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Educational Attainment and Earnings in Europe: Estimating Causal Returns to Secondary and Higher Education Using Instrumental Variables

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APPENDICE

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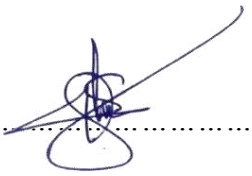
Firma (signature) ……  ……

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Abstract

This paper examines the causal relationship between education and earnings across Europe using an Instrumental Variable strategy. With this two-stage least squares (2SLS) approach, the research leverages on compulsory schooling reforms as IV to isolate exogenous variation in educational attainment.[1] The study draws on data from 33 European countries and focuses on employed individuals aged 25-64. The findings suggest that secondary and higher education significantly increase earnings across Europe, with substantial regional variation in returns. The study also highlights persistent gender disparities in the returns to education, with women consistently experiencing lower returns than their male counterparts, contributing to the gender wage gap. Furthermore, the analysis reveals that parental education plays a key role in shaping individual earnings. Although the study finds a positive relationship between education and self-employment, the evidence for a causal link remains weak. This research underscores the importance of educational policy reforms aimed at increasing access to education, addressing gender inequality, and reducing regional disparities to enhance economic mobility and reduce income inequality for sustainable economic prosperity across Europe.

Keywords: Education, Earnings, Self-Employment, Gender Wage Gap, Endogeneity, Instrumental Variables, Compulsory Schooling Reforms, Europe, Economic Mobility, Income Inequality

[1] Instrumental Variable (IV) approach: The IV methodology used in this study is based on compulsory schooling reforms as ”natural experiments”, which provide a quasi-random increase in education levels across different cohorts in various countries. This method helps in addressing the problem of endogeneity often associated with the relationship between education and earnings.

1 Introduction

1.1 Education and Development

Global Overview

Education has long been recognized as a fundamental driver of economic development. It plays a crucial role in shaping individual productivity, income distribution, and economic mobility, which, in turn, impacts broader societal progress. From a global perspective, education enhances human capital, which is directly linked to higher economic growth. Human capital theory, introduced by Becker (1964), posits that education and training enhance an individual's ability to contribute to the economy by increasing their skills, knowledge, and productivity. This concept is central to many of the arguments in economic development as the quality of a nation's human capital significantly influences its economic performance. Countries with better-educated workforces tend to experience faster economic growth as educated workers are more innovative, adaptable, and productive (Romer, 1990).

In terms of individual economic mobility, education allows individuals to break the cycle of poverty by improving their earning potential. It serves as a pathway to higher-paying jobs and reduced income inequality (Barro, 2001). Furthermore, the universal importance of education in the global economy is evidenced by its consistent role in the World Bank's development strategies (World Bank, 2018), which emphasize investing in education as a key pillar of sustainable economic growth. Education thus has both individual and societal benefits: on one hand, it raises an individual's earning capacity, and on the other, it fosters a more equitable distribution of wealth, reducing income disparities and promoting social cohesion.

The direct relationship between education and income is evident in the vast literature on the returns to education. The earnings of individuals increase with their level of educational attainment, with those holding tertiary education earning significantly more than those with only secondary or primary schooling (Psacharopoulos, 1994). This positive relationship between education and income is observed in various countries, although the magnitude of the returns can differ substantially depending on a variety of factors, such as the type of education, labor market conditions, and economic structure.

The European Landscape

The European context provides a particularly rich setting for examining the relationship between education and earnings due to its diverse educational systems, labor markets, and economic structures. Europe is home to a variety of institutional frameworks and policies across its regions, including Northern, Southern, Eastern, and Western Europe, each with its distinct approaches to education and economic development. These regional disparities in educational policy and economic structure have significant implications for income inequality and social mobility.

In Northern Europe, countries like Sweden, Finland, and Norway have developed strong welfare systems with extensive social safety nets, including universal access to education. These nations have historically prioritized educational equality and accessibility, leading to relatively

low levels of income inequality. Education in these countries is widely seen as a tool for ensuring equitable access to economic opportunities, and the returns to education are often seen as more moderate due to the relatively equal distribution of education and income (OECD, 2018). In these economies, the labor market is typically characterized by high wage compression, where educational attainment may not necessarily lead to as large a differential in income as in other regions.

In contrast, Southern European countries, such as Spain, Italy, and Greece, have experienced higher levels of educational stratification, where access to quality education is often linked to social class and regional disparities. These countries have seen higher returns to education, particularly for those from disadvantaged backgrounds, who benefit more from educational attainment due to the lower initial levels of access to education (Bertola, 2014). However, Southern Europe also faces significant challenges related to youth unemployment and underemployment, which may limit the economic benefits of education for some individuals (Eurostat, 2021).

Eastern Europe presents a distinct picture, shaped by its post-Soviet transition and the restructuring of its educational and labor market systems. Countries such as Poland, Hungary, and Romania have made significant strides in educational attainment, yet the returns to education in these countries remain high due to the ongoing process of economic transformation and labor market liberalization. As these countries transition from centrally planned economies to market-driven systems, higher levels of education are increasingly seen as a necessity for accessing higher-paying and more skilled jobs. The continued expansion of tertiary education in the region has been accompanied by rising inequality in labor market outcomes, with those holding higher educational qualifications benefitting disproportionately (Mayer, 2017).

Western Europe, which includes countries like Germany, France, and the United Kingdom, showcases a mixed approach to education and economic development. These nations have strong labor market institutions and high levels of educational attainment. However, significant differences in returns to education can be seen within countries depending on factors such as regional disparities, the type of education, and labor market segmentation (Dustmann & Schönberg, 2012). Western Europe also faces challenges such as the increasing pressure on public education systems and the growing demand for highly skilled workers in a competitive global economy.

These regional differences within Europe reflect the broader global trend of varying returns to education. They underscore the importance of considering local economic and educational policies when studying the link between education and earnings. Moreover, these differences also highlight the challenges faced by policymakers in creating educational systems that reduce income inequality and promote social mobility.

Relationship Between Education and Earnings

Education and earnings are intricately linked, with numerous studies highlighting the positive relationship between the two. This link is grounded in two primary economic theories. The seminal work by Becker (1964) established human capital theory which asserts that individuals with more education have higher productivity, leading to higher earnings. This theory posits that

education enhances skills and knowledge, which in turn increases an individual's efficiency and output. As a result, educated individuals are able to command higher wages in the labor market. This relationship is particularly important in knowledge-based economies, where the demand for skilled labor is high, and the ability to innovate and adapt is crucial for economic success (Mincer, 1974).

While human capital theory focuses on education as a tool for increasing productivity, signaling theory, as proposed by Spence (1973), suggests that education also serves as a signal to employers about an individual's abilities and potential. According to this theory, education does not necessarily increase productivity directly but rather signals to employers that an individual has the necessary attributes, such as intelligence, diligence, and discipline, which are valued in the workplace. As a result, individuals with higher levels of education are more likely to be hired for higher-paying jobs, even if the education itself does not directly enhance their productive capabilities.

Empirical studies on the returns to education consistently show a positive relationship between educational attainment and earnings. A widely cited study by Psacharopoulos (1994) found that, on average, each additional year of schooling is associated with a 10% increase in earnings, with substantial variation across countries and regions. More recent studies, such as those by Card (1999), confirm these findings, although they also point to the complexities in estimating causal returns due to endogeneity issues, such as omitted variables and ability bias.

1.2 Problem Statement

Endogeneity of Education and Earnings Relationship

A major challenge in estimating the returns to education is the issue of endogeneity. Endogeneity arises when an independent variable in a regression model is correlated with the error term, thus violating one of the core assumptions of ordinary least squares (OLS) regression. In the context of the education-earnings relationship, education is likely to be endogenous due to several factors, including ability bias, omitted variable bias, and reverse causality. These factors complicate the estimation of the causal effect of education on earnings, as they introduce unobserved variables that affect both education and earnings.

One of the most well-known sources of endogeneity in the education-earnings equation is ability bias. Individuals who choose to invest in education are often more able, motivated, and cognitively skilled than those who do not pursue higher levels of education (Card, 1999). This "self-selection" into education means that the observed relationship between education and earnings may reflect not only the returns to education but also the returns to innate ability, which is not accounted for in the analysis. As a result, OLS estimates of the return to education may overestimate the true effect, attributing higher earnings to education that are actually due to higher innate ability. This bias is particularly problematic in cross-sectional studies, where it is difficult to isolate the individual contribution of education to earnings.

Reverse causality further complicates the education-earnings relationship. While it is commonly assumed that education leads to higher earnings, it is also possible that higher

earnings lead to greater educational attainment. For example, individuals with higher earnings might be more likely to afford further education or professional development (Card, 2001). This creates a bidirectional relationship between education and earnings, where causality runs in both directions. As a result, the estimation of returns to education becomes challenging, as OLS estimates may incorrectly capture the effects of earnings on education rather than the reverse.

Another crucial issue in estimating the returns to education is measurement error. In many surveys, education is self-reported by respondents, which opens the door for inaccuracies in reporting educational attainment. For instance, individuals may overstate or understate their level of education, particularly in cases where educational attainment is a sensitive issue or where individuals lack precise records of their academic history (Bound, Brown, & Mathiowetz, 2001). Such measurement errors can lead to attenuation bias, where the estimated returns to education are biased towards zero because the variation in the independent variable (education) is incorrectly captured. This measurement error complicates the estimation process and weakens the reliability of the results. Moreover, when using education as a categorical variable, such as secondary vs. higher education, the boundaries between categories may be imprecise, further exacerbating the issue.

Instrumental Variables as Solution to Endogeneity

The primary methodological strategy in a study of this nature and this study in particular is the use of compulsory schooling reforms as instruments for education. These reforms implemented at various times across Europe serve as natural experiments that offer exogenous variation in educational attainment, unrelated to individual ability or family background (Angrist & Krueger, 1991). The strength of this approach lies in its ability to isolate the causal effect of education on earnings by leveraging policy-induced changes in educational opportunities. Several studies have used compulsory schooling reforms as instruments, showing that such reforms have a substantial impact on educational attainment and earnings (Brunello, Fort, & Weber, 2009; Devereux & Hart, 2010). This study builds on this tradition by applying the IV methodology to a large cross-country sample from the European Social Survey (ESS), ensuring robust identification of the causal effect of education on earnings.

By introducing this IV approach, this research aims to address the key limitations in the existing literature. First, it will provide more credible estimates of the returns to education by addressing the endogeneity of education which has plagued previous studies. Second, it will contribute to the literature by exploring the regional and gendered dimensions of the returns to education in Europe, using data from over 30 countries to provide new insights into the relationship between education and earnings.

1.3 Research Objectives and Scope

Primary Objective:

- To estimate the causal impact of secondary and higher education on earnings in Europe using compulsory schooling reforms as instrumental variable.

Secondary Objectives:

- To estimate the causal returns to education across Northern, Western, Southern, and Eastern Europe.
- To assess gender differences in the returns to education.
- To evaluate the effect of education on self-employment outcomes.

1.4 Scope of the Study

Geographical Focus: The study will span 33 European countries, encompassing a wide range of economic, social, and educational contexts. These countries include nations from Northern, Western, Southern, and Eastern Europe, each with distinct labor market structures, educational systems, and welfare policies. By selecting a diverse set of countries, the research will provide a comprehensive analysis of the returns to education across Europe, allowing for an examination of regional differences. The countries chosen for this analysis have varied histories and educational policies, with some countries experiencing rapid educational expansion, while others have seen slower or more stratified educational development. This geographical diversity will allow for a nuanced understanding of how regional economic structures and education systems shape the economic returns to education.

Population: The study will focus on **working-age adults** (ages 25 to 64) who are employed, specifically excluding those who are either currently in education, retired, or not actively participating in the labor market. This focus ensures that the analysis examines the relationship between education and earnings during individuals' prime working years, when education is most likely to influence earnings. By focusing on employed individuals, the study will capture the true wage differentials that result from educational attainment, avoiding the confounding influence of individuals who may not be fully engaged in the labor market. This approach also allows for a clearer understanding of the relationship between education and earnings, as the majority of people in this age group will have completed their formal education and be fully integrated into the workforce.

Data Sources and Methodology: This research will primarily utilize data from the European Social Survey (ESS, a rich source of cross-national data on socio-economic variables, including education, income, and employment status. The ESS provides detailed microdata from individuals across 33 countries, allowing for the analysis of cross-country and regional variations in the returns to education. The study will rely on an instrumental variable approach, with compulsory schooling reforms serving as the primary instrument for education. This methodology is designed to address the endogeneity of education in earnings equations and provide a more accurate estimate of the causal effect of education on income.

1.5 Research Questions

Main Research Question:

• What is the causal relationship between educational attainment and earnings in Europe, and how do compulsory schooling reforms influence this relationship?

Other questions:

• How do regional differences across Europe affect the returns to education?

• What is the impact of gender on the returns to education, and does the gender pay gap persist after controlling for educational attainment?

• Does education increase the chances of self-employment/entrepreneurship?

• How robust are the results to variations in model specifications, including the use of different age groups and employment sectors?

1.6 Hypotheses

- **Hypothesis 1**: Higher levels of educational attainment lead to a significant increase in earnings in European countries.
- **Hypothesis 2**: Returns to education vary significantly across European regions, with Southern and Eastern Europe experiencing higher returns than Northern and Western Europe.
- **Hypothesis 3**: The gender pay gap in earnings persists even after accounting for educational attainment.
- **Hypothesis 4**: Education increases self-employment.

1.7 Significance of the Study

Policy Implications

The findings from this study hold significant potential to influence educational policy across Europe. By providing robust estimates of the causal relationship between educational attainment and earnings, the research can offer valuable insights into how education policies might be reformed to increase returns on educational investments. Specifically, the instrumental variable approach employed here, using compulsory schooling reforms as instruments, could serve as a guiding framework for policymakers aiming to enhance the impact of education on economic outcomes.

For example, the study's results may highlight regions where compulsory schooling laws or adult education initiatives could lead to significant improvements in labor market outcomes for individuals. Policymakers could use these findings to advocate for longer mandatory schooling, expanded access to tertiary education, or adult education programs designed to boost the earnings potential of individuals who might otherwise face limited educational opportunities. Countries with lower returns to education could consider enhancing the quality or accessibility of higher education to bridge the gap between educational attainment and income.

Furthermore, this research could inform education-to-employment transitions, ensuring that education systems align more closely with the labor market's needs. By evaluating the impact

of educational attainment on earnings, policymakers may be able to identify which levels of education (e.g., secondary versus tertiary) yield the most significant economic benefits and subsequently prioritize reforms that target these stages of education.

Income Inequality

In addressing income inequality, this study underscores the role of education in fostering upward social mobility within European labor markets. Education has long been regarded as one of the most effective tools for reducing income inequality, and this research will examine how differing levels of educational attainment impact income distribution across countries with varying levels of inequality. The findings could provide empirical support for the argument that increasing access to secondary and higher education for underprivileged populations can significantly reduce wage disparities.

By highlighting the variations in returns to education across regions, this study will allow policymakers to understand how educational disparities contribute to broader income inequality in Europe. In regions where educational access is more equitable, the returns to education are likely to be more uniform, leading to more balanced income distribution. Conversely, in regions with lower levels of educational access or quality, returns to education may be highly skewed, exacerbating income inequality. These insights are critical for shaping social welfare policies that aim to promote a fairer distribution of income and reduce disparities based on educational attainment.

Gender and Economic Inclusion

A central theme of this study is the gendered nature of the returns to education. The findings will contribute significantly to the ongoing discourse on gender equity in labor market outcomes, particularly by shedding light on how gender-specific returns to education might vary across different European regions. In many European countries, women have achieved higher levels of educational attainment than men, yet they continue to face lower earnings in comparison. This discrepancy highlights the gender pay gap, which remains a significant issue in labor markets across the continent.

Understanding the gendered differences in the returns to education is crucial for formulating policies that promote economic inclusion and gender equity. If the study finds that women, despite their higher educational attainment, experience lower returns in terms of income compared to men, this would underscore the need for targeted interventions to ensure that women can fully capitalize on their educational investments. This could include anti-discrimination policies, gender-targeted career support programs, and efforts to combat occupational segregation, where women may be concentrated in lower-paying industries or positions. Moreover, the study will provide evidence of how gender dynamics influence the relationship between education and earnings, contributing to a broader understanding of how education can be leveraged to promote not just individual economic success, but also gender parity in economic outcomes.

Contribution to the Literature

This study makes a significant contribution to the labor economics literature by providing more credible causal estimates of the returns to education. Previous studies on the returns to

education have primarily relied on ordinary least squares (OLS) regression, which suffers from endogeneity issues such as ability bias and omitted variable bias. By employing an instrumental variable (IV) approach, specifically using compulsory schooling reforms as instruments for education, this study addresses these endogeneity concerns and provides a more reliable estimate of the causal impact of education on earnings.

Instrumental variable methods have gained prominence in recent years as a robust solution to the biases inherent in OLS estimation. The use of compulsory schooling reforms as instruments allows this study to isolate the exogenous variation in education that is not correlated with individual characteristics such as ability or family background. This improves the credibility of the causal inference and provides a stronger foundation for policy recommendations regarding educational investments and reforms.

Moreover, this approach builds on and extends previous work by Angrist and Krueger (1991), who famously used compulsory schooling laws as instruments to estimate the returns to education. By applying this method to a European context, this study offers novel insights into the returns to education in a diverse set of countries, contributing to the growing body of literature on causal inference in labor economics.

Furthermore, one of the unique contributions of this study is its focus on regional variations in the returns to education across Europe. While much of the existing literature on returns to education has been based on studies of individual countries or broad cross-country comparisons, this research offers a more nuanced examination of how regional economic structures, education systems, and labor market conditions shape the returns to education.

By analyzing data from 33 countries across Northern, Western, Southern, and Eastern Europe, the study provides detailed insights into how regional differences in educational policies, economic development, and labor market characteristics influence the effectiveness of education in boosting earnings. For example, in regions with highly stratified educational systems, such as Southern and Eastern Europe, the returns to education may be higher due to the lower initial levels of access to higher education and the subsequent wage premium for obtaining a degree. In contrast, in countries with more equitable access to education, such as those in Northern Europe, the returns to education may be more modest.

These regional insights are critical for understanding how educational reforms can be tailored to specific regions to maximize their impact on earnings and reduce income inequality. The study's findings will help policymakers better understand the complex relationship between education and earnings in different parts of Europe and will inform future efforts to design region-specific educational policies and labor market interventions.

1.8 Thesis Structure

- **Chapter 1: Introduction:** Introduces the thesis with brief idea of the focus of the research, issues on the topic and contribution of the study.
- **Chapter 2: Literature Review**: A comprehensive review of the academic literature on

returns to education, focusing on Europe, and the methods used to estimate these returns.

- **Chapter 3: Data and Methodology**: A detailed description of the data source (ESS) and the econometric methodology (including IV and 2SLS).
- **Chapter 4: Results and Discussion**: Presentation and interpretation of the empirical results, including robustness checks and sensitivity analyses.
- **Chapter 5: Conclusion and Policy Implications**: A summary of findings, conclusions, and policy recommendations, along with suggestions for future research.

2 Literature Review

2.1 Introduction

The importance of education for pecuniary and non-pecuniary returns has been a contentious discourse amongst economists, educationists and policy makers. This has prompted a lot of advocacy for public investments in education for knowledge production, socioeconomic advancement and progressive development. Over the years, a series of studies have argued in favor of the benefits of education. A large number of empirical studies have evinced that indeed education have strong relationship with increase in earnings. This suggests that an additional year of education increases wages, as such those with higher levels of education are better off in terms of earnings compared to those with lower level of education. (Psacharopoulos and Patrinos, 2018). However, the bone of contention that continues to linger is whether in fact this observed correlation is indeed causal. This effectively opens room for debate on whether as suggested by Becker (1964) that education indeed increases the productivity of an individual which amounts to a corresponding increase in earnings; or whether education in fact education does not necessarily increase productivity but serves as a signal to demonstrate the abilities of job seekers (Spence, 1973). The most interesting of all is whether in fact we can actually associate an increase in earnings solely because of the increase in educational attainment; could there be other factors driving earnings (family background, distance to college, education reforms)? These important yet uncharacterized a priori makes attempts to uncovering the true meaningful effects of education on earnings a critical research focus to guide policy and individuals' choices about investments in education.

Researchers have acknowledged that the empirical problem in studying causal effects of education is the potential endogeneity issue. It is difficult to isolate the effects of additional factors that could really affect earnings besides just an increase in educational attainment. These factors can be cognitive ability, family background, motivation, or socio-economic advantages (Card, 1999). Essentially speaking, it is very a strong assumption to associate earnings adjustments entirely due to additional schooling. In reality, there are people who, besides their educational pedigree, already have in them critical characteristics that may likely make them higher wage earners even with low level of education or absence of education. We then may be overstating the

true effects of education on earnings if we do not account for these confounders. Consequently, these subtleties introduce the discourse of omitted variable bias and the problem of measurement error. Another problem is the issue of reverse causality because it could be that in fact people with higher earnings may be more likely to invest in their education. This leads to a situation where earnings influence education rather than the priori assumption.

Researchers have attempted several methodologies to navigate the endogeneity problem in estimating causal effects. In economics literature, quasi-experimental methods like instrumental variables estimation have continued to gain increasing relevance in the identification of causal effects. This has been done through exploiting exogenous variations in educational attainment (Angrist and Krueger, 1991; Card, 1995).

The study of causal effects of education on earnings is paramount particularly in the European zone. This is due to the systemic variations in the education sector across different countries, in addition to peculiar differences in their wage structure and mechanisms, labor market landscape, amongst others (Harmon et al., 2003). The EU zone is renowned for its public policy on education, unlike the United States where education is mostly privatized. Many European countries instead allocate public expenditure on university education, supporting public education which potentially affects returns to education and an increased in labor force participation. Take Italy for instance which enacted a law for right to education, supporting large number of students to complete higher level of education. Germany alike considers public education very essential, making higher education tuition-free in all public universities.

Brunello and Rocco (2017) in their paper highlighted a very important perspective on skill acquisition. As opposed to the traditional consideration of university education as the principal significant determinant of higher wages, the duo emphasized the prominence of vocational education and apprenticeship systems, especially in countries like Germany and Switzerland as important alternative route to better wages. What this emphasis effectively does is that it acknowledges the complexities in today's labor market where experience and hands-on trainings are significant phenomena in today's labor market. Meanwhile, formal education remains particularly relevant as a key factor in the determination of higher wages in countries such as Italy and Spain. In such countries, a greater emphasis is placed on university education to be successful in the labor market (Montenegro and Patrinos, 2014). Owing to this interesting heterogeneity, research of this nature in the European context is imperative in order to examine to what extent education indeed affects earnings and country-context variations in the labor markets.

Another imperative is the growing expansion of access to education in Europe. In recent years, governments have placed enormous importance on education, leading to significant investment in the sector. This has caused very rapid expansion in the number of graduates in the labor market. Consequently, this created a situation of overeducation, exploding the labor market with many graduates which considering the demand and supply effects causes less valuation of education by employers, problem of skill mismatches etc. The prevailing situation compels a lot of degree holders to take up jobs that do not initially require higher education (Verhaest and Van

der Velden, 2013). In fact, many researchers have now acknowledged that as graduates saturate the labor force, there is huge potential for the deterioration of the wage premium attributed to education. Therefore, in labor markets whose expansion is not enough to cater for all these jobseeker with degrees ends up paying lesser wages (OECD, 2019). It then becomes difficult to really argue in favor of education, as to whether continuous expansion of education really is effective in bringing about economic returns; or other labor market factors are now gaining more relevance, especially work experience, networking, non-cognitive skills etc as stronger determinants of earnings.

To have a nuanced understanding of these complexities and uncharacterized a priories, this literature review seeks to synthesize important theoretical foundations and empirical evidence, with comprehensive exploration of previous methodological approaches that have helped in estimating causal returns to education in Europe. As a background, it will draw inspiration from the three renowned theories prominent in economics literature. It will juxtapose the human capital theory, signaling theory, and the Mincer earnings equation (Becker, 1964; Spence, 1973; Mincer, 1974). Many studies have leveraged on the competing yet reinforcing perspectives of these theories and their significance in explaining wage differentials as a result of educational attainment, their application as well as shortcomings. Furthermore, the review will investigate the various empirical strategies employed by researchers to address the infamous endogeneity problem embattling the effort to uncover causality of returns to education. In particular, it will make good reference on quasi-experimental approaches, typically the Instrumental Variable method and analyze its important differences from a simple OLS, a method highly criticized for its overstatement of educational attainment on earnings. Following this will be an empirical discourse of interesting findings from various European countries, highlighting critical variations and other factors that causes heterogeneous effects of returns to education in these countries. And then the chapter will be concluded by examining the existing gaps in the literature and how this thesis seeks to contribute to the ongoing contentious debate on the relationship between education and earnings as far as the labor market is concerned.

2.2 Theoretical Framework

The study on the causal relationship between education and earnings is grounded in three primary economic theories: Human Capital Theory, Signaling Theory, and the Mincer Earnings Equation. These theories provide a structured understanding of how education influences wages, the mechanisms through which employers interpret educational attainment, and the empirical modeling of earnings. This section integrates these theoretical perspectives to establish a solid foundation for analyzing returns to education in Europe using an Instrumental Variables (IV) approach.

2.2.1 Human Capital Theory

The Human Capital theory is one of the pioneering theories in the economics literature discussing education returns and earnings which is widely use in today's research. Introduced by Becker (1964), the theory suggests that investment in education increases the productivity level of an individual which results in higher earnings in the labor market. It posits that the productivity of an individual is a function of accumulated knowledge and skills from education and training. Widely used in today's research, the theory is adopted by many researchers as a foundational framework in the estimation of causal effects of education on wages.

This theory has been widely used by governments, policymakers and economists to justify investment in public education as an impetus for sustained economic development and wellbeing. According to Schultz (1961), the underlying assumption of this theory is that individuals make rational choices about educational investment principally based on expected returns. The prominent Mincer (1974) equation formalized this theory, providing an empirical framework to estimate returns to education. He argues that any extra educational year leads to an increase in earnings. In principle, he considers equation as a principal equalizer for income disparities amongst individuals in the labor market. One of drawbacks of the human capital theory is its oversimplification labor market outcomes. The theory assumes homogeneity across individuals' educational attainment with respect to their earnings, without consideration of potential confounders that affects earnings such as ability and family background. Spence (1973) in his signaling theory opposes this assumption, highlighting that education is actually a signaling mechanism of an individual's ability instead of the direct improvement of an individual's productivity as far as the labor market is concerned. Accordingly, this argument effectively means that higher payoffs associated among higher educated individuals may be attributed to selection instead of causal effects of education itself.

Nonetheless, a series of empirical studies have supported Becker's human capital theory. Notably, a modest average outcome between 5per cent to 10per cent has been observed by Card (1999) in his review of multiple studies estimating returns to an additional year of education. The OLS estimates notwithstanding demonstrate endogeneity concerns associated with omitted variable bias and measurement error. There exist certain unobservable characteristics such as ability, family background and motivation driving both education and earnings (Ashenfelter and Krueger, 1994). This makes estimates serially bias, reinforcing the need to employ techniques that will address this problem (Card, 1999).

Over the years, researchers have used instrumental variables as a solution to estimate causal effects in studying educational attainment and earnings. For instance, exogenous variations in educational attainment such as parental education (Black, Devereux, and Salvanes, 2005), education reforms policies (Oreopoulos, 2006), and distance to college (Card, 1999) have ben famously used to estimate causal effects of education on earnings.

2.2.2 Signaling Theory

Spence (1973) contributed to the discussion suggesting that education does not necessarily increase productivity and earnings; instead, it is actually a signaling mechanism to demonstrate workers' abilities to employers. This contrast between the human capital theory and signaling theory adds significant dynamics in understanding the nuances of returns to education. The signaling theory is anchored on asymmetric information as employers cannot directly observe the productivity level of job seekers. As a result, they use signals such as educational attainment to estimate important characteristics of individuals such as ability, work ethic, discipline amongst others.

The underlying assumption of this model is that education serves as a costly signal that distinguishes people with high ability from those with low ability. Therefore, education in an efficient labor market is an indicator of a job-seeker's potential productivity level instead of an interpretation as direct effect on skills as in Human Capital Theory. It is Spence's conviction that individuals as a result opt for higher education to bolster their employability in the labor market as opposed to the idea that pursuing higher education is principally for skills acquisition. The implication of the Signal Theory is that people purse education not necessarily to gain skills but to ensure their uniqueness in the labor market, hence higher chances of employment and employability.

Several studies on returns to education have revealed mixed findings on the validity of signaling theory. For instance, Arcidiacono, Bayer, and Hizmo (2010) showed that indeed adjustments in the earnings premium resulting from increased educational attainment is attributed to signaling of a worker's ability instead of skills acquired. Weiss (1995) supported the same argument that differences in wages are mainly explained by signaling effects rather than increase in productivity. Opposing studies but also complementary are Chevalier, Harmon, Walker, and Zhu (2004) who revealed that while indeed educational attainment signals ability, education itself augments an individual's productivity level in the UK, thus supporting both theories. Additionally, Leuven, Oosterbeek, and van Ophem (2004) found similar results in their study comparing wage structures across different European. Essentially, they observed that education served both as a signaling mechanism and a demonstration of skill acquisition.

The shortcoming of Signaling Theory is its assumption that educational attainment is an effective screening mechanism. However, this is not necessarily realistic given the complexities of the labor market as well as other assessing mechanisms such as internship and work experience which may be a basis in the determination of an individual's productivity for hiring (Weiss, 1995). These dynamics make hiring decisions more complex and broader, rendering educational credentials less pronounced as a principal signal in the labor market. The theory also does not consider the fact that essentially there are instances where education has a direct effect on relevant skill acquisition, as is argued in Becker's Human Capital Theory.

The growing number of graduates with higher educational attainment has provided an interesting context for testing the signaling theory in the European labor market. Essentially, increasing access and opportunities for higher education in Europe flooded the labor market with

a lot of degree holders. Consequently, the standard for even a job which required non-degree qualification now requires a degree, explaining the demand and supply dynamics of labor. This therefore led to a situation where you have many people on average having similar qualifications which then makes reliability on education as a primary signal a flawed exercise. This is because as more people earn higher education, the power of education as a signal deteriorates, ushering a overeducation and mismatch of skills in the labor market (Verhaest and Van der Velden, 2013).

Regional variations is also observed on the importance of education as a signal in the labor market given the differences in returns to education from country to country owing to differences in the infrastructure that make up earnings such as labor market institutions, educational systems, and regulatory environments (Hanushek and Woessmann, 2008). In Germany and Switzerland for instance, where vocational training is highly integrated in the labor force, greater importance is place on the acquisition skills than higher educational degree (Brunello and Checchi, 2007). This means in such countries, education as a signal is a weak assessment mechanism. However, countries like Italy and Spain that place great importance to formal educational qualifications considers education as a signaling mechanism and a powerful tool for the determination of wages (Harmon, Oosterbeek, and Walker, 2003).

In general, Signaling Theory provides an imperative understanding of wage differences attributed to education, especially in labor markets landscape underpinned by asymmetric information.

2.2.3 The Mincer Earnings Equation

Jacob Mincer (1974) formalized the empirical estimation of returns to education given education and experience. The standard Mincer equation that simplifies our econometric analysis takes the following:

$$\ln(W_i) = \alpha + \beta S_i + \gamma X_i + \delta X_i^2 + \varepsilon_i \tag{1}$$

where:

- W_i is individual wages;
- S_i represents years of schooling;
- X_i denotes labor market experience;
- X_i^2 accounts for diminishing marginal returns to experience; and
- ε_i is an error term accounting for unobservable factors affecting wages.

The Mincer equation essentially provides a meaningful framework to study returns to education. However, given its focus on ordinary least squares (OLS) methods, numerous concerns have arisen regarding issues of measurement error and omitted variable bias. Instrumental variable techniques have effectively been used to address this shortcoming, leveraging on exogenous variations in school reforms, family background and college distance. Another interesting issue about the equation is its linearity assumption between education and earnings.

It basically considers a corresponding increase in earnings, given an increase in education. However, it fails to account for variations in education levels, for instance, primary Vs. diploma ((Harmon, Oosterbeek, and Walker, 2003).

Over the years, the equation has been widely used in empirical studies to understand returns to education. Psacharopoulos and Patrinos (2004) employed a strategy using cross-sectional and panel data to understand tis relationship. The results of their study evinced a positive relationship between education and earnings.

In a nutshell, combining these paramount theories provides a cogent imperative framework to estimate the effects of education on wages in Europe. For this study therefore, the integration of these theoretical perspectives provides a comprehensive framework for analyzing returns to education in Europe. In effect, the objective of this study is to provide a strong causal estimation of educational returns of education using Instrumental Variables. The three theories help in understanding the nuances of the impact of education in defining the labor market outcomes.

2.3 Empirical Evidence on Returns to Education

Several studies have attempted to uncover the causal relationship between education and earnings. This extensive drive has made available a large body of literature and robust empirical evidence to understand this overarching relationship. Generally and in the context of this study, returns to education basically refers to a percentage increase in wages given an increase in educational attainment. This typically tries to understand by how much an individual's wage adjusts if that individual has taken an additional year of schooling. In a number of literatures, education has been reported to have a positive effect on earnings – at least all things being equal. This wage premium associated to education therefore strongly influences individual choices of investment in education.

In this section, the study analyses existing empirical evidence on returns to education. It will highlight important results from various empirical findings, regional variabilities, some gender perspective, and essentially various methodological approaches implemented to navigate the problem of endogeneity in the attempt to uncover causality between education and earnings. Well, while there exist some variations in results, it is important to underscore that most evidence gathered by existing literature have argued in favor of education as a driver of wages, suggesting that indeed there is a wage premium for individuals who acquire education and that education itself have both private and public benefits overtime.

2.3.1 Overview of Returns to Education: Concept and Measurement

Over the years, economists measure returns to education by estimating what happens to the earnings of an individual given an additional year of schooling. The famous Mincer (1974) equation characterizes this prominent method of uncovering the relationship between education and earnings. Accordingly, the coefficient of years of schooling in a log-wage regression for instance is basically represented as by how how much wages change given one more years of

education (Mincer, 1974). Building on this, the approach has been employed in and essentially demonstrates a positive and statistically significant effect of education on wages. A lot of studies have shown on average some 5per cent to 10per cent increase in earnings attributed to each additional year of schooling. In the United States, OLS estimates have found a typical cluster around 7–10per cent increase in earnings because of additional year of schooling, implying that there is a wage premium associated with school years (Card, 1999). What is remarkable is that there appears to be consistency about similar findings across many data sets and time periods (Psacharopoulos and Patrinos, 2018). These studies have reinforced the common expectation that an additional year of school increases earnings.

The returns to education are multifaceted. Private benefits which basically entail the improvement on the earnings of an individual due to education whereas the social returns accounts for the overall benefit society enjoys from education, particularly externality and public fiscal returns. Well, most empirical studies have been around private returns explained by wage gains due to education. The Mincerian wage regressions or rate-of-return (ROE) formulas have been widely used to measure this benefit which basically compares the costs of education such as tuition and opportunity cost (forgone earnings) with the increase in earnings over a lifetime. A comprehensive review of more than six decades of research on returns to education has reported that on average, there is globally about 9per cent rate of return associated with additional year of education. (Psacharopoulos and Patrinos, 2018). This gives a good picture of the empirical findings of wage premium for an additional year of education over the years, especially with a notable 9per cent ROE which essentially is highly significant for conventional investment standards. The authors went further to argue that the benefit of education also has a social aspect. Essentially, they found that even after taking into account the public subsidies and broader costs given the rising government spending on education in recent years, the overall social return to education is really high and significant. Even though it is a few percentages less than private returns, they observed that the social returns lie still in the range of 8–10per cent for an additional year of schooling (Psacharopoulos and Patrinos, 2018). These similar findings demonstrate that educational benefits are beyond private returns, but go as far as positively impacting society which explains why many economists, policy makers and politicians are proponents of public investment on education as an essential element for sustainable development.

In light of the foregoing findings, how does education make way in the discourse? Well, a number of empirical studies have evinced that compared to high school, attaining a college or university degree pays significant more earnings premium. Take US for example; college graduates have been observed to acquire higher earnings than high school diploma holders. In fact, empirical studies in labor economics have shown that there is a substantial ”college wage premium”. Precisely, individuals with university degrees earned on average 60per cent to 80per cent more wages than a worker with only a high school diploma by the 2000s. (Autor, 2014; Goldin and Katz, 2008). Interestingly, the premium has risen dramatically since the early 1980s (Goldin and Katz, 2008). One of the fundamental reasons can be attributed to the new trend in the labor market where the demand for higher skilled workers is increasingly gaining

prominence. Given that education can be used as a signal for productivity, employers would then tend to consider highly educated jobseekers and this is reinforced by the rising number of graduates in the already saturated labor market. As a result, the earnings gap between college and high school educated workers becomes large as the demand for skilled labor grows, making the value of a higher education greater than ever in modern labor markets (Autor, 2014). From a net present value perspective (NPV), even considering tuition costs and years not in the labor force, the returns of a college are still a large positive return. Autor (2014) and others evinced that the lifetime earnings return from completing college compared to stopping at high school is way greater than the upfront costs, implying that investment on education is highly rewarding and results in a high internal rate of return. These findings have been seen in different national contexts. Although the exact magnitude of wage premium associated with education varies, there is a notable consistency on the wage benefits of higher education.

2.3.2 Variations in Returns by Education Level

A fundamental question arises in the discourse and literature of returns to education, notably whether different levels of education (primary, secondary, higher) lead to different earnings. Well, earlier studies conducted show a pattern of diminishing returns to any additional year of education. In essence, the studies observed that primary education is associated with the highest level of earnings, followed by secondary school. Higher education was, however, seen at the bottom of earnings compared to the lower levels. Psacharopoulos (1994) in his popular global survey examined the rate-of-return estimates of education from dozens of countries from 1980s to the 90s. The findings evinced that primary education had the highest private returns in many low developed countries (LCDs). This pattern is attributable to the labor market realities of these countries where basic literacy and numeracy were limited, thus highly rewarded in such markets. Notwithstanding, both secondary and higher education indeed pays positive labor market returns but not as much as primary education did at the time (Psacharopoulos, 1994). A cogent intuition to this narrative of returns to education in those decades is the fact that at the time, there were only a few people going to school. As a result, even a small level of education yields a very large gain and given the cost of secondary and higher education, it was suboptimal in terms of returns in some datasets at that time, considering also that at the time the demand for high-skilled work was not too high.

However, recent studies show different patterns with regards to returns to education given an additional year of schooling. Countries all over the world are now achieving universal access to primary education while others are already expanding to a secondary level due to growing international conventions such as the millennium development goal and recently the sustainable development goals. This creates a situation where the labor force is polarized with many people with these levels of education. Consequently, higher education has now become increasingly relevant in the labor market, gaining prominence over primary and secondary education. More returns to education are observed at higher education level since the 1980s substantially over lower levels of education (Montenegro and Patrinos, 2014; Patrinos, 2019). Psacharopoulos

and Patrinos (2018) linked the increasing returns to higher education, even whereas access to higher education is increasing, to the growing demand for high skill expertise in the labor market. Accordingly, many findings by the 2000s suggest a notable premium to higher education over primary and secondary education in most countries. Adding to the literature is Patrinos (2019) where he highlighted that in roughly three-quarters of countries studied, the rate of return for completing higher level of education is now higher than the returns to completing primary education. Montenegro and Patrinos (2014) alike found that in over 80 per cent of the 139 countries examined, the returns to higher education are exceedingly larger than the returns primary and secondary education. That is to say in today's world, people who complete a university degree receive the largest bang-for-the-buck in percentage terms, compared to those with just secondary or primary education.

The new dynamics characterizing the increasing returns to education is multifaceted and can be associated to several reasons. For instance, technology has now taken center stage in shaping a skill-based economy. Modern economies that have observed compelling technological advancements have now accelerated their demand for higher-skilled workers. As a result, people with higher education who are associated with higher cognitive, technical and analytical skills have more prominence over people with low level of education. These modern dynamics caused a shift in the labor market outcomes, favoring higher wages to higher-skilled workers. Goldin and Katz (2008) characterized this so-called new world order as "race between education and technology". The massive technological progress countries are observing creates a situation where the advancement of technology pushes up the demand for higher educated workers than the universities can provide. This leads to graduates enjoying high wage premiums given the imbalances in demand and supply for higher skill workers. One of the most observable Another causes for the dramatic shift in earnings in favor of higher level of education is the remarkable expansion of universal access to education at lower levels. Well, while this policy reform helps in building an informed society, what it ultimately does in pushing those at the lower levels of education either at the bottom of earnings or even unemployed. Therefore, as we see higher access to primary and secondary education, the labor force is then saturated with many people who acquired just basic and secondary schooling, making these levels of education less relevant in the labor market. On the other hand, higher education even though is gaining increasing access is still not at the level of universal access. Often only a few students have the access and affordability to university degree. Therefore, a university degree makes a unique distinction in the labor market, making individuals stand out with higher wags (Patrinos, 2019)

Well, there is more to the story than just the level of educational attainment on earnings. Unarguably, higher education is more specialized and tends to match education with the labor market. In fact, universities are now gaining prominence over one another based on how well their degree programmes are tailored to the job market. With the modernization of education at tertiary level there, quality and content of education creates a strategic role in influencing earnings, compared to lower education levels where curriculums are quite broad and uncharacterized as far as the labor market is concerned. Higher education is then seen as having direct and impactful

influence on the skills and productivity level of individuals, thus creates an incentive for higher wage premium. In essence, we observe a higher marginal returns to earning a university degree compared to all other levels in the recent data.

In as much as the pattern of returns to education shifts to favor individuals with higher levels of education, it is imperative to underscore that we cannot rule out the fact that primary and secondary education pays. In fact, recent data still maintains that all levels of education still have positive returns. Psacharopoulos and Patrinos (2018) supported this argument in their finding where they indeed found that higher education has the highest level of returns on average, although other levels of education were also observed to be positive. In fact, policymakers recognized this fact especially in developing countries where technological advancement is not as prominent and expansive, hence both primary and secondary education levels remain highly significant in the labor market. This is why governments continue to support public investment in primary and secondary education to consolidate human capital but also to consider supporting higher education access given its even much more pronounced importance in sustainable economic development.

2.3.3 Variation in Returns to Education in Europe

Several studies have revealed significant variations in the returns to education in Europe, especially between the North, South, and East part of the region. Harmon et al (2003) and Patrinos (2019) have attributed these variations to the labor market and education structure of these countries, highlighting that among these countries, there are notable differences in their education policies and systems, labor market structures and the relative demand for high skilled workers. This therefore leads to heterogeneous gains from education with some European countries demonstrating a high wage premium for individuals with university degrees while modest returns in other EU countries even within with the same level of education. Notwithstanding, the rate of return for higher education has been considerably higher in developing countries than the EU.

Within Europe, Southern and Eastern European countries have been consistently showing greater returns to higher level of education than countries in the North and West (Montenegro and Patrinos, 2014; Patrinos, 2019). Brunello et al (2021) have also demonstrated similar pattern, showing that in particular education pays more in countries such as Portugal, Hungary, and Poland than countries in Scandinavian (Sweden, Denmark, and Norway).

This is potentially due to the existential differences in the labor market structures and institutional wage-setting mechanisms. Pareliussen et al (2018) argued that in especially countries like Nordic where there are stringent compression policies and collective bargaining agreement, we observe a wage distribution that takes an egalitarian shape thereby making returns to education in such countries not as high. In Sweden for instance, returns to education have been observed to be the lowest in the EU due to these characterized structural frameworks, making wage premium for education only about 20per cent as opposed to a staggering 50per cent in countries such as (Harmon et al., 2003). In these countries where the wage premium is significantly high, Southern and Eastern European countries, the absence or less regulatory labor market frameworks and

existence of high-income inequality are the fundamental drivers for these wage gains with respect to education (Brunello et al., 2021).

Several other studies including Montenegro and Patrinos (2014) and Patrinos (2019) further supported the wage differentials within the EU, systematically categorizing countries in the South and East of Europe with higher returns to higher education and countries in the North and West with lower returns. The studies continue to consistently estimate the rate of return for university degree holders 50per cent in Portugal, Hungary, Poland, Lithuania, and Slovakia (Psacharopoulos and Patrinos, 2018). Hormon et al (2003) associated these significant gains to the relative scarcity of university graduates who are often considered more skilled in a labor market that place high importance to education. Therefore, this drives up the earnings of individuals who complete university education in these countries. Interesting findings in fact suggest that Portugal most especially have demonstrated a staggering differential in the rate of return between degree holders and non-degree where in some cases the differencing shooting to astonishing 100per cent, making it the country in the EU with the highest returns to higher education (Brunello et al., 2021). Similar pattern is observed in Hungary and Poland; post-1990, these countries have undergone a colossal transformation in their economies, with a corresponding expansion in higher education. However, the supply of university graduates is not able to meet the increasing labor market demands for these graduates thereby offering them a significant wage returns (Montenegro and Patrinos, 2014).

Meanwhile, OECD (2020) and Pareliussen et al (2018) have reported the lowest returns to education in Sweden, Denmark, Norway, Germany, and the Netherlands – showing a wage return of education of just about 25per cent. In these countries, vocational education and training (VET) are highly developed, taking center stage in the labor market, in addition to having strong labor laws therefore making education less important (Brunello and Rocco, 2017). For instance, VET programmes offer more attractive employment opportunities in Germany, Austria, and Switzerland. This therefore clamps down the impact of university degrees on earnings. (OECD, 2020). One of the most progressive VET programmes is in Germany. Their famous dual apprenticeship system continues to offer individuals a resounding alternative career path that lands them on jobs that pay relatively high wages. Therefore, this tends to close the wage gap between them and those with higher level of education (Harmon et al., 2003). Scandinavian countries like Sweden are renowned for their efforts to achieve equality, by adopting wage-setting mechanisms that standardize pay scales, which reduces earning gaps associated with education levels. (Pareliussen et al., 2018).

Brunello et all (2021) acknowledged the rapid expansion of education in Europe as a significant contributing factor to the differences in returns to education. Accordingly, the study revealed that in countries such as Spain and Italy where the labor market is saturated by graduates, there is considerable decline in the wage premium as a result of education. Verhaest and Van der Velden (2013) associated this decline to credential inflation which is a situation where the labor market demands much more such as work experience instead of traditionally relying on higher education completion. Consequently, the magnitude of the returns of university

degree on earnings falls in these countries. Similar results is observed in countries such Sweden and Denmark that are renowned for their progressive tax systems and strong minimum regulations which then compresses the wage differentials, curtailing the returns to education. In contrast, in Portugal and Lithuania where there is no strong minimum wage and less market regulation generally, the wage premium of university education remains high (Pareliussen et al., 2018).

Beyond Europe, returns to education are particularly reported to be higher in developing countries compared to the developed world. Intuitively speaking, because there is less access to higher level of education in low-income countries, individuals in the labor market command higher wages. This is evinced by cross-country reviews observing that in Sub-Saharan Africa and Latin America, there is considerably highest returns to higher education in percentage points due to somewhat scarcity of highly educated workers in these emerging economies. Most notable studies towards this end, for instance by Psacharopoulos and Patrinos (2018) reported that higher returns to education in Latin America and Sub-Saharan Africa alike at a staggering 15 to 20per cent gains. This shows a dramatic difference in wages between those with university degrees and those with a lower level of education. Furthermore, their study generally showed the average private return to education at 9per cent for individuals in low developed counties whereas around 8per cent in advanced countries. And the gap in fact becomes wider in favor of poor countries as the level of education approaches university levels. The variations observed can be attributed to the structural changes in the labor markets and scarcity of highly educated individuals, thereby gaining a special reward in wages. In essence, the labor market is less saturated and individuals with higher education in poor countries tend to uniquely stand out in the labor market.

Similar to within Europe, what is also fascinating in Africa is that earning variations across regions are observed. Notably, Malawi and South Africa are highlighted for its outstanding returns to education with Psacharopoulos and Patrinos, (2018) reporting the social return to education in Malawi at around 35per cent, which effectively implies an even greater private return (wages). This kind of circumstance can be associated with high demand for more educated workers chasing few available highly education individuals. Meanwhile, lower returns to education is considerably observed in some Middle Eastern or North African where in fact the returns can be as low as single digits (e.g., 5–8per cent), perhaps because of factors like public sector wage compression or a potential mismatch between the skills of higher education earners and jobs in the labor market. In a nutshell, while the existing literature truly demonstrates a positive return to education across all regions, we can indeed observe a notable variance in the magnitude of the effect of education on earnings, given a regions local economic context. What is clear notwithstanding is that the common consensus in the literature is that indeed private returns on average is highest in regions like Latin America and Sub-Saharan Africa, lowest in Middle and North Africa, and a modest level in Assia and the West. Psacharopoulos and Patrinos, 2018; Montenegro and Patrinos, 2014)

To sum up, a significant variation exists amongst European countries as far as returns to education are concerned. With the Southern and Eastern European countries demonstrating significantly high returns, countries in the North and West observe modest gains. due to strong

vocational programmes, regulated wage structures, and egalitarian labor policies. It is imperative to understand these unique differences to support policymaking in the design for education and labor market policies that optimize the economic benefits of higher education.

2.3.4 Gender Variations in Returns to Education in Europe

The relationship between gender and returns to education has been widely studied in the economic literature, with research showing that women often experience equal or even higher returns to education compared to men in percentage terms (Psacharopoulos and Patrinos, 2018; Montén and Thoursie, 2021). However, despite these higher relative returns, women continue to earn lower absolute wages than men, partly due to gender wage gaps, occupational segregation, and differences in labor market participation (Boll et al., 2016; Kunze, 2019). These patterns raise important questions about the role of education in reducing gender wage disparities and the structural factors that influence the realized economic benefits of education for women in Europe.

Like regional variations, gender differences is also an important phenomenon in the empirical analysis of returns to education. Access to education before recently have been skewed towards the male child, making women having to strive much harder to equal the gap. This has called for global concerted efforts to empower the education of women. This is supported by recent literature interestingly showing that women receive as many returns to education as men or even more in some cases, particularly in developing countries. (Psacharopoulos and Patrinos, 2018). The study further asserted that when we look at the returns to education for when in the global sense, the data showed that male has more returns from education. This is not surprising if we consider the sociopolitical dynamics of it where women are subject to sociocultural demerits which curtail their possibility to attain higher education and in fact their earning potentials. However, women who tend to break to overcome cultural discrimination to attain a degree are particularly motivated and determined to do great in the labor market. They are more likely to take up higher paid jobs with higher earnings. Furthermore, education has the potential to help women break into formal labor markets and higher-paying occupations, yielding a big relative gain. Take for instance a woman who has a university degree; there is greater chance that she might access more professional jobs that would otherwise be accessible, which therefore boosts her earning capacity compared to a woman with primary/secondary education.

Montenegro and Patrinos (2014) in their empirical work support the foregoing analogy where many developing countries demonstrate a gender gap as the returns to additional year of education for women is slightly in percentage points greater than that of men. Well, it is imperative to highlight that women observing higher returns to education in percentage points does not necessarily mean women earn more than men in absolute terms. Instead, the data explains that there is greater proportional effect of education on women's wages even though the average earnings of women's average may still be lower. This phenomenon in recent years has reinforced the compelling advocacy for girls' education across the world given the notable positive outcomes.

Within the EU in particular, several studies have suggested higher returns to education for

women. Globally speaking, Psacharopoulos and Patrinos (2018) in their analysis found that on average a greater return of 11per cent for women and just 9per cent men, given an additional year of school. This pattern is also consistent within the context of the EU where studies have also supported the idea that for any additional year of education, women's earnings are higher than men's. (Boll et al., 2016; Montén and Thoursie, 2021). Using data from the European Union Statistics on Income and Living Conditions (EU-SIL similar pattern has been observed in terms of returns to education where women realized a rate of return between 6per cent and 12per cent while between 5per cent and 10per cent for men, demonstrating a higher wage premium to women in Europe (OECD, 2020). However, cross-country variations as returns to education is seen to be higher for women than men in countries such as Italy, Spain, and Portugal while the gendered differences is somewhat lower in Germany, Denmark, and Sweden (Boll et al., 2016).

Kunze (2019) associated this phenomenal pattern to the observable realization that education players a greater role in determining the labor market outcomes of women, compared to men. As a result, women with university degrees are more likely to have access formal employment, secure higher-paying jobs, and reduce their risk of labor market discriminations, which ends of making economic payoff of education more significant for them. Although women realize higher rate of returns to education, it does not mean that women in absolute terms earn more than men.

Notable studies have demonstrated that even though women receive higher returns to education, there still exists significant persistence of wage gap between men and women across European countries (OECD, 2020). Eurostat (2021) reported that women in European countries earn 13per cent on average less than men in Europe even after controlling for levels of education. Analyzing this phenomenon, Boll et al (2021) stated that while a university degree has the potential to increase the earnings of women women's more proportionally than for men, women graduates still earn lower wages in absolute terms compared to their male counterparts.

There is also an observable variation in gender wage gap amongst European countries. For instance, the gender wage gap in Northern European countries such as Sweden, Finland, Norway is relatively small. In fact, in these countries, the returns to education are more or less equal for both men and women which many researches like Pareliussen et al. (2018) have associated to the existence of strong labor market regulations, gender-equal policies, and significant female labor force participation. On the other hand, countries in the Southern and Eastern part of Europe (Italy, Greece, Poland) observe a larger return to education for women but demonstrate a significant gender wage gap in favor of men (Boll et al., 2016; Montén and Thoursie, 2021). Meanwhile, Germany and Austria observe a particularly pronounced gender wage gap despite similar education levels, reflecting occupational segregation and differences in labor market participation (OECD, 2020).

Researchers have attempted to explain this gender wage gap amongst European countries. Kunze (2019) highlighted to persistent career interruptions amongst women especially caused by childbearing and higher family responsibilities which algother compress women lifetime savings, even for those with higher educational attainments. A more nuanced explanation is given by Boll et al (2016) where he argued that the existence of occupational segregation, which renders

women to taking jobs in low-paying industries and jobs (e.g., education, healthcare, and public sector roles) compared to their male counterparts who basically dominate higher-paying jobs, especially in STEM and finance sectors have created a yawning gender wage gap in Europe.

Broadly speaking, the existential variation in gender wage gaps between men and women is as a result of labor market institutions, social policies, and family-related employment policies (Pareliussen et al., 2018) which essentially shape their wage outcomes. In countries that that institutionalized strong parental leave policies and affordable childcare support like Sweden, Denmark, Franc, women participation in the labor force is fantastically higher. This creates a situation where returns to education for women are more fully realized, thus lesser gender wage gaps in such countries (OECD, 2020). The contrasting scenario is in countries like Italy, Greece and Poland where policies that protect and incentivize labor market participation are less pronounced. Consequently, women in these countries indeed do observe higher returns to education but at lower wages compared to their male counterparts due to the absence of social policies that promote more vibrant women participation (Boll et al., 2016).

Labor market flexibility and part-time work also play an important explanatory role. In some countries, women are mainly engaged in part-time working, essentially curtailing their absolute earnings despite their wage premiums associated with education (Pareliussen et al., 2018). This is mostly the case for Germany, Netherlands, Austria. In contrast, parttime work is less common in in Southern and Eastern European countries; therefore, women in these countries are obliged to work on fulltime basis or not work at all, thus the effect on their realized returns to education is more pronounced (Montén and Thoursie, 2021). Additionally, countries that have strong union influence and centralized wage-setting like Sweden, Norway, Germany, efforts to ensure income parity tends to reduce the gender pay gap which leads to a less pronounced importance of education in determining wages overall but achieves greater gender equality in earnings (Pareliussen et al., 2018). However, in extremely market-driven economies, there exists yawning wage disparities between men and women and the returns to education is significantly high. This is the case for UK, Portugal, and Hungary where there is high gender wage gap (Boll et al., 2016).

In a nutshell, the existing literature on gendered returns to education in Europe have consistently demonstrated that women experience higher returns to education than men in percentage terms. However, this does not translate to women earning more than men. In fact on average, women earn 13 per cent less than men (Eurostat, 2021). This existential disparity has been associated with a legion of factors such as regional labor market conditions, occupational segregations, difference in wage-setting policies, parental leave systems, childcare support amongst others. Given this reality, it is crucial to address the labor market framework and policies as an impetus to the full realization of returns to education for women.

The variation in return to education is beyond gender or region. There exist certain demographic factors such as ethnicity or socioeconomic background that potentially affect returns to schooling. This can sometimes be as a result of discrimination in the labor market, family background, special network amongst others. In essence, existing literate have evinced

different levels of returns to education across different groups. What remains notable is that more disadvantaged groups such as individuals from lower socioeconomic status might see particularly large returns from attaining a university degree, as it can serve as a trail to better-paid jobs that would not have been accessible without a degree. In a nutshell, current data is characterized by the universality of the returns to education as a positive; regardless of region or demographic group, a college degree tends to pay off, even if the exact rate of return varies.

2.3.5 Evidence of Causality: Addressing Ability Bias in Estimated Returns

One of the greatest fundamentals in estimating returns to education is the problem of causality. Essentially, it is particularly challenging to isolate the effect of education on earnings from other potential factors that could drive earnings. It is difficult to distinguish correlation from causation; in other words, does an individual observe an increase in wages because of their educational attainments or is it in fact that an individual who has greater abilities and advantage of other backgrounds has the chance of attaining a higher level of education and higher earnings altogether. This conundrum and uncharacterized situation make estimating returns to education a challenge. For instance, if an individual regardless of education or not will actually realize higher wages principally due to innate ability or family background, then a simple comparison of individuals will lead to overstating the true causal effect of education on earnings. Researchers have used different approaches to address this endogeneity problem, albeit a good body of literature points out that indeed a large fraction of the observed wage premium given education is indeed causal; thus, education itself raises earnings, rather than just signaling pre-existing ability.

Natural experiments and instrumental variables have been renowned in the attempt to uncover cause and effect. Instrumental variables in particular have been used by many researchers to obtain exogeneous variation in schooling. Notably, the seminal work of Angrist and Krueger (1991) remains one of the most fundamental approaches in address endogeneity in estimating returns to education. They exploited quirks in school attendance polices in the United States which makes attending school mandatory up to a certain level contingent on the quarter of birth. Leveraging on this policy, they use quarter of birth as an instrument influencing educational attainment of students. This is because children born earlier in the year could legally drop out after a certain age having completed less schooling while children born in the fourth quarter are obliged to stay longer in school; in essence, being born at a certain quarter affects one's level of education, which ultimately affects wages – satisfying the exclusion restriction. Angrist and Krueger (1991) employed this method and discovered that the IV estimate of the returns to education was significant. Interestingly, the results remain the same when compared with simple ordinary least square (OLS) estimation, approximating to about 7 per cent increase in earnings for any additional increase in years of education. The result of the study is consistent with the view that the relationship between education and earnings reflects a true causal effect rather than just selection. This study is imperative because it provides credible evidence that compulsory schooling increases future earnings, reinforcing the human capital argument.

Similarly, policy changes such as compulsory schooling years have been examined by many

researchers in various countries. Notably, Harmon and Walker (1995) studied returns to education in the UK, leveraging on the law mandating a certain school leaving age for all. Results of their study showed significant returns to additional year of education brought about by the reform – a staggering 15 per cent earnings premium as a result of the extra year of secondary education mandated. This is consistent with the observable causal effect of education on earnings (Harmon and Walker, 1995). Additionally, Areopoulos (2006) exploited compulsory schooling reforms in several countries (the United States, Canada, and the UK). As before, the results of the study demonstrated higher future earnings for individuals compelled to stay longer in school due to the mandatory law, than those who left school earlier. They reported an appreciable return to education in the range of 10-15per cent for students who had more education which again suggests that higher educational attainment leads to higher earnings, particularly for those at risk of dropping out.

Estimating returns to education for twins and siblings is another interesting aspect of the discourse. Researchers have attempted to estimate the earnings of twins, controlling for family background and genetic ability. This approach is interesting because it allows us to effectively differentiate innate ability to a significant extent by analyzing the incomes of identical twins with varying levels of education. The remarkable work of Ashenfelter and Rouse (1998) gave an insight into estimating causal effects in this context. They conducted a conventional twin study and discovered that the twin with greater educational attainment earned more; nevertheless, the estimated return in their sample was somewhat lower than the OLS estimate, suggesting a little upward bias in naive estimates; notwithstanding, what is tenable is the estimates remained significantly positive. Even after controlling for ability and family background, with data from the United States, an additional year of education demonstrated an increase in earnings to around 7–9per cent on average (Ashenfelter and Rouse, 1998). The implication is that, although ability bias does exist, it is not significant enough to offset the benefits of education; even when unobserved talents are held constant, education continues to be a significant predictor of earnings.

A plethora of reviews of various studies by Card, (1999); Harmon, Oosterbeek, and Walker (2003) discovered that most credible methods, quasi-experiments in particular, to estimate the causal effect of education have shown results ranging from 6per cent to 12per cent increase in earnings given an additional year of education. This result is in line with or slightly above the simple cross-sectional estimates. In fact, Card (1999) highlighted an interesting pattern, that many estimations of the returns to education using Instrumental Variables are at the higher end of the range (often around 10per cent or more). This implies that the individuals who are induced to get more education in these experiments, for instance, individuals who only attend college because college became more accessible, actually observe higher wages, on average. This could be a sign of return heterogeneity, that maybe individuals who are on the margin of going to school gain a lot from it or it could be a reflection of how measurement error in education biases OLS estimates downward. In any case, the conclusion is that a significant positive return is still obtained even after accounting for biases.

2.3.6 Returns to Education and Ability Bias: Evidence from European Countries

Estimating the causal returns to higher has taken a center stage in the discourse of labor economics in Europe. The growing access to education and the emphasized relevance to investment in education have led to an increase in higher educational attainments and earnings. These dynamics make estimating returns to education with ordinary least squares (OLS) to overstate the return to schooling (Card, 2001). The address this biased induced by innate ability and family background studies across European countries have exploited policy changes and natural experiments to isolate exogenous variation in educational attainments to attempt to uncover more credible estimates of the returns to education (Harmon and Walker, 1995; Ichino and Winter-Ebmer, 1999). These quasi-experimental methods such as instrumental variables, regression discontinuity designs, difference in difference and family fixed-effects have proven to present credible results, thereby providing a rich body of evidence on whether conventional estimates are upward-biased due to ability differences.

One of the most prominent strategies employed by researchers interested in returns to education in the EU is leveraging compulsory schooling laws as instruments for education. Such reforms that oblige additional years of education for certain birth cohorts allows us to realize an exogeneous generate variation in education that is not correlated to an individual's own ability. For example, the United Kingdom's extensions of the minimum school-leaving age from age 14 to 15 in 1947, and 15 to 16 in 1972 as well as similar reforms in France, Germany, and Italy have been extensively studied (Grenet, 2013; Pischke and von Wachter, 2008). Researchers exploited these reforms to compare cohorts slightly before against after the reform while others employ two-stage least squares to instrument education with the reform. This strategy allows researchers to obtain causal returns to education. Principally, Regression Discontinuity Design (RDD), which basically is applied where the policy change created a sharp cutoff. Grenet (2013) used this method to analyze the 1967 French reform and its British equivalent. On the other hand, the use of instrumental variable has also gained prominence where researchers exploited geographical or temporal variation, such as the staggered introduction of comprehensive schools in Sweden (Meghir and Palme, 2005) or differences in college availability. Furthermore, the twin and sibling studies provide a paramount perspective. Researchers compare the wages of twins with different levels of education which allows us to differentiate variabilities like family background and a significant part of innate ability (Bonjour et al., 2003). Difference in Difference (DID) also has been used by researchers to study causal effects in the EU. These empirical methods with their different sets of assumptions have been used to address omitted variable bias stemming from ability in the attempt to obtain causal effects.

The body of existing evidence in the European countries have demonstrated varying magnitude of the effect of education on earnings but also the prominence of ability bias in determining wages. While in many cases we observe that simple OLS overestimates the returns to education which is an indication of positive ability bias, there exist scenarios where in fact OLS underestimates or is similar to the true return of education. Several prominent studies have often reported a larger IV estimates than OLS; this implies that there exists a little or even negative ability bias.

This case was uncovered by Harmon and Walker (1995) in the UK where they used the 1947 school-leaving age reform as an instrument. The results of their IV estimate showed an earning return on the order of 15per cent for any additional year of education, which is roughly about a double of the corresponding OLS estimate at around 7–8per cent. What this interesting finding implies is that it is not necessarily the case that individuals with higher abilities pursue more additional education.

According to (Card 2021), another potential issue is measurement error in education or heterogeneity in returns when there is higher returns for those induced to stay in school by the reform can lead to OLS understating the true causal effect. Brunello and Miniaci (1999) also reported a similar result in Italy where their IV estimates stood at about 6per cent per year given an additional year of schooling which was slightly above their OLS estimates, again implying a minimal upward bias in that context. There is also a case where the bias is pretty modest with IV estimates ranging between about 4per cent and 9per cent as does the OLS results using multiple instruments from Italy and Austria (Ichino and Winter-Ebmer, 1999. These studies underscore that the conventional concern of ability bias overstating the actual returns to education is not necessarily a threat as shown in some European settings where estimating methods that accounted for ability yielded as high or even higher results than the naive OLS estimates of return to education.

It is not cogent to conclude that we can then proceed with simple OLS to estimate returns to education because there are many studies that have shown evidence that OLS estimates yielded significant upward-bias and the causal returns much lower. Some studies exploited later reforms and different populations have often found more moderate returns. Grenet (2013) revised the UK's 1972 school-leaving age reform using a regression discontinuity design approach. The results of the study implied a positive ability bias with the causal estimates reporting about a 6–7per cent wage increase given an additional year of schooling induced the reform which is slightly lower than the OLS estimate for that cohort. Furthermore, Grenet's revealed an interesting finding when comparing results in UK and France. According to the results, there are wage gains for individuals who are obliged for extra years of education due to the 1972 UK reform. However, in direct contrast, the analogous French reform of 1967 had effect on impact on wages. For the case of France, individuals who were required to stay in school an extra year did not earn more than those who left earlier. However, a simple OLS regression would have erroneously shown a positive return to education. This suggests that the apparent wage benefit in France was not due to education itself, but rather because more able students tended to stay longer in school, while less able students left earlier which implies that the observed relationship was driven by selection rather than a true causal effect. In short, the OLS result was misleading because it reflected who stayed in school, not the effect of staying in school.

A study in Germany also showed a spectacular finding. Pischke and von Wachter (2008) analyzed German reforms implemented in German states that increased compulsory basic schooling from 8 to 9 years. They discovered essentially no wage gains for students who had been affected by the reform. But the story is different with OLS regression which showed that a

positive returns to education of around 3–5per cent which again implies a case for substantial upward ability bias in the German context. They attributed this result to the German's unique educational system (tracking and apprenticeship systems). Essentially, the negligible effect of the extra year of schooling means that individuals who would have left school after year 8 were often already equipped with relevant job market skills through the structured apprenticeship programs. As a result, the additional year of mandatory schooling from 8 to 9 which is basically in the lower academic track provided limited additional human capital value, explaining why there is no significant improvement in their job prospects or earnings (Pischke and von Wachter, 2008).

A study in Sweden also demonstrated a positive ability bias, using the country's comprehensive school reform that increased schooling years and delayed tracking (Meghir and Palme, 2005). According to the estimates, there is 3–4per cent wage gains as a result of the reform, which was somewhat below simple OLS estimates, implying that individuals who pursued more education were, on average, more able or advantaged than those who did not. This means that part of the wage difference observed in OLS estimates may reflect pre-existing differences between individuals rather than just the effect of education itself (Meghir and Palme, 2005). Supporting the body of evidence for positive ability bias is the case for sibling and twin studies. Controlling for family fixed effects, a study conducted in the UK of identical twins reported a reduction in the estimated returns to education by about 1 to 2 percentage points from roughly 10per cent to 8per cent with simple OLS. This implies that innate ability is an explanatory factor for higher wage returns but even regardless, when ability is differenced out, education still has wage premium. (Bonjour et al., 2003).

In a nutshell, previous studies on returns to education in the European countries have consistently evinced substantial premium associated with higher educational attainment and the significance of accounting for innate ability bias to obtain the causal effect. The variability in the estimation results from OLS and IV have shown that the extent of ability bias is not uniform as data from some countries (UK, Italy, some Nordic areas) OLS estimation has proven to be effective and even in some case with even understated effect; while in countries such as France, Germany OLS is crystally overstated in terms of returns to education when corrected for ability bias. Well, what the results effectively unveil is the existential variability of how educational policy reforms interacts with labor market context and learning systems – determining whether the marginal students induced to get more education are those who benefit less (as in France) or more (as in the UK) from additional schooling.

Overall, the consensus from the various European studies after accounting for innate ability biases is that the causal private return to an additional year of education is generally in the range of 5per cent and 10per cent in earnings (Harmon et al., 2003; Card, 2001). Advanced econometric strategies exploiting reforms. notably instrumental variables have been critical in validating that investing in education has positive payoffs, while also clarifying that unobserved ability can, in some cases, inflate or attenuate the apparent returns. The literature continues to refine these estimates, but it broadly finds that education causally improves earnings across

Europe, even if the precise magnitude of return and the degree of ability bias vary by country and context. In other words, if an individual attends university instead of stopping at high school, they can actually anticipate a substantial increase in their earnings induced by the additional increase in education. This consensus strengthens the argument that investing in education has real economic payoff, not just for those already inclined to be high achievers but for a wide range of individuals.

2.3.7 Beyond Averages: Heterogeneity in Returns to Education

The emerging discourse in the study of returns to education is the issue of heterogeneity in the results. Most previous studies look at the estimation as a single number; however, recent studies have shown existential variability in earnings based on other essential factors such as field of study, quality of university, and individual ability. These factors often make university degrees paying different wage premiums. For example, with the explosion of technological progress and a transformed labor market, degrees in high-demand fields such as engineering, computer science, or finance tend to pay higher wages than degrees in fields like the arts or some humanities (Altonji, Arcidiacono, and Maurel, 2016). As a result, two students with a university degree observe different earning potentials, making the internal rates of return differ by major (an engineering degree vs liberal arts). This is a reflection of changes in labor market demands where STEM and business fields often command higher wages; so does the wage premium for individuals who obtained degrees in these fields. Also, Brunello, Weber, and Weiss (2021), in a meta-analysis covering multiple EU countries, found that returns to education differ substantially by field of study, with STEM and economics-related degrees yielding the highest premiums, and arts and humanities degrees exhibiting lower but still positive returns. Their findings also highlight that this variation is persistent across countries, though magnified in those with more flexible labor markets. However, this does not invalidate that there is positive returns to education for those with arts degrees. In other words, even for lower-paying fields, the wage premium usually remains positive and individuals in these categories still generally earn more than those with only a high school diploma, albeit less of a premium compared to fields in STEM, business and finance.

Furthermore, there are studies that investigated the potential effect of university quality and prestige on earnings. A series of research has suggested that graduates from more selective or higher-ranked universities experience higher wages. However, what remains the challenge is agreeing on the size of the premium which has seen an interesting debate over the years. For instance, studies in the UK and US have discovered significant wage gains for elite university graduates; however, the magnitude shrinks as they control for innate ability which therefore implies that at least part of the wage gap reflects selection rather than institutional quality alone (Hoekstra, 2009; Hussain, McNally, and Telhaj, 2009). Moreover, there is an observable bias in the recruitment practices where certain high-paying sectors such as finance, law, and consulting, disproportionately recruit from prestigious universities. This obviously puts such elite students at the advantage of receiving higher earnings when in fact the incremental payoff

of an elite college vs. a non-elite college is moderate after controlling for ability (Brewer, Eide, and Ehrenberg, 1999). Well, even though overall the average returns to education differences between universities does not really have a renowned effect, institutional prestige remains highly relevant for individual choices, especially for those targeting competitive industries or career paths.

There is also the aspect of credential effects as an explanatory factor to difference in earnings. Basically, this concept emphasizes the completion of a degree itself which has a discrete effect on earnings above and beyond the years of study. In other words, it is not enough to argue about the number of years in university increasing your earnings. However, what is more tenable to your earning outcome is completing the degree itself, which often yields a higher wage increase than the sum of the three years of university without completing the programme. This implies that what actually gets rewarded is the attainment of the degree and not merely years before completion. Hungerford and Solon (1987) reported that completing an educational level such as university degree leads to a corresponding jump in earnings that cannot be explained solely by the additional year of education, implying employers value the degree itself. These sheepskin effects emphasize that the returns to completing a degree are significantly high and just merely attending university for a couple of years without graduating pays a smaller return. This motivates policies to improve university completion rates and not just university enrollment, given that the full benefits accrue largely upon obtaining the degree itself.

We can also observe heterogeneity in the dynamics of earnings over the life cycle of individuals. For instance, young graduates may not immediately earn significantly larger wages than high school graduates when both are just in the beginning of the careers especially if the high school graduate has been working while the college student was in school. However, the dynamic changes as careers progress and ultimately university graduate workers earn increasingly higher wages and with growing experience comes higher paid positions. The wage gap then becomes wider as careers reach mid-level, reflecting that higher level of education indeed demonstrates higher level of wage premium. Walker and Zhu (2011) supported this with their findings in UK that the lifetime earnings gap between graduates and non-graduates is substantially larger than the early-career wage gap. In fact, Oreopoulos and Petronijevic (2013) suggested that the college wage premium actually grows with age and experience as such the returns to education can compound over time. This phenomenon is consistent with the argument that higher education not only provides an entry-level wage advantage but also better opportunities for promotions and skill accumulation.

In summary, the average return to education is high but it is not uniform across all degrees and individuals. The field of study, institution quality, completion of the degree, and career dynamics have an effect on the potential gains from education. However, what remains indelible is that for the vast majority of individuals and degree specializations, obtaining higher education is financially beneficial relative to stopping education earlier.

2.3.8 Trends Over Time and Recent Developments

The returns to education over the years have not been static as it changes with emerging economic and social trends. In the late 90s, studies have reported a compounding gains to education where higher education had significant earning returns over those decades. As mentioned before in the United States, the actual returns to education shrinks with decline in educational attainment while rises with technological advancement (Goldin and Katz, 2008). The existential trend is also similar in many other countries as returns to education rises and falls with driving factors.

However, results from recent studies from around 2010s into the 2020s have sparked an interesting debate on returns to education with the growing conviction that the college premium might be flattening or narrowing in some contexts. Take United Sates for example, Author (2014) have shown that returns to college education have though been increasing but at a decreasing rate, implying a lessened gap in percentage points vs a high school diploma. This emerging situation has been attributed to an increasing supply of graduates in the labor market, making education in some cases with less power to command wages (Autor, 2014). Notwithstanding, graduates are more likely to still weather economic shocks such as recession much better on average compared to those with high school diplomas. As a result, graduates are more likely to maintain lower unemployment rates and higher earnings, reaffirming the value of the degree.

Europe alike, the same pattern of a dynamic returns to education has been observed. In particular, the increasing access to education and expansion in public investment in the late 20th century has led to emerging concerns about over-education. This century has seen a drastic rise in the number of individuals attaining higher level of education and increasing participation in the labor market. However, one of the potential unintended consequences of this rapid expansion is a situation where some graduates have to take jobs that traditionally did not require a degree, which may lower the expected wage returns to education. This phenomenon is often referred to as credential inflation, where more workers have degrees, but the economic value of these degrees diminishes (Verhaest and Van der Velden, 2013). Notwithstanding these concerns, studies have consistently reported better earning outcomes for graduates compared to those without a degree, which indicates the continued positive private returns to education (Brunello, Weber, and Weiss, 2021). This reinforces the case for both public and private investments in education as a university degree still provides substantial economic benefits compared to not having one (Psacharopoulos and Patrinos, 2018).

Recently, the discourse has shifted to include postgraduate education (Master's, professional degrees, PhDs). Research suggests that postgraduate degrees pay higher additional earnings premium beyond that of a bachelor's degree. Like in the case of a degree highlighted before, the magnitude of earning premium for postgraduate degrees also varies across fields. Professional degrees, for example in the medical and legal field pay significantly high returns; MBA degrees as well as postgraduate in the field of engineering alike have significantly high earnings premium. In contrast, certain research-oriented or academic master's degrees are observed to exhibit modest returns but as specialization in career paths become strengthened, there is likelihood of catching up with much higher earnings (Jäntti et al., 2015). However overall, the current

body of literature has maintained a consistent higher returns to education for individuals with the attainment of postgraduate degrees, notwithstanding the observable phenomenon when compared to bachelor's degree level is that the incremental rate of returns for postgraduate is generally lower. Oreopoulos (2006) attributed this pattern to the much greater importance of first degree in massively shaping and building the knowledge and skills of individuals given the observable higher jump in returns from high school diploma to first degree than from a first degree to postgraduate degree. What this implies is that a postgraduate degree does really pay higher earnings compared to a first degree. However, the rate of earnings for postgraduate degree is highly continent on the specialization field, (for instance STEM, business, law) which means it does not necessarily apply. In contrast, a first degree is less specialized and makes individuals more versatile to apply their knowledge and skills across a wider range of professions (Harmon et al., 2003).

Several authors have also recognized another emerging trend as alternatives to higher education like vocational training and specialized professional courses. Deissinger (2018) in his paper compared these alternative pathways to the long standing traditional academic degrees in an attempt to understand the role of vocational and technical education. The findings of the study demonstrated a comparable return between VET and academic degrees and the results even hold stronger when the programmes are highly aligned with the needs of the labor market. This is particular an observable phenomenon in Germany and Austria. These countries implemented a vibrant and effective such that graduates from vocational tracks can earn more or less the same wages with individuals who underwent the traditional academic education, and this is particularly prevalent in the engineering and manufacturing sector (Oosterbeek and Webbink, 2007). This is why Brunello and Rocco (2017) stated that while vocational training pays, the magnitude of the returns is highly contingent on the corresponding value the labor market places on the skills in attained from these programmes, concluding with acknowledging the important role of labor market demands in determining the economic value of different types of qualifications (Brunello and Rocco, 2017).

It is important to also highlight the performance of education amidst economic meltdowns to understand how the returns on education adjust with staggering challenges. Notably, several discourses on the value of education have been triggered in the wake of the COVID-19 pandemic which took a drastic toll on all sectors of the economy, as some graduates faced challenges in securing employment amid weak job markets. Coming to provide empirical answers was Baker et al (2020) who showed that even amidst crisis, education demonstrated resilience in terms labor market outcomes. Essentially, individuals with higher level of education were more likely to maintain employment or shift to remote work as opposed to those with lower level of education who face the brunt of poor economic outcomes. Hout (2012) also showed similar results, maintaining that economic crisis has not really eliminated earnings premium associated with education. He further demonstrated how in fact such economic hurdles increase the income gap become individuals with education and those without degrees. In other words, less educated workers have a pattern of experiencing poor economic outcomes in times of crisis

from job instability and unemployment (Hout, 2012). This trend highlights the resilience of higher education in its potential to present positive returns, especially in times of crisis.

2.3.9 Implications and Policy Considerations

As insinuated before, the empirical evidence on returns to education has provided an imperative for private individuals, economists and policymakers. Beginning with private benefits, several studies have provided results supporting the hypothesis that education indeed does pay; in other words, there exist a better chance for higher earnings for individuals who attained hgiher levels of education on average. Notably Oreopoulos and Petronijevic (2013) in their seminal work dubbed "Making College Worth It" have tried to seek answers to the question whether investment in education has positive returns. Consequently, results of their study showed that – all things equal – there are significant returns to education on average for an individual even amidst rising cost of schooling (rising debt and compounding student debt). Accordingly, they went on to highlight the compelling opportunity cost to not going to college/university, arguing that there are significant potential foregone gains in recent times. This they have attributed to the transformed and complex labor market structure characterized by rising demand for more skilled and higher education individuals, therefore concluding that compared to the past decades, the economic penalty for not attaining higher education is very huge (Oreopoulos and Petronijevic, 2013). Results from this study have strengthened the case for individuals to consider investment in education a worthwhile endeavor that has both benefits to them but also significant role in building their human capital based crucial for economic development.

Based on the above, the policymaker therefore has high incentives for public investment in education owing to its high returns. This is why many studies stated before have noted the increasing expansion of access to college and university education, and even a strong case to also improve the quality of universities, and promote affordability by providing financial aid or student loans to encourage the undertaking of education. Policymakers acknowledge the significant social gains of education. When the social returns are also high (only slightly below private returns), it means there is a net gain to society from having a more educated populace. The social benefit is beyond only through higher productivity and GDP but additionally meaningful gains through positive externalities such as crime reduction, better health outcome and recently researchers have also considered gains on civic engagement, understandably and educated society is an informed one; thus greater civic engagement. Thus, subsidizing education can be seen as an investment with a social payoff.

However, while education pays, higher returns to educations have the potential to widen inequality in the society – making some better off and others in the lower end of income at a disadvantage (Psacharopoulos and Patrinos, 2018). This is why many countries have imposed large subsidies on education while others are expanding scholarship investments to support students. But given these investments are funded by taxpayers themselves, there are important implications to consider. For instance, when the private returns accrued to education are particularly high, it is imperative to make a case for tax schemes that target graduates for

redistribution purposes crucial for reducing the yawning income inequality, especially since high-earning graduates can afford to pay back. But another imperative to consider is that when we do not make education equally accessible, we run the risk of having students from underprivileged backgrounds foreclosed from undertaking education, thereby leading to inequality between the rich and poor families.

This makes it critical to ensure broad access to education to ensure that the earnings premium associated to education is not limited to those from privileged families but also the underprivileged ones, therefore reducing inequality and stalled social mobility. Therefore, it is paramount to advance social and human development programmes such as scholarships, income-based loans and other incentives in order to support many students access college/universities. In essence, the empirical evidence on returns to higher levels of education provides a strong economic rationale for policies that promote secondary and tertiary education for all, particularly for underrepresented or disadvantaged groups.

Furthermore, the results from studies examining returns to education can help students make informed choices when in their decision to invest in university education for instance. Over the years, there has been an observable pattern that students take reference from the labor market and therefore beyond passion, they consider career prospects as crucial factor in making decision. This makes it increasingly important to explore core issues around returns to education in order to ensure transparent data availability to students to make informed choices which universities and governments recognize now. Policymakers have continued to spotlight high yielding fields to individuals and society as a whole such as the STEM. This is to promote awareness and preparation in order to get individuals to choose careers in these fields which have now taken over the labor market. The result is gainful career outcomes for individuals and greater participation in development.

In a nutshell, the extensive empirical literature on returns to education consistently presents that there is indeed a significant gain for investment in education to both private individuals and society. Individuals who have undergone have been reported by numerous studies to demonstrate better employment outcomes, higher earnings and many other related benefits. Even amidst variations in the earnings rate characterized by variations in country context, time period, level of education and other individual attributes, the central finding that education pays off remains remarkably robust. This evidence from recent decades have evinced that providing empirical results that wage premium associated with educational attainment is gaining important prominence in economies, and in fact even in emerging ones with their rates often higher than that of the advanced countries. While education might not be the solution to all economic problems, it is evident that it has lifted many individuals and societies on the footing of higher living standards and better outcomes in general.

New emerging concerns are surfacing to understand the multifaceted and nuanced effect of education on earnings. This makes this field of study remain active as researchers explore nuances such as quality of education, field-specific returns, and recently non-pecuniary returns. What remains uncontested and a well-established examination in the current literature is that

the empirical data have proven that investment in education has significant returns. Therefore, this large body of evidence has been used to support the case for policies and programmes that seek to offer opportunities to pursue education and acquire skills without challenges that would otherwise foreclose access, especially for underprivileged groups. This is why education is considered one of the faster equalizers to income equality as both the rich and the poor have access, they all have potential to benefit from the income premium associated with returns to education. In light of the high pecuniary and non-pecuniary returns to education documented in the literature, promoting comprehensive access to education can contribute to both individual advancement and overall economic growth.

3 Data and Methodology

This chapter entails the description of the data for this study and how the key variables were constructed. In addition, it presents the empirical methodology applied in the study, including model specification and estimation strategy.

3.1 Data Source and Sample Selection

In this section, I discuss the data source and description of the variables.

3.1.1 Data Set: European Social Survey

Principally in this study, I pool microdata from all the rounds (round one to eleven) of the European Social Survey (ESS). This data source is a cross-national survey which collects comprehensive data on demographic, socio-economic, and attitudinal information from individuals across Europe. The ESS introduced since 2002 has gained prominence among social scientists as a viable data source to examine cross-country variations in plethora of social phenomena, especially in the study of education and wages. Jowell et al. (2007) have described this study as adopting comprehensive and robust probability sampling and face-to-face interviews which have made it impeccable for researchers interested in high quality data and national representativeness for all countries in Europe involved.

The data set contains important variables (education, income, and employment status, age, amongst others) across a diverse set of European countries relevant for studying returns to education. What makes the ESS design more acceptable is its comparability powers with standardized questionnaires and data collection methods, allowing for comparison across the European countries. The availability of data for educational attainment (edulvlb) and household income (hinctnta) together with comprehensive set of socio-economic and demographic controls presents me a unique opportunity to examine the relationship between higher education and earnings at the European level. By and large, it provides rich data from more than 100,000 individuals across over 30 European countries. Essentially, the ESS data provides a nuanced picture of the late novel European labor market which makes it an imperative relevant for an

analysis of this nature. Given that the data is cross-national, it allows me to explore the existential variabilities to estimate the causal effects of education on earnings. It also provides data on important country-specific factors such as regional labor market characteristics, education, and income distribution.

3.1.2 Country Coverage and Selection Criteria

To ensure representativeness of the European context, I examine 33 countries acrosss all the regions of the continent (Northern, Western, Southern, and Eastern Europe). The following table shows the countries selected for the analysis of returns to higher education in Europe. Table 1 below shows the countries under study.

Table 1: Countries Under Study by Region

Region	**Countries**
Northern Europe	Finland (FI), Sweden (SE), Denmark (DK), Iceland (IS), Norway (NO)
Western Europe	Germany (DE), France (FR), Netherlands (NL), Belgium (BE), Austria (AT), Ireland (IE), Luxembourg (LU), Switzerland (CH), United Kingdom (GB)
Southern Europe	Italy (IT), Spain (ES), Portugal (PT), Greece (GR)
Eastern Europe	Poland (PL), Slovenia (SI), Slovakia (SK), Hungary (HU), Czechia (CZ), Estonia (EE), Latvia (LV), Lithuania (LT), Bulgaria (BG), Romania (RO), Croatia (HR)
Other (Non-EU)	Israel (IL), Turkey (TR), Ukraine (UA), Russian Federation (RU)

The selection of the countries above is due to their variability in geographical representation among other factors such as differences in periods of educational reforms policies, labor market structure and development as well as social welfare schemes. This approach is particularly important because it allows analysis of returns to higher education to capture also the difference in regional contexts, especially the notable variation in labor market structures and education policies that might influence the returns to education.

The imperative for the foregoing selection is to ensure that my data captures both advanced economies with relatively low-income inequality (e.g., Nordic countries) and economies with more variation in earnings due to their labor market structures (e.g., Eastern and Southern European countries). Brunello et al., (2007) has provided a strong case on the importance of regional peculiarities with respect to returns to education in Europe. The results of their study showed countries in the Southern and Eastern European countries generally experience higher earnings premium given an additional year of education when compared to countries in Northern and Western Europe. Therefore, selecting clusters of countries the regions in Europe would allow me to systematically examine these subtle differences and test for the consistency of returns to education across the varied labor market conditions in the different regions.

As part of my analysis, I will also address these country variations by including country fixed effects in my regression in order to have a more nuanced estimate of returns to education in Europe. By doing this, I will be able to generate a single aggregate return to education for the entire sample of European countries and at the same time account for the country differences that may influence earnings. In essence, including country fixed effects controls unobserved heterogeneity at country level to ensure that my estimated return is a truer reflection of Europe-wide patterns rather than the influence of country-level disparities (Card, 2001). This strategy will further present deeper insights into the variation in returns to education across Europe.

3.2 Sampling Technique

This study employs a restricted sampling strategy where I consider only prime working-age adults who are currently employed at the time of the survey. Well, this is very crucial in ensuring that the analysis is an account of individuals who are actively participating in the labor market and whom we can cogently assume that their income is representative of the wages from employment. This approach therefore allows me to discard individuals whose primary earnings are receiving passive income or social benefits. Consequently as per OECD (2020) and Eurostat practices for analyzing labor market outcomes of the core workforce, I define the "working age" as individuals between the age of 25 to 64 years old. This is necessary to isolate individuals who may either be still going to school or are mere beginners in the labor market as well as those in old age who are either retired or no longer active in the workforce. In summary, allows me to study all individuals who would have actually completed their education, hence capturing the earnings during their main career years, which is appropriate for estimating returns to education.

Besides age, I impose further restrictions by considering only individuals who are currently in paid employment at the time of the survey while excluding respondents whose main activity is being unemployed, retired, in education, or otherwise outside the labor force. This way, I can particularly isolate the effect of education on earnings among the employed population. Having applied these filters and other data cleaning including dropping missing observations, I end up with a final analytic sample of 156,490 employed individuals across the 33 selected countries, with a mean age of 43.85 years and standard deviation of 10.43, representing a diverse cross-section of Europe's working-age population; this is comprised of roughly over 4000 respondents per country on average but with some variability as some countries for instance Romania as low as 537 respondents and Germany close to 10,000 respondents. However, this variability discussed later will be addressed with employing weights and accounting for country fixed effects. Notwithstanding, the magnitude of the sample size seeks a robust statistical power and the focus on only the working population (active workers) for whom the education-earnings relationship is most relevant to is a plausible strategy to establish more reliable estimates.

3.2.1 Weights and Description of the Final Sample

For the analysis, I applied sampling weights to ensure that the estimates derived from the ESS data are representative of the national populations. These weights take into consideration the survey's design; this includes non-response adjustments and unequal selection probabilities among countries. In essence, each respondent is assigned a particular weight in the sample to account for the likelihood of their selection as well as the demographic variations between the sample and the overall population. This in other words means each individual is weighted to represent an equal fraction of their country's working-age population, thus each country contributing equally to the pooled analysis. With this strategy, we can avoid for instance the many respondents from Germany overwhelming the fewer respondents from Romania.

The ESS also provides post-stratification weights to match the sample with known population demographics. This makes cross-national comparisons more accurate, especially when pooling data from many countries; hence crucial to make sure that no one country disproportionately affects the outcome. Applying these weights therefore ensures my analysis reflects the average European context rather than the peculiarities of specific countries with larger sample sizes. Moreover, it is particularly crucial to adjust for population size when pooling countries in a single regression (also known as the analysis weight) to ensure that each country contributes equally to the pooled analysis. In a nutshell, all analyses are conducted using weighted regressions with robust standard errors (Huber-White standard errors) in light of the complex survey design. More specifically, standard errors for the pooled regression will be clustered to account for the unique variation the pooled regression This approach allows for more robust estimates and improves the precision of the results.

3.2.2 Country and Cohort Clustering

Furthermore, to account for potential intra-group correlation in the error terms especially for the pooled estimation, standard errors in the 2SLS estimation are clustered at the level of country-by-cohort. This clustering strategy reflects the structure of the instrumental variable (compulsory schooling reforms) which varies by both country and cohort. Failing to cluster at the appropriate level can result in downward-biased standard errors, potentially overstating statistical significance (Cameron & Miller, 2015). By clustering at the interaction of country and cohort, the model allows for arbitrary correlation of residuals within these groups, thus producing more reliable inference. This approach follows econometric best practice when treatment or instrument assignment is determined at higher aggregate levels (Angrist & Pischke, 2009)

3.3 Construction of Key Variables

In this section, the key variables relevant for the analysis are discussed.

3.3.1 Education Variable

Since this study seeks to estimate the effects of educational attainment on earning, the main regressor of interest is the respondent's level of education. This variable represents the highest level of education as measured in the ESS (primary, secondary or higher education). It categorizes education into several levels based on the International Standard Classification of Education (ISCED). However for all intent and purpose, this study focuses only on secondary and tertiary educational attainment i.e. secondary, college or university degree; this corresponds to ISCED levels 3 to 6 in the ESS dataset. These categories represent individuals who have completed secondary school, college, bachelor's, master's, and doctoral degrees respectively. On the other hand, respondents who reported attaining a lower level of education are categorized separately. This binary treatment is crucial and simplifies my analysis as I am typically interested in examining the returns to secondary and higher education relative to lower levels of schooling.

The education variable is coded as follows for the analysis:

1 = for an individual who has at least completed secondary education (ISCED 3 to 6)

0 = Lower/otherwise

With this binary classification therefore, I can estimate the marginal effect of acquiring at least secondary education on earnings – controlling for other factors such as age, gender, occupation, parental education. However, it is important to point out that up to ESS 4, the education variable was named edulvla. So I replaced/moved observations under this variable to the corresponding edulvlb column on Stata in order to have a single variable for education (edulvlb) which now contains all information on education.

3.3.2 Income Variable (Decile Income Values)

The dependent variable for this study is earnings defined in the ESS as household income. The ESS survey measures income in decile bands from 1 to 10 and respondents report which decile their household income falls into. This is a conventional practice applied in large-scale surveys mainly to protect the privacy of respondents and improve data reliability, particularly given the sensitivity of income-related questions.

Well, a notable caveat of using household income for this study of causal returns to education on an individual is that the income provided by the data set is household income, not individual earnings. This is important to acknowledge because respondents often live in households where they are not necessarily the only earner in that particular household. As a result, household income may not only reflect the earnings of the individual in question but other members of the household such as spouse. The variance in our income measure therefore comes not only from wages accrued to individuals but also that of the household composition. To address this, I restrict the data to only cover employed individuals (those in paid work) with the assumption that employed individuals are usually the main earners or at least contributors to the household income. In other words, the implicit assumption is that education affects the earning of an individual which consequently influences significantly their household's income rank. At least for the case of the European contexts, this is a reasonable assumption to make because of

assortive mating, where people tend to marry those with similar education/income level.

The mean decile in my sample is 6.5 with over 65

3.3.3 Control Variables (Gender, Age, Occupation, Parents' Education and Fixed Effects etc.)

Moving on, it is crucial to control for other key control variables in the analysis in order to isolate the effects they may have on the outcome variable (earnings): The following are important controls considered:

***Gender*:** A binary variable indicating whether the respondent is male or female (gender = 1 for female, gender = 0 for male). This is to address the extensively documented gender pay gap in European labor market where women typically earn less than men. Even when they have the same level of education and similar experience, Eurstat (2021) reported that women earn about 13% less than their male counterpart with more or less the same level of education and experience. It is therefore crucial to account for gender to ensure that the estimated returns to higher education is unbiased by the disparate salary patterns of males and females. In my sample, about 41% of respondents are male and 59% are female which is an interesting dynamic underscoring the necessity to control for gender.

***Age*:** Consistent with the classic concave Mincerian experience profile, earnings typically increase with experience/age at a decreasing rate. Therefore to account for this important phenomenon, I include in my regression model age and age squared, allowing returns to experience to diminish at older ages. By including a flexible age profile, I am able to partial out lifecycle earnings effects that could correlate with education; for example, older cohorts have both lower average education and lower current earnings due to being near retirement. As individuals age, their earnings typically increase, but at a diminishing rate. This is consistent with the Mincerian wage equation (Mincer, 1974), where the returns to experience are initially large but decline as workers accumulate more years in the labor market. Because we also include cohort fixed effects (discussed below), the age effect is largely identified from within-cohort variation by comparing slightly older with younger individuals born in the same period. In my sample, the mean age is 43.12 years with a standard deviation of 10.02 years, indicating a moderate age diversity. This suggests that while the majority of the sample consists of individuals in their 40s, the data span employed individuals from early-career to those nearing retirement. This age diversity is important for understanding the life-cycle earnings profile, allowing to capture the effects of both early-career earnings growth and the diminishing returns to experience as individuals approach retirement. Therefore not controlling for age would risk conflating education effects with seniority effects; for instance, more educated individuals might be younger in some countries, especially in Europe due to rapid educational expansion; and such younger workers also often earn less initially as a result of limited experience which could downward-bias the education coefficient if not accounted for.

***Occupation*:** To enhance the analysis and account for the nature of employment, I classify jobs using the International Standard Classification of Occupations (ISCO-08) into broad groups

such as managers, professionals, technicians, clerical, service, and craft workers. This is important because education often determines the kind of job an individual gets thus a crucial factor in understanding earning dynamics; for example, higher education graduates are more likely to work in managerial or professional positions compared to less-educated individuals who are likely into manual or elementary employment. To reflect the natural skill variations between occupations, I group the jobs into two broad categories: high-profile jobs (ISCO codes 0 to 3330) and low-profile jobs (ISCO codes 3331 to 9629) totaling to 45.42% of individuals in "high-education" jobs and 54.58% in "low-education" jobs. This allows me to effectively compare people with similar education levels within each major professional category. Essentially by including occupation dummies, I can isolate the "within-job" effect of education on earnings, allowing me to accurately measure the returns to education across different skill levels within the same occupation category. Furthermore, controlling for occupation helps limit potential biases from individuals sorting into high or low paying occupations based on their varying innate ability. This approach guarantees that the returns to education mirror the abilities and credentials needed for different professions rather than only the sort of job itself, hence minimizing ability bias. However, controlling for occupation might understate the true returns to education since part of the advantage of education is in fact to provide access to higher-paying or more prestigious jobs. I strike a balance by using broad occupation groups, capturing major skill levels rather than very granular job titles in order to avoid over control. The inclusion of occupation indicators is supported by empirical research, such as that by Boll et al. (2016), which highlights the role of occupational segregation in explaining wage disparities, especially by gender. By considering occupation, we mitigate the risk of confounding education effects with differential representation across high- and low-paying occupations. Like in constructing the income variable, observations in the earlier rounds of the ESS were recorded under iscoco. Therefore, on Stata I moved those observations to the corresponding cells under the Isco08 column for consistency.

Parents' Education: With the belief that the educational level of an individual may be as a result of the educational attainment of their parents, I controlled for father's and mother's education in my regression (Becker, 1993). The idea is to take care of any factors that have the potential to confound the estimation of education on earnings. Therefore by including parental education, the model accounts for the intergenerational transmission of education which has been shown to significantly impact the educational outcomes and earning potentials of individuals (Blanden, 2013; Davies & Bian, 2021).

In a nutshell, including these control variables is crucial in accounting for differences in the labor market outcomes that are due to factors other than education, notably gender disparities in pay (Eurostat, 2021). Moreover, it is also important to capture variations in earnings by age and experience (Mincer, 1974), and occupational sorting (Brunello et al., 2007) parental education.

Fixed Effects Variables (Country, Wave and Cohort)

It is also necessary to account for fixed effects which is characterized by unobserved heterogeneity that varies by country, wave and cohort. As a result, I include country fixed effects, wave fixed effects and birth cohort fixed effects in my main IV model as follows:

***Country and Wave Fixed Effects*:** Essentially, this reflects the existential systematic differences among the 33 European countries selected for this study. Disparities such as wage structures, labor market conditions, cultural views toward education, economic growth, and educational systems across the different survey waves could influence labor market outcomes of individuals. This makes it paramount to control for country and wave fixed effects to effectively compare people within the same country and wave using variation around the average outcome for that country. This is especially important since countries like Germany or Norway have greater absolute wage levels than, say, Lithuania or Portugal; Therefore, including country fixed effects allows me to isolate the within-country variation in earnings (Card, 2001; Blundell & Dias, 2002).

Cohort Fixed Effects: This is also another important factor that could skew earnings. Therefore, is it crucial to control for generational effects which can be brought about due to differences in education opportunities and labor market conditions that vary by birth cohort (e.g., those born in the 1950s vs. the 1980s). Therefore, including such fixed effects allows me to ensure robustness in the causal interpretation of my results as I would be controlling for unobserved factors that might confound the relationship between education and earnings (Angrist & Krueger, 1991).

The inclusion of fixed effects has important implications for identification: our estimates of the education effect are identified from within-country, within-cohort variation. In other words, I compare people of the same age (birth cohort) in the same country, and in the same survey wave who happened to attain different levels of education, and see who earns more. This fixed-effects strategy differences out any unobserved factors constant within a country, wave or cohort. It strengthens causal interpretation, especially in my instrumental variable approach (discussed in the next chapter), where the identifying variation comes from policy changes that affected educational attainment for certain cohorts in certain countries. By including fixed effects, I ensure that such variation is not conflated with broader country or time trends. For example, consider the case of the UK's 1947 school-leaving age reform: it forced younger cohorts to stay in school longer than slightly older cohorts. In such framework, country FE would control for any permanent UK-vs-others differences, and cohort FE would control for any baseline differences between those birth years – thus the remaining variation (used in IV estimation) is the reform itself, a clean source of exogenous educational difference.

3.3.4 Descriptive Statistics and Tables

Table 2 to Table 5 below provides summary statistics for the key variables used in the analysis. The table shows the mean, standard deviation, and range for each variable, offering an overview of the sample characteristics.

Table 2: Summary Statistics for Education, Gender and Occupation (Counts and Percentages)

Variable	Category 0	Percent 0	Category 1	Percent 1	Total
Education	21,205	13.55%	135,285	86.45%	156,490
Gender	81,280	51.94%	75,210	48.06%	156,490
Occupation	90,693	57.95%	65,797	42.05%	156,490

Table 3: Summary Statistics for Age and Income Rank

Variable	Mean	Standard Deviation	Minimum	Maximum
Age	43.85	10.43	25	64
Income Rank	6.51	2.47	1	10

Table 4: Summary Statistics for Age Cohorts

Cohort Label	Frequency	Percent	Cumulative Percent
1 (24–34)	35,919	22.95%	22.95%
2 (35–45)	49,805	31.83%	54.78%
3 (46–56)	49,147	31.41%	86.19%
4 (57–64)	21,619	13.81%	100.00%
Total	**156,490**	**100.00%**	

Table 5: Summary Statistics for Income Rank (Deciles)

Income Decile	Frequency	Percent	Cumulative Percent
1 (Lowest)	3,214	2.05%	2.05%
2	7,444	4.76%	6.81%
3	11,555	7.38%	14.19%
4	15,008	9.59%	23.78%
5	17,100	10.93%	34.71%
6	18,415	11.77%	46.48%
7	20,533	13.12%	59.60%
8	21,248	13.58%	73.18%
9	23,266	14.87%	88.05%
10 (Highest)	18,707	11.95%	100.00%
Total	**156,490**	**100.00%**	

3.4 Empirical Strategy

Pooling data from all the rounds of the European Social Survey (ESS), this section outlines the empirical approach for estimating the returns to higher education across 33 countries. I describe the baseline Mincerian earnings specification estimated with OLS, address endogeneity issues, and then offer an instrumental variable method using compulsory education changes in these nations. Moreover, I elucidate on the two-stage least squares estimation, the set of control variables and model specification applied, and the weighting to ensure strong inference. Emphasizing identification technique and causal inference rigor, the approach builds on well-established methods in labor economics and international evidence from Europe and OECD countries.

3.4.1 The Mincerian Earnings Equation (OLS Baseline)

The classical Mincerian earnings equation (Mincer, 1974) which suggests a log-linear relationship between earnings and education is the starting point. This gives a baseline Ordinary Least Squares (OLS) estimation of the private return to an extra year of education. Formally, I estimate a model of the following form:

$$Y_i = \alpha + \beta_1 S_i + \beta_2 X_i + \beta_3 X_i^2 + \Pi' \Phi_i + \varepsilon_i \tag{2}$$

where Y_i is household income in decile for an individual (our dependent variable, constructed from EUROMOD-simulated disposable household income), S_i is educational attainment, X_i denotes labor market experience (I proxy this by age, and include a quadratic term X_i^2 to allow diminishing returns to experience), and Φ_i is a vector of additional controls (discussed in Section

3.2.4). All things equal, the coefficient S_i is interpreted as the Mincerian return to education, i.e., the change in earnings associated with obtaining a secondary/higher education.

Consistent with the extensive literature on returns to education, we expect S_i to be positive. Across OECD countries including the European countries, individuals with higher level of education experience substantially higher incomes. For example, tertiary and secondary educated adults earn on average more than those with just primary education. This corresponds to an annual return on schooling typically in the range of roughly 5%–10% per additional year of education reported in series of studies. Essentially, these results have been commonly observed when fitting a Mincer equation by OLS, and numerous studies (e.g. Psacharopoulos, 1994; Harmon, Oosterbeek & Walker, 2003; Card, 1999) have documented returns in this range for many countries and time periods. In fact, Card's (1999) survey of cross-sectional studies finds an average OLS return around 5–10% per year. Therefore using modern data, my OLS baseline seeks to provide a benchmark estimate of S_i for the pooled European sample.

However, it has been well documented that indeed correlation is not really causation in terms of the relationship between education and earnings due to observed confounders established over the years. The Mincerian OLS estimate may therefore be biased if education is endogenous. In other words, S_i captures the relationship between education and earnings but not necessarily the true causal effect of education on earnings. It is then crucial to consider this dynamic when interpreting the OLS results as the true return to education. Consequently, I go further to address the potential sources of bias of the simple OLS.

3.4.2 Endogeneity of Education and Identification Concerns

There are notable grounds to anticipate schooling as endogenous in the wages equation. The body of extensive literature have indeed noted that individuals with higher level of education earn more. However, this is not simply because of education itself but also because of other unobserved factors linked with education. Ability is one of the main concerns in terms of endogeneity in this instance; those with greater innate ability, talent, or motivation are more likely both more education and have higher earning potential. This means that there is some form of correlation between education and ability, therefore the OLS assumption that $E[\varepsilon_i \mid S_i] = 0$ would fail to hold. As a result, the OLS estimator $\beta_{\text{OLS}} = \frac{\text{Cov}(S,Y)}{\text{Var}(S)}$ would be overestimated in this situation as it accrues to education the earnings advantage that come about due to ability differences, a situation famously described as omitted variable bias. Other biases that could operate in the contrary direction; for example, measurement error in reported education or selection effects where credit-constrained individuals stop education early despite high potential returns, making the OLS estimates downward biased or attenuated (Card, 1999). Theoretically, the net bias in β_{OLS} is unclear; however, what is evident is that OLS might not recover the actual causal return to education.

Empirical researchers have documented these endogeneity concerns. The related problem is that the coefficient on education contains confounding effects from the influence of both family background or innate ability on education and earnings. Consequently, the OLS estimates

becomes less credible for policy interpretation as it does not address the causal issue of how much an individual's income would grow should we exogenously raise their educational attainment. In my context, different European countries may also have varying patterns of selection into education (e.g. tracking systems, early dropout of disadvantaged students), exacerbating endogeneity concerns. This is illustrated in the seminal paper by Angrist and Krueger (1991). They exploited the US compulsory schooling laws which obliged children born earlier in the year start school at an older age and can legally drop out after fewer completed grades. Simply comparing earnings by education therefore could be biased by ability. Although similar estimates, their IV estimate showed that individuals compelled to stay in school longer due to the law earned about 7.5% higher wages per additional year of schooling.

Interestingly, many studies using various strategies have found that IV estimates tend to exceed OLS estimates of returns to schooling. In Card's review of evidence, instrumental variable (IV) estimates of are often on the order of 20–30% larger than OLS estimates; for instance, using parental background or quarter-of-birth as instruments often yields returns a few percentage points higher than OLS. One interpretation is that OLS may be biased downward (perhaps due to measurement error or because those who are induced by an instrument to get more education are individuals who reap particularly high benefits). Another interpretation is ability bias upward in OLS is offset by the IV capturing a Local Average Treatment Effect (LATE) for a subgroup with higher returns (Card, 1999). In any case, the divergence between OLS and IV in prior research underlines the importance of tackling endogeneity to achieve a credible causal estimate.

Given these concerns, my analysis prioritizes an identification strategy to isolate exogenous variation in education. I seek to answer: *what is the causal effect of educational attainment on income in Europe, holding other factors constant?* To do so, I need an instrumental variable that affects schooling but is not correlated with the determinants of earnings. In the next subsection, I will discuss my choice of instrument and why it can plausibly be treated as exogenous.

3.4.3 Instrumental Variable Strategy (Compulsory Schooling Reforms)

To identify the causal returns to education, I implement an instrumental variable (IV) approach using changes in compulsory schooling laws in Europe as a source of exogenous variation. The idea is to exploit discrete policy changes that required students to attend school longer, thereby increasing educational attainment for certain cohorts independent of individual ability or family background. These schooling reforms act as natural experiments: whether an individual was affected by a reform depends largely on their birth year (cohort) and country, not on their personal characteristics, thus providing a *quasi-random* boost to education for some people. This strategy has a strong pedigree in the literature of returns to education having been used in many studies to address endogeneity (e.g. Harmon & Walker, 1995; Oreopoulos, 2006; Brunello, Fort & Weber, 2009).

Compulsory Schooling Reforms in Europe: During the post-war decades, most European countries increased their minimum school-leaving age or extended mandatory schooling duration. For example, France's 1959 reform raised compulsory schooling from age 14 to 16; West

Germany did so in 1967; Italy in 1999; England and Wales in 1972; Spain in 1957; Finland in 1961, among others. Each reform effectively obliged younger or affected cohorts to obtain additional schooling relative to slightly older cohorts who were not subject to the new law. I denote by Z_i an indicator (instrument) for whether individual i was affected by that country's reform; for instance, whether they were born in a year such that they turned age 14 after the new law came into effect. Thus, Z_i takes the value 1 for those who, by virtue of their birth cohort, were compelled to attain more education, and 0 for those just older who were not affected.

The instrument Z_i is essentially a country-cohort dummy identifying individuals who faced a higher compulsory schooling requirement. This exploits both cross-country variation in the timing of reforms and within-country variation across birth cohorts. By using multiple countries, we leverage a larger set of "experiments" similar to a differences-in-differences across cohorts and countries. Brunello, Fort, and Weber (2009) adopt a similar multi-country IV approach, finding that these laws significantly increased educational attainment especially for lower-ability individuals and led to higher wages on average. My strategy follows this approach, treating each country's reform as contributing to a common instrument for schooling. Effectively, I assume that aside from the change in schooling, there were no other concurrent shocks affecting the earnings of the impacted cohorts differentially in those countries. This assumption is strengthened by including rich controls.

Exogeneity and relevance of the instrument: For Z_i to be a valid instrument, it must satisfy two key conditions: ***(i) Relevance:*** the reform must have a significant effect on educational attainment (i.e., Z_i is strongly correlated with S_i). This is empirically testable. In my context, historical evidence shows these reforms have had substantial impacts on average years of schooling. For instance, the UK's raising of the school-leaving age in 1947 and 1972 each induced large fractions of students to remain in school an extra year. Oreopoulos (2006) reports that the 1947 British reform kept approximately half of 14-year-olds in school for at least one additional year. Similarly across Europe, compulsory schooling laws led to marked jumps in educational attainment for affected cohorts. I will present first-stage results to confirm that indeed Z_i significantly predicts schooling in my sample.

(ii) Exogeneity (exclusion restriction) and Identification: the reform indicator must affect earnings *only* through education, not through other channels. In other words, apart from its impact on schooling, the instrument should be uncorrelated with the error term in the earnings equation . Well, this is plausible given my assumption that the timing of compulsory schooling changes was driven largely by policy (often aimed at increasing general education levels) rather than short-term labor market conditions or any other shocks. Therefore, an individual's birth cohort relative to these policy changes is essentially random with respect to their innate ability or family advantage. Furthermore, I bolster this assumption by also controlling for any general cohort and country fixed effects so that identification comes from sharp discontinuities rather than broad trends. In essence, I assume that two people of the same country born a few years apart would have similar earnings potential on average, except that one faced a stricter schooling law which caused them to obtain more education. Any difference in their adult incomes can then

be attributed to the additional education, under the exclusion restriction.

The IV strategy employed can be summarized as follows: I use compulsory schooling exposure (Z_i) as an instrument for actual education attainment (S_i). This approach has been widely applied. For example, Harmon and Walker (1995) used the 1947 UK reform as an instrument and found returns on the order of 15% in the UK, much higher than OLS estimates of about 7%. Oreopoulos (2006) likewise exploited the UK 1947 reform using a regression discontinuity design and found very large returns (about 10 - 15%) that were close to the population-average effect. By contrast, later work by Devereux and Hart (2010) who re-examined the UK reform with more detailed data found smaller returns (about 4 - 7% for men, and zero for women). The mixed findings in the literature underscore the importance of painstaking modeling. Therefore due caution is employed in designing my two-stage estimation and in choosing control variables (for instance, ensuring cohort effects are properly accounted for, as failing to do so was criticism of some earlier analyses. Ultimately, the IV approach should recover a local average treatment effect (LATE) i.e. the return to education for those individuals ("compliers") whose schooling choices were changed by the compulsory schooling laws. This LATE is policy-relevant as it pertains to the population affected by actual education reforms.

3.4.4 Model Specification

My model, building on existing literature, is specified as follows:

Two-Stage Least Squares (2SLS) Estimation

I implement the instrumental variable strategy using a two-stage least squares (2SLS) regression framework. The first stage predicts education as a function of the instrument, and the second stage regresses income on the predicted education. The two equations are as follows:

First stage (education equation):

$$S_i = \pi_0 + \pi_1 Z_i + \pi_2 X_i + \pi_3 X_i^2 + \Pi' \Phi_i + \eta_i \tag{3}$$

where Z_i is the reform-based instrument (as defined before), and I include the same set of exogenous control variables (X_i, X_i^2, and Φ_i) as in the OLS specification—experience, experience squared, and controls like gender, occupation, fixed effects etc., detailed in Section 3.2.4. The coefficient π_1 measures the average increase in years of education induced by exposure to the reform. In theory, we expect that $\pi_1 > 0$, which means the reform successfully increased educational attainment S_i. I will report the results of the first-stage in the next chapter, especially the F-statistic for π_1 to assess and validate the strength of the instrument; a large F (generally > 10) is desirable to avoid weak instrument concerns (Stock & Yogo, 2005).

Second stage (earnings equation):

$$Y_i = \beta_0 + \beta_1 \hat{S}_i + \beta_2 X_i + \beta_3 X_i^2 + \Pi' \Phi_i + \varepsilon_i \tag{4}$$

where $\hat{S}_i$ is the fitted value (predicted educational attainment) from the first stage. In this stage, the coefficient β_1 is our IV estimate of the return to an additional year of education. Intuitively,

β_1 measures the wage increase for individuals who obtained more education (secondary/higher) as a result of the compulsory schooling reforms. Under the IV assumptions, β_1 can be interpreted as the causal effect of education on Y_i for the compliers. I implement 2SLS using Stata's IV regression procedures, treating Z_i as an exogenous instrument for S_i.

It is important to note the interpretation of the 2SLS estimate in this context. Because different countries' reforms affected slightly different groups of the population (in terms of birth years and pre-reform schooling levels), the β_1 I obtain is essentially a weighted average of the returns for those marginal students across 12 countries. In theory, if returns to education are heterogeneous, our IV estimate is a LATE specific to individuals who were induced to attain more education by the introduction of a compulsory schooling reform (Imbens & Angrist, 1994). Studies often find that such individuals are disproportionately from lower-education backgrounds as they were the ones at risk of leaving school early. Therefore if those individuals have different returns than the average person, the IV estimate may differ from the OLS estimate (which reflects the average return among the entire population of education levels). For example, many studies have found that IV estimates using schooling reforms or similar instruments tend to be higher than OLS, suggesting that those who only attend additional schooling when forced by law actually experience relatively large earnings gains from that extra education. This pattern is consistent with the idea that credit constraints or other barriers prevent some high-return individuals from acquiring education voluntarily, so when a reform compels them to do so, their payoff is especially high (Card, 1999; Carneiro, Heckman & Vytlacil, 2011). In the next chapter, I will compare the 2SLS estimate to the OLS estimate to see if a similar pattern holds in my European sample.

In a nutshell, the model specified is designed to capture known determinants of earnings and isolate the variation in schooling that is due to compulsory education reforms. This strategy is consistent with best practices in the literature; For example, Devereux and Hart (2010) emphasize controlling for cohort effects when using the UK reform, and Brunello et al. (2009) include country and cohort controls in their multi-country analysis. This way, I am able to improve the credibility of the causal estimates of the returns to education.

3.5 Robustness and Sensitivity Analyses

To validate the results and test their robustness to different specifications and assumptions, I conduct a series of robustness checks and sensitivity analyses. These tests aim to assess the sensitivity of my conclusions to variations in model specifications, sample restrictions, and other underlying assumptions. Employing these techniques allows me to ensure that the estimated returns to education are not driven by misspecifications, outliers, or unaccounted factors.

3.5.1 Gender-Specific Subsample Analysis

An important aspect of labor market earnings, especially in Europe is the gender pay gap. In many European countries, women tend to earn less than men even after controlling for education

and experience (Eurostat, 2021). This differential can complicate the interpretation of the returns to education, as women's earnings may be systematically lower due to gender-based wage structures. To address this, I perform a gender-specific subsample analysis where I split the sample by gender and estimate the returns to education separately for men and women. This allows me to explore whether the causal effect of higher education on earnings differs between genders. We would expect to find that the return to education is larger for men than for women, consistent with the well-documented gender pay gap in Europe (Boll, Leppin, Rossen, & Wolf, 2016).

The empirical model for this subsample analysis is as follows:

$$\ln W_{i,\text{gender}} = \alpha + \beta S_{i,\text{gender}} + \gamma X_{i,\text{gender}} + \delta X^2_{i,\text{gender}} + \Pi' \Phi_{i,\text{gender}} + \eta_{i,\text{gender}} \tag{5}$$

where $\ln W_{i,\text{gender}}$ represents earnings for males or females, $S_{i,\text{gender}}$ is the education variable (indicating whether the individual has attained secondary or higher education), $X_{i,\text{gender}}$ and $X^2_{i,\text{gender}}$ control for experience and experience squared, and $\Phi_{i,\text{gender}}$ denotes other control variables, which include factors relevant to earnings such as occupation, parental education.

3.5.2 Regional Subsamples

Another sensitivity check is to estimate the returns to education within regional subsamples of the data, dividing the sample into four regions: Northern, Southern, Eastern, and Western Europe. The regional differences in the structure of education systems, labor market characteristics, and income inequality mean that the returns to education may vary considerably across regions (Brunello & Checchi, 2007).

By comparing the returns to education in different regions, I gain insights into how regional economic conditions and policies influence the effectiveness of education in raising earnings. For instance, countries in Northern Europe, such as Sweden and Finland, typically have universal access to education, which may lead to smaller returns to education, as much of the population already has access to higher education. In contrast, countries in Eastern Europe may have larger returns to education due to the catch-up effects as educational systems modernize and expand.

This regional analysis can be formalized by including regional fixed effects in my regression model, which would capture region-specific influences on the education–earnings relationship. This I will do in the next section.

3.5.3 Alternative Specifications and Definitions

To further test the robustness of our findings, I consider several alternative model specifications.

Estimation without Fixed Effect: Having acnkowledged the importance of fixed effects, I will run an alternative model without FEs in order to see whether they cause biases of my results. Thus, I will exclude all FEs (country, wave, and cohort).

Alternative Age Group: Second, I explore the impact of experience on earnings by estimating the model with alternative age group, principally a category that contained individuals in their

mature career level. This helps assess whether my primary findings are driven by specific assumptions about experience or job characteristics.

Alternative Outcome Variable: Beyond income, I will explore the relationship between education and self-employment. The goal is to attempt to uncover whether education drives people to entrepreneurship development.

3.5.4 Placebo and Falsification Tests

In addition to the robustness checks mentioned above, I perform placebo tests to further assess the validity of my instrumental variable strategy. The idea behind a placebo test is to examine whether the compulsory schooling reform has any effect on non-education outcomes, such as health or social attitudes, which should not be influenced by educational attainment. If the instrument has a significant effect on non-education outcomes, this would raise concerns about the instrument's validity. I conduct these placebo tests by regressing non-education outcomes on the instrumented education variable, using the same methodology as in the primary analysis. A lack of significance in these tests would provide support for the claim that the instrument is exogenous and not affecting outcomes outside the labor market.

3.5.5 Data and Measurement Limitations

Despite the strengths of the ESS data, there are several limitations that must be acknowledged:

- **Income measurement**: As discussed earlier, income is reported in deciles. This makes it impossible to transform the outcome variable into logarithm, thus making interpretation rather difficult.
- **Self-reported data**: The ESS relies on self-reported education and income data, which may be subject to reporting bias. For instance, individuals may underreport their income or overstate their educational attainment, especially when sensitive topics such as income are involved.
- **Omitted variables**: While we include a comprehensive set of controls, it is possible that there are unobserved factors (such as motivation or cognitive ability) that influence both education and earnings but are not captured in the data. These omitted variables could bias the estimates of the returns to education, even after using an instrumental variable strategy.
- **Generalizability**: Our analysis focuses on 33 European countries, but the findings may not be directly applicable to countries outside Europe, especially those with vastly different education systems or labor market structures.

4 Results and Discussions

In this chapter, I present the results of my regression together with rigorous analyses of the findings. I implement alternative model specifications and conduct falsification test to assess the

relevance and validity of my instrument. For comparison, OLS results are also presented to have a nuanced insights into the findings overall.

4.1 Baseline OLS Estimates (Pooled Sample)

I begin the analysis with the OLS estimation and detail why it may not provide consistent and unbiased results.

Model Specification and Econometric Framework

This part presents the baseline Ordinary Least Squares (OLS) results of the relationship between earnings and educational attainment in Europe using pooled cross-sectional data from 33 European countries. The dependent variable of the study is defined as income decile or rank where an individual belong to. It is crucial to underline that due to data limitation, the absence of individual earnings in the ESS data set in particular, total household income is used as a proxy which is anchored on the assumption that an individual's education influences household economic well-being primarily through their earnings contribution (Mayer & Jencks, 1989; Phipps & Burton, 1998). This formally means: This formally means:

$$Y_i \approx \left(\sum_{j \in H_i} E_j \right)$$

The OLS framework relies on the standard assumptions for unbiasedness; notably, that all relevant confounders are accounted for and that the error term is uncorrelated with the regressors, particularly education. Under the Gauss-Markov conditions, OLS provides the Best Linear Unbiased Estimator (BLUE). However, if higher education is endogenous (for example, if more able individuals both attain more education and earn higher incomes), then the estimated may suffer from omitted variable bias (OVB). I will discuss these potential biases in detail after presenting the results. For now, I treat the OLS estimates as a benchmark indicating the relationship between education and earnings in my sample, recognizing the conditional nature of the interpretation (i.e. ceteris paribus given the included controls). Formally, Gauss-Markov condition is satisfied under zero conditional mean assumption:

$$E\left[\varepsilon_i \mid S_i, X_i\right] = 0$$

Noteworthy, the independent variable is a binary indicator for educational attainment defined as follows:

$$\text{Education}_i = \begin{cases} 1, & \text{if individual } i \text{ has completed secondary education or higher} \\ 0, & \text{otherwise} \end{cases}$$

This classification is a reflection of the prominent educational threshold broadly associated with labor market qualification and employability across European contexts (OECD, 2018).

The estimated baseline OLS follows the following form:

$$\ln(Y_i) = \beta_0 + \beta_1 \text{Education}_i + \beta_2 \text{Age}_i + \beta_3 \text{Age}_i^2 + \beta_4 \text{Gender}_i + \beta_5 \text{Occupation}_i + \beta_6 \text{FathersEdu}_i + \beta_7 \text{MothersEdu}_i + \varepsilon_i \quad (6)$$

The quadratic term is included essentially to capture the concavity of experience, or in other words the diminishing marginal returns well-documented in the human capital theory (Becker, 1964). Gender on the other hands accounts for the systemic labor market disparities (Blau & Kahn, 2017) while occupation addresses the endogenous sorting of more educated individuals into higher-paying professions which is extremely crucial in order to isolate the true returns to education (Altonji & Pierret, 2001). Parental education controls on the other hand are incorporated as proxy for family background, capturing factors that could influence both educational attainment and labor market outcomes; this necessary to mitigate potential confounding omitted variable bias (Cunha & Heckman, 2007).

4.1.1 OLS Estimation Results

The OLS estimate of education (dummy) follows a similar result documented in the existing literature. With a statistically significant coefficient of $\hat{\beta}_1 = 0.8$ both at 5% and 1% level, the results suggest that individuals who attained secondary education and above on average are 0.8036 deciles more likely to be in higher income rank compared to those with lower education levels, controlling for experience, gender, occupation, and parental background. The finding is in line with the theoretical human capital model which posits that education does augment the productivity of an individual which translates to higher wages (Becker, 1964). Moreover, the magnitude of the findings aligns with empirical evidence across OECD countries (Card, 1999; OECD, 2018). The OLS estimate of education (dummy) follows a similar result documented in the existing literature. With a statistically significant coefficient of $\hat{\beta}_1 = 0.277$ both at 5% and 1% level, the results suggest that individuals who attained secondary education and above on average approximately make 27.8% higher wages compared to those with lower education levels, controlling for experience, gender, occupation, and parental background. The finding is in line with the theoretical human capital model which posits that education does augment the productivity of an individual which translates to higher wages (Becker, 1964). Moreover, it also aligns with empirical evidence across OECD countries (Card, 1999; OECD, 2018).

Table 6: OLS Regression Results – Dependent Variable: *Income_Rank*

Variable	Coef.	SE (Robust)	t-stat	p-value	95% CI
Education	0.8036***	0.0274	29.37	0.000	0.7499 – 0.8572
Age	0.0995***	0.0080	12.40	0.000	0.0838 – 0.1153
Age Squared	-0.0010***	0.0001	-11.26	0.000	-0.0012 – -0.0008
Gender	-0.4518***	0.0194	-23.31	0.000	-0.4898 – -0.4138
Occupation	1.3100***	0.0207	63.25	0.000	1.2694 – 1.3506
Father's Edu	0.0006***	0.0001	8.11	0.000	0.0005 – 0.0008
Mother's Edu	0.0005***	0.0001	6.22	0.000	0.0004 – 0.0007
Constant	2.8040***	0.1727	16.24	0.000	2.4655 – 3.1425

Observations: 156,490
F(7, 156482) = 1355.90, $Prob > F = 0.0000$
R-squared: 0.1178, *Root MSE*: 2.4135

Notes: Robust standard errors reported. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Education is a dummy (1 for individual with secondary/higher education and 0 otherwise). Gender is coded as 0 = male, 1 = female.

As expected, age is seen to have a positive and significant effect on earnings but with the squared age variable, it takes the form of concave. This confirms the expected concave shape of the age-earnings relationship where earnings tend to significantly increase as an individual aged but start falling as the individual gets closer to retirement (Mincer, 1974). My results further acknowledge the existential gendered wage disparity as women continue to earn less than men in the labor market, even after adjusting for human capital and labor market characteristics (Blau & Kahn, 2017). Specifically, women are 0.45 deciles less likely to be in a higher income rank compared to men. Occupation which also is a dummy variable characterizes the wage penalty for "low education" jobs as the results show their counterparts in higher-skilled jobs, which often requiring higher level of education, more likely in higher income rank. Interestingly, the positive coefficients on parental education variables, especially father's education accentuates the assumption that family background significantly influences earnings and labor market outcomes consistent with the literature on intergenerational mobility (Behrman & Rosenzweig, 2002; Cunha & Heckman, 2007).

The model's adjusted R^2 of about 0.12 suggests that approximately 12% of the variation in log earnings is explained by the included regressors which is within typical ranges for cross-sectional wage regressions, especially with simple OLS (Bound, 1991).

4.1.2 Caveats of OLS Estimation

The baseline OLS estimates show that there is a positive relationship between education and earnings. However, there are observable caveats in these results given the potential endogeneity

of the main regressor (education). As stated before, OLS results merely capture correlation and not causal effects. Therefore, it is important to acknowledge this caveat which will be addressed later in the chapter. For example, there is possibility of ability biases and (omitted variable bias) OVB when we have that unobserved factors such as cognitive ability and motivation is serially correlated with both education and earnings (Card, 1999; Ashenfelter & Krueger, 1994). Formally, this condition fails:

$$\text{Cov}(S_i, \varepsilon_i) \neq 0$$

Another issue in the critique of OLS is Measurement error, especially in self-reported education or income data creates attenuation biases which could effectively make my results bias (Bound, 1991). Well, while I have controlled for family background proxied by parental education, it is important to note that this control is imperfect to account for innate ability and motivation; in essence, family background globally just capture; or as Cunha and Heckman (2007) put it, parental education serves only as an imperfect proxy for broader familial and social capital influences, and may not fully capture genetic or environmental endowments (Cunha & Heckman, 2007). Furthermore, the insignificance of mother's education may suggest measurement limitations or differential parental roles in educational transmission (Black et al., 2005).

Therefore, these observable caveats necessitate a further step to uncover causal effect in the relationship between education and earnings. This leads me to the instrumental variable approach.

4.2 Instrumental Variable Approach

This section discusses the IV method used in this study. It entails the 2SLS outlining the framework for first and second stage estimation. Concerns of IV relevance and validity are elucidated as well.

4.2.1 The First-Stage IV Framework

In the first stage, I regress education on the reform and the other exogeneous explanatory variable, particularly individual characteristics and family background. This is expressed in the following equation:

$$S_i = \pi_0 + \pi_1 Z_i + \Pi' X_i + \eta_i \tag{7}$$

Where Z_i is the instrument (compulsory education reform) and Π' is a vector of controls, typically age, family background, occupation and fixed effects. The first stage equation basically exploits changes in the compulsory schooling laws that exogenously affect the attainment of education for a certain birth cohort. This way, I can isolate the part of education that is explained by the reform itself, which essentially then allows for a consistent estimation of the causal effect of education on earnings in the second stage.

$$\text{Reform}_i = \begin{cases} 1, & \text{if individual } i \text{ belongs to the cohort affected by the reform} \\ 0, & \text{otherwise} \end{cases}$$

First-Stage Results

The regression results based on a pooled sample of 156,490 observations across Europe are summarized in Table 7 below. The instrument shows a positive and significant effect with a coefficient of 0.0355. This demonstrates that indeed being subjected to additional schooling obliged by the reform does increase the likelihood of at least completing secondary education by approximately 3.6 percentage points. The first stage essentially captures a Local Average Treatment Effect for the "compliers" who acquire more education because of the reform, a group comprising primarily those who would have left school earlier in the absence of the law (Imbens & Angrist, 1994; Oreopoulos, 2006). A number of studies supporting this result have highlighted the theoretical expectation that reforms do keep affected cohorts longer in school (Angrist & Krueger, 1991; Card, 1999).

$$\hat{\pi}_1 = 0.0355 \quad (\text{SE} = .00447,\ t = 7.94)$$

Although minimal, parents' education is seen to have a positive and statistically significant effect on educational attainment **.** This realization is consistent with the theory of intergenerational transmission of human capital (Black, Devereux, & Salvanes, 2005). Overall, the goodness-of-fit of the model is modest ($R^2 = 0.2$). Well, this is typical for binary outcome models with individual heterogeneity (Long & Freese, 2014). However, what is crucial at this stage is the relevance and validity of the instrument which is discussed next respectively.

Table 7: First Stage Regression Results – Dependent Variable: *Education*

Variable	**Coef.**	**SE (Robust)**	**t-stat**	**p-value**	**95% CI**
Reform	0.0355***	0.0045	7.94	0.000	0.0267 – 0.0442
Age	0.0010	0.0019	0.55	0.580	-0.0026 – 0.0047
Age Squared	-0.00004***	0.0000	-2.04	0.041	-0.0001 – 0.0000
Gender	0.0227***	0.0023	9.68	0.000	0.0181 – 0.0273
Occupation	0.1526***	0.0022	70.06	0.000	0.1484 – 0.1569
Father's Edu	0.0002***	0.0000	21.48	0.000	0.0002 – 0.0002
Mother's Edu	0.0001***	0.0000	12.44	0.000	0.0001 – 0.0001
Observations: 156,490					
F(52, 156437) = 358.97, *Prob* > *F* = 0.0000					
R-squared: 0.2019, *Root MSE*: 0.3165					

Notes: Robust standard errors reported. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Education is a dummy (1 for individual with secondary/higher education and 0 otherwise). Gender is coded as 0 = male, 1 = female. Fixed effects (Country, Wave and Cohort) are included but not reported here. See annex.

Instrument Relevance and Strength

The relevance of the instrument is well-documented as a necessary condition for a valid IV estimation (Staiger & Stock, 1997). In this study, the significance and magnitude of the reform variable looks to demonstrate relevance. This is substantiated by the famous measure of relevance which is the F-statistic. Results of my first stage regression show an F-statistic of 358.97 which is significantly higher than the conventional threshold of 10 (Bound, Jaeger, & Baker, 1995). With this result, I am able to justify the non-weakness of the instrument and the preference of IV estimator over a simple OLS.

$$F = \frac{k\hat{\pi}^2}{\hat{\sigma}^2} \cdot n > 10$$

According to Angrist & Pischke (2009), a modest of the instrument is sufficient to ensure identification as typically this is an observable phenomenon in education reform settings. This is also observed in several other studies that employed education reform as instrument, notably showing albeit small significant shifts in education completion rates (Lleras-Muney, 2002; Brunello & Checchi, 2007).

Validity of the Instrument and Exclusion Restriction

Based on the results, we observe a positive correlation between the reform with the outcome variable. This basically means that cohorts of individuals who are exposed to the reform (compulsory education) are obliged to take up extra education than the previous cohorts. As a result, the first stage estimation reported that indeed the reform increased educational attainment probability by nearly 10 percentage points (ceteris paribus). Accordingly, this discrete jump in schooling induced by the education reform acts as an exogenous source of variation in education that is not correlated with the unobserved determinants of earnings having controlled for age, gender, parental education, and occupation. Essentially, this satisfies the assumption of exclusion restriction meaning that the instrument (reform) only affects earnings ***only and only*** through the endogenous variable (education dummy) and is uncorrelated with the error term in the structural equation for log earnings. This way, we are setting the stage for causal and unbiased estimation of returns to education.

The validity and exclusion restriction takes the following form:

$$\text{Cov}(Z_i, S_i) \neq 0$$

$$\text{Cov}(Z_i, \varepsilon_i) = 0 \quad \textit{or equivalent} \quad E[\varepsilon_i \mid Z_i] = 0$$

It is critical to emphasize that the instrument exploits variation across countries and cohorts: different countries implemented reforms in different years (e.g., Finland in 1961, Poland in 1952, Portugal in 1980). This therefore creates a quasi-experimental setting akin to a difference-in-differences design. The principal assumption is that without these reforms, cohort-year variation would not systematically influence education independent of the reform effect, a plausible assumption strengthened by the inclusion of cohort controls (Imbens & Angrist, 1994; Angrist, 1995). A potential threat to validity is the likelihood of the instrument to

be correlated with other unobserved macroeconomic shocks affecting earnings or educational decisions. However, the staggered reform timing across multiple countries reduces this likelihood of simultaneous unobserved macroeconomic shocks systematically biasing the results (Imbens & Angrist, 1994; Angrist, 1995). This argument is strengthened by controlling for other potential confounding factors such as parental education, age, gender, and occupation which capture major observable sources of heterogeneity. This ensures significant effort to achieve causal effects.

Limitations and Diagnostic Concerns

Well, the first stage result shows that the instrument is both valid and relevant. However, it is important to acknowledge that the magnitude of the coefficient is relatively modest, which is essentially an observable phenomenon especially in Europe. This is because education in Europe is near universal and that compulsory education basically is at the secondary level while my outcome variable captures not only secondary education but higher education as well. This is why indeed we can expect a modest relationship. In a nutshell, the instrument may only capture local average treatment effects (LATE) for marginal students influenced by the reform (Card, 1999).

Moreover, the modest R signals substantial residual heterogeneity in education attainment unexplained by the model. Therefore, it is important to understand the IV estimates as representing returns to education for compliers rather than the entire population (Angrist & Pischke, 2009). [1]

4.2.2 2SLS Second-Stage Estimates: Causal Returns to Education (Pooled Sample)

As mentioned previously, the second stage estimates the causal effects of educational attainment on log-income. What this important ultimate approach does is that, it addresses the potential endogeneity concerns of education that we likely face in the simple OLS method. With the 2SLS approach, I am able to isolate the exogenous variation in education influenced induced by the instrument (education reform policy). This allows for consistent and unbiased estimate of return to education especially having already attained instrument relevance and validity in the previous section. To ensure sample representativeness, all my regressions are done with weights.

In practice, I regress income rank on the predicted education from the first stage, including all other controls. This effectively means using only the reform-induced part of education variation to estimate the income effect. Formally, the second-stage equation is:

$$Y_i = \beta_0 + \beta_1 \hat{S}_i + \beta_2 X_i + \varepsilon_i$$

where $\hat{S}_i$ is the fitted value from the first stage (education predicted by the reform and exogenous

[1] *The first-stage regression provides robust evidence that compulsory schooling reforms serve as a relevant instrument for educational attainment in the European context. The reform indicator induces a statistically significant and economically meaningful increase in the likelihood of completing secondary education or higher. These findings validate the core identification strategy employed in this study, supporting the use of reform-induced variation as a credible source of exogenous changes in education. However, the relatively modest effect size and the specific nature of the LATE underscore the importance of interpreting subsequent IV estimates as applicable primarily to those individuals whose education decisions were directly influenced by these policy reforms.*

controls), and ε_i is the error term from the structural equation. The coefficient of interest, $\hat{\beta}_1$, captures the causal return to achieving secondary and higher education for individuals exposed to the reform. Because reflects only exogenous variation, can be interpreted as the impact of education on income purged of bias from omitted abilities or reverse causality (Wooldridge, 2010). Well to reiterate on exclusion restriction, it is clear from the equation above that the instrument itself (reform) is not reflected in the second stage. Essentially, the instrument only drives earnings through the predicted value of education . Therefore under these assumptions, 2SLS provides a consistent estimator of the education coefficient (Angrist & Pischke, 2009).

This 2SLS procedure is algebraically equivalent to the classic IV estimand that divides the reform's reduced-form effect on income by its effect on education. In fact, with a binary instrument, the 2SLS estimate simplifies to a Wald estimator:

$$\hat{\beta}_{1,\mathrm{IV}} = \frac{E[\ln(\text{Income}) \mid \text{Reform} = 1] - E[\ln(\text{Income}) \mid \text{Reform} = 0]}{E[\text{Education} \mid \text{Reform} = 1] - E[\text{Education} \mid \text{Reform} = 0]}$$

Basically, this is the ratio of the reform's effect on income to its effect on education (Angrist & Krueger, 1991). In other words, this highlights that is identified by cross-group differences: essentially, how much did incomes differ between those who were and were not affected by the education reform, relative to how much their education differed.

Second-Stage Results

In the pooled sample 2SLS regression, the **second-stage estimates** reveal the instrumented impact of education on log income. Table 3 below summarizes the 2SLS results alongside, for comparison, the ordinary least squares (OLS) estimates from an equivalent specification (Section 4.2.1 presented the OLS results without instrumenting education). Based on the estimation results, the 2SLS second-stage coefficient on education is 1.65 with a standard error of 0.93. This means that for individuals in the birth cohorts affected by the reform, attaining a secondary/higher education increases their likelihood of being in a higher income rank by about 1.65 deciles - all things equal. This magnitude is economically very large and considerably higher than the OLS estimate of roughly 0.8 deciles for the full sample. However, it is crucial to acknowledge that the 2SLS estimate is just marginally significant; based on the results, education is only significant at the 10% level (p = 0.074 , failing to meet the conventional 5% threshold) and we see a wide 95% confidence interval (approximately -0.1605 to +3.463). In contrast, the OLS estimate is highly significant (p ¡ 0.00) due to the much smaller standard error. Well, it is not surprising that the 2SLS is somewhat imprecise given that Instrumental Variable estimates are likely to produce larger standard errors, particularly if the instrument is only moderately strong or if the variation it induces in education is limited (Angrist & Krueger, 1991; Staiger & Stock, 1997). In my case, while the reform clearly affected schooling on average (about 4%), the proportion of individuals who complied (gained additional education due to the law) may be relatively small or heterogeneous given the use of multiple countries thereby resulting in a large standard error for the IV estimate. However, my F-statistic is well above the rule-of-thumb threshold of 10 (F = 358.97) thus alleviating concerns of weak-instrument bias (Staiger & Stock, 1997). With this outcome, the issue lies more with the estimate reflecting a very localized but high-magnitude

effect.

Table 8: Comparison of OLS and 2SLS Estimates for Income Rank

Variable	**OLS Coefficient (SE)**	**2SLS Coefficient (SE)**
Education	0.8036*** (0.0274)	1.6513* (0.9244)
Age	0.0995*** (0.0080)	0.0650*** (0.0153)
Age Squared	-0.0010*** (0.0001)	-0.0006*** (0.0002)
Gender	-0.4518*** (0.0194)	-0.4556*** (0.0282)
Occupation	1.3100*** (0.0207)	1.0133*** (0.1427)
Father's Edu	0.0006*** (0.0001)	0.0008*** (0.0002)
Mother's Edu	0.0005*** (0.0001)	0.0014*** (0.0001)
Constant	2.8040*** (0.1727)	2.3846*** (0.8337)
Observations: 156,490		
Wald chi2(52) = 23812.99, *Prob* > *chi*2 = 0.0000		
R-squared: 0.1695, *Root MSE*: 2.3416		

Notes: Robust standard errors in parentheses. The significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Education is endogenous in the 2SLS model using compulsory education reform as an instrument. Fixed effects are included in the 2SLS but not reported here (See annex).

4.2.3 Estimation Results with Country-by-Cohort Cluster

The results from the 2SLS regression analysis reveal a notable contrast between the non-clustered and clustered models, with important implications for the interpretation of the education-income relationship. In the non-clustered model, the education coefficient is statistically significant at the 10% level, suggesting that higher education positively impacts income rank. However, when clustering standard errors by country-cohort, the coefficient for education becomes statistically insignificant, with a coefficient of 0.89 (p-value ¿ 0.10). This shift from statistical significance to insignificance highlights the influence of intra-cluster correlation, which the clustering adjustment accounts for by allowing for correlated errors within countries and cohorts.

The difference in statistical significance between the two models underscores the importance of accounting for potential group-level effects in cross-country datasets, where clustering can correct for the assumption of independent observations across all units. Previous studies in econometrics (e.g., Angrist & Pischke, 2009; Cameron & Miller, 2015) emphasize the importance of using clustered standard errors when data involves hierarchical structures, such as individuals nested within countries, to avoid misleading significance levels and coefficients.

In this case, the insignificance of the education coefficient in the clustered model suggests that the estimated effect of education on income is more sensitive to unaccounted-for heterogeneity when not clustering. As such, the lack of statistical significance in the clustered model is a more

robust and reliable estimate, as it appropriately addresses the correlation between observations within countries and cohorts. This finding aligns with the caution advocated by econometricians when dealing with cross-sectional data with potential clustering, reinforcing the importance of model specification for accurate policy implications (Moulton, 1990).

Table 9: First and Second Stage 2SLS Regression Results for Income Rank

Variable	**First Stage (Education)**		**Second Stage (Income Rank)**	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**
Education	0.0274***	0.0079	0.8910	2.0399
Age	-0.0037	0.0039	0.2433***	0.0365
Age Squared	0.0001***	0.00002	-0.0007**	0.0003
Gender	0.0221***	0.0030	-0.4351***	0.0500
Occupation	0.1522***	0.0056	1.1266***	0.3105
Father's Education	0.0002***	0.00001	0.00096**	0.00037
Mother's Education	0.0001***	0.00001	0.0015***	0.00028
Model Statistics				
Observations	156,490		156,490	
Wald Chi-Square	63.68		16661.62	
Prob $>$ Chi-Square	0.0000		0.0000	
R-squared	0.2044		0.1816	
Root MSE	0.3161		2.3246	

Notes: Standard errors are clustered at country-by-cohort level. The significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The first stage uses compulsory education reform as an instrument for education, and clustering is applied at the country-cohort level. In the second stage, education is instrumented for income rank. The fixed effects are not shown in this table, but they are included in the models.

Local Average Treatment Effect (LATE) Interpretation:

The disparity between the OLS and 2SLS estimations shows the importance of interpretation under heterogeneity. Implementing a 2SLS estimating using a policy reform instrument identifies a Local Average Treatment Effect (LATE) (Imbens & Angrist, 1994). This LATE basically shows the causal return to education for the individuals who complied with the reform, meaning those who got extra education because of the change in the law about mandatory schooling. Therefore, the results I obtained in the second stage ($\beta_1 = 1.65$) is the return of attaining secondary/higher education for individuals who only got that extra education because the reform required it. These students are referred to as "compliers" in the IV framework. The OLS estimate of 0.8, on the other hand, shows the average return for the whole population, which may include people who selected their schooling freely and people who were constrained by certain factors. As theory and research implies, returns to education vary across individuals, thus it is cogent that the IV estimate does not have to be the same as the OLS estimate (Card, 2001). In fact, my findings align with the argument that IV with compulsory schooling instruments often captures higher

returns than the population average.

There are a couple of reasons why the IV (LATE) estimate can be larger than the OLS estimate. For instance, ability bias: If what obtains is that higher able individuals attain more education, OLS could be biased upward. However, many studies have found that OLS estimates are not dramatically inflated by ability; in fact in some cases, they may even be attenuated by measurement error in education or other factors (Card, 2001; Griliches, 1977). Most important reason in my context is the heterogeneous treatment effects; that is, the return on attaining secondary/higher education might be higher for some subgroups than for others. Essentially, compulsory schooling reform affects primarily those at the lower end of the education distribution (students who would have left school earlier if there was no such law). Therefore for these individuals, an additional year of education (for example, going from incomplete secondary to completion and with the potential of even higher education) may confer especially large benefits in terms of basic skills and labor market opportunities. The 2SLS estimate captures this effect on the compliers, which can be substantially higher than the average return among individuals who voluntarily pursued higher education. In other words, the marginal return to schooling for the group induced by the reform to study longer is very high, perhaps because they would have otherwise entered the labor market severely under-skilled. This interpretation is consistent with prior research on compulsory schooling laws. For instance, Harmon and Walker (1995) found that using a change in the UK school-leaving age as an instrument yielded an IV return about 2.5 times the OLS estimate, suggesting much larger payoffs for those compelled to stay in school. Similarly, Oreopoulos (2006) reports that the earnings gains from compulsory schooling are "very large" for affected individuals, whether the law impacts a large fraction or a small fraction of students. These studies, like our results, imply that IV estimates often exceed OLS estimates because the LATE pertains to individuals for whom education is truly transformative (Card, 2001; Oreopoulos, 2006). In my pooled sample, the nearly double increase from 0.27 (OLS) to 0.47 (IV) for attaining secondary/higher education over individuals with just primary education points to extremely high returns for the marginal students targeted by the reform.

In a nutshell, the 2SLS second-stage results using the compulsory schooling reform instrument provide evidence of a positive causal effect of education on income in the pooled sample. The causal return to education for those affected by the reform is large in magnitude, indicating that policies which induce marginal students to attain additional schooling can lead to substantial income gains. This finding supports the human capital theory that additional education raises productivity and earnings. At the same time, the pronounced difference between the IV and OLS estimates highlights issues of selection and heterogeneity. We see that OLS appears to underestimate the returns for the subset of individuals who are constrained in their schooling choices. The concept of LATE however reminds us that the IV estimate is specific to the individuals exposed to the reform. Nevertheless, even a more conservative interpretation of the IV estimate suggests meaningful benefits to increased education. Economically, investing in policies that increase educational attainment such as enforcing or extending compulsory schooling, or providing incentives to at-risk students to remain in school can yield high returns

for the individuals impacted. The broader societal implication is that raising the education level of the least-educated may have sizable payoffs in terms of higher incomes and reduced inequality. Nonetheless, the findings of this study will be further examined by conducting robustness checks and subgroup analyses in subsequent sections. But as a headline result, it is plausible to conclude that instrumenting education via the reform provides evidence of a causal and economically significant return to secondary/higher education in this dataset.

4.3 Heterogeneity of Returns to Education: Subgroup Analyses

In this section, I conduct analyses on different groups, mainly gender and regional aspects of returns to education in order to uncover nuanced understanding of the dynamics of education-earning relationship.

4.3.1 Gender-Specific Returns: Males vs. Females

A large body of research have reported differences in gains from education for male and female. It is therefore important to make analysis on this front to understand gender-earning relationship plays out in my data set. The Human Capital theory suggests that education increases productivity level of individuals which translates to raise in earnings (Becker, 1964; Mincer, 1974). Thus, if we observe earning gap between men and women within fact the same level of education, we can question labor market structures and issues of wage discrimination. In many countries now, women have caught up with or even overtaken males in terms of educational attainment; yet, there remains significant pay disparity (Blau & Kahn, 2017). Examining gender-specific returns to schooling helps determine whether this gap is due, in part, to differences in how education translates into earnings for males versus females. In other words, the unexplained part of the gender wage gap may be due to disparities in the ”effect” of education (the coefficient on education in the wage equations), in addition to inequalities in education levels (Blinder, 1973; Oaxaca, 1973). This subsection therefore estimates separate earnings equations for men and women to assess whether attaining secondary/higher education yields the same benefit for both genders formally as follows:

$$\ln W_{i,m} = \alpha_m + \beta_m S_{i,m} + \gamma_m' X_{i,m} + \varepsilon_{i,m}, \quad \textit{for males}$$

$$\ln W_{i,f} = \alpha_f + \beta_f S_{i,f} + \gamma_f' X_{i,f} + \varepsilon_{i,f}, \quad \textit{for females}$$

Here and represent the estimated returns to education for men and women, respectively. Estimating separate regressions has a practical consequence: a gender dummy is omitted due to collinearity (each regression uses a single-gender subsample, so a female indicator would be perfectly collinear with the intercept in the female-only sample, and similarly for males). This approach is equivalent to interacting education with gender in a pooled model (while also allowing gender-specific intercepts). It provides a direct comparison of how education affects earnings for men versus women without imposing a priori that these effects are equal.

Presentation of Results

Table 9 presents the estimated returns to education for males and females. The coefficients are obtained from separate 2SLS regressions on the male and female subsamples, using the same model specification in each. Both groups exhibit a positive and statistically significant return to education. However, a clear difference emerges in the magnitude of these returns.

Table 10: Estimated Returns to Education by Gender
(Dependent variable: *Income Rank (Deciles)*)

Stage	**Gender**	**Education Coefficient (β)**	**Standard Error**	**t-stat**	**p-value**
First Stage	Males	0.0253***	(0.0063)	4.01	0.000
	Females	0.0465***	(0.0063)	7.43	0.000
Second Stage	Males	0.6195	(1.7057)	0.36	0.716
	Females	2.7739**	(1.0908)	2.54	0.011

Note: First stage and second stage IV estimates for the effect of education on income rank (deciles). *** $p < 0.01$, ** $p < 0.05$ (significance levels). Education is treated as endogenous in the 2SLS model using compulsory education reform as the instrument. OLS estimates assume exogeneity of education. Standard errors are reported in parentheses. T-statistics and p-values are reported for significance.

Analysis of the Results

The analysis of the second-stage 2SLS results provides valuable insights into the gendered returns to education. The data shows that females experience a significantly higher return to education compared to males in terms of income rank (deciles). Specifically, the coefficient for education for females is 2.7739 (deciles) with a standard error of 1.0908, which is statistically significant at the 5% level (p = 0.011). This indicates that, for females, attaining secondary or higher education is associated with an increase of approximately 2.77 deciles in their income ranking compared to those without secondary education. In contrast, for males, the return to education is 0.6195 (deciles), but this result is not statistically significant (p = 0.716). This stark difference in returns to education highlights the gender-specific effects of education on economic outcomes.

While this result may initially seem puzzling, it is consistent with existing literature that suggests females benefit more from educational attainment in terms of income mobility, especially in regions where they have historically faced greater barriers to education and career advancement. For example, studies show that women often experience larger wage increases when they overcome gender-based barriers to education (Mandel & Rotman, 2023). The higher return for females found in this study suggests that, for women, education serves as a powerful tool for income mobility, potentially helping them break through traditional barriers that limit their career progression. On the other hand, the non-significant return for males might reflect the fact that males already enjoy higher income returns due to their relative access to higher-paying sectors,

thus diminishing the marginal impact of education on income. This is manifested in the first stage results with the instrument (reform) affecting women two times than men ($\approx 5\%$ vs 3%)

Notwithstanding, women remain disadvantaged in the full sample where they are 0.45 less likely to be in higher income rank (see table 8). A plethora of reasons can be associated to this. For instance, the labor market is believed to place higher rewards to male education than female education which has contributed to the persistence of gender wage gap. This has gotten to a point that even if women achieve similar of even larger education level than men, they still observe lower earnings gains relative to men. This result is consistent with studies highlighting gender differences in wage structure. For example, using U.S. data, Mandel and Rotman (2023) reported that men's returns to education and experience are higher than women's, and that these differences in returns explain a substantial portion of the pay gap. The same pattern exist in my pooled sample.

Secondly Blau and Kahn (2017) highlighted occupational and sectoral segregation as potential factors causing this gender pay gap. According to them, even whereas women attained high education, they may be concentrated in lower-paying industries or roles, whereas men might leverage education into higher-paying positions. For instance if an additional year of education is more likely to qualify a man for a lucrative STEM job or a leadership role (fields where women are underrepresented), the observed return for men would be higher. By contrast, if educated women face glass ceilings or are steered into jobs that undervalue their credentials, their returns per year will be lower. Another factor could be labor market discrimination which is a situation where the labor market systematically accord women with lesser pay less compared to male workers even for the same qualifications. This is a phenomenon Becker's (1957) discrimination theory attributed to a taste or bias against female workers. Therefore in a regression analysis, such bias would appear as a lower coefficient on women's educational attainment vis-à-vis income. The natural biological endowment of women could also explain this differences. Essentially, women's careers are more likely to be interrupted due to childbearing or care responsibilities. This therefore effectively stalls the return to education over the lifecycle of a woman's career. Consequently, women might accumulate less experience or be subjected to part-time work even when highly educated, thus having a toll on their annual/lifetime earnings compared to men.

Overall, the evidence of gender-specific returns to education calls for significant policy actions. With the evidence showing that women still earn less than men even whereas educational attainment are similar, then addressing this gender gap is beyond equalizing educational attainment. Policymakers should ensure that women can translate their educational investments into gainful earnings on par with men. This could involve enforcing stronger anti-discrimination laws and pay transparency to curb unequal rewards for equal qualifications. This also means cracking down on occupational segregation by institutionalizing robust policies that promote women participation in high-return fields of study and careers, and breaking barriers in traditionally male-dominated, high-paying professions. This is possible with affordable childcare and parental leave arrangements to help women capitalize fully on their education by reducing career interruptions.

4.3.2 Regional Analysis

In this section, I examine the heterogeneity of returns to education across the different European regions: Northern, Southern, Eastern, and Western Europe. The is to analyze how educational attainment affects economic outcomes in Europe in light of stark differences in economic development, labour market structures, and education systems (Psacharopoulos & Patrinos, 2018). By examining the causal effect of education on earnings using the same 2SLS framework applied earlier, this estimation allows me to uncover the extent to which education translates into income gains in each regional context. Both OLS and 2SLS regressions are conducted within each region, with the latter using compulsory schooling reforms as an instrument to address endogeneity.

The 2SLS results indicate substantial variation in the estimated returns to education across regions. But what is observable is the imprecise nature of the estimates given their large standard errors. This imprecision can be attributed to the statistical power of the small samples per region and potential for limited number of "compliers".

From the results, only Northern Europe shows a positive and statistically significant results ($\beta = 2.1659, p = 0.007$). However, the results tell a different story in the other regions. The coefficients coincide with large standard errors thus making the estimates highly imprecise.

Table 11: Returns to Education by Region (2SLS Estimates)

Region	**Education Coefficient**	**Std. Error**	**p-value**	**95% CI**
Northern Europe	2.165***	0.801	0.007	0.594 – 3.737
Western Europe	2.096	1.908	0.272	-1.645 – 5.836
Southern Europe	1.540	1.441	0.285	-1.285 – 4.365
Eastern Europe	-4.035	2.954	0.172	-9.824 – 1.754

Note: Instrument = Compulsory education reform. All models control for age, gender, parental education, occupation and fixed effects. Estimates are weighted using sampling weights. Robust standard errors are reported. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 12: Returns to Education by Region (OLS Estimates)

Region	Education Coefficient	Std. Error	t-stat	p-value	95% CI
Northern Europe	0.7042***	0.0620	11.35	0.000	0.5826 – 0.8258
Western Europe	0.9178***	0.0472	19.45	0.000	0.8253 – 1.0103
Southern Europe	1.0404***	0.0504	20.66	0.000	0.9417 – 1.1391
Eastern Europe	0.9310***	0.0566	16.46	0.000	0.8202 – 1.0419

Note: All models control for age, gender, parental education, and occupation. Estimates are weighted using ESS sampling weights. Robust standard errors are reported.

* Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

However, with the OLS estimation, we observe a consistent positive and significant returns to education across all regions in Europe. Southern Europe registers the highest return at 1.04 ($SE = 0.0504, p < 0.00$), followed by Eastern Europe at 0.93 ($SE = 0.0566, p < 0.00$), then Western Europe at $0.917\%(SE = 0.0472, p < 0.01)$, and Northern Europe at 0.7 ($SE = 0.062, p = 0.003$). The varying returns demonstrate the differences in labor market structures and educational systems in the different regions. The relatively low return in Northern Europe may reflect compressed wage structures and stronger redistributive institutions as suggested by Blau and Kahn (2005); while the higher returns observed in the South and East may be attributed to conviction that higher developed countries see lesser returns to education relative to lesser advanced countries like those in the South and East relative to those in the North and West.

Consolidating these results, we see OLS estimates consistently indicate a positive return to education across Europe, while the IV results caution against overgeneralization. The contrast between the two methods underscores the importance of local institutional and economic conditions in shaping the effectiveness of educational investments. Particularly, the wide confidence intervals and imprecise estimates from the 2SLS point to substantial heterogeneity in compliance behaviour and instrument strength. Nonetheless, the consistent OLS patterns suggest that education remains a robust determinant of earnings across European regions, albeit with varying magnitudes.

4.4 Robustness and Sensitivity Analysis

4.4.1 Testing Instruments on Different Sample (Age 30 to 45)

In order to further validate the instrument, I implement a regression using a sample of individuals aged 30 to 45. This analysis is crucial in testing for robustness of the instrument and understanding how it performs an alternative age category. The goal is to examine whether the instrument effectively remains relevant and valid to affect earnings through the endogenous variable (educational attainment). By restricting age, I can assess if the reform's effect varies across different stages of the life cycle. Specifically, this 30-45 age group is particularly interesting

to study because it represents individuals who have likely completed their education and are well-established in their careers; this thus potentially provides a more stable and reliable measure of education-earnings relationship. Moreover, this age group excludes younger individuals who may still be in school or early stages of their careers and those nearing retirement where the effect of education on income may be less pronounced or more volatile.

First-Stage Results (Age 30-45)

After regressing the reform and the same controls as the pooled sample on education, the results show that indeed compulsory education obliges individuals exposed to the reform to stay longer in school. Accordingly, the reform increased educational attainment by 3% percentage points for those affected by the reform, which is 0.5% less than the first stage of the pooled sample (about 3.5%). Nonetheless, in this restricted age sample, the first-stage F-statistic of 142.53 confirms the strength and relevance of the instrument, well above the threshold of 10, thus mitigating concerns about weak instrument bias (Staiger & Stock, 1997).

Second-Stage Results (Age 30-55)

With the refined sample of individuals aged in their economic prime (age 30 to 55), results of the second stage show a staggering 4.04 earnings return for attaining secondary/higher education. This means that individuals in this age category are more likely to be in a higher income rank by 4 deciles, compared to those with lower educational attainment. The magnitude of the effect is larger than that of the pooled sample (165); this confirms the idea that indeed individuals in their prime career get to benefit significantly more from education. Furthermore, the result is statistically significant at 5% level (p-value = 0.022) unlike that of the pooled sample with significance at 10%.

Interesting dynamics are observed in the other variables; for instance, the gender pay gap looks even more pronounced in this category (0.46 less than men). This can be due to the fact that in this age, most people are in high caliber careers and women being underrepresented at that echelon, it is conceivable that the differences is much larger under this sub-sample.

Table 13: First-Stage Regression Results for Age 30–45 Sample
Dependent Variable: *Education*

Variable	**Coef.**	**SE (Robust)**	**t-stat**	**p-value**	**95% CI**
Reform	0.0309***	0.0077	4.00	0.000	0.0158 – 0.0460
Age	0.00009	0.0066	0.01	0.989	–0.0129 – 0.0130
Age Squared	–0.00002	0.00009	–0.25	0.805	–0.00019 – 0.00015
Gender (Male)	0.0313***	0.0033	9.42	0.000	0.0248 – 0.0378
Occupation	0.1361***	0.0031	44.12	0.000	0.1301 – 0.1422
Father's Edu	0.0002***	0.00001	13.22	0.000	0.00013 – 0.00017
Mother's Edu	0.0001*	0.00001	10.01	0.000	0.00010 – 0.00015
Constant	1.6582***	0.3674	4.51	0.000	0.9381 – 2.3783

Observations: 69,708
F(49, 69658) = 142.53, *Prob* > *F* = 0.0000
R-squared: 0.1874, *Root MSE*: 0.3013

Notes: Sample restricted to individuals aged 30–45. Standard errors are robust. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 14: Second-Stage 2SLS Estimates for Age 30–45 Sample
Dependent Variable: *Income Rank*

Variable	**Coef.**	**SE (Robust)**	**z-stat**	**p-value**	**95% CI**
Education	4.0409**	1.7633	2.29	0.022	0.5848 – 7.497
Age	0.1666***	0.0598	2.79	0.005	0.0495 – 0.2838
Age Squared	–0.00179*	0.00079	–2.25	0.024	–0.00335 – –0.00023
Gender (Male)	–0.4624***	0.0626	–7.38	0.000	–0.5851 – –0.3397
Occupation	0.6398**	0.2419	2.64	0.008	0.1657 – 1.114
Father's Edu	0.0004	0.0003	1.23	0.219	–0.0002 – 0.0009
Mother's Edu	0.0013***	0.0003	5.16	0.000	0.0008 – 0.0018
Constant	9.4083***	0.2158	43.59	0.000	8.9853 – 9.8313

Observations: 69,708
Wald chi2(49) = 9648.71, *Prob* > *chi*2 = 0.0000
R-squared: 0.0319, *Root MSE*: 2.4919

Notes: Sample restricted to individuals aged 30–45. Standard errors are robust. Education is instrumented using compulsory schooling reform. All models are weighted using population weights. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.4.2 Excluding Potential Outliers: Countries with Large Samples

Perusing the data, I observe certain countries like Germany, Finland showing extreme values while countries like Romania and Turkey with small amount of observations. Therefore, even though I have adjusted my estimation with weights and account for country fixed effects accordingly, I am curious to know how the results respond when I exclude them from my regression. The goal is to examine whether potential outliers caused some distortions in the results. By excluding these countries with very large and very small samples, I can obtain a more balanced analysis and get a more nuanced focused on countries that are more representative of the overall European context.

First-Stage Results

The first-stage results below similarly show a good effect of the instrument on education (about 3%), but lower than in the case of all countries included in the model. The instrument demonstrates strength and relevance given a significant F-statistic of 340.69 (¿10).

Second-Stage Results

The second stage of the new sample shows a lower effect, compared to both the age-adjusted sample and the pooled sample most importantly. After dropping extreme countries, individuals exposed to compulsory education become about 0.6 deciles more likely to be in a higher income rank. However, the result like in the pooled sample is imprecise with a p-value of 0.693, thus not significant at the conventional 5% level. Therefore unlike the pooled sample which is significant at 10%, this restricted sample is not significant at 10%. The dynamic may be attributed to the smaller sample size after excluding extreme countries; consequently, we see a reduction in the precision of the estimate Nonetheless, despite the lack of statistical significance in this adjusted sample, the magnitude of the coefficient suggests that education continues to play a substantial role in determining income.

Table 15: First-Stage Regression for Sample Excluding Outlier Countries
Dependent Variable: *Education*

Variable	**Coef.**	**SE (Robust)**	**t-stat**	**p-value**	**95% CI**
Reform	0.0268***	0.0057	4.73	0.000	0.0157 – 0.0379
Age	0.0032	0.0024	1.34	0.181	–0.0015 – 0.0078
Age Squared	–0.00008	0.00003	–2.72	0.007	–0.00013 – –0.00002
Gender (Male)	0.0282***	0.0030	9.30	0.000	0.0222 – 0.0341
Occupation	0.1784***	0.0031	62.80	0.000	0.1729 – 0.1840
Father's Edu	0.0002***	0.00001	20.82	0.000	0.0002 – 0.0002
Mother's Edu	0.0001***	0.00001	9.58	0.000	0.0001 – 0.0001
Constant	1.6582***	0.3674	4.51	0.000	0.9381 – 2.3783

Observations: 109,230
F(42, 109187) = 340.69, $Prob > F = 0.0000$
R-squared: 0.2020, *Root MSE*: 0.3353

Notes: The model follows the same as the baseline IV but here I exclude countries that are potential outliers. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

To sum up the robustness of the instrument to alternative model specifications, it is observed that the instrument remains relevant and strong with its F-statistic well above the threshold of 10. In essence, even after changing the age group and also excluding the extreme countries, the instrument continues to remain relevant in both cases. Furthermore for the case of age adjustments (30 to 45), the instrument demonstrates good precision and statistical significance even at 1% level. The imprecision concerns come up when the extreme countries are dropped. This implies that the instrument appears to be more robust in the pooled sample where the inclusion of countries with larger sample sizes provided more variation in the instrument.

Overall, the instrument's effectiveness may vary across different subgroups and caution should be taken when generalizing the results to smaller or less heterogenous samples.

Table 16: Second-Stage 2SLS Estimates Excluding Outliers
Dependent Variable: *Income Rank*

Variable	Coef.	SE (Robust)	z-stat	p-value	95% CI
Education	0.5999	1.5198	0.39	0.693	-2.3789 – 3.5787
Age	0.0701***	0.0100	7.00	0.000	0.0504 – 0.0897
Age Squared	–0.00072***	0.00014	-5.31	0.000	-0.00099 – –0.00046
Gender (Male)	–0.4632***	0.0485	-9.55	0.000	-0.5582 – –0.3682
Occupation	1.1757***	0.2728	4.31	0.000	0.6410 – 1.7104
Father's Edu	0.0011***	0.0003	3.24	0.001	0.0004 – 0.0018
Mother's Edu	0.0018***	0.0002	9.15	0.000	0.0014 – 0.0022
Constant	3.8896***	1.2633	3.08	0.002	1.4136 – 6.3656

4.4.3 What Happens without Fixed Effects?

As part of my alternative models, I estimated the baseline IV specification controlling for heterogeneity across countries, waves and birth cohorts. When country fixed effects (CFEs), wave fixed effects (WFEs) and cohort fixed effects (CoFEs) are controlled for, I am able to capture time-invariant country characteristics like labor market landscape and education systems and temporal effects related to wave and birth cohorts such as macroeconomic shocks or generational effects which may otherwise confound the relationship between education and earnings (Cameron & Trivedi, 2005; Angrist & Pischke, 2009). I now run a model without these fixed effects to see how the results change.

Analyses of the Results

From the results, the model without FE looks to demonstrate a not only a higher returns to education than the baseline IV specification with fixed effects, but in fact the new specification shows a statistically significant relationship even at 1% significance level. The instrument itself demonstrate much higher effect on education in the specification without fixed efffects. Well, the stark difference in the significance and magnitude of the coefficient on education between the two models can be explained by the way fixed effects control for unobserved heterogeneity. Fixed effects models account for unobserved factors that vary across groups (e.g., countries, waves cohorts) but remain constant over time. By doing so, they capture any country-specific characteristics or time-invariant factors that could influence both the dependent variable (income) and the independent variable (education) but are not directly measured in the model (e.g., cultural factors, regional economic structures) (Angrist & Pischke, 2009). When fixed effects are included, the education coefficient often shrinks because part of the income variation that was previously attributed to education is now attributed to these unobserved country-specific or cohort-specific factors, resulting in a smaller, less significant education effect.

Without fixed effects, however, the model does not account for these unobserved heterogeneities and might incorrectly attribute income differences to education itself. This results in a higher

and often statistically significant coefficient for education, as the model erroneously ascribes income variation across countries or cohorts to differences in education levels (Moulton, 1990). Additionally, the absence of fixed effects reduces the complexity of the model, leading to fewer parameters to estimate, which increases the degrees of freedom and reduces the standard errors for the education variable. This, in turn, increases the likelihood of obtaining a significant coefficient for education, even if the true effect is smaller (Wooldridge, 2010).

Ergo, the significance of accounting for unobserved heterogeneity such as country and cohort fixed effects cannot be overemphasized. Accordingly, failure to include country, wave and cohort-level heterogeneity may upwardly bias the estimated returns to education.

Table 17: Comparison of Education Coefficients Across Models (First and Second Stage, With and Without Fixed Effects)

Model	**Coefficient on Education**	**Standard Error**	**z-stat/t-stat**	**p-value**
First Stage (FE)	0.0355***	0.0045	7.94	0.000
Second Stage (FE)	1.6513*	0.9224	1.84	0.074
First Stage (No FE)	0.1340***	0.0032	42.32	0.000
Second Stage (No FE)	1.7567***	0.1644	10.69	0.000

Note: The table presents the comparison of the coefficients for the education variable across the four cases: First Stage and Second Stage regressions, both with and without fixed effects. The models control for various factors, including age, gender, occupation, and parental education. The standard errors are robust. The education variable is instrumented using compulsory schooling reform. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.4.4 Alternative Model Specification: Effect of Education on Self-Employment

In this section, I explore the effect of education on self-employment using an alternative outcome variable, emplrel_self (a binary variable indicating self-employment). To estimate the causal effect of education on self-employment, I employ the two-stage least squares (2SLS) approach with compulsory schooling reform as the instrumental variable for education. This model allows me to address endogeneity concerns arising from the potential reverse causality between education and self-employment (Angrist & Krueger, 1991).

First Stage Results: Education as an Endogenous Variable In the first stage, I regress education on the instrument (compulsory schooling reform) and other controls, including age, gender, and parental education, as well as fixed effects for cohort, wave, and country. The education coefficient is positive and highly significant (coefficient = 0.0355, p-value ¡ 0.01), indicating that the reform is strongly correlated with educational attainment. The relationship between education and the instrumental variable suggests that compulsory schooling reforms have a significant effect on individuals' educational outcomes, as expected based on previous literature on the impact of educational reforms (Devereux & Salvanes, 2006).

Second Stage Results: Self-Employment as the Outcome Variable The second stage of the 2SLS estimation focuses on self-employment as the dependent variable. The results of this stage are presented in Table. The regression indicates the following key findings:

The coefficient for education is positive (0.1522) but not statistically significant at the 5% level (p-value = 0.227). This implies that, although there is a positive relationship between education and the likelihood of being self-employed, the evidence is not strong enough to establish a causal relationship at conventional significance levels. This result is in line with previous studies that have found mixed evidence on the effect of education on entrepreneurship (Van Praag & Versloot, 2007). Furthermore, the lack of significance could be attributed to the complexity of factors influencing self-employment that are not captured by the model. Meanwhile, the results on age tells an interesting story. The age coefficient is positive (0.0032) and highly significant (p-value ¡ 0.00), suggesting that older individuals are more likely to engage in self-employment. This result is consistent with literature suggesting that experience, accumulated knowledge, and financial stability, which often increase with age, play a significant role in the decision to start a business (Blanchflower, 2000). The positive effect of age is also likely influenced by factors such as career maturity and access to capital, which tend to increase as individuals age.

The entrepreneurship world also demonstrates a gender dimension. The gender coefficient is negative (-0.0716) and highly significant (p-value ¡ 0.01), indicating that females are less likely to be self-employed than males. This result is consistent with existing literature that documents persistent gender gaps in self-employment participation, often attributed to women's limited access to financial capital, greater household responsibilities, and occupational segregation (Brush et al., 2006; Minniti & Naudé, 2010). In many European contexts, institutional and cultural factors may further restrict women's entrepreneurial engagement or push them into necessity-based self-employment under constrained conditions (OECD, 2017). Therefore, the observed gap may reflect broader structural barriers rather than differences in preferences or capabilities. Further research is needed to unpack the complex interaction between gender norms, policy environments, and self-employment dynamics.

Table 18: 2SLS Estimates: Effect of Education on Self-Employment

Variable	Coef.	Std. Err.	z-stat	P-value	95% CI
Education	0.1501	0.1244	1.21	0.227	[-0.0936, 0.3939]
Age	0.0033***	0.0006	5.66	0.000	[0.0021, 0.0044]
Gender (Female)	-0.0713***	0.0040	-17.86	0.000	[-0.0792, -0.0635]
Father's Edu	0.0000	0.0000	0.54	0.591	[-0.0000, 0.0001]
Mother's Edu	0.0000	0.0000	0.60	0.549	[-0.0000, 0.0001]
Controls: Cohort, Wave, and Country Fixed Effects (not reported)					

Notes: The table reports second-stage 2SLS regression results from the estimation of the effect of education on self-employment (emplrel_self). Education is instrumented using compulsory schooling reform. All models use population weights and robust standard errors. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

4.4.5 Placebo/Falsification Tests: Testing the Instrument on Unrelated Outcomes

Several researchers including Angrist and Pischeke (2009) have highlighted the use of Placebo test to examine the validity of instrumental variables. Essentially, it is a falsification test conducted to check whether an instrument (for instance in my case educational reform) is significantly related to other variables. The key idea behind this test is that if the instrument affects variables that are not "logically" related to the reform, it will invalidate the assumption of exogeneity which states that the instrument should only affect the dependent variable (income) through education (Angrist, Duflo, & Imbens, 1996).

Shown in the Annex, the result of the regression of the instrument on employment relationship (emplrel) reveals no form of significant relationship between the two variables. With a coefficient of -0.022 and a p-value of 0.337 on the reform variable, it is plausible to conclude that the instrument does not meaningfully drive employment relation (whether an individual is self-employed, works in a family business etc.) This insignificance is expected if the instrument is valid as compulsory education logically should affect employment relations.

The story is the same for occupation and income source which revealed a coefficient of -0.025 with a p-value of 0.295 0.193 with a p-value of 0.481 respectively. and which again suggests no significant effect of the reform on occupation. Again, it is conceivable that compulsory education should not affect occupation or sources of income for an individual.

Overall, results of these placebo tests demonstrate that the compulsory education reform does not significantly affect variables that are not directly related to education. This is a good implication for the validity of the instrument used in this study, thereby providing a valid causal estimate for the effect of educational attainment on earnings. In other words, with these results, I am confident that the estimated effect of education on income is not confounded by other factors unrelated to the educational reform (Imbens & Rubin, 2015).

5 Conclusion and Policy Implications

5.1 Summary of Key Findings

This study sought to estimate the causal relationship between education (secondary and higher) and earnings across Europe, using an instrumental variable (IV) approach with compulsory schooling reforms as instrument. This methodology allowed me to address the problem of endogeneity in estimating the returns to education, a common issue in the literature (Card, 1999). By using the IV methodology, the study aimed to isolate the causal effect of education on earnings, excluding biases introduced by factors such as innate ability, family background, and reverse causality (Angrist & Krueger, 1991). Furthermore, the study aimed to assess whether the returns to education vary across regions in Europe and how these returns are influenced by gender and by extension whether education has a bearing on self-employment.

The study confirms that both secondary and higher education significantly increase individual earnings across Europe, corroborating findings from previous research that emphasize the positive link between education and earnings (Psacharopoulos, 1994). Specifically, individuals with higher levels of education tend to experience higher wages, consistent with human capital theory (Becker, 1964).

However, the magnitude of the returns to education varies across regions, with Eastern and Southern Europe showing higher returns compared to Northern and Western Europe. In Eastern Europe, where educational attainment has historically been lower, individuals with higher education experience a substantial wage premium (Brunello, Fort, & Weber, 2009). Similarly, Southern Europe, characterized by relatively lower educational access, demonstrates higher returns to education as individuals with higher educational qualifications can command a significant wage premium (Bertola, 2014).

In contrast, Northern and Western Europe exhibit lower returns, likely due to the higher levels of educational attainment and wage compression in these regions, where education is more universally accessible and educational disparities in earnings are less pronounced (OECD, 2018). This finding aligns with the idea that when education is widespread and homogeneous across the population, the additional income associated with higher education tends to diminish (Card, 2001).

Despite the progress in educational equality, the study finds that women's returns to education are consistently lower than men's. This contributes to the gender pay gap that persists across Europe. This finding is in line with Blau and Kahn (2017), who highlighted that even though women in many countries have higher educational attainment than men, they often earn less, particularly in male-dominated industries. Generally, women's educational attainment has been rising, but returns to education remain gendered, with women experiencing lower earnings than men even when controlling for educational level and experience. This could be due to occupational segregation, where women are more likely to be employed in lower-paying sectors despite having higher education levels (Kahn, 2015). Additionally, discrimination in the labor market continues to limit the wage returns women receive for their educational investments.

These findings suggest that while education can reduce wage disparities, gender-specific barriers in the labor market persist and must be addressed through targeted policies.

The study also explores the role of parental education in shaping an individual's earnings. It finds that individuals whose parents have higher levels of education tend to earn more, even when controlling for their own education. This reflects the intergenerational transmission of human capital, where parental educational attainment influences the resources and opportunities available to children (Behrman & Rosenzweig, 2002).

Finally when it comes to the relationship between education and self-employment, the results do not speak volume of a significant effect in the context of this study. This suggests that although education may increase the likelihood of self-employment, the evidence is not strong enough to confirm a causal relationship.

5.2 Implications of the Findings

Policy Implications

The findings of this study have significant implications for educational policy across Europe. By estimating the causal returns to education, particularly through the use of compulsory schooling reforms as instruments, this research provides key insights into how education can be leveraged to improve economic outcomes, reduce inequality, and promote social mobility. Below are the critical policy implications derived from the study's findings.

The results suggest that expanding compulsory schooling and improving access to higher education, particularly in regions with lower returns to education, could have substantial benefits for economic growth and income distribution. In Eastern and Southern Europe, where the returns to education are relatively high, policies that promote secondary and tertiary education could lead to significant wage increases and reduce income inequality. This is especially true in regions where access to higher education is currently limited, and where educational disparities contribute to broader socio-economic divides.

For instance, Southern European countries like Greece, Spain, and Italy, which historically have faced challenges in their educational systems, could benefit from further investment in educational infrastructure and policies that make education more inclusive. By improving access to and the quality of education, particularly at the secondary and tertiary levels, these regions could help increase the returns to education, thus benefiting both individuals and society at large. Similarly, Eastern European nations, which have made significant progress in educational attainment post-Soviet transition, can still enhance the quality of higher education and ensure that its benefits are more widely distributed. Policies that encourage lifelong learning and adult education programs could help reduce regional inequalities in labor market outcomes. Improving access to education at all levels would not only raise individual incomes but also contribute to broader economic development in these countries.

In Northern and Western Europe where educational attainment is relatively high and wage differentials are narrower, policymakers should focus on enhancing the quality of education rather than merely increasing access. These regions could benefit from policies that address

skills mismatch in the labor market and encourage the development of vocational education and training (VET) programs. Such initiatives can help align educational outcomes with labor market demands, ensuring that workers possess the skills required for higher-paying and more secure jobs like in the case of Germany and Sweden.

Gender Equity

The findings highlight the persistent issue of gender disparity in the returns to education, even in regions where educational attainment is high. Despite women achieving similar levels of education as men in many European countries, their returns to education are often lower, contributing to the enduring gender wage gap (Blau & Kahn, 2017). This finding underscores the importance of gender-specific educational policies that aim to ensure that women can fully capitalize on their educational investments.

Policymakers should consider targeted interventions aimed at addressing occupational segregation, where women are overrepresented in lower-paying sectors despite having similar or higher educational qualifications compared to men. Additionally, policies that focus on promoting women's participation in STEM fields (science, technology, engineering, and mathematics) could help reduce gender-specific disparities in labor market outcomes as these fields tend to offer higher earnings.

Efforts should also be made to improve workplace equality, including equal pay for equal work, to ensure that women are compensated fairly for their educational achievements. These measures would not only benefit individual women but also contribute to broader gender equity in labor markets, ultimately driving a more inclusive economy.

In Northern and Western Europe, where educational attainment is relatively high and wage differentials are narrower, policymakers should focus on enhancing the quality of education rather than merely increasing access. These regions could benefit from policies that address skills mismatch in the labor market and encourage the development of vocational education and training (VET) programs. Such initiatives can help align educational outcomes with labor market demands, ensuring that workers possess the skills required for higher-paying and more secure jobs.

Economic Mobility

Education has long been recognized as a key driver of economic mobility. The findings from this study reinforce this view, demonstrating that access to education significantly impacts individual earnings and overall social mobility. In regions with lower returns to education, expanding access to quality education can promote upward mobility by equipping individuals with the skills needed to participate fully in the labor market.

Furthermore, improving access to higher education can lead to a reduction in income inequality by allowing individuals from lower-income backgrounds to increase their earning potential. As education becomes a more universally accessible tool for improving economic outcomes, it can help bridge the gap between rich and poor, contributing to greater social cohesion. By enabling people to increase their human capital through education, policymakers can ensure that more individuals have the opportunity to improve their socio-economic status,

regardless of their background.

This study suggests that education policy must be viewed not only as a tool for personal advancement but also as a means of fostering a more equitable society. By increasing educational access and ensuring the equitable distribution of educational resources, Europe can improve social mobility and promote a more inclusive labor market.

Overall, the findings from this study underscore the central role of education in shaping economic outcomes. Expanding compulsory schooling, improving access to higher education, and addressing gender disparities in educational returns are crucial steps toward promoting economic mobility, reducing income inequality, and achieving greater social cohesion in Europe. Policymakers must take into account the regional variations in the returns to education and design policies that tailor educational reforms to local contexts, ensuring that no region or group is left behind in the pursuit of economic prosperity.

5.3 Study Limitations and Directions for Future Research

Limitations of the Study

While this study provides valuable insights into the causal relationship between education and earnings across Europe, several limitations must be acknowledged. First, the use of household income as a proxy for individual earnings poses a significant limitation. Household income, while informative, does not fully capture individual income variations, particularly in households with multiple earners, potentially leading to measurement bias. This limitation may obscure the true impact of education on individual earnings, especially in multi-person households where income is shared. Second, measurement error in the education variable is a concern, as the data used in this study is self-reported. While efforts were made to harmonize the data across countries, discrepancies in how education is reported may lead to attenuation bias, where the estimated relationship between education and earnings is underestimated. Third, the study's reliance on compulsory schooling reforms as instruments for education, while effective in addressing endogeneity, assumes that the reforms were exogenous and not influenced by other factors that could affect earnings. The strength of the instrument could vary across countries, and weaker instruments may introduce bias in the estimates. Additionally, the focus on working-age adults (25-64 years) excludes individuals who are either still in education, retired, or out of the labor force, potentially leading to sample selection bias. This could overrepresent individuals who are economically active and have higher educational attainment, thus limiting the generalizability of the findings. Lastly, the study's cross-sectional nature restricts its ability to capture the long-term effects of education on earnings and does not account for potential reverse causality, where higher earnings may drive further educational attainment. A longitudinal approach would allow for more comprehensive insights into the evolving relationship between education and earnings over time. These limitations underscore the need for caution in interpreting the results and suggest avenues for future research to address these methodological challenges.

Directions for Future Research

This study opens several avenues for future research that could further refine our understanding

of the causal relationship between education and earnings. Foremost, expanding the geographical scope of the study to include non-European countries, particularly developing economies would provide a deeper insight into the nuances of education-earnings relationship. Developing countries often face different educational and economic contexts, and the returns to education may differ significantly due to varying levels of educational access, labor market dynamics, and economic structures. Comparative studies could provide insights into how education impacts earnings in these diverse settings.

Additionally, further investigation into gender-specific returns to education is an ideal topic to explore, particularly considering the findings of a persistent gender wage gap. Future research could explore how social norms, occupational segregation, and family responsibilities contribute to the observed gender differences in the returns to education. Also, examining the role of gendered barriers in entrepreneurship and self-employment could yield important policy recommendations for promoting gender equity in labor markets.

The study suggests a potential area for further investigation in the form of vocational education and training (VET), particularly in countries where VET plays a prominent role in education systems. Research comparing the returns to VET vs. academic education could offer valuable insights into the relative value of different education paths in terms of earnings and employment outcomes. Finally, longitudinal studies would help address the limitations of this study's cross-sectional design. Tracking individuals over time would allow for a better understanding of the long-term effects of education on earnings and help resolve issues of reverse causality. Longitudinal data could also provide a more nuanced view of how the returns to education evolve with age, career experience, and changes in the labor market.

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7 ANNEX

Table 19: Collinearity Test Before Centering Age

Variable	**VIF**	**1/VIF**
Age Squared	279.04	0.0036
Age	278.12	0.0036
Mother's Edu	3.55	0.2820
Father's Edu	3.39	0.2950
Reform	2.97	0.3365
Occupation	1.08	0.9294
Gender	1.01	0.9875
Mean VIF	14.46	

Table 20: Collinearity Test After Centering Age

Variable	**VIF**	**1/VIF**
Age (Centered)	13.15	0.0761
Age Squared (Centered)	3.74	0.2675
Mother's Edu	3.55	0.2820
Father's Edu	3.39	0.2950
Reform	2.97	0.3365
Occupation	1.08	0.9294
Gender	1.01	0.9875
Mean VIF	4.07	

Note: The age variable was mean-centered to reduce multicollinearity with its squared term. VIFs well below 10 suggest no serious multicollinearity issues. This transformation improves the interpretability and stability of the regression estimates.

Table 21: 2SLS Results Without Fixed Effects: First and Second Stage Estimates

Variable	**First Stage (Education)**			**Second Stage (Income Rank)**		
	Coef.	SE	p-value	Coef.	SE	p-value
Reform	0.1340***	0.0032	0.000	–	–	–
Education	–	–	–	1.7567***	0.1644	0.000
Age	–0.0007	0.0010	0.500	0.0979***	0.0081	0.000
Age Squared	0.000002	0.000012	0.836	–0.00097***	0.00009	0.000
Gender (1 = Female)	0.0269***	0.0024	0.000	–0.4811***	0.0201	0.000
Occupation	0.1529***	0.0022	0.000	1.1653***	0.0324	0.000
Father's Edu	0.00013***	0.00001	0.000	0.00045***	0.00008	0.000
Mother's Edu	0.00011***	0.00001	0.000	0.00038***	0.00009	0.000
Constant	0.6640***	0.0212	0.000	2.1014***	0.2174	0.000

Notes: The first stage estimates the effect of the compulsory schooling reform on education. The second stage uses predicted education to estimate its causal effect on income rank. No fixed effects (country, wave, or cohort) are included in this specification. Robust standard errors are reported. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 22: First Stage Estimates for Males and Females (Dependent Variable: Education)

	Males			**Females**		
Variable	Coef.	SE	p-value	Coef.	SE	p-value
Reform	0.0253***	0.0063	0.000	0.0465***	0.0063	0.000
Age	–0.0017	0.0014	0.227	0.0014	0.0014	0.335
Age Squared	–0.00001	0.00002	0.590	–0.00005***	0.00002	0.001
Occupation	0.1581***	0.0032	0.000	0.1444***	0.0029	0.000
Father's Edu	0.00020***	0.00001	0.000	0.00014***	0.00001	0.000
Mother's Edu	0.00013***	0.00001	0.000	0.00009***	0.00001	0.000
Cohort Group	0.0056	0.0060	0.354	0.0089	0.0059	0.133

Note: Results are from separate regressions for males and females, predicting years of education using the reform instrument and controls. Country and wave fixed effects included. Robust standard errors reported. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 23: Second Stage Estimates for Males and Females (Dependent Variable: Income Rank, Excluding Cohort Group)

	Males			**Females**		
Variable	Coef.	SE	p-value	Coef.	SE	p-value
Education	0.6195	1.7057	0.716	2.7739**	1.0908	0.011
Age	0.0853***	0.0111	0.000	0.1220***	0.0127	0.000
Age Squared	–0.0008***	0.0001	0.000	–0.0012***	0.0002	0.000
Occupation	1.3038***	0.2711	0.000	0.7350***	0.1606	0.000
Father's Edu	0.0010***	0.0004	0.006	0.0006***	0.0002	0.001
Mother's Edu	0.0015***	0.0002	0.000	0.0013***	0.0002	0.000

Note: Instrumental Variables (2SLS) estimates of income rank using reform as an instrument for education. Estimates are reported separately for males and females. Model controls for fixed effects. Robust standard errors are reported. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 24: OLS Regression Results for Different Regions

Variable	Northern Europe			Western Europe		
	Coef.	SE	p-value	Coef.	SE	p-value
Education	0.7042***	0.0620	0.000	0.9178***	0.0472	0.000
Age	0.2210***	0.0171	0.000	0.1802***	0.0118	0.000
Age Squared	–0.0025***	0.0002	0.000	–0.0019***	0.0001	0.000
Gender (Male)	–0.4179***	0.0415	0.000	–0.3573***	0.0275	0.000
Occupation	1.4938***	0.0439	0.000	1.4112***	0.0283	0.000
Father's Edu	–0.0007***	0.0002	0.000	0.0001	0.0001	0.629
Mother's Edu	–0.0007***	0.0002	0.000	–0.0003**	0.0001	0.013
Constant	1.6582***	0.3674	0.000	1.3786***	0.2553	0.000

Variable	Southern Europe			Eastern Europe		
	Coef.	SE	p-value	Coef.	SE	p-value
Education	1.0404***	0.0504	0.000	0.9310***	0.0566	0.000
Age	0.0087	0.0182	0.632	–0.0048	0.0164	0.770
Age Squared	–0.00003	0.00021	0.887	0.00008	0.00019	0.671
Gender (Male)	–0.2307***	0.0435	0.000	–0.6155***	0.0401	0.000
Occupation	1.1937***	0.0504	0.000	0.8488***	0.0434	0.000
Father's Edu	0.0008***	0.0002	0.000	0.0019***	0.0002	0.000
Mother's Edu	–0.0005**	0.0002	0.033	0.0022***	0.0002	0.000
Constant	4.4951***	0.3908	0.000	3.9672***	0.3457	0.000

Notes: The table presents OLS regression results for income rank, estimated separately by region (Northern, Western, Southern, Eastern Europe). Each model controls for education, age, age squared, gender, occupation, and parental education (father's and mother's education). Robust standard errors are reported. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 25: Placebo and Falsification Tests: Testing the Instrument on Unrelated Outcomes

Variable	**Emplrel**			**Occupation**		
	Coef.	SE	p-value	Coef.	SE	p-value
Reform	0.0070	0.0061	0.247	-0.0043	0.0064	0.498
Age	0.0030***	0.0006	0.000	0.0022***	0.0006	0.001
Gender (Female)	-0.0647***	0.0033	0.000	0.0148***	0.0037	0.000
Father's Edu	0.00006***	0.00001	0.000	0.00044***	0.00002	0.000
Mother's Edu	0.00003**	0.00001	0.033	0.00029***	0.00002	0.000
Constant	1.0049***	0.0205	0.000	0.1248***	0.0235	0.000

Variable	**Hincsrca**		
	Coef.	SE	p-value
Reform	0.0043	0.0100	0.671
Age	0.0058***	0.0009	0.000
Gender (Female)	-0.0089*	0.0052	0.091
Father's Edu	0.00003	0.00002	0.252
Mother's Edu	-0.00003	0.00002	0.213
Constant	0.9139***	0.0339	0.000

Notes: The table presents placebo regressions testing whether the compulsory education reform instrument is significantly associated with unrelated outcomes: employment relationship (emplrel), occupation, and income source (hincsrca). Across all models, the coefficient on reform is statistically insignificant, supporting the instrument's exogeneity. Regressions include controls for age, gender, parental education, cohort, wave, and country fixed effects. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 26: Country Sample Distribution

Country (Cntry)	Frequency	Percent (%)	Cumulative Percent
AT (Austria)	4,862	3.11	3.11
BE (Belgium)	6,912	4.42	7.52
BG (Bulgaria)	4,128	2.64	10.16
CH (Switzerland)	7,131	4.56	14.72
CZ (Czechia)	6,554	4.19	18.91
DE (Germany)	9,846	6.29	25.20
DK (Denmark)	5,289	3.38	28.58
EE (Estonia)	4,356	2.78	31.36
ES (Spain)	6,017	3.84	35.21
FI (Finland)	9,061	5.79	41.00
FR (France)	6,903	4.41	45.41
GB (United Kingdom)	6,397	4.09	49.50
GR (Greece)	3,337	2.13	51.63
HR (Croatia)	1,996	1.28	52.90
HU (Hungary)	4,304	2.75	55.65
IE (Ireland)	5,970	3.81	59.47
IL (Israel)	4,113	2.63	62.10
IS (Iceland)	2,147	1.37	63.47
IT (Italy)	3,294	2.10	65.57
LT (Lithuania)	4,206	2.69	68.26
LU (Luxembourg)	679	0.43	68.70
LV (Latvia)	1,152	0.74	69.43
NL (Netherlands)	7,531	4.81	74.24
NO (Norway)	8,348	5.33	79.58
PL (Poland)	5,210	3.33	82.91
PT (Portugal)	4,203	2.69	85.59
RO (Romania)	537	0.34	85.94
RU (Russia)	4,004	2.56	88.50
SE (Sweden)	7,783	4.97	93.47
SI (Slovenia)	4,835	3.09	96.56
SK (Slovakia)	3,062	1.96	98.52
TR (Turkey)	793	0.51	99.02
UA (Ukraine)	1,530	0.98	100.00
Total	156,490	100.00	

Table 27: Reform Information: Country and Birth Cohort

No.	Country	Reform Start Year	Reform Indicator Assignment
1	Austria	1951	reform = 1 if (cntry == "AT" and yrbrn $\geq$ 1951)
2	Belgium	1969	reform = 1 if (cntry == "BE" and yrbrn $\geq$ 1969)
3	Bulgaria	1955	reform = 1 if (cntry == "BG" and yrbrn $\geq$ 1955)
4	Croatia	1961	reform = 1 if (cntry == "HR" and yrbrn $\geq$ 1961)
5	Czechia	1974	reform = 1 if (cntry == "CZ" and yrbrn $\geq$ 1974)
6	Denmark	1957	reform = 1 if (cntry == "DK" and yrbrn $\geq$ 1957)
7	Estonia	1978	reform = 1 if (cntry == "EE" and yrbrn $\geq$ 1978)
8	Finland	1961	reform = 1 if (cntry == "FI" and yrbrn $\geq$ 1961)
9	France	1953	reform = 1 if (cntry == "FR" and yrbrn $\geq$ 1953)
10	Germany	1953	reform = 1 if (cntry == "DE" and yrbrn $\geq$ 1953)
11	Greece	1963	reform = 1 if (cntry == "GR" and yrbrn $\geq$ 1963)
12	Hungary	1941	reform = 1 if (cntry == "HU" and yrbrn $\geq$ 1941)
13	Iceland	1970	reform = 1 if (cntry == "IS" and yrbrn $\geq$ 1970)
14	Ireland	1958	reform = 1 if (cntry == "IE" and yrbrn $\geq$ 1958)
15	Israel	1965	reform = 1 if (cntry == "IL" and yrbrn $\geq$ 1965)
16	Italy	1984	reform = 1 if (cntry == "IT" and yrbrn $\geq$ 1984)
17	Latvia	1982	reform = 1 if (cntry == "LV" and yrbrn $\geq$ 1982)
18	Lithuania	1977	reform = 1 if (cntry == "LT" and yrbrn $\geq$ 1977)
19	Luxembourg	1987	reform = 1 if (cntry == "LU" and yrbrn $\geq$ 1987)
20	Netherlands	1980	reform = 1 if (cntry == "NL" and yrbrn $\geq$ 1980)
21	Norway	1947	reform = 1 if (cntry == "NO" and yrbrn $\geq$ 1947)
22	Poland	1984	reform = 1 if (cntry == "PL" and yrbrn $\geq$ 1984)
23	Portugal	1980	reform = 1 if (cntry == "PT" and yrbrn $\geq$ 1980)
24	Romania	1974	reform = 1 if (cntry == "RO" and yrbrn $\geq$ 1974)
25	Russia	1956	reform = 1 if (cntry == "RU" and yrbrn $\geq$ 1956)
26	Slovakia	1985	reform = 1 if (cntry == "SK" and yrbrn $\geq$ 1985)
27	Slovenia	1941	reform = 1 if (cntry == "SI" and yrbrn $\geq$ 1941)
28	Spain	1977	reform = 1 if (cntry == "ES" and yrbrn $\geq$ 1977)
29	Sweden	1958	reform = 1 if (cntry == "SE" and yrbrn $\geq$ 1958)
30	Switzerland	1964	reform = 1 if (cntry == "CH" and yrbrn $\geq$ 1964)
31	Turkey	1982	reform = 1 if (cntry == "TR" and yrbrn $\geq$ 1982)
32	Ukraine	1941	reform = 1 if (cntry == "UA" and yrbrn $\geq$ 1941)
33	United Kingdom	1958	reform = 1 if (cntry == "GB" and yrbrn $\geq$ 1958)

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