HIGHER EDUCATION AND EARNINGS IN EUROPEAN COUNTRIES: A DIFFERENCE-IN-DIFFERENCES ESTIMATION OF THE BOLOGNA PROCESS EFFECT

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Executive summary

The Bologna process was signed in 1999 by 29 countries, aiming at harmonizing higher education systems across European countries. Among other things, the reform reorganised the tertiary education structure, creating a three-cycle organization: the bachelor's, the master's and the doctorate's cycles. Focusing on four countries – Belgium, France, Germany and the Netherlands –, the Bologna process's major effect was to extend the tertiary education journey by a year.

Using cross-sectional data from the EU Statistics on Income and Living Conditions (EU SILC) for Belgium, France, Germany and the Netherlands from 2005 to 2017, this thesis aims at estimating the effect the Bologna reform has had in terms of returns to tertiary education over the decade. Conducting a difference-in-differences analysis, results reveal a positive and significant joint impact of the Bologna process on the difference in income between secondary and higher education's graduates in the four countries of interest. Computed at the country level, the difference-in-differences estimation shows a non-significant effect of the Bologna process.

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Contents

1. Introduction

Literature has widely demonstrated that education has a significant impact on the labor market, especially tertiary education. Recruiters pay attention to the academic background and being graduated gives access to a wider range of jobs providing higher income in the future. However, the labor market is continuously evolving as a result of various reforms or economic events, and fear that returns to tertiary education may vanish over time tends to arise. This thesis focuses on one specific reform, the Bologna process.

The Bologna declaration was signed in 1999 by 29 European countries, with the aim of harmonizing higher education systems across Europe and thus facilitating student mobility. The European Higher Education Area (EHEA) was therefore established to ensure more coherence and equivalence in the participating countries' education systems. The reform relies on three major pillars: "introduce a three-cycle higher education system consisting of bachelor's, master's and doctoral studies, ensure the mutual recognition of qualifications and learning periods abroad completed in other universities and implement a system of quality assurance, to strengthen the quality and relevance of learning and teaching" (European Commission, n.d.a).

Using independently pooled cross-sectional data from the EU Statistics on Income and Living Conditions (EU SILC) for Belgium, France, Germany and the Netherlands from 2005 to 2017, this thesis aims at estimating the impact the Bologna reform has had in terms of returns to tertiary education over the decade. Firstly, the traditional multi-period earnings function developed by Mincer is estimated, using OLS, to evaluate the rate of return to an extra year of schooling. Secondly, the difference-in-differences approach is used to estimate the impact of the policy reform over the decade. This model involves education through educational attainment and the dependent variable is the logarithm of the yearly gross income, expressed in real terms. Controlling for the country, the experience, the gender and the effective working time, the difference-in-differences estimator represents the difference following the Bologna reform in the difference in income between higher education and upper secondary's graduates. This analysis is conducted at the general level, involving jointly the four countries of interest, as well as at the country level.

The thesis is structured as follows: after a brief overview of the literature on the returns to schooling's field in section 2, section 3 describes the Bologna reform as well as its effect on the higher education's structure in the countries of interest (Belgium, France, Germany and the Netherlands). Section 4 and 5 present the methodology and data used in this paper and the estimations' results are discussed in section 6. Section 7 concludes the analysis.

2. Literature review

This section starts with the presentation of two theories, Becker's theory of education as an investment and Spence's theory of education as a signal, that establish the link between education and human capital. Then comes the presentation of the most popular equation used to measure the returns to education, Mincer's equation. Some critics of this equation are discussed as well as some other determinants of the returns to education. The last part covers the impact that some policy reforms have had on the returns to education.

2.1. Education and human capital

2.1.1. Education as an investment

Gary Becker was the preeminent proponent of the research in the human capital field, starting his work around 1960. In the introduction of his first book, he justified his interest in the subject by stating: "The origin of this study can be traced to the finding that a substantial growth in incomes in the US remains after the growth of physical capital and labor has been accounted for". Becker developed an innovative theory bringing some "unmeasured features of the quality of the labor force", named human capital, into consideration (Weiss, 2015).

He published three editions of his book "Human Capital" between 1964 and 1995. In the literature, human capital is defined as "the collection of productive skills embodied in a person that can be used to generate earnings in the labor market and to augment household's consumption options" (Weiss, 2015). In a standard view, human capital increases a worker's earnings.

Becker distinguishes two types of human capital: education and training. Both are investments as they have a cost and their reward is a higher remuneration, due to a better productivity. Differences in wages are then explained by differences in productivity, which is related to the investment people make in their education and training.

In terms of training, he considers two types of training: general training and specific training. On the one hand, general learning on the job provides skills that are helpful for many firms and types of jobs. On the other hand, specific training provides specific skills that are helpful for one particular type of job. Whereas the cost of the general training is fully supported by the worker through a lower initial wage, the employer has an incentive to provide specific training to the worker and the cost of the specific training is shared between both parties.

In his theory, Becker argues that education is a source of future income only if wages reflect the marginal productivity of the worker. Education is then a source of human capital accumulation, as it provides various skills that accumulate throughout the educational journey.

The aim of empirical studies is to estimate the rate of return to education, which is the average increase in earnings resulting from an extra year of schooling. Using Census data from 1930 and 1940, Becker obtained an internal rate of return to college education of around 13 percent per year.

Becker was criticized for his work on several aspects. The first critics related to the focus on the monetary benefits to compute the rate of return from schooling. For example, Solow blamed him for not taking into consideration the non-monetary side of human capital such as psychic returns. Becker defended himself later saying that psychic benefits are difficult to measure and data are not available.

The second major debate revolved around the ability bias. Not taking into consideration some unobserved factors such as ability can lead to an over-estimation of the rate of return. This problem is an endogeneity issue that can be solved using an instrumental variable method. This issue is discussed in more detail later in this section.

2.1.2. Education as a signal

Despite viewing education as an investment like Becker's approach, Spence (1973) considered education as a signal on the labor market. The signaling theory is at odds with the human capital one, as here, education does not aim at improving the productivity of the individuals.

In this theory, the investment is the hiring decision, as its benefits take time to materialise because the employee needs some time to learn the job and sometimes, he also needs a training period. The hiring decision is made under uncertainty regarding the real productive capacities of the candidate. In this context, the employer uses some observable personal characteristics to make his decision. These characteristics are numerous and classified into two categories, the non-alterable characteristics such as the sex or the race that are called indices by Spence because the individual cannot manipulate them, and the signals that are the alterable characteristics such as education or previous professional experience.

The idea behind the theory is that individuals with the highest productive capacities are those who performed the most during their studies. Hence, the educational degree serves as an estimation of the applicant's capabilities. If the education level actually signals high potential to the employers, the individuals tend to over-educate themselves.

Whether we consider education as an investment to improve productivity (Becker's approach) or as a signal for high productive capabilities (Spence's approach), both theories argue that there is a correlation between education and earnings. The aim of the empirical estimation of the rate of return to education is to verify whether or not this correlation is a causal relation.

2.2. The Mincer's equation

Mincer worked with Becker on the human capital field. Whereas Becker's approach was theoretical, Mincer focused on the empirical aspect (Teixeira, 2014). He developed the so-called "human capital earnings function" in 1974, that uses the logarithm of the wage as the dependent variable. The controls are years of schooling and a quadratic form of the experience (Chiswick, 2003).

The popular Mincer's equation can be expressed as follows:

$$\mathrm{Ln}\ (w_i) = \alpha_0 + \alpha_1 S_i + \alpha_2 X_i + \alpha_3 X_i^2 + \varepsilon_i$$

Where w_i is the wage, S_i stands for years of schooling, X_i represents the experience (measured in years) and ε_i is the error term. In this context, the estimated parameter α_1 is the most interesting as it represents the rate of return to education. It can be interpreted as "one more year of schooling leads to an increase in the wage of β_1 or $100.\beta_1$ %".

The simple form of Mincer's equation and its extended forms have been widely used in the literature to evaluate the rate of return to education in various countries. It can also be used to estimate rates of return overtime. Hartog and Gerritsen (2016) analyzed the evolution of the returns to schooling for The Netherlands. Results from Mincer earnings function follow a U-shaped curve, with the bottom attained in the mid-1980s.

2.3. Critics of the Mincer's equation

Many authors consider the Mincer's coefficient to be biased due to endogeneity of education.

Heckman et al. (2008) proposed an alternative method to estimate the internal rate of return (IRR) to schooling, using a general nonparametric approach and compared their results with the internal rates of return obtained with the Mincer's equation. Following Heckman et al. (2008) conclusions, the coefficient from the Mincer's model can be interpreted as the internal rate of return only if several assumptions are met: linearity in the log wage-schooling relationship (which means that every year of schooling has the same return), parallelism (separability of earnings in schooling and experience components), independency between length of working life and schooling level, no income taxes nor cost of education. Heckman & al. developed a model that takes into account income taxes, tuition costs and nonlinear relationship between earnings, education and experience. Coefficients from the Mincer model seem to be biased due to endogeneity of education.

In order to avoid the endogeneity issue, several authors used instrumental variables. Angrist and Keueger (1991) used quarter of birth interacted with year of birth, Staiger and Stock (1997) used quarter of birth interacted with state and year of birth and Kane and Rouse (1995) used tuition at 2 and 4-year state college and college proximity as instruments for schooling. Others used reforms such as change in the minimum leaving school age as instrument for schooling (Harmon and Walker, 1995). Card (2001) compared different studies using institutional features of the supply side of the education system as instruments for schooling. He concluded that IV estimates are typically equal or higher than corresponding OLS estimates.

Other authors used twins to avoid to deal with the endogeneity of education, as twins' unobserved characteristics are supposed to be similar. According to Ashenfelter and Rouse (1998), the differences in the returns to education between genetically identical people are somewhat less significant than those discovered by comparing the length of education and incomes of any two random people. Their results were confirmed by Oreopoulos and Salvanes (2011), who used Norwegian data on people born since 1920 and found that the annual income of siblings who attended school one more year is on average 5.2 percent higher than that of their less educated siblings.

Bhuller & al (2017) used Norwegian panel data to compute returns to schooling over the life cycle earnings. After taking into account income taxes and controlling for endogeneity of schooling, they found an internal rate of return of around 10 percent, which is higher than with the Mincer's equation. These results confirm that Mincer's equation underestimates the rate of return to schooling.

Migali and Walker (2018) used a short panel to compute returns to education with a selection model. They acknowledged that schooling is endogenous and rejected the separability assumption. Balestra and Backes-Kellner (2017) used IVQR (instrumental variable quantile regression) on Swiss data and found that returns to schooling are heterogeneous over the earnings distribution. Those who profit the most from education are people in the lower quantiles of the wage distribution.

The literature seems to agree on the endogeneity issue, leading to biased Mincer's estimates for the returns to schooling. However, authors do not agree on the direction of the bias. Whereas the majority tend to find that Mincer's equation underestimates the internal rate of return, some find an upwards bias of the Mincer's coefficient compared to non-parametric approach that controls for ability bias (Garcia-Suaza & al., 2014).

2.4. Reforms that have impacted the returns to education

Many authors analyzed the impact of several education reforms on the returns to schooling, using different approaches. As the aim of this thesis is to estimate the impact of a specific reform on the returns to schooling, this section presents some important works in the literature to see whether educational reforms used to have a significant impact on returns to schooling in the past.

In 1960, Norway increased the number of compulsory schooling years from seven to nine years, with the aim of improving education level and attainment. Comparing two models to estimate the returns to schooling, it seems that using education as a discrete variable (by defining different education levels for example) instead of as a continuous variable (through the number of years of schooling for example) is more appropriate to study the impact of an education reform, since returns to education show a nonlinear pattern. The Roy model revealed high returns to schooling for the upper secondary and master levels (Aakvik et al., 2010).

Clark (2023) estimated the impact of the British compulsory schooling reform in 1947, increasing the minimum leaving age from 14 to 15, on several labor market variables. He found that this increase in the minimum leaving school age had a nearly zero impact on several labor market outcomes such as labor market participation, unemployment or wealth (proxied with a dummy variable based on home ownership). The result is the same in terms of earnings. Clark cannot reject the zero impact of the reform on the returns to education. He explained this surprising result by the fact that the reform affected only “lower-track” schools, which are characterized by low-quality of teaching. The students attending “higher-track” schools, which are the better schools with high-quality teaching, were not affected by the reform as they were not supposed to leave the school before 16.

In 1992, the Dutch government introduced a reform for the university level. Surprisingly, this reform did not increase the number of years of schooling like the majority of the other reforms that have been studied in the literature, but it reduced the length of the university journey from five to four years. The aim of the reform was to reduce the cost of higher education at the national level. Webbink (2007) used this reform to estimate the impact of one year of higher education on the wage in 1997. Using a difference-in-differences approach that compares wages of cohorts of graduates from the old regime and from the new regime, graduates who obtained their degree after the reform (that is in the four-years program) earned, in 1997, between 7 and 11% less than graduates who received their degree before the reform (that is in the five-year program).

Poland introduced a large education reform in 1999 in order to improve the level and the quality of education and reduce the inequalities. Among other changes, the reform increased general education by one year and changed its structure, and introduced standardized evaluations at the end of each education level. Drucker et al (2022) used a difference-in-differences approach to evaluate the impact of the Polish reform on labor market incomes. Their results showed a positive effect on both employment probability (about 3 percentage points) and the earnings (4-5% increase).

Vilerts et al. (2017) looked at the change in returns to education during and after the economic crisis in Latvia. Mincer standard and extended models, wage differentials and IV models show an increase in the returns during the crisis and a slight decrease during the few years after the crisis.

The authors seem to agree on a positive impact of an additional year of study on various labor market variables, especially on the earnings. These results make one think that the introduction of a reform that extends the duration of studies must have a significant and positive impact on earnings, at least in the first few years after graduation.

3. The Bologna process

As this thesis focuses on one specific reform, which is the Bologna process, this section presents this reform in more detail. First, the process is presented with its main objectives and then the comparison of the higher education system before and after the Bologna reform is done for the four countries analyzed in this research, which are Belgium, France, Germany and the Netherlands.

The idea of the Bologna process was first introduced by the "Joint declaration on harmonization of the architecture of the European higher education system", also called the Sorbonne declaration (Allegre et al., 1998). The Sorbonne declaration, which aim was to create a unified "European area of higher education" in order to allow students to study abroad, was signed by only four countries (France, Italy, The United Kingdom and Germany) in Paris on May 25, 1998. At the beginning, the harmonized system was composed of two cycles, undergraduate and graduate. In the undergraduate cycle, students "should have access to a diversity of programs, including opportunities for multidisciplinary studies, development of a proficiency in languages and the ability to use new information technologies". The graduate cycle is more research oriented and composed of the "shorter master's degree and the longer doctor's degree".

The objective of the Sorbonne declaration was then confirmed and reinforced with the signature of the Bologna declaration by 29 European countries in 1999. The Bologna declaration relies on the voluntary participation in the establishment of the European Higher Education Area (EHEA) by 2010 in order to bring more coherence and improve the competitiveness of the higher education systems across Europe.

The reform is based on six pillars: "

1. Adoption of a system of easily readable and comparable degrees
2. Adoption of a system essentially based on two main cycles, undergraduate and graduate
3. Establishment of a system of credits (such as in the ECTS[1])
4. Promotion of mobility by overcoming obstacles to the effective exercise of free movement for students, teachers, researchers and administrative staff
5. Promotion of the European cooperation in quality assurance with a view to developing comparable criteria and methodologies
6. Promotion of the necessary European dimensions in higher education"

(The European Higher Education Area, 1999).

The effective implementation of the Bologna objectives has been assessed on a regular basis through various ministerial conferences. The first one took place in Prague in 2001, two years after the signature of the Bologna declaration, and brought together the European Ministers in charge of higher education from 32 countries. In the release, the Ministers pointed out the importance of considering higher education as a public good and a public responsibility. They also emphasized the social dimension of the process, as the aims of the European Higher Education Area is to make Europe a competitive and "knowledge-based" economy by enhancing the social cohesion and reducing the social inequalities, providing access to higher education to all students, regardless of their background. In every meeting, the Ministers reaffirmed the need to involve all stakeholders, including the students, in the process.

[1] The European Credit Transfer and Accumulation System is a tool in the EHEA aiming at making studies more transparent and facilitating student mobility.

The second meeting took place in Berlin in 2003 and gathered Ministers from 33 countries. One major agenda item related to the recognition of degrees. They "set the objective that every student graduating as from 2005 should receive the Diploma Supplement[2] automatically and free of charge. It would be issued in a widely spoken European language." This meeting also revised the structure of the system by introducing the doctoral degree, corresponding to three or four years full-time, as the third cycle of the European Higher Education Area, emphasizing the key role of the research in the knowledge-based society.

The Bergen meeting (2005) noticed the efforts made to achieve the objectives of the Bologna declaration, especially the implementation of the two (three) cycles system, but pointed out the lack of employability of graduates from the first cycle. At the time of the meeting, 36 of the 45 signatories had endorsed the Lisbon Recognition Convention (the "Convention on the recognition of qualifications concerning higher education in the European Region"), which requires fair recognition of academic qualifications.

The following meeting took place in London in 2007 and redefined the Bologna objectives in order to respond to the challenges of globalization. They notably stressed the recognition aspect as "easily readable and comparable degrees and accessible information on educational systems and qualifications frameworks are prerequisites for citizens' mobility and ensuring the continuing attractiveness and competitiveness of the European Higher Education Area." In a globalization context, the social aspect took an even more key role, as immigration must be taken into account. The strategy "The European Higher Education Area in a Global Setting" therefore required to build a knowledge and culture-based society, reflecting the diversity of the European population.

The Leuven meeting (2009) confirmed the objectives already set up by the previous conferences and settled the priorities for the following decade, taking into account the financial crisis that emerged in 2008. In a changing economy and labor market, focus is placed on "student-centred learning" and mobility, including the use of new technologies. The purpose of higher education is to prepare students for another cycle of studies, for the labor market and for their lives as citizens.

The Budapest/Vienna committee (2010) saw the official launch of the European Higher Education Area as an "unprecedented example of regional, cross-border cooperation in higher education". The following meetings (Bucharest, 2012; Yerevan, 2015; Paris, 2018 and Rome, 2020) reported on the progress made to improve the European Higher Education Area and reach its initial goals as well as responding to various new challenges that Europe is facing, such as economic crisis, demographic changes, migration or conflicts between countries. For the second decade, the main goals are to further improve the quality of higher education, namely using digital technologies, to further facilitate and encourage the mobility of students, learning staff and researchers, to reinforce cooperation between institutions and to consolidate collaboration between learning, innovation and research programs.

The Rome committee (2020) defined the vision for the European Higher Education Area by 2030. The Ministers "commit to building an inclusive (because every learner will have equitable access to higher education and will be fully supported in completing their studies and training), innovative (because it will introduce new and better aligned learning, teaching and assessment methods and practices, closely linked to research) and interconnected (because our shared frameworks and tools will continue

[2] "The diploma supplement is a document attached to a higher education diploma. It gives a detailed description of its holder's learning outcomes, and the nature, level, context, content and status of individual study components. […] It is free from any value judgements, equivalence statements or suggestions about recognition."

The European Higher Education Area. (2018, January 29) to facilitate and enhance international cooperation and reform, exchange of knowledge and mobility of staff and students) EHEA by 2030, able to underpin a sustainable, cohesive and peaceful Europe."

The impact of the Bologna process on the returns to higher education was estimated by Glauser et al. (2019), using longitudinal data over the period from 2006 to 2016 in Switzerland. Based on the job market signaling theory, they found a monetary advantage for a person entering the labor market with a master's degree rather than with a bachelor's degree one year after graduation (4% for women and 14% for men). This advantage is persistent as it reaches 13% for women and 12% for men five years after graduation. The explanation relying on the signaling theory is that a bachelor's degree delivered a noisy signal on the labor market as it represented uncertainties (before the Bologna process, there was no equivalent degree of the new bachelor's degree).

3.1. The higher education systems

The following section compares the higher education system[3] before and after the implementation of the Bologna reform in four countries, which are Belgium, France, Germany and the Netherlands. This comparison helps to see which impact the reform has had on the structure of higher education in these countries.

3.1.1. The Belgian higher education system

With the third state reform in 1988, education was transferred to the communities' competences. In Belgium, there are three communities: the Flemish community, the French community and the German-speakers community, but only two of them are in charge of higher education, the German-speakers typically enrolling either in the institutions in the French community or in Germany. Despite the separation of systems by community, institutions from the French community and the Flemish community have the same pattern.

Before the Bologna process

Prior to the implementation of the Bologna process, the Belgian higher education system was split into two types of institutions: universities and university colleges (*Hautes écoles* in French or *Hogescholen* in Dutch). Whereas universities offered two-cycle and doctorate courses, university colleges offered one- and two-cycle (short and long type) courses, one cycle representing two to four years, depending on the field of study (Verhoeven & Beuselinck, 1996).

The system offered the following degrees:

- The graduate qualification, which was received at the end of a one-cycle program in the university college (typically 3 years of study).
- The candidature degree, which was given at the end of the first cycle in a university or a university college offering two-cycle courses (typically 2 years of study, 3 for medicine). The candidature degree was not used on the labor market, it only served to access the second cycle of study.
- The licentiate qualification, which was delivered at the end of the second cycle (typically 2 years of study, except for medicine, vets, pharmacists and engineers).
- Doctorate degree was delivered only by universities at the end of a doctoral thesis.

[3] This section presents higher education institutions from the general education. Colleges of Arts or Music are specific cases and not mentioned in this thesis.

After the Bologna process[4]

The Belgian higher education system was reshaped in order to comply with the Bologna declaration signed in 1999. Education and in particular higher education is still a communities' competence, but the structure is still similar across the communities.

There still exists two types of institutions, universities and university colleges.

The system offers the following degrees:

- The Bachelor's degree, which is delivered at the end of the first cycle for the long-type programs or at the end of the short-type program. It can be academic (leading to the master's program) or professionally oriented (leading directly to the labor market) and is obtained after 180 ECTS[5], which typically represent three years of study (or 240 ECTS / four years for specific fields).
- The Master's degree, which is obtained at the end of the second cycle of study. It represents 120 or 60 ECTS (180 for medicine or veterinary programs) and gives access to an advanced master's degree, the third (doctorate) cycle or to the labor market.
- The doctorate degree, which is awarded on the completion of a doctoral thesis.
- From the academic year 2019-2020, the Flemish community added a short-cycle program, leading to the associate degree. This program is recognized as ISCED level 5[6].

In Belgium, the reshaping of the structure of the system started in September 2004, but the new three-cycle structure was fully implemented for the academic year 2007-2008.

3.1.2. The French higher education system[7]

This section compares the higher education system before and after the implementation of the Bologna process.

Before the Bologna process

In France, the reform of the programs took place in 2006. The period "before the Bologna process" therefore means the period prior to 2006. The structure was divided into short courses and long courses.

For the short courses, the following degrees of ISCED level 5 were delivered:

- The higher technical diploma (BTS - *brevet de technicien supérieur* in French*)*, which was delivered after two years in a STS (*section de techniciens supérieurs)*, a section in some *Lycées* that offers higher education programs in some specific and precise functions in the sectors of industry and services. The BTS led either to the labor market or to another year of study in order to obtain the national diploma in specialized technology (DNTS – *diplôme national de technologie spécialisé).*

[4] Source: European Commission. (n.d.b). *Overview.* Retrieved July 8, 2023, from https://eurydice.eacea.ec.europa.eu/national-education-systems

[5] European Credit Transfer and Accumulation System

[6] International Standard Classification of Education. As a matter of comparison, bachelor and master' degrees are classified at the ISCED level 6 and 7.

[7] This section is based on the report from the CHEPS (center for higher education policy studies) (Kaiser, 2007).

- The university diploma of technology (DUT – *diplôme universitaire de technologie)*, which was delivered after two years in a university institute of technology (IUT - *institut universitaire de technologie).* DUT-holders could either enter the professional life or make another year of study and obtain the national diploma in specialized technology (DNTS) or further continue their studies in a university or another institution.
- The diploma of scientific and technical university studies (DEUST – *diplôme d'études universitaires en sciences et techniques)*, which was delivered after two years and prepared students for direct entry into the labor market.

The long courses were organized by the universities and university colleges (*Grandes écoles)* into three cycles, leading to the following degrees:

- The general university diploma (DEUG – *diplôme d'études universitaires générales),* awarded at the end of the first cycle, which comprises two years of study. The DEUG was regarded as the second cycle's prerequisite diploma.
- The second cycle courses were split into general and professional programs.
    - The *Licence* (DEUG+1) was given after one year of the general program and the *maîtrise* (*Licence*+1) was given after the second year of the general program. Both degrees allowed the holders to enter the professional life.
    - The one-year professional program led to the *Licence professionnelle*, which led to the labor market.
    - The two-year professional program led to the *maîtrise* diplomas. There existed three types of *maîtrise*: the *maîtrise* in sciences and technology (MST), the *maîtrise* in management sciences (MSM) and the *maîtrise* in management informatics (MIAGE – *maîtrise de méthodes informatiques appliquées à la gestion)*.
    - The three-year professional program led to the *magistère* diploma and was available for a limited number of students only.
- The academic third cycle led to the DEA (*diplôme d'études approfondies)* after one year. The DEA was seen as a prerequisite for the Doctorate, which typically took three to four years. The highest academic degree was the *habilitation à diriger des recherches* (HDR), which was a prerequisite to teach at the university.
- The professional third cycle led to the DESS (*diplôme d'études spécialisées)* or the technical research diploma (DRT - *diplôme de recherche technologique)* for the engineer's graduates. These programs took one year and focused on applied research.

<u>After the Bologna process</u>

In order to comply with the Bologna declaration signed in 1999, the structure of the higher education system was reorganised. The new structure, called LMD-structure has been in place in the universities and the *Grandes écoles* since the academic year 2006-2007. The LMD-structure is organized into three cycles as follows:

- The first cycle is awarded with the Licence's degree, which is the French equivalent of the Bachelor. It takes three years and replaces the previous two-years DEUG and the one-year Licence programs. Despite the implementation of the LMD system, France still offers certain intermediate diplomas. The professional licence was reformed and mixed with the DUT. The new professional licence is a program of one to three years that leads to the university bachelor of technology (BUT – *bachelier universitaire de technologies),* recognized ISCED level 6. The

DUT is still available as an intermediary degree and the BTS is also still delivered after two years in a STS[8].

- The second cycle takes two years and is awarded with the master's degree. There are two types of master's programs: the research master, which replaces the previous *maîtrise* and the first year of the DEA, and the professional master, which replaces the previous *maîtrise* and the first year of the DESS.
- The doctorate is delivered at the end of the third cycle, which comprises three years of study and research. The doctorate's program is directly available for research master's holders and professional master's holders can access it if they meet specific conditions.

3.1.3. The German higher education system[9]

In Germany, higher education is a competence of the states (*Länder)* and comprises three types of institutions: the universities, the colleges and the universities of applied sciences (*Fachhochschulen)*. The structure of higher education was reshaped following the Bologna declaration.

<u>Before the Bologna process</u>

Before the implementation of the three-cycle system, German higher education was structured as follows:

- The *Diplom* was delivered after four or five years of study in a university of applied sciences (*Fachhochschule)* or in a university.
- The *Magister* was also delivered after four or five years of study in a *Fachhochschule* or in a university. The difference with the *Diplom* is that the *Diplom* focused on one main subject, whereas the *Magister* combined several subjects.
- Some studies (e.g. medicine, dentistry, law, education, …) required a state examination to allow the graduates to practice in the professional life.

<u>After the Bologna process</u>

Germany signed the Bologna declaration in 1999 and started to reform the structure of higher education in 2002. This transformation took time and Germany expected to fully implement the three-cycle structure by 2010. Since then, German higher education has been structured as follows:

- The first cycle is closed with the Bachelor's degree after three years of study in the university or in the *Fachhochschule*. The courses mostly take three years, but a large majority of the bachelor's programs take seven semesters (three years and a half) because *Fachhochschule* include an internship semester without losing time for courses.
- The second cycle is closed with the Master's degree after two years of study in the university or in the *Fachhochschule* (sometimes more for specific fields of study). Given that the bachelor's programs are one semester longer in the *Fachhochschule*, the Master's programs offered by the *Fachhochschule* often take three semesters (one year and a half) instead of four.
- Despite the implementation of the three-cycle system, some German institutions still deliver *Diplom* and *Magister* degrees. These degrees tend nonetheless to be replaced fully by the traditional Bachelor-Master programs and disappear.

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[8] Source: *Formation générale*. (2022). Étudiant.gouv. https://www.etudiant.gouv.fr/fr/formation-generale-544.

[9] This section is exclusively based on the report from the CHEPS (center for higher education policy studies). Kaulisch, M., & Huisman, J. (2007). *Higher education in Germany*. (Country report; No. C7-016). Center for Higher Education Policy Studies (CHEPS). http://www.utwente.nl/mb/cheps/publications/

- The third cycle is closed with the doctorate. As in the other countries, only universities are allowed to deliver doctorate degrees. It is therefore not possible to obtain a doctorate in a *Fachhochschule*.

3.1.4. The Dutch higher education system[10]

In the Netherlands, the higher education institutions are split into the WO sector (universities) and the HBO sector (professional higher education institutions).

Before the Bologna process

Before the implementation of the Bologna process, Dutch higher education was regulated by the "Higher Education and Research Act (WHW)" and was structured as a one-cycle system. The degrees delivered were:

- The *doctorandus (drs.)*, the *ingenieur (ir.)* or the *meester (mr.),* which were delivered at the end of the studies in a university, depending on the field of study (ir was delivered to the engineers, mr was for the law program and drs was for the other fields of study). They all allowed the holders to enter in the PhD program in order to obtain the title of doctor.
- The *bac* or the *ingenieur* (ing.) were delivered at the end of the studies in a *hogescholen,* which is a higher education institution in the HBO sector and that is similar to the university college.

After the Bologna process

The Netherlands signed the Bologna Declaration in 1999 and started to introduce the Bachelor-Master system in 2002. Since then, the following degrees have been delivered:

- The Bachelor is delivered at the end of the first cycle. It generally takes three years in the university and four years in the HBO sector (*hogescholen)*. Both allow the holders to enter the labor market or to continue their studies.
- The Master is delivered at the end of the second cycle, which takes one or two years in the university and in the HBO sector.
- The doctorate is delivered at the end of the third cycle in the university. Like in the other countries, only universities are allowed to offer PhD programs.
- The associate degree is a short-type program and is delivered after two years in a *hogeschole* (European Commission, n.d).

Despite the introduction of the two-cycle Bachelor-Master system, the previous degrees are still sometimes delivered by the Dutch higher education institutions in addition to the Master's degree.

Comparing the four countries, it appears that the implementation of the three-cycle program started and finished at different times. Regarding the structure of higher education, the major effect of the Bologna process was to extend the student journey in the university by a year. A diagram illustrating the structure of the higher education system before and after the reform for each country can be found in appendix.

[10] This section is exclusively based on the report from the CHEPS (center for higher education policy studies). de Weert, E., & Boezerooy, P. (2007). *Higher education in the Netherlands. Country report*. (International higher education monitor). Center for Higher Education Policy Studies (CHEPS). https://ris.utwente.nl/ws/portalfiles/portal/5148438/Weert07netherlands.pdf

4. Methodology

This section sets out the empirical methodology that is used to test whether or not the Bologna reform had an impact on the rate of return to education of the graduates. First of all, the basic Mincer's equation is recalled and extended. Then, the estimation method, which is the difference-in-differences approach, is presented and the final equation is modeled.

4.1. Mincer's approach

As previously indicated, the most popular equation used to estimate the rate of return to education is the Mincer's equation that considers the logarithm of wage as the dependent variable and uses the professional experience and the years of schooling as controls. The basic equation can be expressed as:

$$\ln(w_i) = \alpha_0 + \alpha_1 S_i + \alpha_2 X_i + \alpha_3 X_i^2 + \varepsilon_i$$

Where w_i represents the wage of individual i, S_i is the number of years of schooling, X_i represents the professional experience and ε_i is the error term.

As explained in section 2, this equation has been widely criticized in the literature due to the endogeneity issue. This means that one explanatory variable is correlated with the error term (which contains all unobserved factors that affect the dependent variable), leading to biased estimated coefficients (Wooldridge, 2015). In this case, education is shown to be endogenous, as ability, which is unobserved and therefore included in the error term, may have an impact on the years of schooling. Indeed, students with lower ability capacities tend to stop their studies earlier than those who have the higher ability capabilities. This typical issue is called the ability bias and can be solved using instrumental variables (IV).

Many variables have been tested as instruments in the literature such as the quarter of birth, siblings, parents' education or a structural reform regarding the education system. In this thesis, only quarter of birth is tested as there is no information about siblings and information about parents' education is poor in the dataset.

Using instrumental variables can help to avoid the ability bias, but the estimation could lack of significance as the wage is determined by a range of other factors than simply the years of schooling and the experience. In order to increase the power of the overall estimation, an extended form of the Mincer's equation is used by adding several covariates such as the year of the survey, the country, the gender and different measures of the time people actually worked (the usual number of hours worked per week as well as the number of months they worked full-time or part-time during the previous year).

The significance of the different variables is tested as well as their squared forms and some interaction terms, using several t-tests.

4.2. The difference-in-differences approach

The purpose of this thesis is to estimate the impact of the Bologna reform on the returns to higher education over the last decade. In other words, it is a policy analysis as the Bologna reform reshaped the structure of the higher education system in several countries. The estimation method is therefore chosen to be adapted to such an analysis.

The difference-in-differences (diff-in-diff) estimator is widely used for policy analysis as it provides an estimation of the effect of a specific event, considered to be a natural experiment[11], on the dependent variable over a certain period. The method consists in splitting the sample into two categories. The control group is composed of individuals who were not affected by the event and the treatment group represents the individuals who were affected by the event. The method requires two periods of data[12], one before the event and one after the event. Each group is then split into the "before" and "after" groups regarding the time of the event, leading to four categories: the control group before and after the change and the treatment group before and after the change. To split the sample into these four categories, a dummy variable is created for the time period and another dummy variable is needed to differentiate between individuals who belong to the control group and those who belong to the treatment group.

In this case, let's create the dummy *y2*, which is equal to zero for the "before" period (first period) and one for the "after" period (second period), and the dummy *higheduc*, which is equal to zero for the control group and one for the treatment group. As the Bologna process reformed the higher education system in the participating countries, people whose higher diploma corresponds to upper secondary school were not affected by the reform. The control group is therefore composed of these people, whereas the treatment group represents the individuals who continued their studies and obtained a degree from higher education. The aim of this estimation is to evaluate the difference in the income regarding the highest degree individuals obtained (higher education or secondary education), before and after the reform.

The model to be estimated is thus of the following form:

$$\ln(w_i) = \beta_0 + \delta_0 y2 + \delta_1 higheduc + \delta_2 y2.higheduc + \beta Z + \varepsilon_i$$

Where Z is a vector of controls including the country, the gender, the experience and its quadratic form as well as different measures of the working time (the number of hours individuals generally work per week and the number of months they worked full-time or part-time during the previous year). The instrument *quarter of birth* is also tested to avoid the endogeneity issue of the education variable "*higheduc*" and some interaction terms are added to allow the marginal effects to evolve over time or across countries.

The coefficient of interest is δ_2, as it represents the difference in the wage between the treatment and the control groups, after and before the event. δ_2 is the difference-in-differences estimator, which measures the effect of the reform. The following table illustrates the difference-in-differences estimator.

Table 1: Decomposition of the diff-in-diff estimator

	Before	After	After - before
Control	β_0	$\beta_0 + \delta_0$	δ_0
Treatment	$\beta_0 + \delta_1$	$\beta_0 + \delta_0 + \delta_1 + \delta_2$	$\delta_0 + \delta_2$
Treatment - control	δ_1	$\delta_1 + \delta_2$	$\boldsymbol{\delta_2}$

Source: Wooldridge, 2015 p.411

[11] "A natural experiment occurs when some exogenous event – often a change in government policy – changes the environment in which individuals, families, firms or cities operate." (Wooldridge, 2015 p.410).

[12] The difference-in-differences method can be applied on either a panel dataset or on a dataset composed of independently pooled cross sections.

5. Data

This section presents the dataset used to estimate the models explained in the previous section. The variables used in the models are defined and some interesting descriptive statistics are also given to better understand the data.

Data used in this thesis come from the EU Statistics on Income and Living Conditions (EU-SILC) from 2005 to 2017. This survey is conducted on an annual basis and provides information on income and living conditions at the household level, but also information at the individual level, such as education, labor status and earnings. In the context of this research, only personal data are used for the four chosen countries: Belgium, France, Germany and the Netherlands.

The diff-in-diff method requires to select two periods of data in order to estimate the effect of a specific event. As presented in the section 3.1, the Bologna process was implemented at different times in the four countries. However, it seems that in 2008, it was fully implemented in Belgium and in France, whereas it was already highly developed in Germany. 2008 is therefore considered to be the year of the implementation of the Bologna reform across European countries. The time periods selected in the analysis are thus chosen to be before and after 2008. Firstly, 2005 is chosen as the first year of the first period as it is the first year for which data is available for the four countries of interest. The “before” period is then extended to increase the size of the sample and contains the years 2005, 2006 and 2007. Secondly, the first “after” year is chosen to be ten years later, which is 2015 and the period also contains three years of data, which are 2015, 2016 and 2017. This large window may allow to see a real evolution in the returns to schooling.

The original sample of the EU SILC survey is composed of people aged 16 and over living in the European Union. Restricting the sample for the purpose of this research, only working people, and more precisely, only people who declare themselves as employees with a minimum education level (upper-secondary level) are kept. People are then selected regarding the year of their graduation. As 2008 is regarded as the implementation year of the Bologna structure, people who graduated between 2008 and 2013[13] belong to the “after” sample, which gives a six-year period of time. Keeping this same six-year window, the “before” sample is composed of people who graduated between 1998 and 2003. Finally, the sample is restricted regarding the age of individuals. People aged 34 and higher are dropped in order to observe the individuals into the same age bracket. The final sample contains 18,160 individuals, who are employees aged between 18 and 33, owning at least a degree from the upper secondary school.

Table 2 shows the composition of the sample by country regarding the four categories created and table 3 describes the full dataset.

According to table 2, the size of the sample is relatively similar across countries, which allows for country comparison. However, regarding the composition of the treatment and control groups, some differences appear, especially for Belgium and Germany. Indeed, the Belgian treatment group is composed of almost twice the number of individuals of the Belgian control group and the reverse occurs in the German control and treatment groups. These differences in the samples’ size may be an issue in the estimations at the country level.

[13] 2013 is kept as the upper limit because the survey in 2015 gives the income for the year 2014. It is therefore necessary to limit the year of graduation before 2014.

Regarding the full dataset, individuals are observed within the same age bracket (18 – 33). These people were aged between 16 and 31 when they obtained their highest degree. Surprisingly, some of them obtained their first job before completing their studies, which can be explained by the work-study programs. Students who attended this type of programs split their time between studying at school and working in a company. Concerning the professional experience, observed individuals count up to 25 years of experience, which is quite high. Moreover, some have zero years of experience, meaning that they had not yet completed a year on the job market, but only a few months at the time of the interview.

Table 2: Composition of the sample by country

	BELGIUM			FRANCE			GERMANY			NETHERLANDS			TOTAL		
	Control	Treatment	Total	Control	Treatment	Total	Control	Treatment	Total	Control	Treatment	Total	Control	Treatment	Total
Before	723	1,118	1,841	1,468	1,502	2,970	1,629	750	2,379	1,286	1,263	2,549	5,106	4,633	9,739
After	516	992	1,508	966	1,286	2,252	1,393	848	2,241	973	1,447	2,420	3,848	4,573	8,421
Total	1,239	2,110	3,349	2,434	2,788	5,222	3,022	1,598	4,620	2,259	2,710	4,969	8,954	9,206	18,160

Source: own elaboration with data from EU SILC

Table 3: Descriptive statistics

Variable	Observations	Mean	Std. dev.	Min	Max
Year	18,160	2010.637	5.0266	2005	2017
Quarter of birth	8,571	2.477	1.1000	1	4
Year of birth	18,160	1983.192	5.6633	1972	1997
Female	18,160	0.510	0.4999	0	1
Age	18,160	27.444	3.1568	18	33
Year when highest ISCED level was attained	18,160	2005.292	5.3147	1998	2013
Age when highest ISCED level was attained	18,160	22.099	2.8317	16	31
Age when obtained first job	14,746	20.974	3.0342	14	34
Experience	14,773	5.757	3.2844	0	25
Weekly worked hours	18,046	36.692	8.951	1	99
Months worked part-time during the previous year	18,128	2.104	4.325	0	12
Months worked full-time during the previous year	18,128	8.943	4.9189	0	12
Months of unemployment	18,128	0.351	1.5220	0	12
Net income for the previous year	9,319	17,445.51	8,326.336	0	77,700
Gross income for the previous year	18,160	24,994.52	13,435.03	12	99,343
Gross monthly earnings for the previous year	459	2,044.116	687.5372	322	5,000
Father's isced level	1,382	3.216	1.5020	0	5
Mother's isced level	1,459	2.9753	1.4057	0	5

Source: own elaboration with data from EU SILC

5.1. The dependent variable

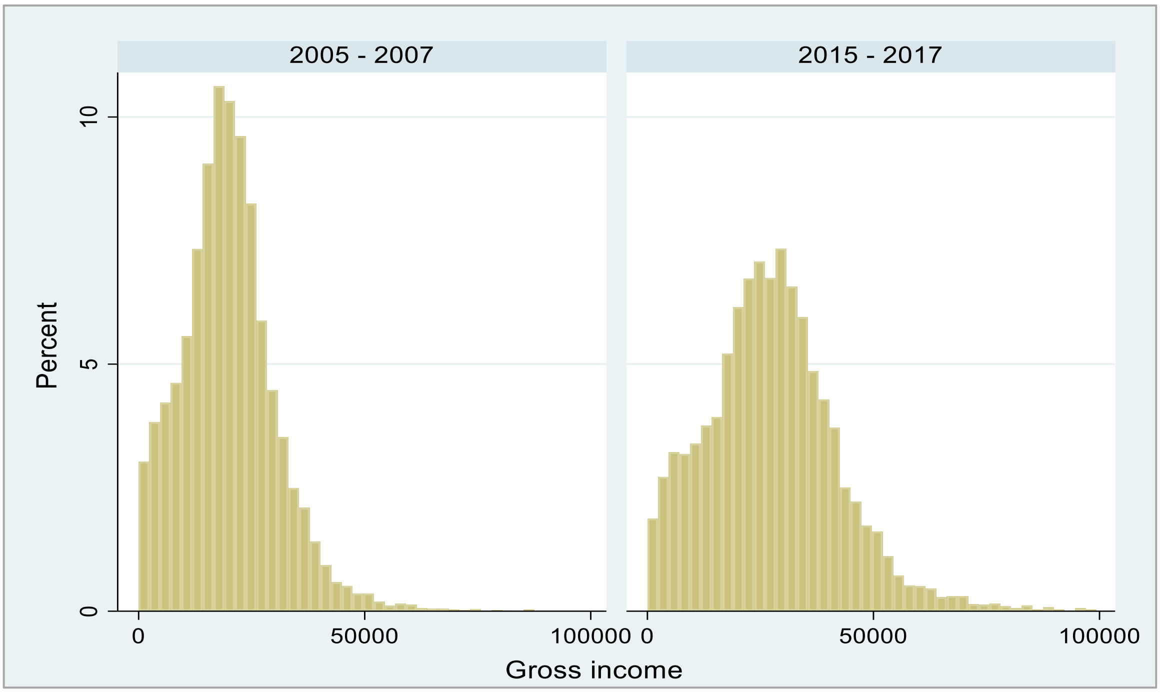
The dependent variable in the model is the wage in its logarithmic form, which is measured with the annual gross income. As shown in table 3, the EU SILC survey provides information for the gross and the net income, but information is more complete for the gross income (19,017 observations) compared to the net income (9,788 observations). This is why the gross income is chosen as the dependent variable. In gross terms, returns to education can be interpreted as the amount the employers are ready to pay to have an employee with an extra degree (or an extra year of education for the Mincer's approach).

Figure 1 presents the distribution of the annual gross income by period. The amounts for the yearly gross income are given in real terms, using consumer price indexes from OECD Data (n.d.), to take the inflation into account and avoid any kind of bias due to the different rates of inflation in each country.

The biggest evolution revealed by the figure is that the proportion of individuals in the first half of the distribution sharply decreased over time while those who belong to the highest part of the distribution increased slightly, which leads us to think that income may have increased over the decade.

Indeed, the mean gross income for the first period was €19,937.27 and increased to €27,676.11 in the second period, representing a €7,738.84 increase over ten years. Computing the monthly equivalent (supposing that individuals worked twelve months in the year), this represents an increase of €644.90 per month, which is a great rise in real terms regarding the long period of time.

Figure 1: Distribution of the gross income by period



Source: own elaboration with data from EU SILC

5.2. The independent variables

5.2.1. Education

Firstly, the independent variables include education, as the subject of this thesis deals with the returns to education. In the EU SILC survey, education is measured through the highest level of education that has been attained, using the International Standard Classification of Education (ISCED), which is described in table 4.

Table 4: *ISCED 1997*

ISCED level	Name of the level
0	Pre-primary education
1	Primary education First stage of basic education
2	Lower secondary education Second stage of basic education
3	(Upper) secondary education
4	Post-secondary non-tertiary education
5	First stage of tertiary education (not leading to an advanced research qualification)
6	Second stage of tertiary education (leading to an advanced research qualification)

Source: Unesco (2006)

Following the Bologna declaration, the ISCED nomenclature was revised to include the new structure of the higher education system. The ISCED 2011, which is still used, contains nine levels as the tertiary education is more detailed (level 5 for short cycle tertiary education, level 6 for bachelor or equivalent, level 7 for master or equivalent and level 8 for doctorate or equivalent).

This classification can also be used at the aggregated level, where levels from 0 to 2 are considered to be "low education", levels 3 and 4 are "medium education" and "higher education" contains all levels from level 5 (from 5 to 6 for ISCED 1997's nomenclature and from 5 to 8 for the new classification) (Eurostat). Table 5 shows the composition of the sample regarding the level of education for each country.

Table 5: Composition of the sample by level of education and by country

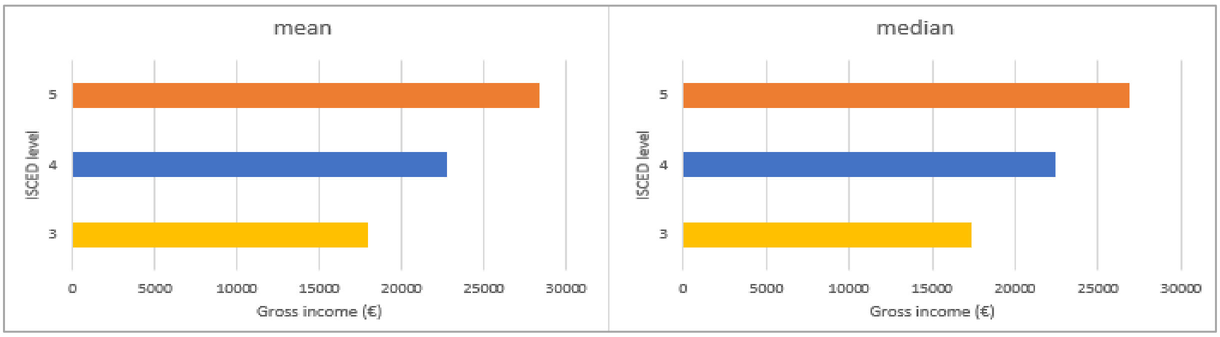
ISCED level	BE	DE	FR	NL	Total
3	1,051	2,119	2,434	2,174	7,778
4	188	903	0	85	1,176
5	2,110	1,598	2,788	2,710	9,206
Total	3,349	4,620	5,222	4,969	18,160

Source: own computations with data from EU SILC

Figure 2 compares the mean and the median value of the gross income for the different levels of education. Unfortunately, all individuals, whose level of education was higher than ISCED level 5, are grouped together in the original dataset in category 5. Level of education 5 therefore contains all individuals who owned a degree from the higher education system, regardless of the type of the degree (bachelor's, master's or doctorate's).

Comparing level of education 3 and 4, the gross income varies slightly for both the average (€4,855.90) and the median (€5,0466.59) yearly income. Owning a higher education's degree over an upper secondary's degree has a greater effect on both the average (€10,445.49 more) and the median (€9,437.40) yearly gross income. In monthly terms (still supposing that people worked twelve months per year), individuals who owned a degree from higher education earned on average €870.46 more than those who possessed the upper secondary diploma.

Figure 2: Mean and median gross income per ISCED level

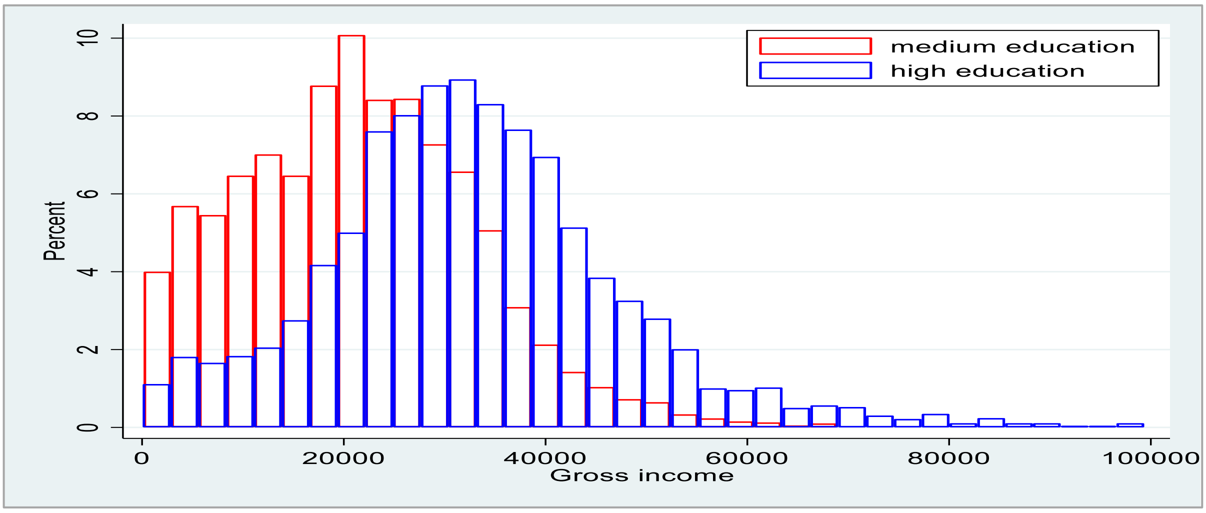


Source: own elaboration with data from EU SILC

This education variable is then used to differentiate individuals who stopped their studies at the end of the upper-secondary cycle (ISCED level 3 or 4) with those who continued their studies into the higher education system (from ISCED level 5). The distribution of the population across the level of education is as follows: 8,954 individuals owned a degree from the medium education system and 9,206 possessed a diploma from the higher education system.

Figure 3 depicts the whole distribution of the gross income for both individuals who owned a higher education's degree and those who owned only a medium education's degree for the second period of time. Comparing both distributions, it appears that the majority of individuals who possessed a medium education's degree are grouped together in the lower part of the distribution, whereas those who entered the higher education cycle are more dispersed throughout the whole distribution, with the majority being spread over the middle of the distribution.

Figure 3: Gross income distribution by education level (2015-2017)



Source: own elaboration with data from EU SILC
Note: the "medium education" group contains individuals whose level of education was either ISCED level 3 or 4, whereas the "higher education" group contains individuals whose level of education was ISCED level 5 or more.

These results confirm that having a higher education's degree may have a positive impact on the real income.

The EU SILC database contains however no information regarding the years of education like the Mincer's equation requires. It is nevertheless possible to approximate it with the age at which individuals attained their highest level of education. This measure of education in years is used in the estimation of the Mincer's model.

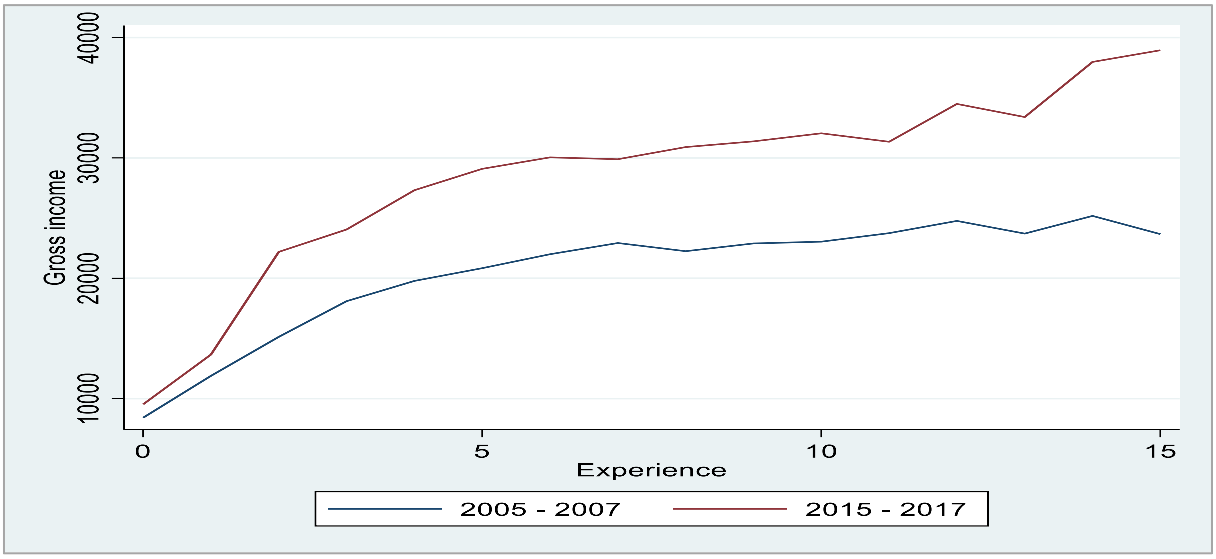
5.2.2. Experience

The second variable of interest in the model is the variable "experience", which represents the length of the professional career of individuals. The EU SILC survey provides this information with the variable that measures the "number of years spent in paid work". The variable which reflects the age of individuals when they began their first regular job also gives information on the professional experience, although it is less accurate than the previous one. Indeed, some individuals may have taken a break in their professional careers and measuring the experience through the age at which people obtained their first regular job does not take this type of career interruptions into account. The experience variable used in the estimations is therefore the "number of years spent in paid work".

The experience is included in the model as a control variable as it may influence the income. Indeed, the income is expected to increase with the experience on the labor market. Figure 4 illustrates the link between the gross income and the experience measured in years, during the first and the second periods. The relationship follows a concave curve, meaning and confirming that income increases with the experience on the labor market, at a decreasing rate, which makes us expect a positive coefficient for the experience, but a negative one for its quadratics in the estimations.

It also appears that the slope is steeper for the first years in the first period than in the second one, meaning that returns to the first years of experience increased over time.

Figure 4: Gross income by years of experience



Source: own elaboration with data from EU SILC
Note: the relationship is designed by computing the average income for each value of experience, in both periods of time.

5.2.3. Gender

Thirdly, as the existence of a gender pay gap has been widely demonstrated in the literature (see Boll and Lagemann, 2019), including a gender variable is necessary to capture this effect. The sample contains 8,892 men and 9,268 women.

The gender pay gap means that, everything else being equal, female workers earn less than male workers for the same job. Table 6 compares the mean gross income for men and women per country. On average, women earned €3,657.89 less than men, which represents a gap of €304.82 per month (considering that people worked twelve months per year). The amount of the gap is not the same in all countries and according to the table, the French labor market seems the most egalitarian, whereas the German and Belgian ones show higher gender pay gaps. This phenomenon is commonly explained by women's tendency to work more part-time than men, and have more frequent career interruptions than men (Vara, 2013).

Table 6: Mean gross income per gender and per country

	BE	FR	DE	NL	Total
Male workers	28,896.93	21,027.75	25,539.94	27,818.81	25,392.67
Female workers	23,737.06	18,620.48	20,767.82	24,308.84	21,734.78
Gender pay gap	5,159.87	2,407.27	4,772.12	3,509.97	3,657.89

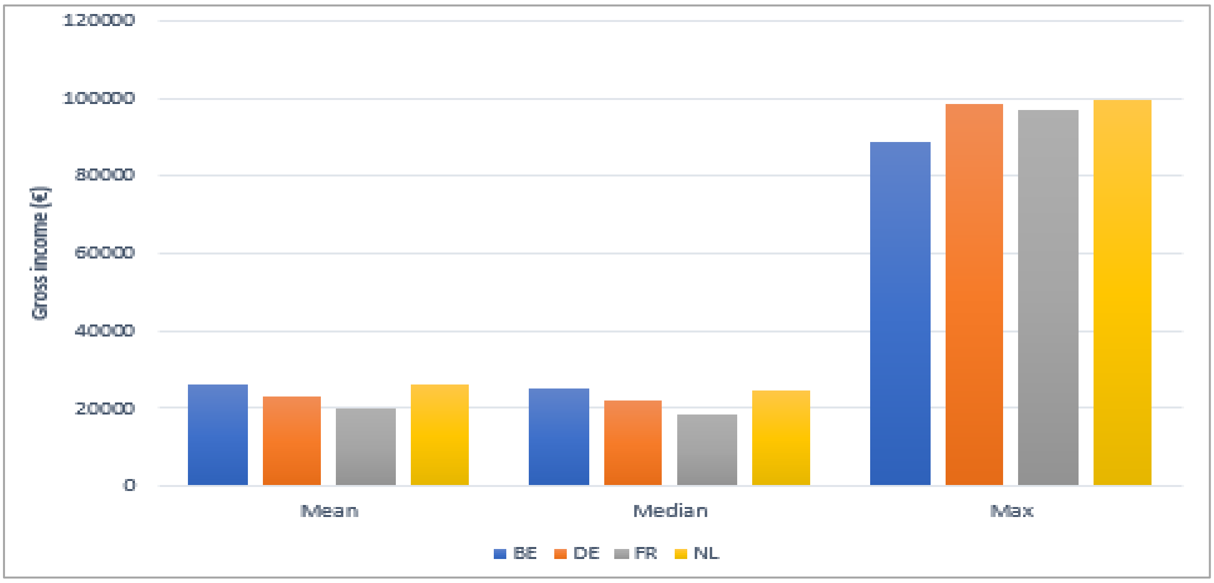
Source: own computations with data from EU SILC
Note: data are given for the whole sample

5.2.4. Country

It is also necessary to include a variable regarding the country of interest as the salary may differ across countries. Belgium was chosen as the first country of interest and then France, Germany and the Netherlands were added firstly to extend the dataset and secondly because they are Belgium's neighbors. Luxembourg was excluded due to the limited information provided in the database. The distribution of the sample across countries is as follows: 3,349 individuals live in Belgium, 4,620 in Germany, 5,222 in France and 4,969 individuals in the Netherlands.

Figure 5 compares the average, the median and the maximum values of the gross income regarding the four countries. It appears that Belgium provided the better income, whereas France may be the less generous in terms of salary (French individuals earned on average €6,386.05 less than Belgian workers, which represents a difference of €532.17 per month, supposing that people worked twelve months in a year). Moreover, working in Belgium or in the Netherlands seems to be equal in terms of salary, as the median and the average values are almost the same (Belgian individuals earned on average €279.94 more than Dutch workers per year, or €23.33 on a monthly basis).

Figure 5: Mean, median and maximum gross income per country



Source: own elaboration with data from EU SILC

5.2.5. Working time

Finally, it is relevant to control for the time individuals actually worked. Indeed, the effective time of work is one of the most influencing factors for determining the income. The EU SILC survey provides this information through different measures.

Firstly, the number of hours people used to work on a weekly basis is included in the model. Table 7 shows the average and median number of hours individuals actually worked on a weekly basis for each country. According to the table, Belgian employees worked on average 3.7 hours more than their Dutch peers, whereas the working time was almost equal in Germany and in Belgium (38 hours on average).

Table 7: Mean and median numbers of hours worked per week, by country

Country	Mean	Median
BE	38.0	38.0
DE	37.8	40.0
FR	37.2	36.0
NL	34.3	36.0
Total	36.7	38.0

Source: own elaboration with data from EU SILC

Secondly, the number of months individuals worked part-time and full-time during the previous year are added as the income amounts are given on a yearly basis. Figure 6 depicts the repartition of individuals regarding the number of months they worked full-time and part-time per country. As shown by the figure, individuals tended to work more full-time than part-time as the majority of the sample actually worked twelve months full-time (12,319 individuals) and zero months part-time (14,195 individuals) per year. This tendency is confirmed for the four countries.

Figure 6: Repartition of the sample regarding the number of worked months in a year

Source: own elaboration with data from EU SILC

Controlling for all the variables presented may capture the majority of the variation in the income variable and provide estimations with a high power of explanation (high r-squared).

6. Results

After explaining the methodology and the data used for the purpose of this research, this section presents the results of the different estimations. Firstly, the endogeneity of education is tested for both the Mincer's equation and the difference-in-differences model. Secondly, general results of estimation of the Mincer's equation are provided to give a first idea of the rate of return to education. Then, results of the difference-in-differences estimation are exposed and discussed in more detail. The difference-in-differences estimation is also done at the country level and some robustness checks are provided. Lastly, the limitations of the model are mentioned.

Before discussing the results, it is important to mention the heteroskedasticity test (Breush-Pagan test) that was performed. The test revealed that data suffered from heteroskedasticity. To solve the heteroskedasticity issue, robust standard errors are used.

6.1. Testing for endogeneity

As previously indicated, Mincer's equation was criticized due to the endogeneity issue. Indeed, education may suffer from the ability bias, as students with less intellectual ability, which is difficult to quantify, tend to stop their studies earlier than their more able peers. It is therefore necessary to test for endogeneity before estimating the model in order to ensure that the coefficients are unbiased.

Wooldridge (2015) introduced a simple method to test whether a variable is exogenous or endogenous, consisting in three steps. The first step consists in regressing the variable which is suspected to be endogenous on all the other controls and all the potential instruments. This regression is called the "reduced form". The residuals of the reduced form are then computed and added to the original model as an extra control variable. This second equation is estimated with OLS and the significance of the residual's coefficient is tested using a t-test. If the coefficient is not statistically significant, the variable is exogenous and the original model can be estimated with OLS without being biased. On the contrary, if the coefficient of the reduced form's residuals is statistically significant, the variable is indeed endogenous and estimating the model with OLS leads to biased coefficients. In this case, the model can be estimated using the IV 2SLS method and choosing relevant instruments for the endogenous variable.

This method has been used to test for endogeneity in both models (Mincer's equation and the difference-in-differences model) as they involve education using different variables.

Firstly, Mincer's equation involves education through the age at which individuals attained their highest level of education. Applying the method mentioned above to test for endogeneity of this variable, it seems that there is no endogeneity issue in the Mincer's model. Table 8 shows the result of the endogeneity test for both forms of the Mincer's equation, involving the quarter of birth as instrument. Column 1 tests for endogeneity in the simple model (involving education, experience and the squared of experience), whereas column 2 tests for endogeneity in the extended model (adding country, gender and effective working time as controls).

As the residuals' coefficients are not statistically different from zero whether in the simple or in the extended model, education, measured through the age at which individual attained their highest level of education, can be considered an exogenous variable. The Mincer's equation can therefore be estimated using OLS as they may provide unbiased estimated coefficients.

Table 8: Results of the endogeneity test for the Mincer's equation

Log (gross income)	(1) Instrument = quarter of birth	(2) Instrument = quarter of birth
Agehighisced	-0.0572	-0.000343
	(0.149)	(0.135)
Experience	0.208***	0.0682***
	(0.0354)	(0.0246)
Experience-squared	-0.00971***	-0.00293***
	(0.00110)	(0.000576)
France		-0.277***
		(0.0599)
Germany		-
Netherlands		-
Female		-0.00301
		(0.0882)
Weekly worked hours		0.0131**
		(0.00557)
Months worked full-time		0.140***
		(0.00549)
Months worked part-time		0.0989***
		(0.00674)
Residuals	0.115	
	(0.149)	
Residuals 2		0.0467
		(0.135)
Constant	10.30***	7.810***
	(3.034)	(2.583)
Observations	8,440	8,364
R-squared	0.167	0.497

Source: own computations with data from EU SILC
*Notes: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*
Agehighisced represents the age at which individuals attained their highest level of education

Secondly, the difference-in-differences model involves education through the highest level of education attained by individuals. Moreover, the level of education is expressed as a dummy variable which is equal to one if individuals entered the higher education system and zero if they possessed a degree from the medium education. Again, applying the method described above to test for endogeneity of this dummy variable, no problem of endogeneity arises, whether in the simplest form or in the extended forms, as none of the residuals' coefficients are statistically significant. The difference-in-differences model can therefore be estimated using OLS. Table 9 displays the results of the endogeneity test for three forms of the diff-in-diff model, involving only one instrument, the quarter of birth.

Table 9: Results of the endogeneity test for the difference-in-differences model

Log (gross income)	(1)	(2)	(3)
Higher education	0.871	0.453	0.438
	(0.615)	(0.530)	(0.512)
y2	0.492	0.395	0.340
	(0.305)	(0.257)	(0.211)
y2 * higher education	-0.418	-0.169	-0.156
	(0.605)	(0.511)	(0.499)
France	-0.264***	-0.246***	-0.249***
	(0.0397)	(0.0315)	(0.0299)
Female	-0.231***	-0.0802	-0.0799
	(0.0511)	(0.0554)	(0.0909)
Experience	0.163***	0.0588***	0.0569***
	(0.0173)	(0.00940)	(0.00928)
Experience-squared	-0.00763***	-0.00239***	-0.00265***
	(0.00122)	(0.000714)	(0.000670)
Weekly worked hours		0.0104***	0.0104***
		(0.00213)	(0.00209)
Months worked full-time		0.136***	0.136***
		(0.00610)	(0.00608)
Months worked part-time		0.101***	0.101***
		(0.00589)	(0.00590)
y2 * female			0.00130
			(0.0813)
y2 * experience			0.00956
			(0.00601)
Residuals	-0.544		
	(0.614)		
Residuals 2		-0.224	
		(0.529)	
Residuals 3			-0.210
			(0.510)
Constant	8.966***	7.579***	7.607***
	(0.284)	(0.182)	(0.160)
Observations	8,440	8,364	8,364
R-squared	0.283	0.557	0.558

Source: own computations with data from EU SILC
*Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

6.2. The Mincer's estimations

In light of the results of the endogeneity test, Mincer's equation is estimated using OLS as they should provide unbiased coefficients. Table 10 shows the results of the different estimations, where the first column represents the simplest model. Several controls are added to capture other measurable effects and increase the power of the model.

Using OLS, the age at which individuals attained their highest level of education has a positive and significant impact on the income. This result matches what was anticipated as the number of years of schooling is expected to increase the income. Depending on the controls added, leaving the education system one year later increases the gross income between 6.33% and 5.28%. Put another way, one more year of education leads to a 5.28-6.33% increase in the yearly gross income. Regarding the experience, its effect is also positive and significant on the gross income, as expected since on the labor market, the income increases with the professional experience.

On the one hand, adding other controls such as the country, the gender and different working time measurements seems to be relevant as it increases sharply the power of the overall regression while reducing the coefficients' standard errors. On the other hand, adding several interaction terms is not relevant as it does not increase a lot the power of the regression and the coefficients of the added interaction terms are not statistically different from zero (except for the interaction term between the education variable and Germany). Moreover, the education coefficient's sign changes and is no more significant at the one percent level of confidence. The third regression is presented to show the irrelevance of the interaction terms but must not be taken into account further.

As shown in the literature, OLS coefficients may be biased due to endogeneity of education. Although the test does not reveal endogeneity, this does not mean that the education variable is indeed exogenous. In fact, it may be that the test does not reveal endogeneity because the instrument tested is too weak (the correlation between the education variable and the birth quarter is almost zero, which does not meet the necessary condition to be a strong instrument). Testing for other stronger instruments may reveal endogeneity in the model and confirm the literature findings.

Mincer's results may also suffer from another source of bias due to the measurement of education in years. Indeed, less intellectually endowed students will spend more time in school to obtain their degree. In this context, the extra years spent in the education system do not represent a higher degree or more knowledge acquired.

Using another measure of education, such as educational attainment as in the difference-in-differences approach, may therefore provide more relevant results.

Table 10: Estimation of Mincer's model

Log (gross income)	(1)	(2)	(3)
Agehighisced	0.0633***	0.0528***	-1.891**
	(0.00288)	(0.00217)	(0.783)
Experience	0.177***	0.0808***	0.0836***
	(0.00819)	(0.00567)	(0.00563)
Experience-squared	-0.00806***	-0.00329***	-0.00350***
	(0.000521)	(0.000340)	(0.000341)
France		-0.257***	-0.269***
		(0.0105)	(0.0910)
Germany		-0.353***	-1.100***
		(0.0141)	(0.102)
Netherlands		0.00119	0.121
		(0.0147)	(0.120)
Female		-0.0207*	0.0448
		(0.0118)	(0.0907)
Year		0.0293***	0.00816
		(0.00108)	(0.00864)
Weekly worked hours		0.0149***	0.0150***
		(0.00116)	(0.00116)
Months worked full-time		0.144***	0.144***
		(0.00390)	(0.00389)
Months worked part-time		0.106***	0.105***
		(0.00420)	(0.00418)
Agehighisced * France			0.000325
			(0.00421)
Agehighisced * Germany			0.0334***
			(0.00453)
Agehighisced * Netherlands			-0.00456
			(0.00535)
Agehighisced * female			-0.00276
			(0.00407)
Agehighisced * year			0.000960**
			(0.000390)
Constant	7.770***	-52.48***	-9.625
	(0.0677)	(2.157)	(17.38)
Observations	14,801	14,679	14,679
R-squared	0.191	0.561	0.566

Source: own computations with data from EU SILC
*Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

6.3. The difference-in-differences model

As the test reveals no endogeneity issue, different configurations of the difference-in-differences model are estimated using the OLS method, as it may provide unbiased coefficients. Table 11 presents the results of the different estimations.

Table 11: Estimation of the difference-in-differences model

Log (gross income)	(1)	(2)	(3)	(4)
y2	0.276***	0.206***	0.236***	0.152***
	(0.0223)	(0.0202)	(0.0157)	(0.0316)
Higher education	0.402***	0.378***	0.279***	0.273***
	(0.0199)	(0.0194)	(0.0154)	(0.0155)
y2 * higher education	0.0670**	0.112***	0.0954***	0.105***
	(0.0307)	(0.0281)	(0.0214)	(0.0217)
France		-0.302***	-0.258***	-0.261***
		(0.0137)	(0.0104)	(0.0106)
Germany		-0.279***	-0.235***	-0.237***
		(0.0193)	(0.0142)	(0.0142)
Netherlands		-0.131***	0.0484***	0.0452***
		(0.0209)	(0.0143)	(0.0144)
Female		-0.201***	-0.0441***	-0.0272*
		(0.0144)	(0.0118)	(0.0155)
Experience		0.187***	0.0870***	0.0821***
		(0.00772)	(0.00566)	(0.00564)
Experience-squared		-0.00786***	-0.00294***	-0.00335***
		(0.000470)	(0.000337)	(0.000353)
Weekly worked hours			0.0146***	0.0146***
			(0.00115)	(0.00115)
Months worked full-time			0.140***	0.140***
			(0.00387)	(0.00386)
Months worked part-time			0.104***	0.104***
			(0.00417)	(0.00416)
y2 * female				-0.0313
				(0.0214)
y2 * experience				0.0164***
				(0.00381)
Constant	9.467***	9.126***	7.345***	7.392***
	(0.0137)	(0.0295)	(0.0565)	(0.0567)
Observations	18,160	14,773	14,652	14,652
R-squared	0.120	0.284	0.572	0.574

Source: own computations with data from EU SILC
*Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

Firstly, the simplest model involves only the dummy variables for the treatment group and for the period with their interaction term. The first estimation provides significant coefficients for both dummies, but the interaction coefficient is statistically significant only at the five percent level of confidence. This simplest regression is not relevant as its power is very low (r-squared = 0.120), meaning that the model captures only 12% of the variation in the dependent variable.

Adding more controls is therefore essential to obtain a significant regression.

Controlling for the country, the gender and the experience seems to be relevant as their coefficients are statistically different from zero at the one percent level of confidence. As expected, the gender coefficient is negative, meaning that being a woman has a negative impact on the income. Men may earn on average 20.1% more than women on a yearly basis, reflecting the gender pay gap demonstrated in the literature. Then, the income increases at a decreasing rate with the experience on the labor market, as it was expected. The second regression is more powerful than the simplest one, but still not powerful enough to provide concrete results.

Adding several control variables for the effective working time such as the number of hours individuals usually work on a weekly basis as well as the number of months they worked full-time and part-time during the previous year, provides more precise (standard errors are reduced) and significant coefficients. The gender coefficient is still negative, but much lower than in the previous regressions. Indeed, controlling for the effective working time overshadows the gender pay gap as its main sources (more part-time and career interruptions for women than for men) are taken into account in the third and fourth models. However, even when controlling for the working time, a slight gender pay gap remains across the four countries as women earned on average 4.41% less than men.

Then, the three working time measurements' coefficients are statistically significant and positive, as expected. Indeed, the more people worked (on a weekly or monthly basis), the higher their wages. On average, an extra weekly hour of work increases the annual gross income by 1.46%. The effect of an extra hour per week has a slight impact on the yearly income as employers tend to conclude more and more fixed contracts, whereas variable contracts tend to rarefy. On the contrary, working one extra month in a year, whether part-time or full-time, has a great effect on the yearly income (14% more for an extra month full-time and 10.4% more for an extra month part-time).

Once again, adding several interaction terms is not relevant as only one coefficient is statistically significant. Moreover, the more complex model provides less precise coefficients (standard errors are increased) without increasing a lot the power of the overall regression.

Comparing the four models, the third one seems the more relevant as it includes more controls with statistically significant coefficients and provides a high r-squared (57.2%). Moreover, including several working time measurements allows to double the power of the overall regression without restricting the sample size too much (only 121 individuals are lost due to the added variables).

Table 12 shows the decomposition of the difference-in-differences estimator for the third model.

Table 12: Decomposition of the difference-in-differences estimator

	Before	After	After - before
Control	7.345	7.581	0.236
Treatment	7.624	7.955	0.331
Treatment - control	0.279	0.374	**0.095**

Source: own elaboration using data from EU SILC

As expected, the difference between the treatment and the control group is positive regardless of the time period, meaning that having a higher education's degree has a positive effect on the salary compared to the medium education's degree. Individuals who entered the higher education system before the Bologna reform earned on average 27.9% more than those who stopped their studies at the medium education level, whereas those who entered the higher education system after the reform earned on average 37.4% more than those who owned a degree from the medium education system.

Moreover, the table shows an increase in the income over time for both control and treatment groups. Relying on the time dummy's (y2) estimated coefficient, yearly gross income experienced a 23.7% increase on average over the decade, or a 23.7% increase on average in the productivity as the income is measured in real terms.

Regarding the difference-in-differences estimator itself, it is statistically significant, even at the one percent level of confidence. This makes us think that the Bologna reform has had an impact on the difference in income between graduates from higher education and graduates from medium education. This result is quite intuitive as the main impact of the reform was to increase the length of study in the higher education system by one year. Given that education measured in years in the Mincer's model has a significant and positive impact on the salary, the Bologna reform was expected to have a positive impact on the income, which is confirmed using the difference-in-differences model.

Taken together, the four countries show a positive impact (9.54% increase) of the Bologna reform on the difference in income between graduates from higher education and graduates from medium education.

The difference-in-differences model has also been estimated for each country independently, using the third model as it seems to be the most relevant. The results of those regressions are presented in table 13.

Table 13: Difference-in-differences estimation per country

Log (gross income)	(1) BELGIUM	(2) FRANCE	(3) GERMANY	(4) NETHERLANDS
y2	0.361***	0.276***	0.229***	0.300***
	(0.0213)	(0.0230)	(0.0245)	(0.0305)
Higher education	0.219***	0.233***	0.429***	0.339***
	(0.0175)	(0.0217)	(0.0333)	(0.0269)
y2 * higher education	0.0426	0.0424	0.0789*	-0.0676
	(0.0265)	(0.0312)	(0.0410)	(0.0430)
Female	-0.124***	-0.0473***	-0.0339	0.0291
	(0.0143)	(0.0164)	(0.0207)	(0.0267)
Experience	0.0820***	0.0611***	0.150***	0.0989***
	(0.0116)	(0.00777)	(0.00996)	(0.0127)
Experience-squared	-0.00454***	-0.00256***	-0.00573***	-0.00495***
	(0.000971)	(0.000484)	(0.000564)	(0.000708)
Weekly worked hours	0.00946***	0.0114***	0.0186***	0.0128***
	(0.00104)	(0.00161)	(0.00196)	(0.00259)
Months worked full-time	0.142***	0.137***	0.144***	0.153***
	(0.00694)	(0.00592)	(0.00638)	(0.00869)
Months worked part-time	0.112***	0.0989***	0.101***	0.130***
	(0.00715)	(0.00656)	(0.00687)	(0.00865)
Constant	7.612***	7.388***	6.603***	7.242***
	(0.0812)	(0.0855)	(0.0959)	(0.126)
Observations	3,320	5,044	3,620	2,668
R-squared	0.639	0.538	0.613	0.651

Source: own computations with data from EU SILC
*Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

Firstly, it is important to note that the four samples are quite restricted, which may lead to less accurate estimates, especially for the Netherlands, which contains only 2,668 observations.

Secondly, as presented in section 5, the size of the treatment and control groups is not similar for the four countries. Whereas samples sizes are comparable for France and the Netherlands, the Belgian control group contains almost half of the Belgian treatment group while it is the opposite for Germany. This huge difference in the size of the groups may have an impact on the estimation of the difference-in-differences coefficient at the country level. These results must therefore be interpreted, keeping in mind this potential issue.

Let's first analyze Belgian results. Like in the general case, the time dummy's coefficient is statistically significant, even at the one percent level of confidence. All the other coefficients are significant except for the difference-in-differences coefficient. Moreover, their signs are consistent with the general model and thus have the same interpretation and intuition. Regarding the diff-in-diff estimator (y2 * higher education), it is not statistically significant, meaning that the Bologna reform has had nearly zero impact on the difference in income between graduates from higher education and graduates from medium education.

Regarding France, the results are quite different, especially for the components of the diff-in-diff estimator. Firstly, the time dummy is still positive and significant, but lower than for Belgium, meaning that the income evolved over time, but less than in Belgium in real terms. Then, the dummy that differentiates graduates from higher education and those from medium education is also statistically significant and higher than the Belgian one. This result makes one think that owning a diploma from the higher education system has a great impact on the French labor market compared to a medium education's degree (23.3% more). Finally, the diff-in-diff estimator is almost similar to the Belgian estimator, but still not significant, even at the ten percent level of confidence, meaning that the Bologna reform had nearly zero impact on the difference in income between graduates from higher education and graduates from medium education. It is also worth noting that the gender pay gap is less pronounced in France than in Belgium and that an extra year of experience is a little bit less valued in France.

Considering the gender pay gap, Germany shows a non-significant coefficient, meaning that controlling for the experience and the effective working time is sufficient to explain the difference in German income across genders. Moreover, an extra year of experience is valued the most on the German labor market. Regarding the components of the diff-in-diff estimator, the gross income evolved the least over the decade, as the time dummy's coefficient is the lowest. However, the level of education's dummy is the highest and most significant. Indeed, workers who owned a higher education's degree earned 42.9% more on average than their peers who owned a medium education's degree. This difference rose by 7.89% following the implementation of the Bologna process in Germany as the diff-in-diff coefficient is statistically significant at least at the ten percent level of confidence. Overall, the German labor market seems to be the most attractive as it shows nearly zero gender pay gap and rewards the experience and the degrees from higher education the most.

Regarding the components of the Dutch diff-in-diff estimator, the time and education level dummies' coefficients are statistically significant and positive, which follows the intuition. However, the diff-in-diff estimator is not statistically significant, even at the ten percent level, which is quite intuitive regarding the timing of the Bologna reform's implementation. Indeed, as indicated in section 3.1.4, the Netherlands already started to implement the Bologna structure in 2002. It is therefore expected to find zero impact of the reform as this analysis considers 2008 as the implementation year of the new structure across European countries.

Comparing the diff-in-diff estimator for the four countries, the Bologna reform seems to have had nearly zero impact on the difference in income between higher education graduates and medium education graduates in Belgium, France and the Netherlands. Actually, the difference-in-differences estimation seems not robust at the country level. This lack of robustness at the country level is explained further in the limitations section.

6.4. Robustness check

As the model shows a lack of robustness at the country level, the robustness of the difference-in-differences model is tested at the general level only. This test consists in applying the same model on the same data, while changing a little bit the construction of the different samples. In this analysis, two configurations have been tested. In the first one, the composition of the treatment and control groups is modified as individuals who owned a degree of ISCED level 4 belong to the treatment group and no more to the control group. In the second one, those individuals are simply excluded from the sample. Lastly, as discussed in the analysis at the country level, the Netherlands started to implement the Bologna structure much earlier than Belgium, France and Germany. Keeping Netherlands in the sample may therefore have influenced the results found previously. The third robustness check consists in removing the Dutch observations from the sample.

Table 14 displays the results for the three tests, using the third difference-in-differences model on the whole sample.

Firstly, the three tests provide statistically significant coefficients at the one percent level of confidence. Secondly, the sign of each coefficient is the same as in the original regression, whether in the first, the second or the third tests.

Regarding the diff-in-diff components, both dummies are robust as their coefficients are quite similar (in the original model, the coefficients were 0.236 for the time dummy and 0.279 for the education dummy). Moreover, the difference-in-differences estimator itself differs slightly across the three models (the original model provided a coefficient of 0.0954).

These results suggest the robustness of the difference-in-differences model, using the experience, the gender, the country and the effective working time as controls.

Table 14: Results of the robustness test

Log (gross income)	Test 1 (ISCED 4 = treatment)	Test 2 (ISCED 4 are excluded)	Test 3 (the Netherlands are excluded)
y2	0.235***	0.227***	0.232***
	(0.0170)	(0.0170)	(0.0165)
Higher education	0.276***	0.296***	0.272***
	(0.0152)	(0.0159)	(0.0165)
y2 * higher education	0.0791***	0.109***	0.110***
	(0.0221)	(0.0225)	(0.0227)
France	-0.242***	-0.251***	-0.259***
	(0.0105)	(0.0106)	(0.0105)
Germany	-0.295***	-0.253***	-0.239***
	(0.0142)	(0.0151)	(0.0144)
Netherlands	0.0610***	0.0533***	-
	(0.0144)	(0.0147)	
Female	-0.0576***	-0.0604***	-0.0494***
	(0.0119)	(0.0124)	(0.0125)
Experience	0.0785***	0.0808***	0.0856***
	(0.00570)	(0.00579)	(0.00597)
Experience-squared	-0.00248***	-0.00267***	-0.00275***
	(0.000339)	(0.000353)	(0.000354)
Weekly worked hours	0.0149***	0.0140***	0.0145***
	(0.00114)	(0.00120)	(0.00120)
Months worked full-time	0.140***	0.140***	0.139***
	(0.00385)	(0.00405)	(0.00410)
Months worked part-time	0.104***	0.105***	0.101***
	(0.00415)	(0.00438)	(0.00451)
Constant	7.362***	7.380***	7.369***
	(0.0564)	(0.0591)	(0.0597)
Observations	14,652	13,680	11,984
R-squared	0.569	0.582	0.569

Source: own computations with data from EU SILC
*Note: Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1*

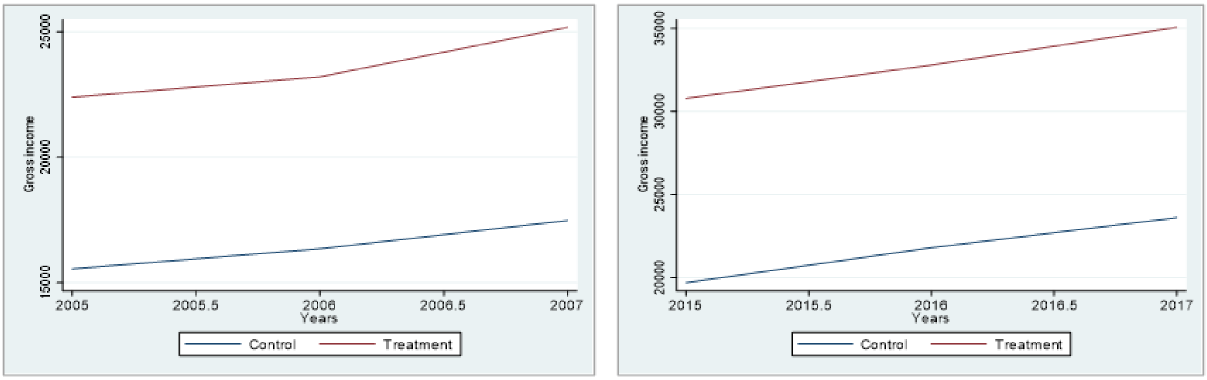
6.5. Limitations

The different estimations provide interesting results regarding the impact of the Bologna reform on the difference in income between graduates from the higher and medium education systems. However, these results may be interpreted and trusted with caution as some econometric issues remain in the difference-in-differences model estimated. Moreover, although the produced results are robust at the general level, robustness does not hold at the country level.

The major explanation to this lack of robustness relies on the necessary condition of the difference-in-differences method. Indeed, an empirical diff-in-diff analysis requires the parallel trend assumption to hold to be valid. The idea is based on the belief that the untreated (control) group can show how the treated group would have changed if they didn't receive treatment. The assumption is that both groups followed parallel trends before the occurrence of the event (McKenzie, 2020a).

Figure 7 depicts the trend in the gross income over the years for both periods. Looking at the left hand-side graph, the parallel trend assumption appears to fail as the trends are parallel when considering only years 2005 and 2006 and start to diverge in 2006.

Figure 7: Trend in the gross income for the whole sample



Source: own elaboration with data from EU SILC

Note: the trend is designed by computing the mean gross income each year for the control and the treatment group.

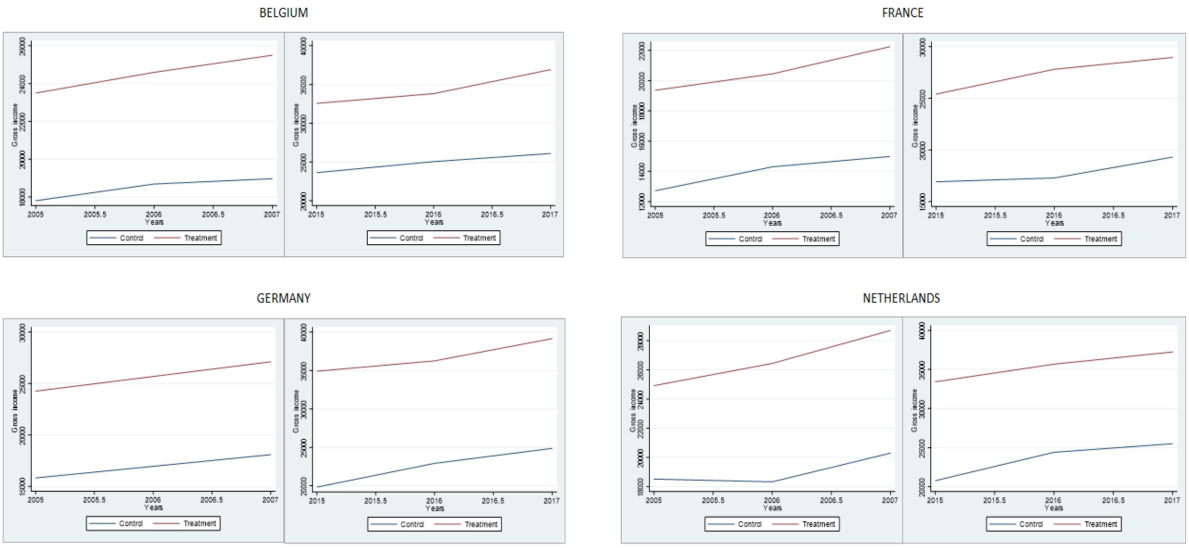
This failure may lead to biased estimation of the difference-in-differences model. The results presented earlier may therefore be interpreted and trusted with caution.

As the analysis is conducted at the general and at the country levels, the assumption must be verified for both general and country levels. Figure 8 depicts the trend in the gross income for each country. Comparing the four countries, it appears that the parallel trend assumption still does not hold, except for Germany. Whereas Belgium displays the same pattern as the general model (parallel trend assumption holds between 2005 and 2006 and starts to diverge in 2006), the trends are parallel neither between 2005 and 2006 nor between 2006 and 2007 in France and in the Netherlands. As in the general model, this failure of the assumption may lead to biased and non-significant estimated coefficients in these three countries.

Regarding Germany, it shows linear and almost parallel trends. It is therefore not surprising to find a significant diff-in-diff coefficient, at least at the ten percent level of confidence, in this country. However, as the trends are almost, but not completely parallel, the estimated coefficient may still be biased.

Further research, whether at the general or at the country level, may use more complex methods to deal with failure of the parallel trend assumption in order to confirm the findings of this research (see McKenzie, 2020b).

Figure 8: Trend in the gross income per country



Source: own elaboration with data from EU SILC

Note: the trends are designed by computing the mean gross income each year for the control and the treatment group in each country separately.

Then, performing the Ramsey RESET test that tests whether the model has omitted variable, the p-value of the test is zero. Such a p-value means that the null hypothesis that the model faces no omitted variable issue is rejected and that the model actually suffers from omitted variable issue. This result is predictable as the income depends on a large variety of factors, which are sometimes difficult to measure or not included in the EU SILC dataset. However, the power of the overall regression is quite high (57.2% for the general one), meaning that the model explains quite well the variation in the dependent variable.

Finally, this thesis focuses on four countries only. Further research including more or different countries may be interesting to compare the effect the Bologna process has had in different European regions. Indeed, showing a positive impact may help convincing more countries to join the European Higher Education Area.

7. Conclusion

The Bologna process has reformed the higher education system in the participating countries, creating a three-cycle structure: the bachelor's, the master's and the doctorate's programs, to harmonize higher education across European countries. This evolution in the structure has had different implications across European countries. This thesis focuses on four countries: Belgium, France, Germany and the Netherlands. Comparing the higher education system in those countries before the reform, it arises that, among other things, the major impact of the Bologna process has been to extend the higher education journey by a year. This thesis aims at evaluating the effect the Bologna reform has had in terms of returns to higher education in the four countries of interest.

Returns to schooling has been widely studied and estimated in the literature using Mincer's equation, which involves education through the years of schooling. Estimating it using OLS, an extra year of schooling provides a 5.28% increase in the yearly gross income. The equation was tested for endogeneity, but no strong enough instrument was found to estimate it without bias using IV.

A difference-in-differences analysis was conducted to evaluate the impact of this reform on the returns to higher education. Firstly, applied to the whole sample, the model reveals a positive and significant impact on the difference in income between graduates from higher education and graduates from secondary education. The analysis was secondly conducted at the country level to estimate this effect in each country. Taken individually, the Bologna reform has had a significant impact on the difference in income between higher education and medium education's graduates in Germany only.

Finally, the difference-in-differences analysis provided interesting results in terms of returns to higher education. However, these results may be treated with caution as some econometric issues remain, especially the non-satisfaction of the necessary parallel trend assumption. Literature about this issue is growing and some methods to deal with it tend to develop. Reconducting this research using those methods would be interesting to confirm the findings of this thesis.

References

Aakvik, A., Salvanes, K. G., & Vaage, K. (2010). Measuring heterogeneity in the returns to education using an education reform. *European Economic Review*, *54*(4), 483–500. https://doi.org/10.1016/j.euroecorev.2009.09.001

Allegre, C., Berlinguer, L., Blackstone, T., & Rüttgers, J. (1998, May 25). *Joint declaration on harmonization of the architecture of the European higher education system.* The European Higher Education Area. https://ehea.info/media.ehea.info/file/1998_Sorbonne/61/2/1998_Sorbonne_Declaration_English_552612.pdf

Andini, C. (2010). A dynamic Mincer equation with an application to Portuguese data. *Applied Economics*, *42*(16), 2091–2098. https://doi.org/10.1080/00036840701765429

Angrist, J. D., & Keueger, A. B. (1991). Does Compulsory School Attendance Affect Schooling and Earnings? *The Quarterly Journal of Economics*, *106*(4), 979–1014. https://doi.org/10.2307/2937954

Ashenfelter, O., & Rouse, C. (1998). Income, Schooling, and Ability: Evidence from a New Sample of Identical Twins. *The Quarterly Journal of Economics*, *113*(1), 253–284. https://doi.org/10.1162/003355398555577

Balestra, S., & Backes-Kellner, U. (2017). Heterogeneous returns to education over the wage distribution: Who profits the most? *Labour Economics*, *44*(January), 89–105. https://doi.org/10.1016/j.labeco.2017.01.001

Bhuller, M., Mogstad, M., & Salvanes, K. G. (2017). Life-cycle earnings, education premiums, and internal rates of return. *Journal of Labor Economics*, *35*(4), 993–1030. https://doi.org/10.1086/692509

Boll, C., & Lagemann, A. (2019). The Gender Pay Gap in EU Countries—New Evidence Based on EU-SES 2014 Data. *Inter Economics*, *54*(2), 101–105. https://doi.org/10.1007/s10272-019-0802-7

Card, D. (2001). Estimating the Return to Schooling: Progress on Some Persistent Econometric Problems. *Econometrica*, *69*(5), 1127–1160. https://doi.org/10.1111/1468-0262.00237

Chiswick, B. R. (2003). Jacob Mincer, experience and the distribution of earnings. *Review of Economics of the Household*, *1*(4), 343–361. https://doi.org/10.1023/B:REHO.0000004794.43782.55

Clark, D. (2023). School quality and the return to schooling in Britain: New evidence from a large-scale compulsory schooling reform. *Journal of Public Economics*, *223*. https://doi.org/10.1016/j.jpubeco.2023.104902

De Weert, E., & Boezerooy, P. (2007). *Higher education in the Netherlands. Country report*. (International higher education monitor). Center for Higher Education Policy Studies (CHEPS). https://ris.utwente.nl/ws/portalfiles/portal/5148438/Weert07netherlands.pdf

Drucker, L. F., Horn, D., & Jakubowski, M. (2022). The labour market effects of the polish educational reform of 1999. *Journal for Labour Market Research*, *56*(1). https://doi.org/10.1186/s12651-022-00317-4

European Commission. (n.d.a). *The Bologna Process and the European Higher Education Area.* Retrieved June 30, 2023, from https://education.ec.europa.eu/education-levels/higher-education/inclusive-and-connected-higher-education/bologna-process

European Commission. (n.d.b). *Overview.* Retrieved July 8, 2023, from https://eurydice.eacea.ec.europa.eu/national-education-systems

Eurostat. (n.d.). *International Standard Classification of Education (ISCED)*. Retrieved July 5, 2023, from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_Standard_Classification_of_Education_(ISCED)

Formation générale. (2022). Étudiant.gouv. Retrieved July 8, 2023, from https://www.etudiant.gouv.fr/fr/formation-generale-544

García-Suaza, A. F., Guataquí, J. C., Guerra, J. A., & Maldonado, D. (2014). Beyond the Mincer equation: The internal rate of return to higher education in Colombia. *Education Economics*, *22*(3), 328–344. https://doi.org/10.1080/09645292.2011.595579

Glauser, D., Zangger, C., & Becker, R. (2019). The Signal and the Noise: The Impact of the Bologna Process on Swiss Graduates' Monetary Returns to Higher Education. *Social Inclusion*, *7*(3), 154–176. https://doi.org/10.17645/si.v7i3.2100

Harmon, C., & Walker, I. (1995). Estimates of the Economic Return to Schooling for the United Kingdom. *The American Economic Review*, *85*(5), 1278–1286. https://doi.org/10.2307/2950988

Hartog, J., & Gerritsen, S. (2016). Mincer Earnings Functions for the Netherlands 1962-2012. *De Economist (Netherlands)*, *164*(3), 235–253. https://doi.org/10.1007/s10645-016-9279-y

Heckman, J. J., Lochner, L. J., & Todd, P. E. (2008). Earnings Functions and Rates of Return. *Journal of Human Capital*, *2*(1), 1–31. https://doi.org/10.1086/587037

Kane, T. J., & Rouse, C. E. (1995). Labor-Market Returns to Two- and Four-Year College. *The American Economic Review*, *85*(3), 600–614. https://doi.org/10.2307/2118190

Kaiser, F. (2007). *Higher education in France*. (IHEM Country report; No. C7-016). Center for Higher Education Policy Studies (CHEPS). http://www.utwente.nl/cheps/higher_education_monitor

Kaulisch, M., & Huisman, J. (2007). *Higher education in Germany*. (Country report; No. C7-016). Center for Higher Education Policy Studies (CHEPS). http://www.utwente.nl/mb/cheps/publications/.

McKenzie, D. (2020a). Revisiting the Difference-in-Differences Parallel Trends Assumption: Part I Pre-Trend Testing. *World Bank Blogs*. https://blogs.worldbank.org/impactevaluations/revisiting-difference-differences-parallel-trends-assumption-part-i-pre-trend

McKenzie, D. (2020b). Revisiting the Difference-in-Differences Parallel Trends Assumption: Part II What happens if the parallel trends assumption is (might be) violated? *World Bank Blogs*. https://blogs.worldbank.org/impactevaluations/revisiting-difference-differences-parallel-trends-assumption-part-ii-what-happens

Migali, G., & Walker, I. (2018). Estimates of the causal effects of education on earnings over the life cycle with cohort effects and endogenous education. *CESifo Economic Studies*, *64*(3), 516–544. https://doi.org/10.1093/cesifo/ifx020

OECD Data. (n.d.). *Inflation (CPI).* Retrieved August 7, 2023, from https://data.oecd.org/price/inflation-cpi.htm

Oreopoulos, P., & Salvanes, K. G. (2011). Priceless: The nonpecuniary benefits of schooling. *The Journal of Economic Perspectives*, *25*(1), 159–184. https://doi.org/10.1257/jep.25.1.159

Spence, M. (1973). Job Market Signaling. *The Quarterly Journal of Economics*, *87*(3), 355–374. https://doi.org/10.2307/1882010

Staiger, D., & Stock, J. H. (1997). Instrumental Variables Regression with Weak Instruments. *Econometrica*, *65*(3), 557–586. https://doi.org/10.2307/2171753

Teixeira, P. N. (2014). Gary Becker's early work on human capital – collaborations and distinctiveness. *IZA Journal of Labor Economics*, *3*(1), 1–12. https://doi.org/10.1186/s40172-014-0012-2

The European Higher Education Area. (1999, June 19). *The Bologna Declaration of 19 June 1999* [press release]. https://ehea.info/Upload/document/ministerial_declarations/1999_Bologna_Declaration_English_553028.pdf

The European Higher Education Area. (2001, May 19). *Communiqué of the meeting of European Ministers in charge of Higher Education in Prague on May 19th 2001* [press release]. https://ehea.info/Upload/document/ministerial_declarations/2001_Prague_Communique_English_553442.pdf

The European Higher Education Area. (2003, September 19). *Communiqué of the Conference of Ministers responsible for Higher Education in Berlin on 19 September 2003* [press release]. https://ehea.info/Upload/document/ministerial_declarations/2003_Berlin_Communique_English_577284.pdf

The European Higher Education Area. (2005, May 19). *Communiqué of the Conference of European Ministers Responsible for Higher Education, Bergen, 19-20 May 2005* [press release]. https://ehea.info/Upload/document/ministerial_declarations/2005_Bergen_Communique_english_580520.pdf

The European Higher Education Area. (2007, May 18). *London Communiqué Towards the European Higher Education Area: responding to challenges in a globalised world* [press release]. https://ehea.info/Upload/document/ministerial_declarations/2007_London_Communique_English_588697.pdf

The European Higher Education Area. (2009, April 29). *Communiqué of the Conference of European Ministers Responsible for Higher Education, Leuven and Louvain-la-Neuve, 28-29 April 2009* [press release]. https://ehea.info/Upload/document/ministerial_declarations/Leuven_Louvain_la_Neuve_Communique_April_2009_595061.pdf

The European Higher Education Area. (2010, March 12). *Budapest-Vienna Declaration on the European Higher Education Area* [press release]. https://ehea.info/Upload/document/ministerial_declarations/Budapest_Vienna_Declaration_598640.pdf

The European Higher Education Area. (2012, April 27). *Making the Most of Our Potential: Consolidating the European Higher Education Area Bucharest Communiqué* [press release]. https://ehea.info/Upload/document/ministerial_declarations/Bucharest_Communique_2012_610673.pdf

The European Higher Education Area. (2015, May 15). *Yerevan Communiqué* [press release]. https://ehea.info/Upload/document/ministerial_declarations/YerevanCommuniqueFinal_613707.pdf

The European Higher Education Area. (2018, January 29). *Advisory Group 4 "Diploma Supplement Revision" Final Report. https://www.ehea.info/media.ehea.info/file/20180205-06-Sofia/73/1/BFUG_BG_SR_58_4f_AG4FinalReport_887731.pdf*

The European Higher Education Area. (2018, May 25). *Paris Communiqué, May 25th 2018* [press release]. https://ehea.info/Upload/document/ministerial_declarations/EHEAParis2018_Communique_final_952771.pdf

The European Higher Education Area. (2020, November 19). *Rome Ministerial Communiqué, 19 November 2020* [press release]. https://ehea.info/Upload/Rome_Ministerial_Communique.pdf

UNESCO. (2006). *International Standard Classification of Education - ISCED 1997*. https://isced.uis.unesco.org/wp-content/uploads/sites/15/2022/12/international-standard-classification-of-education-1997-en_0.pdf

Vara, M. J. (2013). Gender Inequality in the Spanish Public Pension System. *Feminist Economics*, *19*(4), 136–159. https://doi.org/10.1080/13545701.2013.822525

Verhoeven, J., & Beuselinck, I. (1996). *Higher education in Flanders (Belgium). A report for the OECD*. https://lirias.kuleuven.be/1869910

Vilerts, K., Krasnopjorovs, O., & Brekis, E. (2017). Returns to Education During and After the Economic Crisis: Evidence from Latvia 2006–2012. *Comparative Economic Research. Central and Eastern Europe*, *20*(1), 133–157. https://doi.org/10.1515/cer-2017-0008

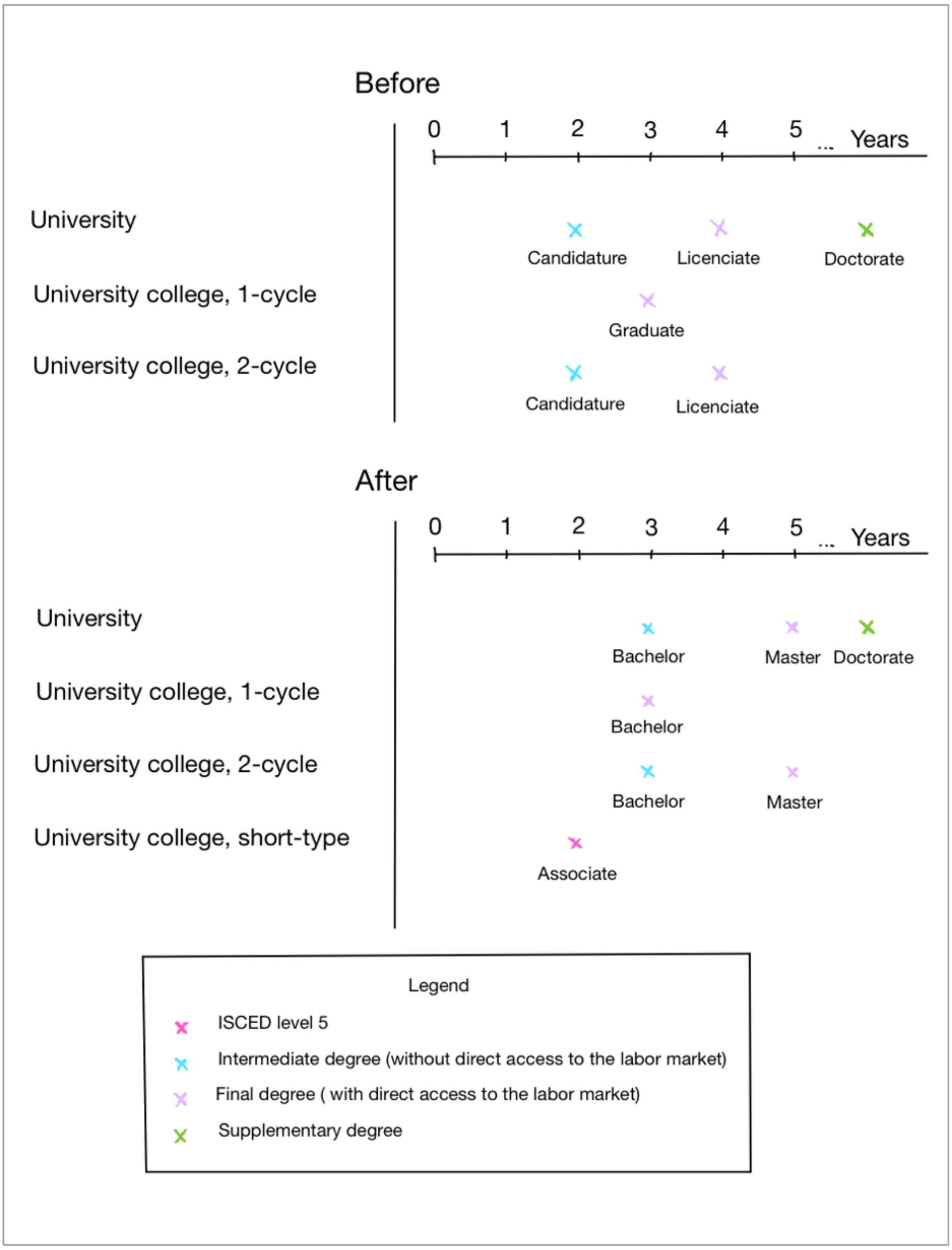
Webbink, D. (2007). Returns to university education: Evidence from a Dutch institutional reform. *Economica (London)*, *74*(293), 113–134. https://doi.org/10.1111/j.1468-0335.2006.00534.x

Weiss, Y. (2015). Gary Becker On Human Capital. *Bulletin de l'Institut de Recherches Économiques et Sociales*, *81*(1), 27–31. https://doi.org/10.1017/dem.2014.4

Wooldridge, J. M. (2015). *Introductory Econometrics: A Modern Approach*. Cengage Learning.

Appendix

Figure A1: The Belgian higher education system



Source: own elaboration using information from section 3.1

Figure A2: The French higher education system

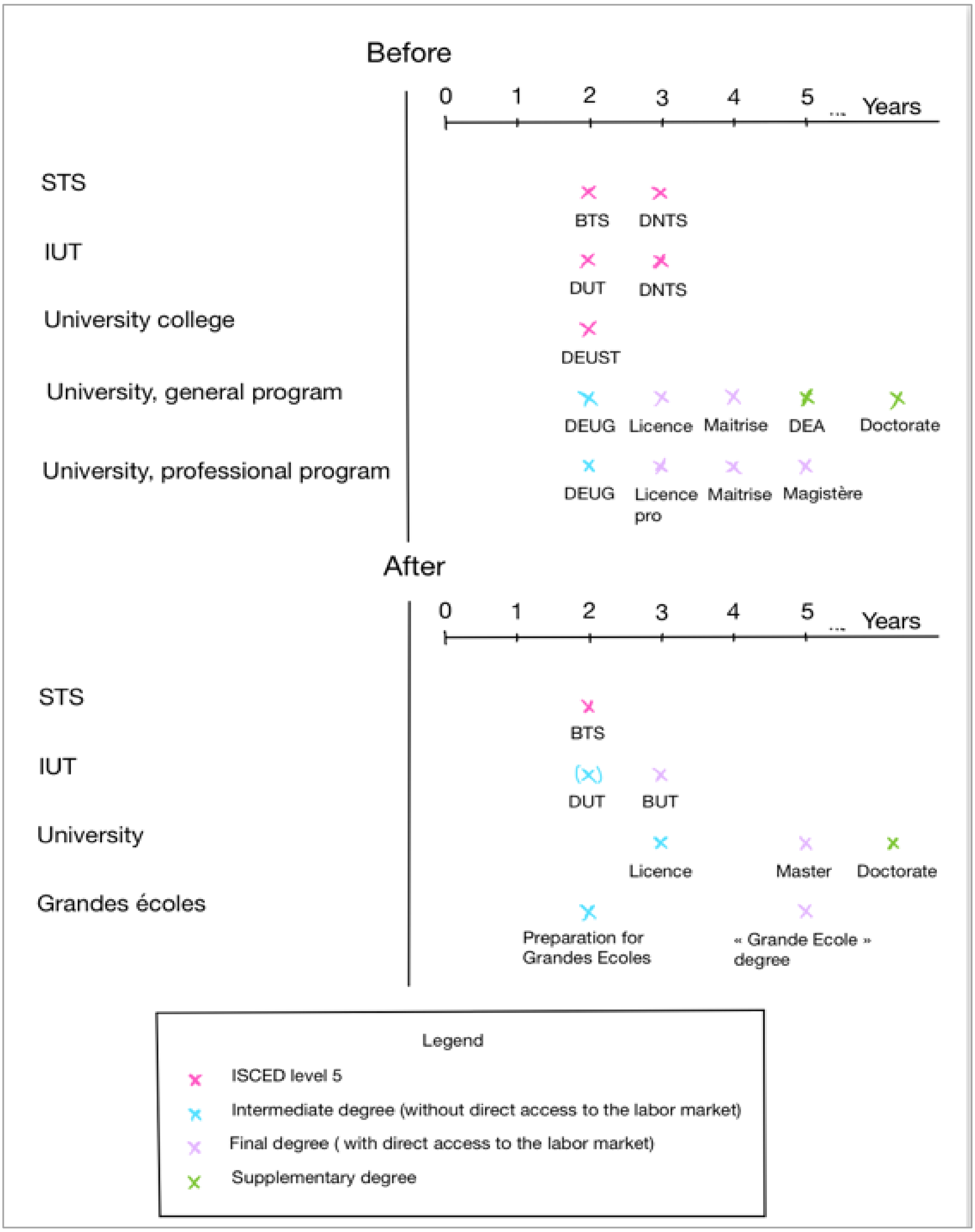


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Figure A3: The German higher education system

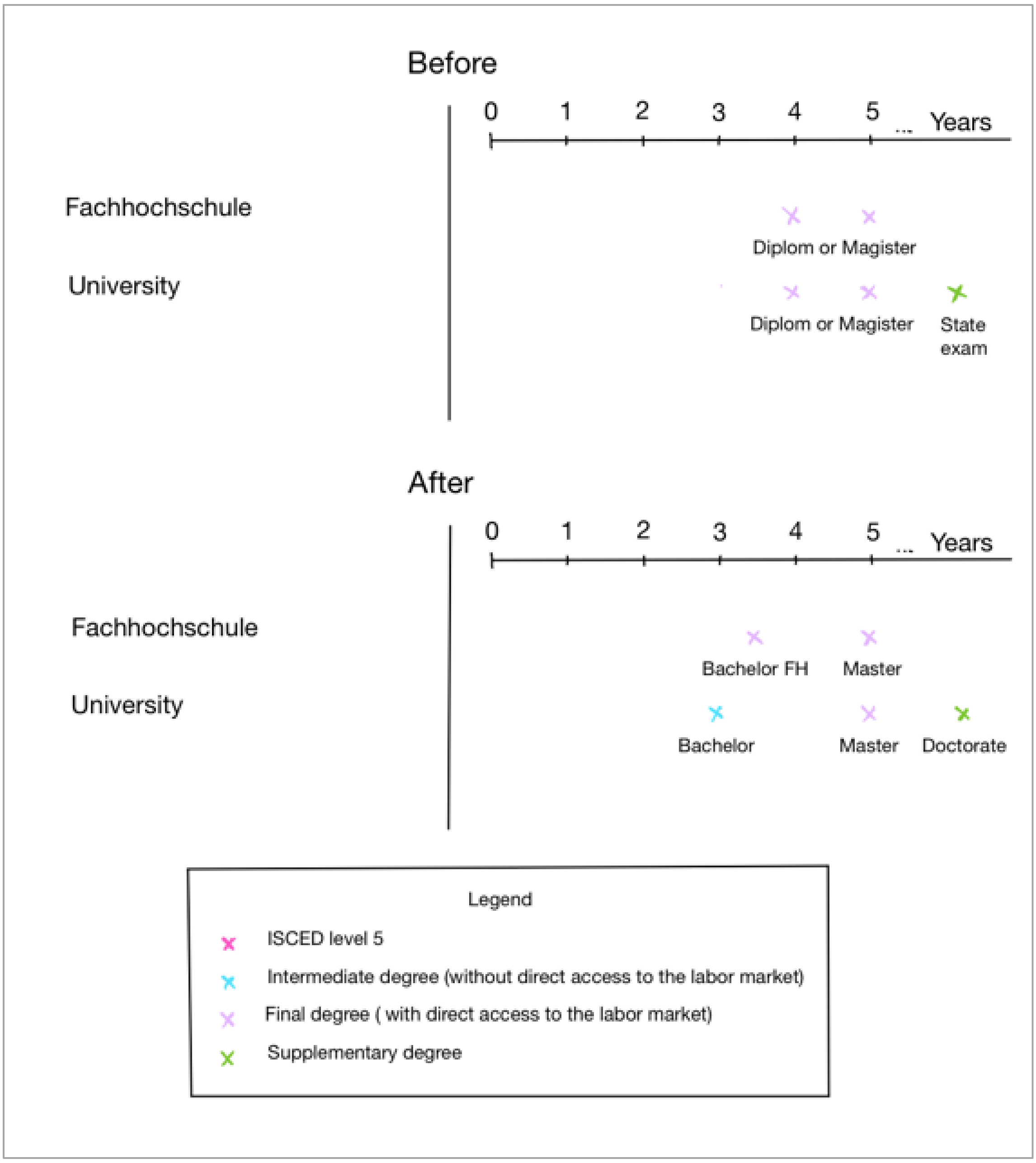

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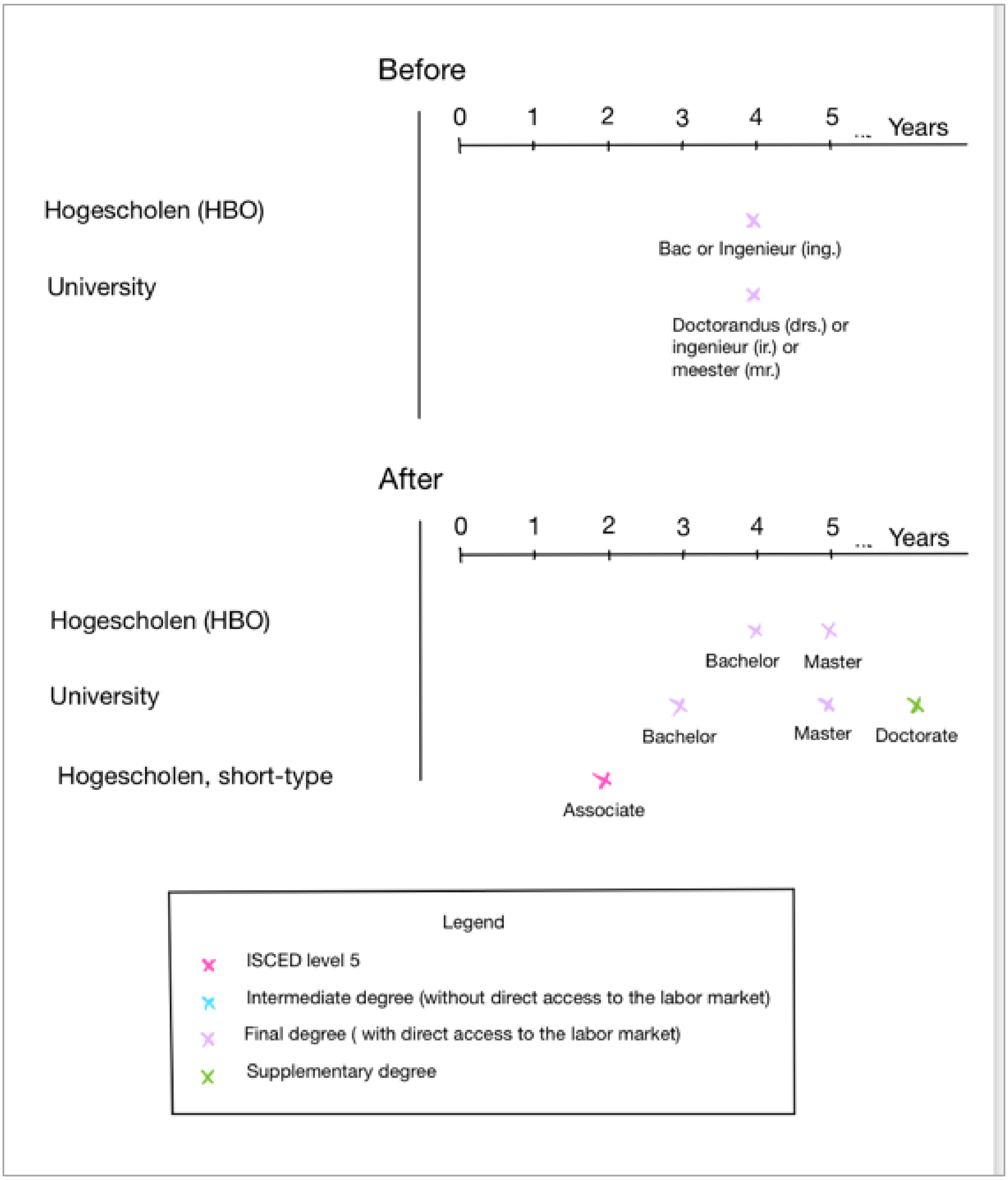
Figure A4: The Dutch higher education system



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