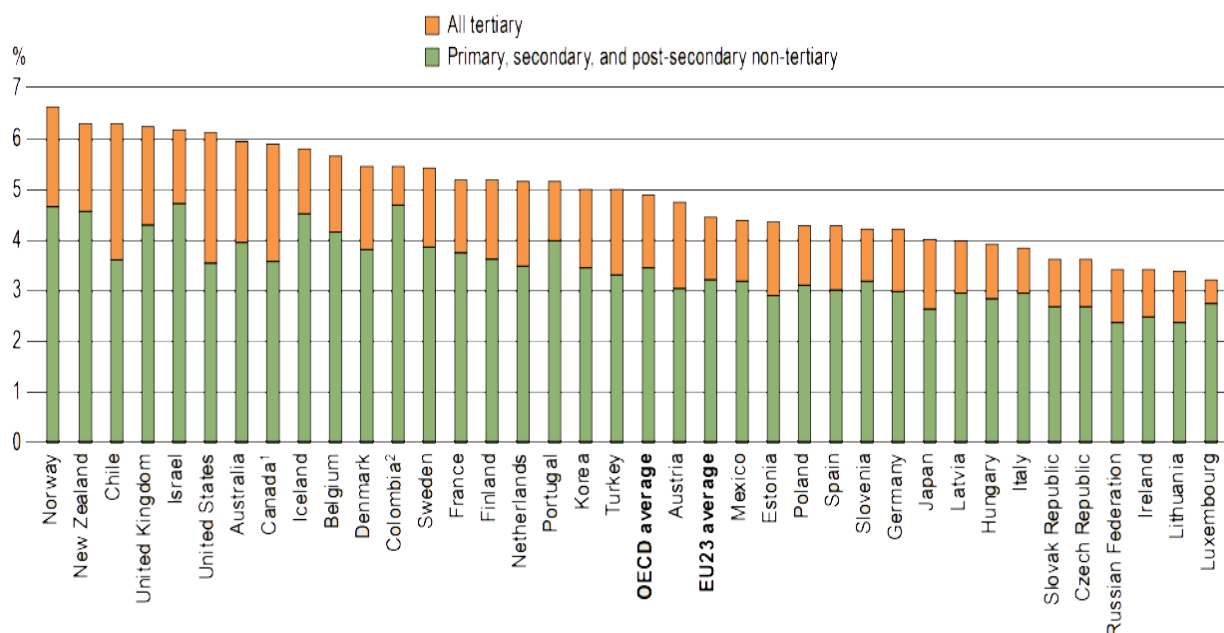
Fig. 2.10 Total expenditure on higher education as percentage of GDP



Source: OECD 2020

The lower public spending on tertiary education entails a greater private contribution: while private investment accounts for one-tenth of expenditure on non-tertiary education, it represents one third of expenditure on tertiary education.

Fig. 2.11 Total expenditure on educational institutions as a percentage of GDP (2017)



Source: OECD/UIS/Eurostat (2020)

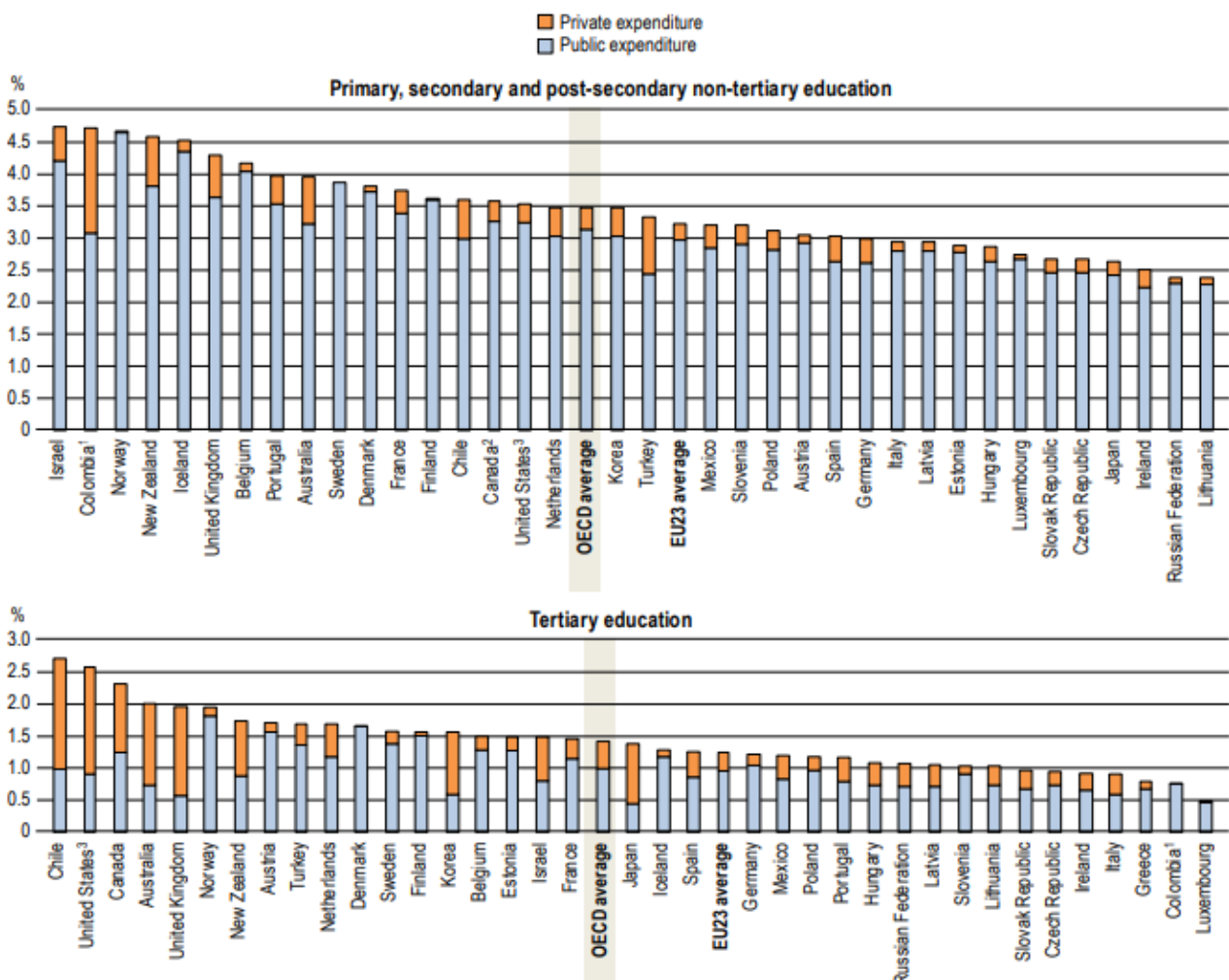
Obviously the level of expenditure is strongly influenced by demographic and employment variables: the number of schooling-age individuals, the enrolment rate, the salaries of teachers and workers in the sector. We must consider, for example, the fact that in most OECD countries the enrolment rate in primary and early upper secondary school is close to 100%. The same cannot be said for the enrolment rate for higher educational levels, so the OECD average is around 40%, with large differences between countries.

Analyzing the last few years of the OECD reports, it can be seen that in the last five years considered (from 2012 to 2017) the level of spending on education in relation to GDP has decreased in about two thirds of OECD countries. That is the effect of the lower growth of expenditure compared to GDP. This reduction has particularly affected expenditure on tertiary education. Total expenditure on education has therefore generally increased, but at a lower rate than GDP, and this remains true even considering private investment.

It is necessary to be aware of the fact that in recent decades the demand for education has grown considerably, due to the social and economic changes taking place. This has created a difficulty for governments to devote more resources to funding education spending programs for an increasing

number of people. The pressure on public funds has therefore caused an increase in the number of cases in which a contribution is requested from those who use educational services.

Fig. 2.12 Total expenditure on educational institutions as a percentage of GDP, by source of funds (2017)



Source: OECD/UIS/Eurostat (2020)

This is particularly the case for tertiary education, for which private funding is requested, generally delegated to the families of students (on average, 74% of the private contribution to tertiary education comes from families in OECD countries). This is also justified by the significant private return linked to tertiary education. There is, however, a heated debate on access to tertiary education with some countries that use instruments such as university loans, others that leverage corporate investments and, finally, those that also intervene in higher levels of education with public funds.

Tuition fees therefore serve to bridge the gap between spending per student and the public and private funds available; it is therefore necessary to consider the various factors that affect spending per student: not only the salaries of teachers and researchers, but also the development of digital teaching and the services of university offices, investment costs for internationalization or the cost in general of university research activities.

However, it is always possible for the government or local authorities to intervene to mitigate the disincentive effect of the cost of tertiary education or to ensure equal opportunities.

Financial support to students can be provided in various ways: through means-based subsidies, family allowances for the student, tax allowances for the students or their parents or other household transfers.

Hence the importance of theoretical study of the effects of the different measures that can be taken emerges. This field of study allows to understand both how the different measures affect individual incentives and how they affect the distribution of opportunities, because they can affect individuals with different incomes in different ways.

Tuition fees are therefore the primary source of cost for enrolled students and vary widely across countries. The OECD identifies three bands of countries: those where no tuition fees are charged to students (e.g. Denmark, Finland, Sweden, Greece), those where fees are moderate (e.g. Italy, Austria, Portugal, Spain) and those where fees are high (e.g. United States, England, Canada)⁸.

It is also true that some OECD countries in the last decade have implemented reforms to broaden the right to study, in particular by addressing support policies to students from a disadvantaged background. In some countries such as Chile, Denmark and Italy in the last decade the percentage of students receiving public financial support has increased significantly (in Italy from 17% to 39%).

The methods of intervention have been different between countries: higher grants, lower tuition fees, more accessible university-loan schemes.

The choice of the combination of these policies is one of the most heated sources of debate. In particular, the dialectic between loans and grants.

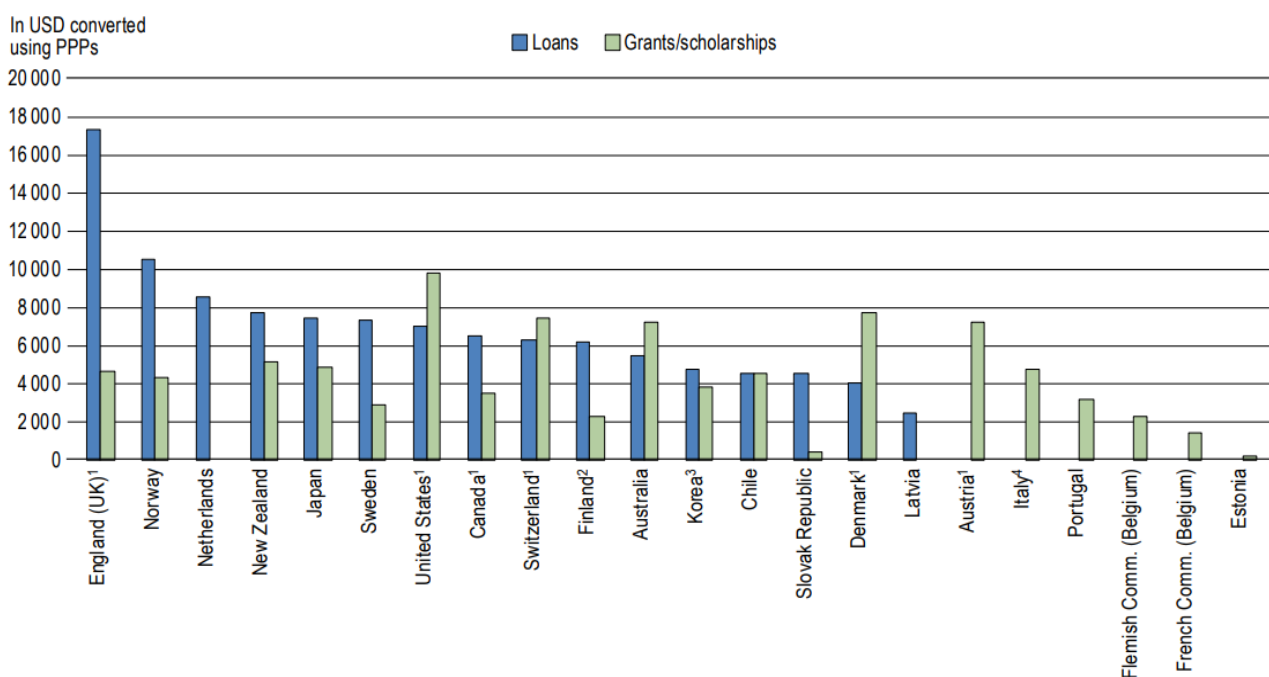
Supporters of the use of loans argue that the use of this instrument allows for a wider audience. The idea is therefore that if the same funds used for scholarships were allocated to loans, these would

⁸ Moderate tuition fees are considered on average below 2 000 USD per year.

reach a larger number of students and thus increase access to tertiary education. Moreover, the use of loans makes it possible to charge part of the cost of higher education to those who actually benefit from it, i.e. individual students, thanks to the return on education.

Those who defend scholarships argue that loans are often an insufficient tool to encourage low-income individuals to enter higher education programs. Moreover, high levels of student debt are dangerous both for students themselves and for governments in the event of solvency problems.

Fig. 2.13 Average annual amounts of public grants/scholarships and loans received by national tertiary students (2017)



Source: OECD 2020

In most OECD countries, the debate is resolved with a coexistence of different instruments that support students both in terms of the cost of tuition fees and the cost of living and materials needed during their studies. There exist, as figure 13 shows, some countries which do not provide loans.

The most frequent selection criterion for both loans and scholarships is the socio-economic condition of the student. In the case of loans, it is usually required to report academic performance, while in the case of scholarships in some cases merit is also taken into account as one of the selection criteria.

Finally, governments may also decide to add to direct financial support some indirect subsidies. These are shaped as full or partial waiving of the tuition fees or as a coverage for additional charges applied to students.

2.7 Education public policies

Analyzing the institutional aspects of public intervention regarding higher education makes it necessary to evaluate educational policies according to efficiency, quality and equity.

Efficiency measures the outputs of the educational system for a given level of resources. It can be difficult to measure efficiency, since there are many different outputs of the educational system. It is possible to use monetary measures, such as the cost per qualification awarded or peer-reviewed publication, or non-monetary measures, such as the enrolment or completion rate.

Quality measures the value of output achieved. This is assessed through evaluation processes that examine for example, the teaching method or the quality of academic publications.

Equity measures the distribution of opportunities for access to higher education and its benefits.

Policy-makers, educational institution workers and students are the main actors involved in the functioning of higher education. They face an environment in which regulatory and economic forces act; these include public policies that govern the functioning of the education system, determine the resources available, the allocation of resources and the public and private funds to be drawn from; then there are actions of non-governmental stakeholder organizations that can affect the organization of education, for example employers' associations and industry that can influence educational programs or trade unions or student organizations; finally there are market forces that influence choices in educational policies, like the degree of competition between educational institutions and staff members.

There are also demographic and structural characteristics that must be taken into account: the nature of the domestic economy, the age composition of the population, the development paths of the global economy, the change in the demand for education, the availability of resources.

Therefore, once this structure is considered, the government can put in place policies with different effects and aims.

Policies that establish which institution and where can provide higher education services. These have an effect on the number of providers in the system and on the level of competition, shaping the higher education market.

Policies that determine how financial resources are collected to maintain the different activities of educational institutions and the resources directed to students. These are strongly influenced by the availability of resources and the historical pattern of funding.

Policies which govern the allocation and use of public and private revenues. They determine the resources allocated to staff or material, research activities, investments, etc..

Policies that determine the design of financial support or benefits to students or their families to support their studies.

It can be said then that in OECD countries governments play a crucial role in the functioning of the higher education system. They design, implement and evaluate specific programs and policies, collaborating with higher education stakeholders.

In order to intervene, however, governments must first of all consider resources at their disposal or identify other sources to collect money to invest in education.

Resources can be public funds allocated to higher education by the government directed to higher education institutions or transfers to individuals who participate in the education system; or private funds from households, such as tuition fees or other taxes or payments for educational and material services or private funds from other entities such as businesses or non-profit organizations that participate in the education system; and finally, resources from international sources such as the World Bank, the United Nations or other non-governmental organizations.

2.7.1 Costs and supports for students

We focus on the costs and the support for students because they are fundamental in the individual investment decision.

Tuition fees, added to the cost of living during studies, materials needed and deferred income, form the cost of higher education.

Tuition fees are certainly the main means by which institutions and governments collect contributions from families for higher education.

Moreover, in systems where these fees exist, they are also the main cost item for students.

Tuition fees can be considered as the price of education. If the price is too high, there may be a difficulty of access. The price can be high compared to the estimated future return or with respect

to the available liquidity of the student or his/her family. Furthermore, in their choices students tend to overestimate present costs and underestimate future earnings (Cohodes and Goodman 2014).

This is why most OECD countries are committed to providing financial support to students to mitigate the price effect and liquidity constraints.

The pattern of financial support and private contributions varies from country to country. There exist different levels of tuition fees and different packages of grants or student loans.

In some countries, higher education is largely funded by contributions from households and governments use public-loan schemes to solve liquidity problems (e.g. the UK and Australia) covering the most of the required contributions.

Other countries with high education costs offer grants and loans, but which only partially cover the expenditure required from the family (e.g. USA, Japan or Chile).

The challenge for public policy design is to ensure both that educational institutions have sufficient income to provide a widespread quality service and that the costs charged to students do not cause a barrier to entry.

First of all, the literature reports that if tuition fees are decided independently by each educational institution, efficiency gains can be achieved through price signals and incentive schemes (Andrews and Stage 2016). Differentiated tuition fees can help students and institutions to make more efficient choices and push the system to be more responsive to the preferences and needs of students and employers.

Generally, while private institutions set their own prices, public institutions are subject to different rules in different countries. In some countries, the government sets a ceiling under which institutions can move their fees (e.g. Italy); in other countries, the government sets a number of public-funded study places and allows institutions to create other fee-funded study places choosing the amount of fees; in countries such as France and Spain, government sets fees without discretion for institutions; and finally, it is possible that government does not regulate the level of fees, but the maximum level of their increase.

The variation in prices has an effect on the enrolment rate in higher education institutions.

Empirical literature suggests that there is a negative relationship between the net price and the enrolment rate (OECD 2008).

This relationship is more striking in families with low socioeconomic status or for students with low performance.

2.7.2 Financial support tools

There are several tools to provide financial support to students and ensure opportunities for access to higher education.

First of all, non-repayable tools such as grants. They can be managed by government authorities, intermediary agencies, educational institutions or jointly by educational institutions and government authorities.

Decisions regarding the allocation of grants often involve educational institutions as they may have more flexibility in designing tailored support schemes for students, but require an assessment regarding horizontal equity between families generally at a national level. Government coordination is necessary because the process of designing support schemes can be probative for individual institutions and especially with regard to monitoring family data and controlling the accuracy of the information provided.

Grants exist in most OECD countries as an alternative or complement to tuition waivers or publicly subsidized or guaranteed loan schemes. Support schemes are generally means-tested but some countries offer universal grants. Merit-based grants are also employed.

Universal grants, not based on economic indicators or merit criteria, exist in Korea, the Netherlands and the Nordic countries. This form of support promotes access to education for socio-economically disadvantaged background students, it makes easier for students to choose to enroll in higher education and guarantee them investment opportunities in education.

If these grants are awarded for the cost of living, in countries without tuition fees, price and liquidity constraints tend to disappear. This may encourage participation in higher education, but some empirical studies show that the effect on completion of studies is modest or ambiguous (Arendt 2012). In addition, an objection often made to universalist measures for higher education is that they are inefficient and regressive because they fund services for individuals without considering the means available and, if they are not completed, represent a loss of resources. Regressive effect may be mitigated in society in which participation in higher education is wide and consequently the wage premium are moderate and tax system is progressive.

To avoid problem of regressivity and loss of resources, means-tested grants are the most common among the instruments of financial support for students, since they give the possibility to allocate resources according to the needs of families. In particular, family income is used as an eligibility

criterion. To this can be added criteria regarding residence, age, level of studies, merit, etc. In many cases a minimum academic performance is set to maintain the right to receive the grant.

This instrument acts on the liquidity constraints of low-income households and thus ensures greater equity in access opportunities. It therefore has a positive effect on the probability of enrolment in higher education programs, moreover because it does not create debt problems that can be decisive in case of uncertainty regarding the return on education.

To set the level of subsidies it is necessary to evaluate the student's reaction to the costs of high education; the most efficient amount is the one that compensates the cost of high education for the marginal student, thus leading him/her to enroll.

In addition, grants must consider not only tuition fees, but also the cost of living during the studies in order to affect correctly human capital investment decisions. In particular because often university choices also include geographical shifts, so if maintenance costs are not taken into account, low-income students would be forced to exclude the possibility of moving to study.

However, it should be considered that grants can also act as an incentive for students who would face significant costs to enroll and complete their studies. So grants' level can be affected also by social or political purposes, fiscal constraints and students behavior.

In addition, non-repayable grants should be limited in duration so as not to create an incentive to extend studies beyond the time required.

There are grants and taxation schemes in place in some countries that provide incentives to complete studies and to do so in the correct time. In Italy, for example, grants decay and additional fees are charged to those who do not complete their studies in time.

Well-designed duration schemes provide the right incentives for students and reduce costs for institutions and government for financial support.

The tax system can also provide a possible non-repayable tool for financial support. In fact, tax credits and tax benefits are used in some countries. Therefore they permit the deductibility of education expenses, but suffer for two problems. First, they are not efficient in reaching those low-income families that are tax-exempt. Second, they provide financial support ex-post, thus not solving the liquidity problems that may exist ex-ante.

On the other hand, the system of financial support to students can be built with repayable tools. This type of tools aims to act on the liquidity problems of families and the credit constraints of students.

It is therefore a type of loan issued by private banks and guaranteed by the government or provided directly by the government to transfer future earnings of students in the present so as to pay for education expenses.

Early repayment usually begins when the student finishes his or her studies and begins to work and earn money.

Student loans are particularly important because they relieve pressure on public funds and charge the cost of education to those who benefit from them. In addition, like grants, they can be used to encourage a particular course of study through specific interest rates or conditions for borrowers. In Norway, part of the loan is converted into a grant in the event of successful completion of studies.

The government guarantee is crucial because it serves as insurance for the borrower in case of low income after the studies or inability to repay the loan.

In some countries, such as Australia, Norway and the United Kingdom, these loans are provided directly through a public fund, while in others, such as Finland, Poland and Portugal, through commercial banks. In Chile both channels are used. While in many European countries, including Italy, student loans are rarely used.

Each country regulates the loan scheme according to peculiarities that may concern interest subsidies, eligibility criteria, duration of the loan, the existence of a grace period after completion of studies and general conditions of the loan.

But the fundamental characteristic of university loans is the repayment structure because it is decisive for the choice of investment of the student.

Usually loans that are granted through commercial banks are set as mortgages. They require a nominal repayment of a certain amount each month for a predetermined number of years. This implies that an increase in the interest rate acts on the monthly payment and that the duration of the repayment is fixed regardless of the individual's income.

This scheme, typical in the United States and Japan in the past, can cause problems in the case of low incomes or periods of unemployment or inactivity. This is why governments have often intervened to make the repayment scheme more flexible in case of financial difficulties of the borrower.

In particular, the trend has been to reform the loan system towards income-adjusted loans. Income-contingent loans are loans whose repayment scheme depends on the borrower's income. Monthly

installments change in accordance with the income level and thus the repayment burden remains under control. Furthermore, in case of variations in the interest rate, these do not affect the monthly payment, but rather the duration of the loan.

Australia, Hungary, the United Kingdom, the Netherlands and other countries have adopted income-contingent loan schemes. In Australia and the UK they are based on current income, in Hungary on past income, in the Netherlands they are based on income only if it is too low to meet the repayment installment.

The scheme that depends on current income is certainly the most accurate in responding to the actual ability to pay of the borrower, but certain conditions are necessary for it to be applicable.

First of all, governments must have full access to complete, timely and reliable information to regulate the repayment structure and this must also apply to graduates working abroad. Another key aspect is that the government must still allocate a large amount of funds to support the loan system, as repayments only occur later when students start earning money.

Moreover, even though it may appear as a cost neutral system, there are in fact many cases that involve an expense for the government, this is because there are high income thresholds for the start of repayments, interest rates lower than market rates, default loans, etc..

It can be said, however, that well designed loan schemes can positively influence participation in higher education. Mortgage-type loans seem to be less effective in this respect than income-contingent loans, particularly compared to low-income students.

Another system that has been tested that is halfway between student support and public funding for educational institutions is a voucher-based system. In this case the public money is allocated for vouchers directed to students who use them in a flexible way to buy educational services.

The voucher represents for the institution a certain amount that will be paid by the government and for individuals a universally recognized right to invest in education. The voucher-system is strongly demand-driven, it gives to the students the opportunity to decide which institution to enroll in and finance. Vouchers represent the minimum education investment recognized to all students. They set a topping-up mechanism in which individuals and families can decide whether to invest more to accumulate more human capital.

2.8 Covid-19 and education

As we have seen, education is closely linked to the economic condition. The Covid-19 pandemic we are experiencing will strongly affect the accumulation of human capital.

Although it is too early to draw conclusions, let us try to imagine some effects, considering what reported before and the disposable information by the institutions.

First of all, the pandemic has revolutionized teaching methods: distance learning for all levels of education has taken hold in a massive way. It is not easy to anticipate what effect this new type of organization will have on learning, certainly is that the current period has shown us how this new tool needs to be improved and tested.

The pandemic has also had effects on the relationship between education and the labor market. In fact, jobs in the field of health and child care or manufacturing and agriculture, guaranteed as essential services during the pandemic, have gained importance again. This certainly has an effect on education, bringing vocational education back into vogue, as personal insurance and as a tool to build more resilient societies.

However, the economic crisis generated by Covid-19 is worrying because it can affect in particular the most disadvantaged. It has caused an almost generalized stop to learning, but the recovery phase can be much more complicated for those with fewer means and material (books, computer supports). It can cause an increase in early school leaving as well as a decrease in the budget available to invest in education, both from the public and private sectors.

It is precisely this decline in public resources that should be somehow avoided. On the contrary, the difficult situation from the economic point of view will require an effort to ensure the provision of education and the opportunity to access as many students as possible. First of all to make schools and universities safe places and to guarantee to students the opportunity to continue their learning in case of lockdown, and then providing incentives to sustain the enrolment rate and funds to lower the individual cost of education.

3. Education in economic theory

Human capital, education policy and taxation are topics widely investigated in economics and particularly in public economics.

From economic theory, human capital can be defined as the set of knowledge or skills that individuals acquire through education or experiences.

This concept generates a wide strand of literature, moreover considering that human capital is considered as an important determinant of economic growth and personal income. In fact empirical and theoretical literature support the idea that human capital accumulation increases labor productivity and provide signal for employers.

It is also necessary to bear in mind the main characteristics of human capital. It is an illiquid asset so it is impossible to resell. For that reason also the problem of riskiness emerges. Furthermore there are problems about the specification and measurement of human capital: it is possible to distinguish between cognitive and non-cognitive abilities or to measure them using tests or schooling attainment.

Taking into account his peculiarity, public economics literature analyzes how human capital formation is affected by the public intervention. Governments have to consider both how public policies can affect the individual decision about investing in human capital and how human capital accumulation impacts on economic growth or generates social externalities.

Various policy instruments exist and are studied (e.g., making education compulsory, financing higher education program, etc). to achieve the optimal level of creation of human capital and to influence its distribution among the population.

Finally it is important to remember that talking about public policy easily implies getting involved in taxation problems. In human capital policies design it is necessary to bear in mind that taxation problems are related with several step of human capital accumulation: taxes on labor income affect the expected return on human capital investment; taxes on capital income or on savings generate a

substitution effect towards human capital accumulation; the features of tax design can affect the distribution of educational opportunity and play an important role in shaping the income distribution and in dealing with inequality and its persistence through different generations.

In this section a review of the literature about human capital is provided. Firstly focusing on pure human capital theories and on the most debated issues about human capital. Secondly focusing on taxation literature which consider human capital accumulation and the potential distortion that taxes can generate on human capital investment decision.

3.1 Human capital theories

Human capital theories originate with Mincer (1958). The idea behind his paper is that asymmetric income distribution is not due to abilities but is related to education attainment. Considering human capital accumulation in terms of year of education or working experience permits to explain the difference between income and abilities distribution, assumed to be normally distributed. Mincer supposes that personal income distribution is the result of rational choices by individuals. To invest or not in human capital, i.e. spending time for education or training, depicts the decision between present earnings and future earnings and determines also the magnitude of earnings.

Mincer does not reject the hypothesis of the existence of a relation between abilities and educational attainment. He supposes that individuals with higher abilities are expected to invest more in human capital.

In the subsequent literature, human capital is considered one of the most important determinants of personal earnings. Mincer (1974) build a personal earnings equation⁹ that describe the earnings profile through schooling and working experience.

Schultz (1961) is the first who considered human beings as a productive input comparable to physical capital and following Mincer (1958) he takes into account human capital investments as a driver of the distribution of incomes. Moreover he extends the concept of human capital investment by taking into account not only formal education and on-the-job training but also health facilities and services, and migration of individuals or families aimed to different job opportunities.

Becker (1962) reinforces the idea that human capital investment is a determinant of earnings profile, observing the effect that this kind of investment has on the distribution of earnings at

⁹ The most widely used version of Mincer's equation is:

$$\ln [(w_i(s, x))] = \alpha_0 + \rho_S s_i + \beta_0 x_i + \beta_1 x_i^2 + \varepsilon_i$$

where the log earnings is a function of schooling and a quadratic form of the years of experience.

different ages. The author aims to explain analytically the effect of human capital accumulation on the labor productivity, distinguishing between different human capital investments (e.g. on-the-job training or schooling). The paper proposes analytical description of the different accumulation processes and of the existing relation between human capital, earnings, costs and rates of return.

Another fundamental contribution is given by Ben-Porath (1967). He analyzes human capital as the stock which is necessary to produce labor services and that can be divided in standard units. A specific function is built to describe the accumulation path of human capital and its properties: the dependence between the marginal cost of acquiring human capital and its rate of production is stressed. Also a relation between age and costs is considered by taking into account the idea that learning effort efficiency is negatively related to age.

Of course these studies force to investigate both how human capital is acquired and accumulated and how the choices of individuals are related to economic or non-economic variables.

Exogenous abilities were mentioned above and can be considered as a determinant of investment decisions for many reasons. First, if we follow Becker (1967) and consider abilities as the potential improvement in future earnings generated by a present investment, it is clear that they affect the decision of an individual through the impact on his expectations. In Spence (1973) abilities are instead the measure of the cost of reaching a certain educational attainment which works as a signal when individual compete in the labor market.

Of course, despite the different perspectives, abilities are positively related with an higher probability of realization of the human capital investment in terms of earnings and so with higher human capital investment (Ben-Porath 1967). Haley (1973) suggests a different idea that a larger initial endowment of human capital has a negative effect on the human capital investment because of the possibility to early entry in the labor market.

The concept of abilities is debated not only because of the differences in the theoretical interpretation but also because of the differences in the measurement methods. Differently from the concept of ability suggested by Becker, Hause (1972) proposes to measure abilities using an IQ test or similar performance indicators. More recently, Gluckman and Hanson (2005) and, then, Cunha and Heckman (2010) investigate deeply the concept of abilities. They take into account a multiplicity of different abilities exist in nature and that, particularly, both cognitive and non-cognitive abilities are important in the determination of schooling, wages and other social and economical aspects of life. They also deepen the debate claiming that the difference between abilities and acquired skills is not appropriate. These studies have enlightened a broad

interdisciplinary field of analysis in which biological issues contribute to the investigation about economic and social phenomena: abilities and acquired skills become part of a complex debate about the identification of the impact of environmental influences, genetic components and education investments.

Risk is another important aspect that is taken into account by human capital theories. Risk should be considered in terms of possibility to conclude successfully education programs and in terms of possibility of realization of human capital investments in the labor market. The variance of earnings is one possible measure of risk related to investments in human capital.

Firstly, riskiness is treated as an exogenous variable by Levhari and Weiss (1974). They consider a theoretical two-period model with exogenously determined labor supply and future labor earnings which are randomly dependent on current human capital investment. They show that the effect of an increase in earnings uncertainty is a reduction of investments in human capital under good states of the world that generates higher marginal returns to education.

Other studies, like Belzil and Hansen (2002), aim to estimate empirically the relation between riskiness or risk aversion and schooling decision. The authors set a dynamic programming model of schooling to estimate risk aversion of individuals using data from the National Longitudinal Survey of Youth and then they estimate the effect of an increase in riskiness on individuals choices. The authors argue that risk aversion and uncertainty on the labor market (i.e. wage dispersion) have a positive effect on education investments: they implies an increase in the human capital investments because people prefer to stay longer in educational programs.

Another question discussed in the literature is if initial non-human wealth affects education choices. Heckman (1976) and Graham (1981) discuss if non-human wealth can influence individuals in their decision about human capital investments, even if the capital market is perfect. Heckman (1976) build a life-cycle model of labor supply, human capital investment and consumption and non-market benefits of education¹⁰ and conclude that variation in initial non-human wealth do not affect the education choice.

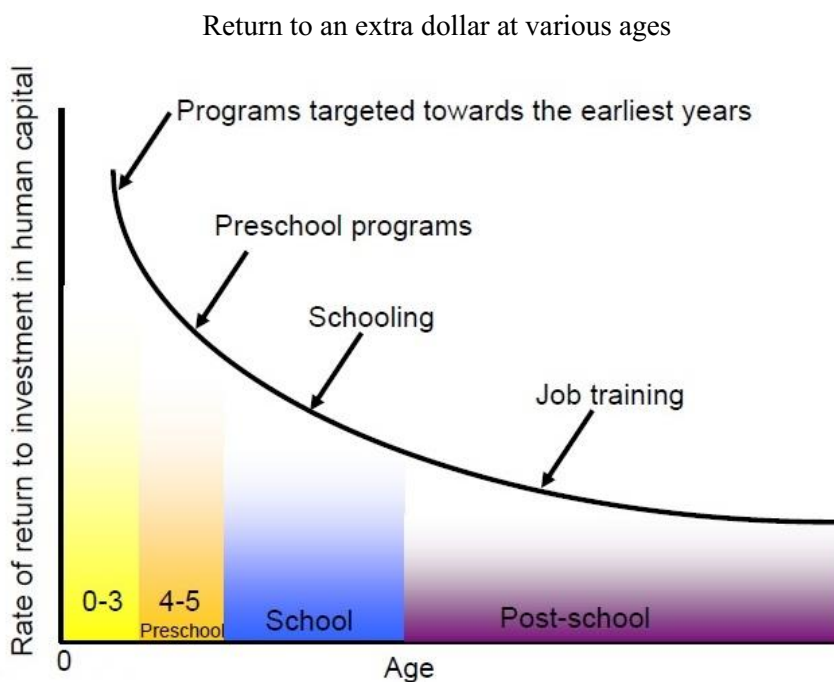
On the other hand, Graham (1981) criticizes this conclusion through a two-period life-cycle model following Levhari and Weiss (1974). The author concludes that a correlation between initial assets and human capital investment exists and, if a complete separability between market goods and leisure time is assumed, that correlation is negative. This negative relation rises because returns on

¹⁰ Non-market benefits of education include various economic or social indexes (e.g. incarceration, mental health, voter participation, trust, etc.). The reader can refer to Heckman, Humphries and Veramendi (2018) for more details.

education are dependent from the future work intensity or similarly from the future consumption of leisure which clearly is related to non-human wealth.

Another important feature of human capital accumulation is timing. Many authors, e.g., Heckman (2005), investigate how human capital policies work for different-age students. There is a broad consensus which considers early investments in education more efficient (as figure 3.1 shows). Life cycle skill formation is dynamic: skills begets skills, motivation begets motivation.

Fig. 3.1 Rates of return to human capital investment at different ages



Source: Heckman 2005

Thus a debate about substitutability or complementarity between different stage education emerge. Some papers, e.g., Becker and Tomes (1986) and Benabou (2002), that treat childhood as a single period, entail the idea of perfect substitutability between investments at different ages, whereas Cunha and Heckman (2010) introduce the concept of self-productivity of investments and so consider inputs at different stages as complements. The self-productivity hypothesis embeds two important concepts. Firstly, skills acquired earlier persist later and, secondly, skills are self-reinforcing and cross-fertilizing¹¹.

Of course considering different stages investments as complements or substitutes is determinant for the policy design. If complementarity is accepted then it is necessary to calibrate a joint educational scheme for earlier and higher education, while if substitutability is accepted different investments can be considered independently.

¹¹ A higher stock of cognitive skill in one period raises the stock of next period cognitive skills.

3.2 Human capital taxation

Taxation plays an important role in human capital choices and in human capital accumulation.

The most of works which address the taxation problem and its links with human capital take roots in the Mirrlees's framework (1971). In the last three decades of the XX century and in the XXI century a challenging debate emerged.

At the beginning the debate was focused on how taxes affect human capital accumulation, through their effect on labor supply or on expected return to education. Different types of taxes are studied in partial or general equilibrium.

Moreover the authors deal with different conditions and dynamics associated with human capital theories which impact also on the specifications of the taxation models.

Uncertainty of return and heterogeneity of agents are two important assumption which set the basis for several models.

Concepts coming from pure human capital theories, like complementarity of education and abilities, play an important role in human capital taxation analysis and design of public policies.

Political problems, like the need of redistribution or the persistence of inequality through generations, lead to a deep exploration of public policies useful to address them; the idea of a negative tax on education (i.e. subsidies) emerges and is jointly studied with taxation and policy design.

So a broad literature has been developed around the effects of public intervention on human capital choices, by the means of both theoretically and quantitative models, in a static or dynamic environment and assuming different information sets for the planner.

Boskin (1975) argues that not necessarily income taxation affects human capital accumulation. A partial explanation is that, considering only foregone earnings as the (opportunity) cost of education, linear taxes on labor income cause a proportional fall in costs and return. Trostel (1993) claims the opposite, taxes have a significant negative effect on human capital investments.

Of course, also the object of taxation is determinant: for example, the possible substitution between human and physical capital implies that taxes on capital or capital income may encourage investments in human capital. Many studies like Heckman (1976) or Lord (1989) are focused on this substitutability.

Heckman (1976) challenges the previous literature (e.g., Ben-Porath 1967 and Boskin 1975) and claims that income taxes influence positively human capital investments. The author build a life-cycle model and, focusing on the effect generated by taxes on human capital accumulation,

conclude that, if income tax comprehend both earnings and interest income taxes, it lowers the effective tax rate and consequently the borrowing cost. Considering that human capital returns are deferred, the effect of tax write-offs is a subsidization of human capital investments. The paper also specifies how interest income taxes may affect the decision between human and physical capital investments.

Davies and Whalley (1989) highlight the ambiguous effect of capital taxation on human capital investment in general equilibrium analysis: a possible fall in the real wage rate due to the decrease in physical capital investment may cause a fall in the return on human capital and so a discouragement of investments in education.

Exploring the hypothesis and the dynamic general equilibrium model proposed by Trostel (1993), that leads to the finding of a significant negative effect of income taxation on human capital, is possible to point out that the positive effects on uncertainty reduction are ignored. Including uncertainty under the condition of constant absolute risk aversion, Eaton and Rosen (1980) show that taxation has a positive effect on human capital since it reduces expected earnings variability.

In the literature also the negative taxation of human capital is considered. It poses the attention on the effect of a public investment to sustain the human capital investment rather than the effect of a reduction of earnings (i.e. human capital return) on the investment decision.

Subsidies should be considered for different reasons. First, there is an idea of redistribution and equality of opportunities that suggests a public intervention.

Talking about this topic, it is important to remind the wide literature addressing the problem of inequality, intergenerational transmission of inequality, persistence of educational attainments, etc.

The debate concerning education subsidies contributes also to point out arguments that create a link between equity and efficiency. Capital market imperfections cause underinvestment in education because of the credits constraints that people face. Moreover the existence of positive externalities linked to education is another argument supporting the implementation of subsidies.

Last but not least, there is an idea of social justice under educational subsidies: granting schooling and human capital accumulation opportunities means to spread culture and technical and civic knowledge for the largest part of the population.

Several papers consider these problems. Romer (1986,1990) argues that underinvestment in education is due to self-interest of individuals, which are concerned only on their private return.

Focusing on the complementarity between education and abilities, Angrist and Krueger (1991) conclude that education subsidies spread the wage gap because mostly high ability people exploit the subsidization policy.

Around the impact of credit constraints on education decisions, different results were obtained: Cameron and Taber (2004) find that borrowing constraints and capital market failure are not a strong determinant of choices about human capital investment; on the other hand Plug and Vijberger (2004) state, controlling for abilities and parental back-ground, that credit constraints are binding for high-ability children in low-income families and that government should intervene to eliminate this malfunctioning.

A contribution supporting the education subsidies comes from Dur and Tuelings (2001). They consider a general Walrasian equilibrium with perfect capital and insurance market and suggest that, with demand for redistribution, education subsidies for all educational levels work as a second-best optimal redistribution policy. The idea is to look at pre-tax income distribution: to incentivize an increase in the general level of human capital generate a decrease in the return caused by a substitution effect; policies directed to stimulation of human capital accumulation imply a compression in wage distribution and so an inequality reduction. Of course, to contribute to redistribution this effect must be sufficiently large to offset the income effect linked to complementarity between education and ability.

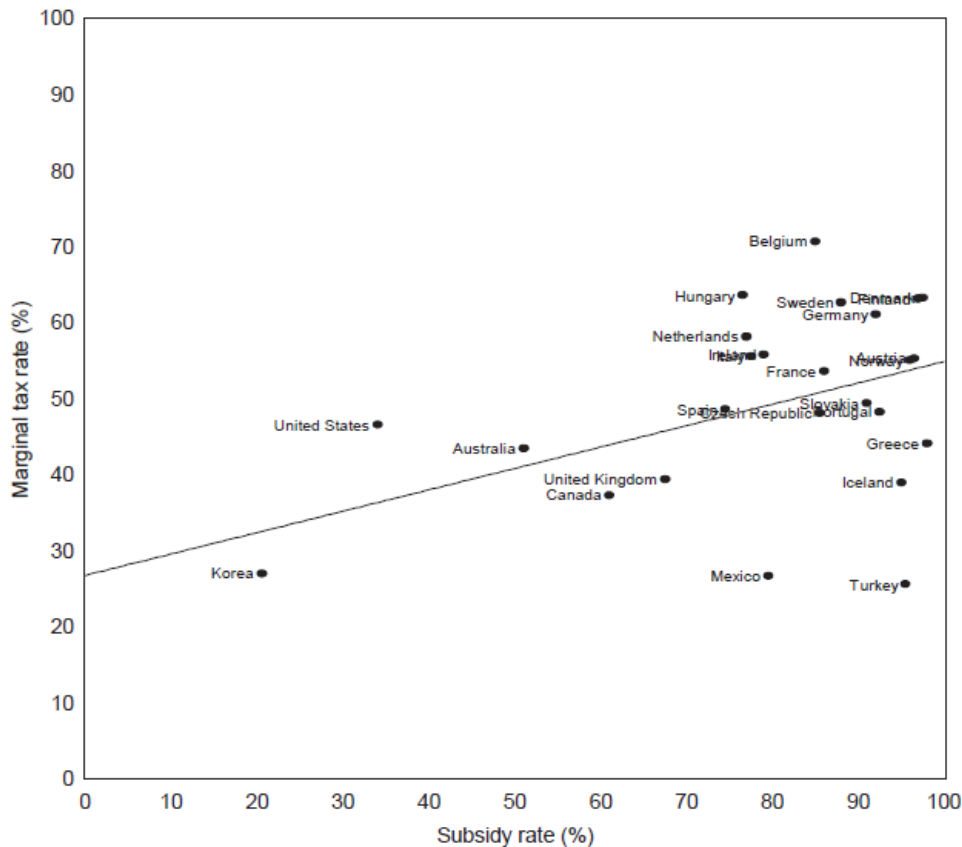
Cameron and Heckman (2001) stand against education subsidies claiming that in a market without failures or imperfection they only create distortions, interfering with the optimal production of human capital.

Benabou (2002) builds an analytic and quantitative model to assess the efficiency of redistributive education finance with respect to tax and transfers. The paper, considering a model with heterogeneous agents and intertemporal choices and then an empirical estimation, suggests that policies concerning education finance and taxes and transfers are different in terms of outcome: the former are more efficient in terms of growth, while the latter are more efficient in terms of ensuring individuals against risk.

In terms of public policies, Bovenberg and Jacobs (2005) outline the strong link between redistribution and education subsidies. The authors firstly derive the optimal linear and non-linear income taxes with endogenous human capital formation. Then, rejecting the idea that education subsidies are justified by positive externalities, which are usually unobservable, or by capital markets failures, they focus on the redistributive features of education subsidies, providing the

analysis of a economy in which government cannot observe all human capital investment, showing that this kind of policies contributes in alleviating tax distortions created by other redistributive policies as progressive income taxation. This is mirrored in the high existing correlation in OECD countries between education subsidies and progressivity of income taxes (figure 3.2).

Fig. 3.2 Marginal taxes and education subsidies in various OECD countries



Source: Bovenberg and Jacobs 2005

The conclusion states that redistributive policies and education subsidies are Siamese twins: subsidies are useful to offset the negative effect of redistributive taxes on human capital accumulation; a combination of taxes and subsidies becomes an instrument for the government to extract rent from ability without creating significant distortions on human capital choices.

Jacobs (2007) follows the analysis of Bovenberg and Jacobs (2005) but considering wages of workers as endogenous instead of exogenous. The author analyzes linear and non-linear income taxes and education subsidies concluding that human capital subsidies has not should to be used for distributional issues.

The paper aims also to investigate the general equilibrium effect from human capital in shaping the linear optimal taxes and education policies, concluding that linear education subsidies should be

zero, considering both the cases of a general equilibrium effect on wages or not. The idea is that linear income taxes cause the same distributional effect, but are more efficient because they do not create distortion on human capital accumulation.

The opposite conclusion is drawn analyzing non-linear policies: by the means of non-linear instruments the government can directly impact the relative supply of labor of skilled human capital. So, at the optimum, non-linear policies allow to exploit general equilibrium effect to achieve redistributive goals.

Many papers analyze the joint design of tax and human capital policies. Grochulski and Piskorski (2006), Da Costa and Maestri (2007), Hogan and Walker (2007), Jacobs, Schindler and Yang (2012) take into account both linear and non-linear taxation and they consider uncertainty and riskiness.

Grochulski and Piskorski (2006,2010) consider a dynamic model where education is not observable for the government and it is endogenous. They look at a non-linear optimal taxation and find that an optimal allocation requires a positive education premium and a positive intertemporal wedge.¹²

Differently from Grochulski and Piskorski, Da Costa and Maestri (2007) assume that education is observable by the policy maker; starting from the results by Eaton and Rosen (1980) on the riskiness of human capital and the optimal tax policies, they consider a model in which they let human capital both increase or decrease the wage variance and they allow the policy-maker to apply a non-linear income tax. They derive three main conclusions: firstly, in terms of social welfare proportional taxes are frequently superior to lump-sum taxes; secondly government is called to encourage human capital investments by reducing their riskiness and directly subsidizing them; finally it is necessary also to discourage savings through taxes as a punishment for those who try to deviate and take advantage from the redistributive policy designed by the government.

Hogan and Walker (2007) study the relation between subsidies and taxation in an environment of stochastic returns on education. The results are that there exists a positive effect of risk on education attainment, regardless of risk aversion, and that progressive taxes and education subsidies are useful instruments to stimulate human capital investments.

Finally, Jacobs, Schindler and Yang (2012) assume a linear income tax in two-period economy similar to Da Costa and Maestri. They find that optimal education subsidies and complementarity

¹² Golosov (2006) defines two types of wedges: a labor wedge which measures the difference between the marginal rate of substitution and transformation between consumption and labor and an intertemporal wedge which measures the difference between the expected marginal rate of substitution of consumption between periods and the return on savings. These wedges are sometimes termed “implicit marginal tax rates”.

between education and labor supply are positively related: subsidies are designed to alleviate the distortion caused by income taxes, by stimulating human capital accumulation and so labor supply.

Anderberg (2009) highlights the difference existing between uncertainty and heterogeneity, following the work of Carneiro, Hansen and Heckman (2003) and specify a model for the pure uncertainty framework concluding that the education premium depends on whether education increases or decreases wage risk and intertemporal wedge should be strictly positive if agents cannot engage in intertemporal trades and education is not observable.

Another strand of works was developed focusing on models with heterogeneous agents. Particularly Bovenberg and Jacobs (2005), Bohacek and Kapicka (2008), Maldonado (2008).

While Bovenberg and Jacobs (2005) analyze a static framework, Bohacek and Kapicka (2008) analyze a dynamic model with heterogeneous agents with private information and observable human capital accumulation. They prove the efficiency of a positive human capital wedge if it is optimal to stimulate labor supply relative to schooling. The existence of this optimal wedge is a starting point to support positive subsidies to education. Without schooling subsidies, considering that second best labor supply is negatively distorted by income taxes, schooling is not incentivized and thus it does not suffer for any distortion with respect to labor supply. Consequently, considering the downwards distortion of labor supply, schooling is lower than its optimal level.

A compensation of this schooling distortion is reachable by the means of education subsidies, which imply an upward distortion of schooling relative to labor supply. The paper shows that this trade-off is generally welfare improving.

The authors propose a policy design concerning education subsidies and taxes which depend on past history of human capital levels and incomes.

As the previous works, also Maldonado (2008) assumes differences in individual innate abilities and observability of education. The model is set to describe labor market income as the result of an interaction between labor supply, education and abilities. The paper takes the unobservability of innate abilities and labor supply as a justification for the implementation of policy instruments like non-linear taxation (or subsidization) of income and education.

The main conclusion is that education elasticity of the wage function is an important determinant that should be taken into account to design education policies.

From Maldonado (2008) and his analysis about importance of elasticity is necessary to understand that the form of the earnings function is determinant to analyze the optimal education policies.

Bovenberg and Jacobs (2011) follow this suggestion and investigate the specifications of the earning function that affect the decision of subsidize or not education considering the rate of the tax distortion. The model extends Bovenberg and Jacobs (2005) and states that complementarity between education and labor effort is a condition to subsidize human capital accumulation to avoid the distortion on labor supply; moreover if there exist some degree of complementarity between education and ability, education should be taxed for redistributive purposes; finally if in the earnings function education is characterized by separability from abilities and labor supply, it should be neither stimulate nor discouraged by government.

Krueger and Ludwig (2013) suggest an optimal fiscal policy that is composed by a progressive labor income tax and a significant subsidy for higher education. They study these measures of fiscal policy by means of a large-scale overlapping generations model. They consider as endogenous human capital accumulation, credit constraints, income risk, the persistence of wealth through generations and abilities, and incomplete financial markets. They consider heterogeneous agents and look at the progressive labor income taxes as an insurance against idiosyncratic income risk. Subsidies enter in the design of public policies to alleviate the downward distortion caused by taxation on human capital accumulation.

Stantcheva (2015) studies in a dynamic intergenerational model the link between income and bequests taxes and education subsidies taking into account the effect on parental decision and labor supply. This paper considers the different ways available for parents to transfer resources to their children. In the first part of the paper of Stantcheva (2015) each generation lives one period and takes care about the utility of the subsequent generation. Education investments and bequests are characterized by a clear difference regarding riskiness: while bequests yield a reasonably safe return, education is risky and faces shocks.

The aim of the paper is to derive optimal formulas for education subsidies, income taxes and bequest taxes, considering not only the classic static optimal formulas, but also the behavioral elasticities and the distributional incidences of the policies.

Moreover Stantcheva, criticizing the result of Bovenberg and Jacobs (2005), argues that not necessarily income taxes must move together with education subsidies and bequest taxes can both increase or decrease with education subsidies according to the complementarity or substitutability of bequests and education investments.

She also extends the analysis to consider an overlapping generations model in which each generation lives for three period to assess the effect of credit constraints on optimal education subsidies. The conclusion is that the existence of strong credit constraints has no effect on bequest

taxes, but it implies an increase in the optimal education subsidies and a decrease in the optimal income taxes.

Finally, the author derives the relation between education and bequest taxes with a full-fledged mechanism design approach, considering the intergenerational setting. She concludes that, at the optimum, social return on bequests must be equal to the social return to education, which consists in the wage increase for the next generation from education and from the incentive implications of education for the next generation.

Findeisen and Sachs (2016) analyze the optimal design of tax system jointly with education finance. The authors deeply evaluate two different policy instrument: education dependent taxes and income-contingent loans. They consider a dynamic environment with uncertainty and in a life cycle model; individuals are heterogeneous and abilities are private information, the distribution of wages depends on the education decision, which are risky and observable by the government.

The idea of income-contingent loans is supported by the fact that they allow the government to implement a correct differentiation of tax distortions distinguishing for individuals with different education attainment or different education returns. This permits to reduce the efficiency cost due to the distortion on labor supply. In addition government can easily calibrate the generosity of the loans to subsidize education.

Koeniger and Prat (2017), using a model with altruistic dynasties, show the distortion generated by taxes on labor income and bequests on human capital investment. The paper starts from the existing trade-off between insurance and incentives, claiming that fighting against the persistence of inequality across generations produces undesirable effects such as the fall in the motivation of parents to provide wealth and education to their children. In their model bequests and human capital are taken as observable while abilities are private information. The wedge for human capital and for bequests result to be strictly related, because of the existing substitutability of these two types of investment aimed at transferring resources to heirs. Of course, the differences regarding riskiness imply a different treatment by the government. The authors use quantitative results for persistence of abilities across generations, calibrated on U.S. data, to find that the human capital wedge should be lower than the bequest wedge and this is mirrored in the existence of human capital subsidization and of taxes on bequests. They conclude also that human capital investment should increase in parental income, considering the persistence of abilities through generations and the implication of higher incomes on expected abilities, and decrease in inherited wealth considering the negative effect on labor supply.

Finally a policy proposal is presented: income and human capital contingent loans should be used to

achieve the social optimum. Considering a taxation scheme like in the U.S. and the unfeasibility of a structural policy reform, they suggest an optimal design of education finance alone. The idea of contingent loans permits to distinguish between investments financed through labor efforts or through inherited wealth, rewarding the firsts and penalizing the seconds.

Another instrument which is considered in the academic debate is age-dependent income taxes. Da Costa and Santos (2018) investigate the implementation of this kind of policy using an overlapping generations model with endogenous accumulation of human capital, particularly looking at the learning-by-doing form of accumulation. They analyze this form of taxation that in other previous paper (e.g Conesa et al. 2009, Gervais 2012) was not explicitly considered but is considered in relation to the possibility to be mimicked by capital taxes or progressive labor income taxes. This paper looks instead at the relation between age-dependent taxes and labor income taxes progressivity and capital taxes. They find that at the optimum age and tax rates increase together and highlight the fact that, since both tax rate and income increase with age, age dependence reduce the scale of progressivity.

They control also for the different technologies describing human capital accumulation, learning-by-doing or learning-or-doing, and substantially confirm the result, stating that high degrees of progressivity are less desirable.

Stantcheva (2017) provides a joint analysis of taxation and human capital policies; her model includes heterogeneous individuals and unobservable abilities and labor efforts. Stantcheva uses a life-cycle human capital model in which human capital investments are measured in terms of money spent, so they are observable by the planner. Abilities are stochastic and jointly with the stock of human capital determine the wage rate. Thus the government can observe human capital, consumption and output, and it knows the wage function, but it cannot observe the wage realization, because it cannot observe abilities.

Analyzing this model, the paper achieves both normative and positive results. It sets out a relationship between labor and human capital wedges: they should move together if and only if the Hicksian coefficient, which measures the complementarity between ability and human capital in the wage function, is lower than 1. The Hicksian coefficient assume a fundamental role to determine whether the human capital wedge should be positive or negative and if it has to comove with the labor wedge, because it takes a picture of the insurance and redistributive effect of human capital. The results are followed by two policy proposal: income-contingent loans and deferred human capital expenses deductibility scheme.

Regarding the income-contingent loans, Stantcheva (2017) indicates two important features: first

these loans should be available in every moment of the life-cycle, also for job training and later education programs; second to build the repayment scheme, government have to take into account the full history of earnings and past loans and not only the current debt position and income.

With respect to the deferred deductibility scheme, the paper suggests that postponing the deduction of a fraction of human capital expenses is another way to incentivize human capital investments, satisfying the individual incentive compatibility and maintaining some degree of progressivity.

Finally, Kapicka and Neira (2019) contribute to the optimal taxation literature using a life-cycle model considering redistribution, insurance and incentives problems. They find that if labor and learning effort are additively separable in the utility function, the inverse of the labor wedge follows a random walk. This fact implies a reconsideration of age-dependent taxes and savings wedge and their relations with future labor effort and present learning effort. The paper challenges also the “no distortion at the top” result from the taxation literature: if the utility function is not additively separable in labor and learning efforts the latter should be incentivized for “top” agents too. They conclude that marginal labor income tax rate results to be strictly decreasing with respect to human capital realizations. The environment which is considered contemplates private information, moral hazard frictions and risky and unobservable human capital investments.

4. Conclusion

In this work the main characteristics, data and theories regarding public intervention in the educational sector have been analyzed.

The topics covered help to understand the vast world of investment in human capital and education policies.

First of all human capital investment is represented as a choice by individuals and families, who evaluate, according to the constraints to which they are subject, whether or not to invest in education. This investment involves costs and benefits. The costs are the deferred earnings, the costs of enrolment, the necessary material, while the benefits are represented by wage premiums and an higher probability of finding a job.

It may therefore seem like an inter-temporal choice to allocate individual or family resources, but it is influenced by objective constraints and government policy choices.

In fact, constraints related to liquidity or credit may a priori preclude the choice to invest in education, as well as financial support policies may incentivize it.

It is therefore necessary to know and analyze the constraints to which individuals may be subjected and how government can access to personal information about those constraints. It is also essential to understand the effects that different public policies may have on those who are subject to them.

It has been said then that there are disparities between students from different socio-economic backgrounds; that there are gender differences; that education affects fundamental aspects of an individual's life.

Therefore, public intervention is necessary with targeted policies that guarantee an equal and efficient distribution of education opportunities and that take into account the side effects that education can generate (both positive effects in the case of obtaining educational qualifications and negative effects caused by the impossibility of investing in education).

However, it has been seen that government is usually heavily involved in financing and providing education at lower levels, while in many countries, it acts in a less decisive way for higher levels of education.

The choice to participate in higher education is more delegated to individuals and families, but public policies are able to build around this choice a system of incentives or support to the demand and supply of education.

So there exists schemes of grants and loans to students to support demand and public funds allocated to educational institutions to support supply.

It is precisely on these policies that the fertile debate developed around the topic of investment in human capital is based. They involve political choices, regarding the distribution of education, but also choices in terms of efficiency, since market failures can prevent an optimal allocation of resources and outcomes.

In addition, human capital policies enter into the system with other public policies. Income taxation, for example, influences both individual choice as it reduces the return on investment in education and public support for education by providing resources to the government. It is then necessary to understand how to efficiently regulate the coexistence of these policies.

Many questions are open for future research. Provide a public educational service directly to the citizens or delegate this task to private institutions? To design and implement means-tested (or tailor-made) policies or universalistic measures? Calibrate educational subsidies with respect to the expenses incurred (if observable) or to individual resources available? How to respond to the actual health crisis which hit also the educational system and dramatically reduce the available resources?

These are some of the open questions. In this work I have tried to prepare the ground with the information and theoretical contributions available so far to address the difficult task of designing public policies for investment in human capital and education.

Bibliography

Anderberg, D. (2009). Optimal policy and the risk properties of human capital reconsidered. *Journal of Public Economics*, 93(9–10), 1017–1026.

Andrews, R. and K. Stange (2016). Price regulation, price discrimination, and equality of opportunity in higher education: Evidence from Texas. No. w22901, National Bureau of Economic Research

Angrist, J.D., Krueger, A.B. (1991). Does compulsory school attendance affect schooling and earnings? *The Quarterly Journal of Economics*, 106(4), 979–1014.

Arendt, J. (2012). The effect of public financial aid on dropout from and completion of university education: evidence from a student grant reform. *Empirical Economics*, Vol. 44/3, pp. 1545-1562.

Becker, G. (1962). Investment in human capital: A theoretical analysis. *Journal of Political Economy*, 70(5), 9–49.

Becker, G. (1967). Human capital and the personal distribution of income: An analytical approach. *W.S. Woytinsky Lecture No. 1*. Ann Arbor: Institute of Public Administration, University of Michigan.

Becker, G. S., Tomes, N. (1986). Human capital and the rise and fall of families. *Journal of Labor Economics*, 4 (3, Part 2), S1-S39.

Belzil, C., Hansen, J. (2002). Earning dispersion, risk aversion and education. *IZA Discussion paper No. 513*.

Benabou, R. (2002). Tax and education policy in a heterogeneous agent economy: What levels of redistribution maximize growth and efficiency? *Econometrica*, 70(2), 481–517.

Ben-Porath, Y. (1967). The production of human capital and the life cycle of earnings. *Journal of Political Economy*, 75(4), 352–365.

Bohacek, R., Kapicka, M. (2008). Optimal human capital policies. *Journal of Monetary Economics*, 55(1), 1–16.

Boskin, M.J. (1975). Efficiency aspects of the differential tax treatment of market and household economic activity. *Journal of Public Economics*, 4(1), 1–25.

Botticini, M., Eckstein, Z. (2007) From Farmers to Merchants, Conversions and Diaspora: Human Capital and Jewish History, *Journal of the European Economic Association*, 5(5), 885–926.

- Bovenberg, A.L., Jacobs, B. (2005). Redistribution and education subsidies are siamese twins. *Journal of Public Economics*, 89(11–12), 2005–2035.
- Bovenberg, A.L., Jacobs, B. (2011). Optimal Taxation of Human Capital and the Earnings Function. *Journal on Public Economic Theory* 13 (6): 957–71.
- Cameron, S., Taber, C. (2004). Estimation of educational borrowing constraints using returns to schooling. *Journal of Political Economy*, 112(1), 138–182.
- Cameron, S., Heckman, J. (2001). The dynamics of educational attainment for blacks, hispanics, and white males. *Journal of Political Economy*, 109(3), 455–499.
- Carneiro, P., Hansen, K., Heckman, J. (2003). Estimating distributions of treatment effects with an application to the return to schooling and measurement of the effects of uncertainty on college choice. *International Economic Review*, 44(2), 361–422.
- Cohodes, S. and J. Goodman (2014). Merit Aid, College Quality, and College Completion: Massachusetts' Adams Scholarship as an In-Kind Subsidy. *American Economic Journal: Applied Economics*, Vol. 6/4, pp. 251-285.
- Conesa, J., Kitao, S., Krueger, D. (2009). Taxing Capital? Not a Bad Idea After All, *American Economic Review*, 99 (1), 25–48.
- Cunha, F., Heckman, J. (2010). Investing in our young people. *NBER Working Paper No. 16201*.
- Da Costa, C.E., Maestri, L.J. (2007). The risk properties of human capital and the design of government policies. *European Economic Review*, 51(3), 695–713.
- Da Costa, C.E. , Santos, M.R., (2018). Age-dependent taxes with endogenous human capital formation. *International Economic Review*. 59 (2), 785–823 .
- Davies, J.B., Whalley, J. (1989). Taxes and capital formation: How important is human capital? *NBER Working Paper No. 2899*.
- Dur, R., Teulings, C.N. (2001). Education and efficient redistribution *CESifo Working Paper No. 592*, CESifo Group Munich.
- Eaton, J., Rosen, H.S. (1980). Taxation, human capital, and uncertainty. *American Economic Review*, 70(4), 705–715.
- Findeisen, S., Sachs, D. (2012). Education and Optimal Dynamic Taxation: The Role of Income-Contingent Student Loans. Technical report, Dept. Econ., Univ. Zurich.
- Gervais, M. (2012). On the Optimality of Age-Dependent Taxes and the Progressive U.S. Tax System, *Journal of Economic Dynamics and Control* 36 (4), 682–91.
- Gluckman, P.D., Hanson, M. (2005). The fetal matrix: Evolution, development, and disease. Cambridge: Cambridge University Press.

- Graham, J.W. (1981). An explanation for the correlation of stocks of nonhuman capital with investment in human capital. *American Economic Review*, 71(1), 248–255.
- Grochulski, B., Piskorski, T. (2006). Optimal wealth taxes with risky human capital. 2006 *Meeting Paper No. 59*, Society for Economic Dynamics.
- Grochulski, B., Piskorski, T. (2010). Risky human capital and deferred capital income taxation. *Journal of Economic Theory*, 145(3), 908–943.
- ISTAT (2020). Livelli di istruzione e ritorni occupazionali. *ISTAT Statistiche e Report*.
- Haley, W.J. (1973). Human capital: The choice between investment and income. *American Economic Review*, 63(5), 929–944.
- Hause, J. (1972). Earnings profile: Ability and schooling. *Journal of Political Economy*, 80(3), S108–S138.
- Heckman, J.J. (1976). A life-cycle model of earnings, learning, and consumption. *Journal of Political Economy*, 84(4), S11–S44.
- Heckman, J.J. (2005). Lesson from the technology of skill formation. *NBER Working Paper No. 11142*.
- Heckman, J.J., Humphries, J.E., Veramendi, G. (2018). The Nonmarket Benefits of Education and Ability. *Journal of Human capital*, vol.12, no.2.
- Jacobs, B. (2007) Optimal Redistributive Tax and Education Policies in General Equilibrium, *International Tax and Public Finance*, 20(2), 312-337.
- Kapička, M., and Neira, J. (2019). Optimal Taxation with Risky Human Capital. *American Economic Journal: Macroeconomics*, 11 (4): 271-309.
- Koeniger, W., Prat, J. (2017). Human Capital and Optimal Redistribution. *Review of Economic Dynamics*, vol. 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: Papers & Proceedings* 103(3), 496–50.
- Levhari, D., Weiss, Y. (1974). The effect of risk on the investment in human capital. *American Economic Review*, 64(6), 950–963.
- Hogan, V., Walker, I. (2007). Educational choice under uncertainty. *Labour Economics*, 14(6), 894–912.
- Jacobs, B., Schindler, D., Yang, H. (2012). Optimal taxation of risky human capital. *The Scandinavian Journal of Economics*, Vol. 114 (3), 908-931.
- Lord, W. (1989). The transition from payroll to consumption receipts with endogenous human capital. *Journal of Public Economics*, 38(1), 53–73.

Maldonado, D. (2008). Education policies and optimal taxation. *International Tax and Public Finance*, 15(2), 131–143.

Mincer, J. (1958). Investment in human capital and personal income distribution. *Journal of Political Economy*, 66(4), 281–302.

Mincer, J. (1974). Schooling, experience and earnings. National bureau of economic research. Human Behavior and Social Institutions, Series No. 2.

Mirrlees, J.A. (1971). An exploration in the theory of optimum income taxation. *Review of Economic Studies*, 38(2), 175–208.

OECD (2008). Tertiary Education for the Knowledge Society: Volume 1 and Volume 2. *OECD Reviews of Tertiary Education*, OECD Publishing, Paris, <https://doi.org/10.1787/9789264046535-en>.

OECD (2013). What Are the Social Benefits of Education? *Education Indicators in Focus*, No. 10, OECD Publishing, Paris, <https://doi.org/10.1787/5k4ddxn139vk-en>.

OECD (2015). How do differences in social and cultural background influence access to higher education and the completion of studies? *Education Indicators in Focus*, No. 35, OECD Publishing, Paris, <https://doi.org/10.1787/5jrs703c47s1-en>.

OECD (2016). How are health and life satisfaction related to education? *Education Indicators in Focus*, No. 47, OECD Publishing, Paris, <https://doi.org/10.1787/6b8ca4c5-en>.

OECD (2017). Educational attainment: A snapshot of 50 years of trends in expanding education. *Education Indicators in Focus*, No. 48, OECD Publishing, Paris, <https://doi.org/10.1787/409ceb2b-en>.

OECD (2020). *Education at a Glance 2020: OECD Indicators*. OECD Publishing, Paris, <https://doi.org/10.1787/69096873-en>.

Piketty T. (2020) Capital and ideology. Harvard University Press, 1093p.

Plug, E.J.S., & Vijverberg, W. (2004). Schooling, family background, and adoption: Does family income matter. *Economic Journal*, 115, 880–907.

Romer, P.M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*, 94(5), 545–567.

Romer, P.M. (1990). Endogenous technical change. *Journal of Political Economy*, 98(5), S71–S102.

Schultz. T.W. (1961). Investment in human capital. *American Economic Review*, 51(1), 1–17.

Spence, M. (1973). Job market signaling. *The Quarterly Journal of Economics*, 87(3), 355–374.

Stantcheva, S. (2015). Optimal Income, Education, and Bequest Taxes in an Intergenerational Model. *Working Paper no. 21177*, NBER, Cambridge, MA.

Stantcheva, S. (2017). Optimal Taxation and Human Capital Policies over the Life Cycle. *Journal of Political Economy*, vol. 125, no. 6.

Trostel, P.A. (1993). The effect of taxation on human capital. *Journal of Political Economy*, 101(2), 327–350.

Varvarigos, D. (2017). Endogenous cycles and human capital, *Journal of Economics*, Springer, vol. 120(1), pages 31-45, January.