"Education and the labour market : three essays on interrelations and multiple effects during lifetime"

Karasiotou, Pavlina

Abstract
This thesis aims at exploring the ties between education and the labour market. It is a micro-analysis of the effects of education on individual labour market outcomes and vice versa, from adolescence till retirement, using both theoretical and empirical tools. The first chapter is a critical discussion of the relevant literature and an introduction to the rest of the chapters. We discuss the special features of the Belgian education system and labour market and explain why we chose Belgium as the country of interest. Finally, we give a brief outline of the methodological tools we are using. The second chapter discusses how family income and parental work status influence children's secondary school track choices, which is a significant determinant of future school attendance and labour market outcomes. Our results suggest that income has no significant effect on track choices after we control for (observed and unobserved) family characteristics. This conclusion is in line with the...

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EDUCATION AND THE LABOUR MARKET:
Three essays on interrelations and multiple effects during lifetime.

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Thèse présentée en vue de l’obtention du grade de docteur en sciences économiques (et de gestion)

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Finally I need to express my gratitude to those who offered their unconditional support and kept me going: My husband, and the rest of my family, my friends and last but not least my colleagues. They all helped me keep my strength and perspective, each one in his/her own way.

To my daughter
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Chapter 1

Introduction

1.1 Another project on private returns of education?

When we first started this project on education and the labour market we had in mind the classical literature on private returns on education (Becker, 1964; Mincer, 1974) and the methodological developments on the issue (Card, 1999). The main idea behind the relevant literature is that better educated workers receive an education premium, resulting to higher earnings. This conclusion has almost become a “universal truth”, since no matter the sample, the estimation method and the specific questions asked, and despite changes in the labour market, all relevant works conclude that education improves individual earnings from work.

But we wanted to go beyond this well established evidence and raise the question of the other potential benefits of education. First we asked whether higher earnings are the only benefit for better educated workers or could there be more in terms of unemployment and higher labour market participation? The question coming immediately after was, how persistent are the benefits of education in the labour market? Do they diminish and stop some years after completing school, or do they follow workers throughout their working lives, via a significant longer duration of their career? And finally, is it only that education affects labour market outcomes or is it a two way relationship, with in particular parental labour market outcomes influencing youth educational attainment?

These three questions resulted into three different papers, each one being a chapter of this thesis project. They can be read separately as each refers to a different age period of an individual’s life and to a different aspect of the labour market–education relationship.

The ties between the three chapters although loose are also very specific. All
three deal with a specific form of education, that is known in the literature as “schooling”, the human capital an individual acquires usually during his early years, from the age of five or six until adolescence or early adulthood. “Education”, as used here, is a subpart of the broader term “human capital”. The knowledge acquired during the schooling period is usually referred to as “initial human capital”, since it describes the human capital endowment when entering the labour market. It also describes the knowledge acquired in schools and universities. In that way we separate schooling from “on-the-job training” or informal learning.

We have put the individual at the center of our research, and we follow throughout his education and working years. This makes our thesis a micro-level research project. We refer to our subject of interest as “worker”, “student”, “retired”, “unemployed”, depending on the issues we examine. It is the individual who makes choices and receives all positive and negative outcomes. We consider the individual at different stages of his/her life from adolescence until retirement, and identify gains and losses from education. The contribution of education to growth and development as well as social benefits of education or general equilibrium effects are beyond the scope of this project. For example we are not exploring how education can affect the average unemployment rate in an economy but rather how education helps individual workers avoid unemployment. We have also limited ourselves to the economic benefits and determinants of education, leaving aside the more sociological or psychological aspects.

All three chapters discuss individual decisions. At each point in time (first at school and then at the labour market) the individual faces a given situation, that he can not control nor change. The educational system, the level of wages and unemployment benefits, the unemployment rate are exogenously set. On the other hand, the individual is born with certain abilities which he can not control, but can cultivate with education. At each point in time, the person evaluates market conditions and given his own preferences and abilities decides accordingly. We speak then about individual decisions concerning the level and type of education, the time spent in the labour market or the moment of retirement. The aim of this project is to identify and measure the economic factors that shape these decisions.

First we dealt with the overall labour markets benefits (higher wages but also lower unemployment) adults derive from education and the differences between general and vocational education. Being an extension to the education returns literature, this seemed a natural starting point. Then we dealt with education and retirement, an issue that gave us the opportunity to go deep into a theoretical model of retirement and expand it further, to account for the role of education attainment on the timing of retirement. Finally we worked on the issue of educational choices made by teenagers and the role of parental income and labour market status. This chapter gave us the opportunity to establish that the education–labour market relationship works both ways, as they constantly affect one another.
1.2 Extending the Becker/ Mincer approach to education

This thesis project has its roots in the intellectual tradition initiated by Mincer (1958) and Becker (1964), but extends it to account for issues that have gradually become more relevant such as i) the effect of education on lifelong labour supply/retirement decision, ii) its benefits in terms of lower unemployment (or higher labour force participation) as well as iii) the impact of family income on teenagers’ propensity to stay on in education.

There have been various approaches to measuring the “wage premium” associated to education increments, starting from basic applications of the standard Mincer equation (Ashenfelter, 1978), to more sophisticated issues such as testing the causality between education and higher wages (Card, 1999; Ashenfelter et al., 1999), exploring the differences between general and vocational education (Conlon, 2001; Dearden et al., 2000), or enriching the mincerian equation with family characteristics and gender effects (Acemoglu & Pischke, 2001; Altonji & Dunn, 1996).

This literature on the wage premium, was a product of a period during which it could be reasonably assumed that most of the economic benefits of education would be reflected by wages. However, as the labour market conditions worsened the question became whether education can also protect against unemployment and inactivity. As soon as from the late 1970’s, Ashenfelter & Ham (1979) were among the first to notice that the benefit of education can be decomposed to an income and a time (in employment) effect. Much later, Mincer decomposes unemployment rates into unemployment incidence and unemployment duration and discusses why and through which paths unemployment rates are lower for better educated workers, both men and women (Mincer, 1991a,b). Better educated workers have better probabilities to find a suitable job and remain attached to it, while they have less risk to become unemployed if they leave their job due to better on-the-job search. On the demand side, technology creates high skilled and substitutes low skilled jobs (Acemoglu, 1999) increasing the unemployment of the less educated.

The assumption of homogeneous and undifferentiated human capital proved to be quite restrictive, especially for continental Europe with stratified education systems. Here the interesting question is how different forms of education affect labour market outcomes. So, while evidence coming mainly from the US show that for those who choose not to continue to tertiary education, vocational courses in high school improve their future labour market outcomes (Bishop & Mane, 2004; Mane, 1999), research in Europe focuses mainly in comparing vocational and academic education with academic education proving more efficient and more rewarding in labour market terms (Conlon, 2001; Dearden et al., 2000).

In Chapter 3 we used those elements, namely types of education, earnings
1. Introduction

and unemployment to get a good idea how and what types of education affect labour market outcomes of Belgian adults. Very few works deal simultaneously with earnings and unemployment and even fewer include types of education. At the same time we felt that we would give further insight into very modern questions such as what type of education gives more rewards in the labour market, in terms of both earnings and employment, in a time period and a country that was experiencing high unemployment. Our findings speak in favour of academic qualifications, similar to the relevant European literature while we find that education significantly improves employment and earnings perspectives.

The second issue that drew our attention (in Chapter 4) was the possible connection between human capital and retirement decisions. More specifically we explore whether better educated workers decide to retire earlier or later and how this decision is affected by social security schemes. In the classical human capital and earnings' lifecycle theories, individuals engage in education more when they are younger at the cost of foregone earnings (Weiss, 1986; Blinder & Weiss, 1976; Ben-Porath, 1967), expecting higher earnings and earnings' growth after entering the labour market.

There has been a great concern lately on the effects of ageing in Europe and its labour market implications (Boersch-Supan, 2001; Blanchet, 2001). From one side falling productivity with age (Lazear, 1979) and technology that makes skills obsolete (Friedberg, 2001; Ahituv & Zeira, 2000) drive older workers earlier outside the labour force, especially when legislation favours such a behaviour through high pension benefits and early exit ages (Berckel & Boersch-Supan, 2003). On the other hand, falling birth rates and shrinking of the labour force create the need to keep older workers longer into the labour market to avoid pressure in the social security and health systems (EC, 2003a; Duval, 2003). Most policy makers and academics find that increased training will keep workers longer in the labour market (EC, 2002). Another approach is that, the reform of pension systems will keep older workers in the labour market, as the generous pension systems of today have created extreme burdens for state budgets and younger workers (Cremer et al., 2004, 2003; Desmet et al., 2003).

With all that interest on retirement decisions, training and social security schemes we found it interesting that so little have been said on how education can affect the moment of individual retirement. This could be a consequence of the belief that education effects diminish after entering the labour market and stop after a certain point. We felt however that there might be significant differences in the retirement behaviour between high and low educated individuals, due to heterogeneity in earnings from work, and retirement incomes. Moreover, social security schemes might increase or alleviate these differences. Therefore, in Chapter 4 we expand a model of endogenous retirement initially developed by Alders (1999) to examine differences in retirement behaviour between workers with different initial education under a number of social security schemes.
The third main question of interest (discussed in Chapter 2) is whether the education/labour market relationship is a one way relationship or it goes both ways. We often overlook the fact that according to the human capital theory, individuals choose their level of education based on future expected benefits that come mainly from the labour market as well as on present cost considerations. The cost of education should not be seen only as the direct cost of schooling (e.g. tuition) but rather as a function that among others includes ability, family income and/or wealth, parental activity and family background. These factors have been relatively less discussed, however they remain very important in shaping educational choices. Chapter 2 discusses how family income and parental labour market status affect education track choices for young pupils in Belgium. While we find income to have no real effect on pupils track choices, the (un)employment of parents could have a separate and significant effect.

1.3 Why is Belgium an interesting case?

1.3.1 The educational system and labour market features in Belgium.

Most of the data used in this thesis to extend the Becker/Mincer analysis of education, refer to Belgium, its educational system and its labour market. To us, the choice of Belgium came almost naturally, not only because Belgium has been our host country throughout this thesis project, but also because many aspects of its educational system or its labour market allow us to explore the issues we deal with empirically in Chapter 2 and Chapter 3.

First, the educational system delivers different/heterogeneous forms of human capital (i.e. different tracks). It has large participation rates in vocational and technical programmes (both in secondary and tertiary education). On top of that we see that participation in non-university tertiary education programmes as well as in vocational secondary education is steadily higher from the EU19 and the OECD average (see Table 1.3.1). Belgium is thus a good terrain to assess whether different types (and not just different levels) of education affect individuals’ labour market performances (Chapter 3). Tracking also intervenes early in Belgium and is strongly correlated with differences in terms of the final level of educational attainment (for example the likelihood of obtaining a university degree). Hence, the country is also ideal to explore the link between family income (or labour market status of parents) and early educational choices (as we do in Chapter 2).
1. Introduction

Table 1.3.1: Upper secondary enrollment patterns, by programme destination and programme orientation, 2006

<table>
<thead>
<tr>
<th></th>
<th>By programme destination</th>
<th>By programme orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ISCED 3A</td>
<td>ISCED 3C</td>
</tr>
<tr>
<td>Belgium</td>
<td>49.4</td>
<td>50.6</td>
</tr>
<tr>
<td>EU19</td>
<td>70.1</td>
<td>24.1</td>
</tr>
<tr>
<td>OECD</td>
<td>69.8</td>
<td>26.0</td>
</tr>
</tbody>
</table>

Source: OECD (2008a)

Second, school performance is higher in the general than in the vocational education tracks (see Table 1.3.2). The over 100-point difference in maths and science performance between the two tracks is very large compared to the OECD average and one of the highest among European countries. The differences in performance persist, even after controlling for pupils’ socio-economic background (ESCS). This could have two possible explanations. First, the curriculum of vocational programmes promotes technical skills at the expense of general knowledge in reading literacy, maths or science (i.e. the measure of “school” performance in Table 1.3.2). An interesting question that we raise in Chapter 3 is thus to determine whether, on the labour market, the technical skills delivered by vocational programmes are enough to compensate for lower general skills. The second explanation is that the vocational programmes attract pupils that are intrinsically less able. This raises challenging endogeneity problems but also represents an opportunity to explore the possibilities of modern econometric identification strategies (more on this below).

Table 1.3.2: Performance of 15 year-olds on the PISA science and mathematics scales, (S.E in parenthesis)

<table>
<thead>
<tr>
<th></th>
<th>General programmes (A)</th>
<th>Vocational programmes (B)</th>
<th>(A)-(B)</th>
<th>(A)-(B) after controlling for ESCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maths (2003)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>585 (2.5)</td>
<td>469 (3.2)</td>
<td>116 (4.3)</td>
<td>78 (3.7)</td>
</tr>
<tr>
<td>OECD</td>
<td>510</td>
<td>466</td>
<td>45</td>
<td>27</td>
</tr>
<tr>
<td>Science (2006)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belgium</td>
<td>558 (2.8)</td>
<td>458 (3.3)</td>
<td>100 (4.5)</td>
<td>78 (4.2)</td>
</tr>
<tr>
<td>OECD</td>
<td>599</td>
<td>473</td>
<td>35</td>
<td>23</td>
</tr>
</tbody>
</table>

Source: OECD (2008a, 2007)

Third, better educated workers perform better in the labour market, in terms of earnings but also in terms of (un)employment rates (Table 1.3.3). According to OECD (2008a), wage premia in Belgium (and also in several major western countries) have been relatively stable during the past decade. But, the employment premium has risen. This tentatively suggests that Belgium is ideal to explore the non-wage benefits associated to education (Chapters 3 and 4). Its labour market institutions seems to generate “quantity” adjustments as much as “price” adjustments.
Table 1.3.3: Labour market outcomes by education level and gender, 2006

<table>
<thead>
<tr>
<th>Level completed</th>
<th>Employment (%)</th>
<th>Unemployment (%)</th>
<th>Relative Earnings(^{(1)})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>F</td>
<td>M</td>
</tr>
<tr>
<td>Secondary vocational</td>
<td>81.6</td>
<td>60.2</td>
<td>6.9</td>
</tr>
<tr>
<td>Secondary general</td>
<td>80.8</td>
<td>65.5</td>
<td>5.4</td>
</tr>
<tr>
<td>Post-secondary non-tertiary</td>
<td>87.5</td>
<td>85.4</td>
<td>n.a</td>
</tr>
<tr>
<td>Tertiary non-university</td>
<td>86.8</td>
<td>79.0</td>
<td>3.4</td>
</tr>
<tr>
<td>University</td>
<td>87.6</td>
<td>82.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Upper-secondary education (general and vocational)=100, data on relative earnings correspond to 2004.

Source: OECD (2008a, 2007)

From the stylised facts we can speak about the existence of strong ties between education and the labour market. These, along with some special features of the Belgian education system (early tracking, tuition-free, etc), have been the motivation behind this project and the choice of Belgium.

A final reason behind our country choice is simply the novelty of our analysis in the Belgian context. Very few things have been published so far regarding the different interactions between education and the labour market that we explore in this thesis. The works focus instead on programme and policies evaluation (Cockx & Ries, 2004; Cockx, 2003a), special features of the Belgian labour market (D’Addio & Nicaise, 2003; Pestieau & Stijns, 1997), or policy reforms and their effectiveness (Desmet et al., 2003).

1.3.2 The panel study of Belgian households (PSBH)

The Panel Study of Belgian Households (PSBH) is the dataset used in this project. The survey was launched in 1992 jointly by the Universities of Liege (for Wallonie) and the University of Antwerp (for Flanders). From 1994 onwards it became part of ECHP, the European Household Panel, and continued as such until 2002, the final year of the European project. From 1994 onwards, the PSBH changes fundamentally in order to comply with the European survey. This results to a significantly different questionnaire, which made it difficult to compare between waves especially before and after 1994.

The PSBH includes three separate questionnaires, for adults, households and children younger than 16 years old. Among others, it provides rich information on income, employment and education household composition, therefore it suits the needs and purposes of this project. As the survey lasted for eleven years, it made it possible to follow and examine persons and households for a significantly large period of time in a number of levels (individual, family, couple) and for several aspects of their lives (social, economical).

The most serious problem is that we loose a significant number of respondents between waves. According to the survey administrators, this is an immediate result of the survey duration. During the eleven waves the composition of households has changed, through births, marriages, divorces and deaths. Moreover, many respondents choose to quit the survey for personal reasons.
Therefore we have a significant loss of representativeness combined with a significant proportion of non-response. This combination created a number of problems, as it limited the number of information available and the number of individuals and households with complete 11-year spells.

We use the data from the PSBH survey in the two out of the three chapters in this thesis project. The third chapter is focused on the development and expansion of a theoretical model. In each chapter we use a different sample and a different set of variables depending on the questions answered and the issues examined. Therefore in each case we discuss separately the dataset and sample issues.

1.4 Methodological issues and questions

Our work in Chapters 2 and 3 is mainly empirical, while Chapter 4 deals with a theoretical model. For our empirical chapters we used longitudinal data instead of cross section. This implied a cost in simplicity and comparability with other works. However, using longitudinal data allows for time-effects, as we follow individuals for more than one periods, and addresses problems such as unobserved individual characteristics and endogeneity of education.

A serious critique to OLS estimation is that the estimated schooling coefficient does not show a causal effect between education and wages but is just a correlation that reflects several other effects that are both connected with wages and schooling. Potential correlation leads to biased estimates and under-(over-)estimation of the true effects. This was the main econometric problem we faced here although each time it appears in a different form and asks for a different solution.

In Chapter 3 we are interested in measuring the effect of schooling on employment and earnings. However schooling is endogenous and correlated to a person’s ability and skills. Failure to measure and isolate the ability effect on earnings and employment leads to (upward) biased schooling coefficients (Heckman & Vytlacil, 2000; Card, 1999). The main ways to deal with it is either to try to capture the ability effect by using some proxy for ability, which often is some IQ or other ability test score (Altonji & Dunn, 1996; Willis & Rosen, 1979), or use IV estimation techniques (Angrist & Lavy, 1999), or a combination of both.

Information on tests that can be used as proxies for ability are more common on US datasets. IQ or similar tests are a less usual practice in European schools, therefore European datasets (including the PSBH) do not contain that information. Therefore, ability proxies were not an option.

IV techniques have been used very widely as a way to remedy heterogeneity or ability bias due to unobserved effects. The idea behind, is to find an observable variable that is correlated to education but uncorrelated to the unobserved ef-
effects and use it as an instrument for education. Apart from the difficulty of finding good solid instruments, a usual critique to IV estimation has been that it produces larger estimates compared to OLS, a somewhat odd result considering that IV is used to correct for the upward ability or heterogeneity bias. A plausible explanation is that, depending on the instrument used, the IV provides consistent estimates of schooling for the population affected by the instrument and not for the whole population (LATE effect). An instrument that would affect educational choices of people with higher marginal returns to education would yield upward biased estimates (Card, 2000). Despite those problems, IV estimation is very widely used in the literature of education returns.

The use of instrumental variables was not such an obvious choice in our case due to the fact that we were using longitudinal data. Moreover, the two most used panel data estimation methods, i.e. fixed effects or random effects were also not proper here. We could not use fixed effects estimation because the main variable of interest, education is time invariant and thus disappears with the within transformation. On the other hand, random effects estimation yields inconsistent estimates in case of correlation between education and unobserved effects. Our choice was the Hausman-Taylor estimator, that combines fixed effects and IV estimation to produce consistent estimates without eliminating time invariant variables. The Hausman-Taylor fits the purpose of Chapter 3; its creators themselves use it to estimate returns to schooling (Hausman & Taylor, 1981).

The problem of unobserved effects appears also in Chapter 2, in a somewhat different context. We want to calculate the effect of parental income and parental activity on children’s educational choices. However, as income and activity may be correlated with unobserved family effects, we probably end up with biased estimates. However, as income and activity can vary with time, the Hausman–Taylor estimator is of no use. On the contrary we take advantage of within-families variation and estimate siblings fixed effects models. This is another common method in the literature to deal with unobserved effects (Levy & Duncan, 2000; Ashenfelter & Krueger, 1994). We assume that siblings who grow within the same family have faced similar conditions; therefore taking first differences between siblings will eliminate unobserved family effects, and produce unbiased estimates. Each of the methods described above are discussed in detail in the following chapters.

1.5 The project’s structure

As the title points out, the project itself is composed of three essays, each one pertaining to a different individual life period, discussing the connection between education and the labour market during that period. Each of the chapters can be read separately as it is independent both in content and methodology from the other two. What connects the three chapters is their relation to the labour market and the fact that each one reveals and develops a different
1. **Introduction**

aspect in the labour market–education relationship, at different moments of life. We need not say that this project does not exhaust possible connections between education and the labour market. We chose to examine the ones we felt were the most important for each period and those better connected to the time and place we examine.

- **Chapter 2: Do parental jobs and money buy higher schooling? Evidence from track choice in Belgium.**

Belgium is a country with an extensive social security system and active labour market policies that target especially families with children. However, while a large part of the literature discusses the direct effects of these policies on adults' labour market outcomes, not much has have been said on how they can improve children’s school performance (known to be a very important determinant of employment and income prospects). We aim to cover this void by discussing how family income and labour market status can influence children’s education track choices. Around the age of 14, children are sorted in two different tracks, one academic (called the transition track) and the other vocational (called the qualification track). This sorting has serious implications for future education attendance and labour market choices, and although it is supposed to be based on academic performance up to then, it can also be influenced by parental income and activity, given the early age of children. We seek then to identify whether these two factors can have a causal effect on track choices, despite the fact that Belgium has no tuition fees at secondary education. Therefore we use siblings fixed effects models to control for any unobserved family effects. The results suggest that there is no significant income effect on track choices, which is in line with similar literature findings, but that children with unemployed fathers have significantly more probabilities to follow the vocational track.

- **Chapter 3: General education versus vocational training: How do they affect individual labour market performance?**

While at school, pupils constantly make several choices concerning the future of their studies. The two most important choices concern the duration and the type of education. Given Belgian students’ choices, this chapter attempts to answer if and to what extent they affect future labour market outcomes. We measure labour market “success” by earnings, (un)employment and (in)activity. The more a worker earns and the more time he spends working, the more successful he is assumed to be. Again this is an empirical research paper that measures the effects of different educational choices on several labour market outcomes, allowing for comparisons between the different tracks. Usually, works in the literature focus on one educational choice and its effects (for example returns to continuing to tertiary education), or make comparisons between mostly two choices (for example between vocational and general education). The second basic element of the paper is the use of the Hausman-Taylor estimator, which combines the merits of a fixed-effect estimator with the flexibility of a random-effect estimator. To our knowledge this estimation method has never been used with European data. Our results suggest
significant gains from education in terms of earnings, unemployment and labour supply. These gains tend to be larger for general education, while we also find significant complementarities between different tracks.

- **Chapter 4: Retirement, education and the role of pension benefits**
  The last chapter deals with a rarely discussed aspect of the education–labour market relationship; the effects of education on retirement decisions. Many believe that education and retirement lie too far apart in a person’s life for the first to affect the second. Therefore, most attention has been given to other factors, such as retirement of spouse and future retirement income. Here we show that education does play a role on retirement decisions despite the time gap between the two events. Better educated workers had better careers and therefore have different expectations from their retirement period. We analyse and expand a model of lifetime human capital and earnings with endogenous retirement and we adjust our findings to different retirement regimes. This chapter has been a challenge for us as we had not worked with theoretical models up to that point. While results depend on the parameters of the model (mainly from the rate of intertemporal substitution), in most cases high skilled workers retire no earlier than low skilled. This is because retirement benefits are designed in a way to replace a larger share of the low–earners’ (low skilled) work–income.
Chapter 2

Do parental jobs and money buy higher schooling? Evidence from track choice in Belgium.

2.1 Introduction

Belgium is a country with an extensive social security system which comprises transfers earmarked for families with children (for example child allowances, higher unemployment insurance benefits if the unemployed person has dependent children). Another aspect of the Belgian social policy is that significant resources are spent on combating and/or reducing parental unemployment. Many active labour market programmes (ALMPs), some of them targeting parents, alongside costly employment subsidy schemes have been introduced over the past decades.

Traditionally, researchers discuss the direct benefits of these policies. For instance, do social transfers successfully limit child poverty? Belgium seems to have been successful at combating child poverty, as the country has one of the lowest child poverty rates (10 percent of the total population in 2005 compared to 11.0 percent for EU-26 and 12.4 percent for OECD (OECD, 2008b)). As to employment policies, researchers discuss the effectiveness of ALPMs or employment subsidy in terms of better labour market outcomes for adults (Cockx & Ries, 2004; Cockx, 2003b). However, they rarely explore the relationship between those policies and educational attainment (known to be crucial determinant of the long-term employment and income prospects of individuals). This chapter aims at filling that void. It tries to identify the causal effect of family income and parental employment status on educational attainment.

In the Belgian context, a crucial determinant of a child’s final educational at-
Do parental jobs and money buy higher schooling? Evidence from track choice in Belgium.

Tainment is the sorting between the qualification (vocational and technical education) versus the transition (general and artistic education) track that takes place at a very early stage (generally around 14). This—in theory relatively neutral choice—has in fact long lasting effects on scholastic and/or academic prospects. Track choice at the age of 14 is a very strong predictor of tertiary educational attendance. Pupils who end up attending the qualification track are much less likely to undertake (and a fortiori complete) tertiary education (Eurostudent, 2005). It is thus important to identify the determinants of track choice, in particular to assess the causal role of parental income and/or labour market status. Although sorting is supposed to be based solely on achievements during primary and early secondary school, it could also, given the early age of youth, be influenced by parental background (Checchi & Flabbi, 2007; Dustmann, 2004; Maurin, 2002), including parental income or labour market status.

Parental income and/or labour market activity could affect track choices if capital markets are not perfect and parental budgets are constrained (Card, 1999; Becker & Tomes, 1986, 1979). Skeptics could rightly argue there is no tuition fees for secondary schooling in Belgium. Still, direct costs might differ between school tracks. This could be due to costs associated with qualification versus transition track attendance (as for example higher peer pressure to spend on clothes or books, or traveling to general schools). A second reason why a causal effect of family income on track choice potentially exists, is if discount rates for future earnings or the level of altruism differs between households due to differences in parental income or the labour status of parents (Tamm, 2008). In this case, the opportunity cost of not working will differ for otherwise identical children (Flannery & O’Donoghue, 2009). Since the number of years until completion of schooling differs between tracks and is shorter for the qualification track, poor households might more likely opt for those tracks, where children are prepared to immediately enter the labour market at the end of compulsory education. Other reasons for income and employment having a causal effect on school choices are that their absence might cause an emotional stress among parents (Barón, 2009; Gregg et al., 2008; McLoyd, 1990), resulting in lower parenting quality and compromising children’s chance of getting the grades needed to successfully attend and complete the transition track.

Most works in the literature focus on the role of parental income. One of the innovations of this chapter is to also consider the role of parental activity. Another specificity is that the great majority of published works do not address the issue of secondary school track choice but rather deal with post-secondary school decisions (Vandenbergh, 2007; Dearden et al., 2004; Carneiro & Heckman, 2002; Shea, 2000). This is probably because in many European countries , and across most English-speaking ones, crucial (and irreversible) school choices intervene at rather older age (generally 18+) and primarily correspond to the decision to attend college/university. Most exceptions are found in papers that analyse the German education system (Tamm, 2008; Checchi & Flabbi, 2007), where like in Belgium, early tracking is very common. However, they only consider the role of family income.
Most researchers find that there is a positive correlation between household income and the probability of attending a higher (i.e. general/academic) track (Germany) or going to college/university (US or UK). Using OLS regression and controlling only for a modest set of family related and demographic characteristics, we also find some positive correlation between family income and the likelihood of attending the transition track.

However, apart from any causal effects, there are several other reasons why income and school choices are correlated. First, it is likely that parents with high income (and facing a lower risk of unemployment) also have higher education, reflecting differences in ability that might be passed on to their children (Chevalier et al., 2005; Maurin, 2002). In principle, the empirical analysis should be able to account for parental education and any other observable characteristics. Yet, in addition, there might be unobservable factors that are transmitted from parents to children, for example motivation or aspects of ability that are not entirely reflected in parental education. Furthermore, there might exist social relations and pressure from peer groups which influence schooling decisions and thus increase (decrease) the likelihood of choosing higher level (i.e. general) track for their offspring (Mohanty & Raut, 2009; Tamm, 2008).

This paper tries to overcome this problem and capture the causal effect of income and labour market activity status by applying sibling fixed effects models (Levy & Duncan, 2000; Ashenfelter & Krueger, 1994), comparing track choices of siblings who were sorted to tracks under different circumstances, due to the fact that they decide on which track to follow at different points in time. Our main results about the role of parental income are in line with those found regarding university attendance (Vandenberghe, 2007; Dearden et al., 2004; Carneiro & Heckman, 2002) or track choice in Germany (Tamm, 2008). We indeed dismiss the idea of a causal relationship once we control for unobserved family fixed effects using the siblings identification strategy. We hence conclude that differences between high- and low-income families regarding track choices are driven by unobserved heterogeneity. By contrast, the labour market status of parents could matter. We find that having an unemployed father significantly reduces the probability of choosing the transition track, while having a mother who stays at home increases that probability.

In the next section we discuss the choice between the qualification and the transition tracks of secondary education and how this can affect subsequent education and career paths. We present the econometric framework and a number of econometric problems in Section 2.3. Section 2.4 presents the sample and Section 2.5 presents and discusses the estimation results. Section 2.6 concludes.
2. Do parental jobs and money buy higher schooling? Evidence from track choice in Belgium

2.2 Choosing between different education tracks in Belgium

Belgium is a federal state and education is primarily the responsibility of the Communities. However, the structure of the education system is the same between the communities and also resembles those of Central Europe (as for example the German and Italian ones). One of its main features, and the one under examination here is the existence of multiple tracks and sorting of students into different tracks at a very early age, compared to the Anglo-Saxon education systems.

After completing primary education, and providing they have not repeated any grades that far, young pupils in Belgium enter secondary education around the age of 12. After two common years of studies (“the observation cycle”), pupils are asked to choose between one of the two tracks offered.

The transition track includes the general and artistic education. It consists of two 2-year cycles (the orientation and the determination cycle). Its main objective is to provide general knowledge from a wide range of academically oriented disciplines (maths, languages, sciences) and prepare students for tertiary level (university and non-university) education.

The qualification track on the other hand includes the technical and vocational forms of education. Like the transition track it consists of two 2-year cycles. Pupils usually enter the qualification track after completing the common observation cycle, however it is also common to enter later as a result of poor performance. Pupils in the qualification track attain professional qualifications in specific fields such as agronomy, industry, construction or paramedics and the main objective is to prepare them for the labour market (Eurydice, 2001). We have to note though that, in theory, it does not exclude students from continuing to tertiary education; similarly the transition track does not exclude students from entering the labour market after completing secondary education. However, this is rarely the case. It seems thus reasonable to consider that track choice in Belgium is far from being a “neutral” choice.

Choosing between the qualification and the transition tracks has serious implications for future academic choices as well as wage profiles and unemployment experiences (Chapter 3 contains evidence supporting the latter). As the transition track aims to prepare pupils for tertiary education we can also expect them to get on average more years of schooling. Prolonged education implies higher earnings (see Belzil (2004); Heckman et al. (2003); Card (1999)), lower unemployment and less time spent in inactivity (Mincer, 1991a). Table 2.2.1 gives an idea of cost and benefit components from completing upper-secondary education and tertiary education(1). Prolonging education has a cost in terms

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1See OECD (2008a) for the detailed methodology and computations. In short we say here, that the IRR has been computed as the interest rate that equalises costs and benefits from investment in education
of increased income taxes, social contributions and foregone earnings, however this is overcovered by increased wages and lower unemployment.

Table 2.2.1: Private internal rates of return (IRR) and discounted cost and benefits components, Belgium, 2004

<table>
<thead>
<tr>
<th>Education level</th>
<th>Upper-secondary (ISCED 3/4)</th>
<th>Tertiary (ISCED 5/6)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
</tr>
<tr>
<td>IRR</td>
<td>9.0</td>
<td>9.2</td>
</tr>
<tr>
<td>Direct cost</td>
<td>-1.1</td>
<td>-1.1</td>
</tr>
<tr>
<td>Foregone earnings</td>
<td>-29.1</td>
<td>-29.9</td>
</tr>
<tr>
<td>Gross earnings</td>
<td>30.8</td>
<td>30.2</td>
</tr>
<tr>
<td>Unemployment</td>
<td>18.7</td>
<td>14.1</td>
</tr>
<tr>
<td>Income tax effect</td>
<td>-12.9</td>
<td>-12.6</td>
</tr>
<tr>
<td>Social contribution</td>
<td>-6.9</td>
<td>-6.4</td>
</tr>
<tr>
<td>Composite Impact</td>
<td>0.5</td>
<td>5.7</td>
</tr>
</tbody>
</table>

Source: OECD “Education at a glance, 2008”

School systems with very early tracking have also been held partly responsible for low mean and high variance in literacy scores of 15-year-olds in the PISA 2000 assessment (OECD, 2000). In countries with early tracking and streaming policies (Belgium is among them), over half the variation in performance is attributable to between-tracks differences. Furthermore, some works argue that early sorting of students also leads to low educational mobility and could be held responsible for a strong association between educational attainment and labour market inequality (Checchi & Flabbi, 2007; Dustmann, 2004).

The relative importance of each type of secondary education has changed over the years (see Figure 2.2.1(2)), showing a preference for vocational education. Nevertheless, for the youngest age cohort (18-22) we have a higher incidence of general education. For females, differences are less pronounced, as they follow the general track more often compared to men, but they still prefer the vocational track in total.

### 2.3 The econometric framework

#### 2.3.1 The model

The main variable of interest here is the choice between the qualification (vocational) \((Y = 1)\) and transition (general) tracks \((Y = 0)\). We seek to estimate the effect of family income and parental activity on young pupils’ educational choices once we have controlled for long-run family background variables \(F\) and child characteristics \(C\). We use linear probability models (LPM)

\[
Y = a + \beta Q + \delta_f A_f + \delta_m A_m + \gamma_C C + \gamma_F F + u \tag{2.3.1}
\]

where \(Q\) measures the relative position of the household in the income distribution, \(A_f\) is a dummy for father’s activity status and \(A_m\) is a dummy for

\(^2\text{The general track attendance is a mirror image of the vocational track attendance curves, thus we omit them.}\)
2. Do parental jobs and money buy higher schooling? Evidence from track choice in Belgium.

Figure 2.2.1: Vocational track attendance by age cohort and gender, Belgium, (2001 Census)

mother’s activity status.

Before going further, let us briefly discuss some advantages and disadvantages of the LPM

\[ P(y = 1|x) = xb \]  

(2.3.2)

with \( y \) taking the values 1 or 0. With the progress in computers and econometric software, we now rarely see discrete choice variable models estimated with LPM, as they are heteroscedastic and a second significant drawback is that fitted probabilities can lie outside the \([0, 1]\) interval (Greene, 2000). The first weakness is corrected using White heteroscedasticity-robust standard errors. The second (probably more serious drawback) may not be so important in our case. Most of our explanatory variables are binary variables for mutually exclusive and exhaustive categories, then the fitted probabilities are simply the average \( y_i \) for different values of \( x \) and the problem of fitted probabilities outside the \([0, 1]\) interval is minimised. Despite these drawbacks that are largely corrected for, the LPM often gives good estimates of the partial effects near the center of the distribution of \( x \) (compared with estimates from nonlinear models such as the logit or probit) (Wooldridge, 2001). It is also a simple model and easy to interpret, which makes its use quite appealing. Apart from that we prefer to use LPM to estimate family fixed effects than fixed effects logit models. This is because fixed effects logit models can only identify the parameters using those observations where the outcome differs. This implies
a significant loss of information, which in our case would leave us with a very small sample, high standard errors and misleading outcomes.

### 2.3.2 Unobserved family effects and siblings’ models

A strong correlation between family income, parental activity and educational choices, as captured by the estimated $\beta$’s from cross section models, is not necessarily a proof of a causal relationship between these variables. A number of observed and unobserved factors correlated with income or parental unemployment and educational choices can affect these relationships.

Not accounting for those observed and unobserved family related factors, will result to biased estimates. This problem can be partly corrected by including observed family factors in the regressions. However, family income can still be positively correlated to unobserved and unmeasured family effects such as parental ability and ambition, while we expect that parental unemployment is negatively correlated with unobserved family effects. OLS will then still produce upward biased coefficients for family income and downward biased effects for parental unemployment.

To state the problem formally, the educational choice of child $i$ who lives in family $j$ is:

$$Y_{ij} = a + \beta Q_{ij} + \delta_f A_{ijf} + \delta_m A_{ijm} + \gamma_C C_{ij} + \gamma_F F_j + u_{ij} \quad (2.3.3)$$

where,

$$u_{ij} = Z_j + v_{ij} \quad (2.3.4)$$

with $Z_j$ being a vector of family-specific unobserved factors, and we assume that: $\text{Cov}(Q_{ij}, Z_j) > 0$, $\text{Cov}(A_{ijf}, Z_j) < 0$, $\text{Cov}(A_{ijm}, Z_j) < 0$ and $E(Y_{ij}, Z_j) = 0$.

To deal with this problem we estimate family fixed effects models using differences between siblings (Tamm, 2008; Blanden & Gregg, 2004; Levy & Duncan, 2000). This method takes advantage of the fact that siblings make their educational choices in different points in time. This introduces variation in family income and parental activity, while casts out the effect of unobserved factors assumed to be the same for all children within a family. Our data include information on continuous income; then we get significant income variation which facilitates fixed effects estimation. Variation is smaller for parental activity variables and we keep this in mind as a possible problem when we discuss results below.

By estimating family fixed effects models we simply observe whether a positive (negative) deviation from mean family income implies a positive (negative) change in educational choices. Similarly, sibling fixed effects models show whether a short run change in parental activity (positive or negative) causes changes in educational choices between siblings.

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Two main drawbacks of the fixed effects model is first that we get no estimates on the effect of observed time invariant variables. Secondly, since we take only into account differences in income and activity within families, measurement error can be enhanced, introducing a downward bias in the estimated coefficients. For these reasons, results from fixed effects models should be better considered as the lower bound of income effects (Blanden & Gregg, 2004). On the other hand, sibling fixed effects models have received the critique that while they cast out most of the endogenous variation between siblings, they do not eliminate it, and at the same time they also filter out much of the exogenous variation. If the remaining endogenous variation comprises as large a proportion of the remaining between siblings variation as it does of the cross sectional variation, then the fixed effects estimates can suffer of as much endogeneity inconsistency as cross section estimates (Bound & Solon, 1999, pp.170). This critique may have little meaning in our case as we mostly want to filter out endogenous within family variation (e.g. permanent income effects, unobserved parental characteristics). Then we have no reason to believe that there is any unobserved variation left after differencing between siblings.

2.3.3 Some further issues and drawbacks

Before going further with the sample and the estimation results we need to discuss some further issues and how we deal with those.

An assumption we make here is that parents provide their children according to their income and their children’s needs (Aakvik et al., 2005; Carneiro & Heckman, 2002). The assumption of fully altruistic parents can lead to biased estimates of the true income effect, since if it does not hold, children may have limited or no access to family income. However we believe it is not a serious problem in our case, since we examine educational choices at a very early age and it is highly likely that the assumption of altruistic parents holds.

The second issue is very closely connected to the income variable. Finding a strong relationship between family income and educational choices does not necessarily imply the existence of strong short term income effects, even after controlling for family background. Family income is strongly correlated throughout the life cycle: children, who lack financial support around the moment of choice, would most probably have lacked financial support at early childhood. A large and statistically significant family income coefficient could thus imply a permanent income effect. Similar works (Aakvik et al., 2005), try to control for permanent income using various measures such as family income at early childhood or average family income between age 0-18 for children. Here we had no similar reliable measures of permanent income. However, the family fixed effect models is another way to correct for this problem, as the permanent component of family income is removed.

Finally, we should discuss the problem of omitted ability variables. To the extend that a pupil’s ability is correlated with family income, not controlling for ability results to (upward) biased OLS income coefficients. However, the
within transformation can be a remedy to that. In this case we are only dealing
with deviations from the average ability across siblings. There is no good rea-
tion to believe that ability deviations will be correlated with income deviations
at the age of 14. In parallel we use a grade repetition variable to control for
school performance, which can also mitigate omitted ability problem.

2.4 The sample

In our empirical analysis we use the Panel Study of Belgian Households (PSBH).
PSBH has rich information on households, adults and children younger than
16 years old from 1992 to 2002. However, it suffers from certain drawbacks:
i) high incidence of non-response, led to relatively small samples and limited
explanatory variables, and ii) changes in the questionnaires from year to year,
made available information difficult to use.

We include in the sample families with at least two children in secondary edu-
cation for at least one wave of the survey. This left us with 402 families, the
majority of them has two children (314 families or 78.11 percent of the sample),
83 families (20.65 percent of the sample) have 3 children and 5 families (1.24
percent) have four. We end up with a total sample of 897 observations. The
sample includes only biological siblings who have grown up in the same family
to be able to identify common parental and family effects.

The data allows us to observe the time of track choice. For those who fol-
low the qualification track we observe the transition from general to vocational
education and keep the corresponding wave. However, we can not observe a
similar change for those who are in the transition track. For them we keep the
first wave they are in upper secondary education (after successful completion
of two years in secondary education), assuming this is the year they choose to
continue with the transition track. We end up with one observation per child
and up to four per family. The rationale behind this sample is that we want
to catch the family income and parental activity at the time of track choice.
The observation per child reflects exactly this: it is a snapshot of the family
situation at the year of track choice.

As a result, there is age heterogeneity among students. Even though the “nor-
mal” track choice age is 14, we have children that postpone their choice after
that age. This can happen either because of grade repetition they had on
the past, or because they follow the qualification track after spending one or
two years in the transition track. This later choice can be due to low per-
formance or other reasons. Both cases can happen quite frequently. On the
other hand, we have cases when children appear to choose tracks at 13 (while
we dropped off the sample a few observations when track choice is made at 12).

It is quite important to capture differences in income and activity effects due to
heterogeneity in track choice age, as we expect parental effects to shrink when
choices are made later than normal. Opting for the qualification track later is
also an indication of higher ability pupils (compared to those who choose the qualification stream at age 14) or lower ability pupils (compared to those who complete the transition stream). We include in the regressions interactions between income, activity and age. On the contrary we treat cases of earlier choice as made at the normal age. Age is calculated as the difference between “year of survey” and “year of birth”, so the one-year differences is merely a result of not exploiting information on “month of birth”.

Educational choices of younger siblings can be affected by the educational choices of their older siblings but not the other way around. For illustration purposes we assume that the older sibling in each family is $S_1$, and so on, $i = 1, 2, 3, 4$ being siblings’ birth-order, but also the different moments in time each sibling made his choice.

Central to our analysis is the calculation of income and parental activity. By construction of the sample we have information on parental income and activity at the year of track choice. For the calculations we use (net) monthly\(^3\) household income. This includes salaries and wages, social security allocations and additional earnings. We used a number of income measures to check for the sensitivity of the results, which included income quartiles and the level of earnings. Finally we created a measure of relative household income vis-à-vis mean income per wave. This captures the relative position of each household in the income distribution, and it is also comparable between waves\(^4\). Here we present results for the relative income measure.

Income is highly correlated to track choice, with children from wealthier families opting more often for the transition track (see Table 2.A.1 in the appendix). Income–track choice correlation is also stronger for older siblings (see Table 2.A.2). Following the literature that argues that parents tend to invest differently in their children based on the time they were born (Ramnohan & Dancer, 2008; Ejrnaes & Pörtner, 2004) we attempt to capture possible birth order effects in the regressions.

We capture parental inactivity using separate variables for fathers and mothers, assuming they affect differently children’s track choices (Norberg-Schönfeldt, 2008; Aakvik et al., 2005). We only account for unemployed fathers, leaving out of the sample inactive or retired. The relative unemployment variable in the PSBH is a combination of self-declared unemployment and objective information on hours of work.

We followed a different strategy for mothers’ activity. A large share of them are housewives (64 percent of inactive mothers and 21 percent of the whole sample) and a significant number has never been in the labour market (around 10 percent of the sample). To cover all possibilities we examine separately the

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\(^3\)Monthly income is in fact a yearly average rather than the income of one specific month.

\(^4\)\(Q = \frac{I_i}{MI_j}\), where $I_i$ is net monthly income of family $i$ at wave $j$, and $MI_j$ is mean family income at wave $j$. 

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The effects of unemployed, housewives and inactive(5) mothers on track choice, plus we control for the case when a mother has never been in the labour market. Again, we use both objective and subjective information to create the activity variables.

Families with an unemployed father count for around 8.5 percent of the sample. The corresponding percentage for mothers is around 10 percent. These numbers are quite close to the average unemployment rate in Belgium for the period 1992-2002 and for the ages 31 to 60 (visit http://www.stats.oecd.org).

Children with employed parents are more likely to follow the transition stream, as was the case with income (see relevant tables in appendix 2.A).

Table 2.4.1 summarises the main variables (track choices, income and parental activity). Attention should be given in the last column of the table, the “within” percentage(6). This is the fraction of time each family has the specific value for each variable, thus it measures the variation of the main variables within families. For time invariant variables the within percentage is 100.

Table 2.4.1: Description of the dependent and main explanatory variables (percentages)

<table>
<thead>
<tr>
<th>variable</th>
<th>Mean (st.d)</th>
<th>Between</th>
<th>Within</th>
</tr>
</thead>
<tbody>
<tr>
<td>pupils followed the qualification track</td>
<td>32.80</td>
<td>44.63</td>
<td>70.90</td>
</tr>
<tr>
<td>pupils followed the transition track</td>
<td>67.20</td>
<td>78.86</td>
<td>84.76</td>
</tr>
<tr>
<td>relative family income</td>
<td>1.362 (0.570)</td>
<td>0.531</td>
<td>0.221</td>
</tr>
<tr>
<td>father unemployed</td>
<td>8.54</td>
<td>9.70</td>
<td>73.56</td>
</tr>
<tr>
<td>father absent from household</td>
<td>15.72</td>
<td>17.41</td>
<td>87.58</td>
</tr>
<tr>
<td>mother unemployed</td>
<td>10.92</td>
<td>12.79</td>
<td>64.60</td>
</tr>
<tr>
<td>mother housewife</td>
<td>20.23</td>
<td>24.55</td>
<td>80.93</td>
</tr>
<tr>
<td>mother out of labour force</td>
<td>9.41</td>
<td>9.95</td>
<td>89.89</td>
</tr>
<tr>
<td>mother never worked and housewife now</td>
<td>5.35</td>
<td>5.97</td>
<td>85.71</td>
</tr>
<tr>
<td>mother never worked and inactive now</td>
<td>0.67</td>
<td>0.75</td>
<td>100.00</td>
</tr>
</tbody>
</table>

1 For binary variables this column shows the percentage of observations taking the specific value. For continuous variables, it shows the mean and standard deviation (in parenthesis).

2.4.1 Control variables for family and social background

Control variables are divided into two subgroups. The first C includes children’s individual characteristics, namely sex, age (interactions with income and unemployment), siblings’ birth order, and the number of grade repetitions which we use as a proxy for school performance. The second group F includes variables that describe family background, namely parental education, parental nationality, region of residence and the level of family wealth. The F group in

5 Inactive mothers are those who stay outside the labour market because of illness, disabilities etc. Housewives are capable to work but stay at home instead. PSBH includes relevant information.

6 In the case of discrete variables as we have here, the “overall” percentage shows the number of observations and the percentage of the (total) sample (children) who fall in each group. The second column shows the “between” variation, i.e. how many families have been in each group at least once. The last column of the table shows the percentage of the families that have been in the same group throughout the whole sample period.
most part “disappears” from the fixed effects models, because most variables are time invariant, however they are still very interesting to include in the cross section models to capture observed heterogeneity within families. Finally we catch possible time effects by including wave dummies.

School performance is a significant factor in shaping track choices. It signals the child’s ability to acquire cognitive skills and his capacity to successfully follow and complete a more demanding academic track. Children with a grade-repetition record are more likely to be advised by their school and/or family to attend the qualification track or they may drop out of school earlier to minimise opportunity costs. Grade repetitions are a common phenomenon in Belgium, even in primary education. Around 20 percent of the sample has repeated some grade/year before they decide which track to follow. We combine information on age, level of studies and year of studies, to determine whether a child attends a specific grade at the normal age or later. In case his age tells us that the pupil should be at a more advanced grade than the one he attends, then we conclude that this student has at least repeated one grade. One or more years of repetition signal a student with poor school performance. The correlation between track choices and grade repetitions is strong and statistically significant.

In the C group we also include the child’s gender and whether he/she is first-born. Finally we include income–age and activity–age interactions to capture differences due to late track choices as already discussed.

Group F includes information on parental education (primary, secondary and tertiary), separately for mother and father. We include a variable indicating whether the father is present in the household or not (due to divorce or death). We also control for parental nationality, region of residence that reflect institutional and other differences between the different communities in Belgium and the type of family the child is living into. Finally we use a measure of family wealth in the regressions assuming that families with net worth of assets up to 2.5m BF are low wealth, families with net asset value up to 10.0m BF are medium wealth and over 10.0m BF are high wealth families.

In Table 2.4.2 below we present the variables that describe children’s characteristics and family background.
2.5 Empirical results

We seek to identify the effect of family income and parental activity on secondary education track choices for Belgian students. The main problem in similar works is how to identify causal effects, as the obvious correlation between the explanatory variables and track choices could be contaminated from family factors that affect simultaneously income, activity and track choices. We approach this problem in two stages. First, we control for a number of observed family and children characteristics. Yet in this way, the bias due to unobserved effects remains. In the next section we address this problem by estimating sibling fixed effects models. Finally we introduce parental activity as a way to capture short run constraints separately from income. With fixed effects we are able to capture the effects from a short run income or activity shock on track choices.

2.5.1 Family income and track choices. The linear models.

The equation we are estimating in this section is:

\[ Y = a + \beta Q + \gamma C C + \gamma F F + u \]  

(2.5.1)

For now, we do not include parental activity, focusing on income as the main economic factor to affect track choices. In the tables below we present regression results from three models. In model 1 we regress \( Y \) on income and income
2. Do parental jobs and money buy higher schooling? Evidence from track choice in Belgium.

square. In model 2 we add pupil’s characteristics \( C(7) \) and in model 3 we add parental background variables \( F(8) \). All regressions include dummies for the survey waves in order to capture any time trends. As all estimated wave coefficients were close to zero and statistically insignificant, we do not report them in any of the tables below. Full result tables can be found in the appendices.

Table 2.5.1: Family income effects on attending the qualification stream, Belgian students, PSBH 1992-2002. Linear Probability Models (st.errors in parenthesis)

<table>
<thead>
<tr>
<th>Variables</th>
<th>model 1</th>
<th>model 2</th>
<th>model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>income</td>
<td>-0.504 (0.063)</td>
<td>-0.476 (0.061)</td>
<td>-0.352 (0.067)</td>
</tr>
<tr>
<td>income square</td>
<td>0.080 (0.014)</td>
<td>0.076 (0.014)</td>
<td>0.070 (0.013)</td>
</tr>
<tr>
<td>income×(age&gt;14)</td>
<td>0.219 (0.031)</td>
<td>0.213 (0.030)</td>
<td></td>
</tr>
<tr>
<td>obs.</td>
<td>897</td>
<td>897</td>
<td>897</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.0921</td>
<td>0.2091</td>
<td>0.3544</td>
</tr>
<tr>
<td>percent correctly predicted</td>
<td>67.20</td>
<td>75.32</td>
<td>78.32</td>
</tr>
</tbody>
</table>

(in **bold**): statistically significant at 95 percent confidence level  
(in *italics*): statistically significant at 90 percent confidence level

Family income has a strong negative effect on track choice. After controlling for children’s and family characteristics this effect shrinks considerably, however it remains statistically significant and relatively large. One unit change in the relative position of the household in the income distribution decreases by 35 percent the probability of following the qualification track, after controlling for observable characteristics. These results are different from Carneiro & Heckman (2002) and Dearden et al. (2004), where income effects become negligible and statistically insignificant after controlling for observable characteristics. On the other hand, Tamm (2008) is more in line with our findings. Barón (2009) also finds small negative but significant effects for income. There could be two possible explanations for the accordance of our results with Tamm (2008). The first explanation has to do with model specification. Both models may not fully capture observed family heterogeneity or we still need to control for unobserved heterogeneity. However the resemblance with Tamm (2008) and the differences with Carneiro & Heckman (2002) may indeed reflect the different educational systems.

The relation between income and track choices is not linear. The negative and significant coefficient for the square term implies that a change in income, affects track choices more for poorer households than for richer ones. Similar results are common in the literature (Plug & Vijverberg, 2005).

Family income appears to play a smaller role in later choices. This has two possible explanations. Older children become more independent and parental

---

7 Group \( C \) includes: grade repetitions, sex, interactions between age and income, birth order

8 Group \( F \) includes: father absent, parental education, parental nationality, region of residence, family wealth, family type
Empirical results

income affects less their decisions. Secondly, track choices after the normal age are more affected by school performance and individual characteristics than by income. Both explanations appear plausible here.

From an econometric point of view, the models seem to work relatively well. The percentage of correctly predicted values for the dependent variable $Y$, ranges from around 68 percent to almost 80 percent after controlling for family background.

School performance as we capture it by no grade repetitions has a strong negative effect on choosing the qualification track (see appendix 2.B). Once we include it in the regressions the income coefficients fall dramatically, but remain significant.

From the group of family background variables $F$, parental education largely affects and shapes track choices. Low-educated parents increase the probability of children following the qualification track. This also holds for parents with secondary education, although estimated coefficients are no longer statistically significant. Mother’s education affects track choices more than father’s, implying that mothers have a greater impact on children’s school performance and preferences (Norberg-Schönfeldt, 2008). Parental characteristics are an indicator of stimulating environment for children that promotes cognitive and non-cognitive abilities.

Low levels of wealth increase the probability to follow the qualifications track compared to children from medium and high wealth families. Given the strong correlation between the level of family wealth and family income, it is very important that income coefficients remain large and significant even after controlling for the level of family wealth. The rest of control variables have the expected sign and effect on educational choices. Boys are more probable to choose the qualification track. Parents’ nationality also plays a significant role. Leaving in a family with both biological parents and siblings does not affect significantly pupils’ choices, once we have controlled for family background and income.

2.5.2 Siblings fixed effects models, and family income shocks.

Linear cross section models do not control for biases due to unobserved heterogeneity and they also probably do not capture all observed heterogeneity, no matter how extensive the group of explanatory variables might be. Therefore we proceed with the estimation of sibling fixed effects models. The main assumption behind these models is that unobserved family effects such as ability or talent do not change over time, thus they affect siblings equally. With fixed effects, time invariant effects cancel out, thus potential bias from omitted variables is removed. A usual critique however is that limited variation of the main explanatory variables may lead to high standard errors and insignificant coefficients (Levy & Duncan, 2000). Here however, the income variable exhibits
2. Do parental jobs and money buy higher schooling? Evidence from track choice in Belgium.

Sibling fixed effects models allow us to identify the effect of income “shocks” on educational choices, that is how a short term positive (negative) change affects pupils’ decisions. Table 2.5.2 also presents OLS results for comparisons.

Table 2.5.2: The effects of family income changes on the probability of attending the qualification stream, Belgian students, PSBH 1992-2002. Linear probability models (st.errors in parenthesis)

<table>
<thead>
<tr>
<th>Variables</th>
<th>model 1</th>
<th>model 2</th>
<th>model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>income</td>
<td>-0.504 (0.063)</td>
<td>-0.476 (0.061)</td>
<td>-0.352 (0.067)</td>
</tr>
<tr>
<td>income square</td>
<td>0.080 (0.014)</td>
<td>0.076 (0.014)</td>
<td>0.070 (0.013)</td>
</tr>
<tr>
<td>income × age &gt; 14</td>
<td>(-)</td>
<td>0.219 (0.031)</td>
<td>0.213 (0.030)</td>
</tr>
<tr>
<td>obs.</td>
<td>897</td>
<td>897</td>
<td>897</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.0921</td>
<td>0.2591</td>
<td>0.3544</td>
</tr>
<tr>
<td>percent correctly predicted (1)</td>
<td>67.20</td>
<td>75.32</td>
<td>75.32</td>
</tr>
<tr>
<td>percent correctly predicted (2)</td>
<td>84.06</td>
<td>87.72</td>
<td>87.74</td>
</tr>
</tbody>
</table>

controls (FE models): Model 1: wave dummies, Model 2: Model 1 + C, Model 3: Model 2 + father absent, family wealth, family type

(1) Fitted values: $x_{ij}b$
(2) Fitted values including fixed effect, $x_{ij}b + Z_j$
(in bold): statistically significant at 95 percent confidence level
(in italics): statistically significant at 90 percent confidence level

The results here show that track choice in secondary education is not significantly affected by income for any of the specified models. This implies that children face no short run constraints due to low income and findings in the previous section are probably biased because of unobserved family effects. Our results are in line with Tamm (2008), where they also find that while income has a significant effect even in the strictest cross section model, the fixed effects coefficients become small and insignificant. They also interpret their findings as a proof of no causal relationship between income and track choice.

The percentage of correctly predicted educational choices imply that the models work relatively well, especially when we include the fixed component of the error term $Z_j$. Smaller values of R-squared are quite expected since all time invariant variables are dropped out.
2.5.3 Parental activity as a choice constraint. Evidence from fixed effects models.

The findings in the previous sections fail to establish a causal relationship between income and track choices. In this section, we discuss possible short run effects of parental activity. Working parents can affect their children through various paths. First they earn money and provide for them, but at the same time they spend less time with their family. On the other hand, unemployment, apart from loss of income creates extra psychological and other burdens. It could be then the case that children face some short run choice constraints, not due to shortage of income but due to their parents’ activity status.

Showing that parental activity has a separate and significant effect on educational choices could prove a strong policy instrument. Lowering unemployment is always within the economic priorities, much more than increasing working income. Therefore, altering educational choices and improving future career prospects could be a positive side-effect.

Belgium is a good case to study possible separate effects of parental activity. Unemployment and inactivity do not necessarily imply a low income family because of high replacement rates and strong social policies. However, an unemployed father or a housewife mother can affect pupils’ choices independently of the family’s financial situation, showing that not only the level, but also the source of income matters.

The model we estimate here includes both income and parental activity as possible decisive factors for track choices.

\[
Y = a + \beta Q + \delta_{\alpha,f} A_f + \delta_{\alpha,m} A_m + \gamma C + \gamma F + u \tag{2.5.2}
\]

where \( A_f \) is father’s activity, \( A_m \) is mother’s activity and \( \alpha \) is activity group\(^9\). The reference group is “parent working”.

Table 2.5.3 presents the results. Again we estimate parental effects on the probability of following the qualification stream. Concerning variation of parental activity, the last column of Table 2.4.1 shows that around 27 percent of families had experienced a change in father’s activity and around 35 percent of mothers had a transition from unemployment to something else and vice versa. Then we find that there is enough variation to get fixed effect estimates for parental activity.

\(^9\)“working, unemployed” for fathers and “working, unemployed, housewife, inactive” for mothers
2. Do parental jobs and money buy higher schooling? Evidence from track choice in Belgium.

Table 2.5.3: The effects of parental activity changes on the probability of attending the qualification stream, Belgian students, PSBH 1992-2002. Linear probability models (st.errors in parenthesis)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Model 4</th>
<th>Model 5</th>
<th>Model 6</th>
<th>Model 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>father unemployed</td>
<td>0.188 (0.110)</td>
<td>0.208 (0.127)</td>
<td>0.181 (0.108)</td>
<td>0.176 (0.101)</td>
</tr>
<tr>
<td>mother unemployed</td>
<td>-0.089 (0.081)</td>
<td>-0.118 (0.083)</td>
<td>-0.046 (0.081)</td>
<td>-0.032 (0.081)</td>
</tr>
<tr>
<td>mother housewife</td>
<td>-0.143 (0.122)</td>
<td>-0.142 (0.123)</td>
<td>-0.189 (0.116)</td>
<td>-0.169 (0.118)</td>
</tr>
<tr>
<td>mother inactive</td>
<td>-0.109 (0.084)</td>
<td>-0.094 (0.085)</td>
<td>-0.045 (0.080)</td>
<td>-0.026 (0.081)</td>
</tr>
<tr>
<td>mother never worked × housewife now</td>
<td>-0.371 (0.195)</td>
<td>-0.391 (0.197)</td>
<td>-0.366 (0.187)</td>
<td>-0.377 (0.188)</td>
</tr>
<tr>
<td>father unemployed × (age &gt; 14)</td>
<td>-0.056 (0.230)</td>
<td>-0.236 (0.249)</td>
<td>-0.124 (0.236)</td>
<td>-0.136 (0.255)</td>
</tr>
<tr>
<td>no obs</td>
<td>897</td>
<td>897</td>
<td>897</td>
<td>897</td>
</tr>
<tr>
<td>R-sq (within)</td>
<td>0.0309</td>
<td>0.0357</td>
<td>0.1474</td>
<td>0.1545</td>
</tr>
<tr>
<td>percent correctly predicted (1)</td>
<td>65.00</td>
<td>65.23</td>
<td>69.52</td>
<td>70.12</td>
</tr>
<tr>
<td>percent correctly predicted (2)</td>
<td>89.60</td>
<td>91.50</td>
<td>90.98</td>
<td>93.92</td>
</tr>
</tbody>
</table>

controls (FE models): Model 4: father absent + wave dummies, Model 5: Model 4+ income level, Model 6: Model 5 + C, Model 7: Model 6 + family wealth, family type

Unlike income coefficients, estimated coefficients for father’s unemployment are now relatively large and significant at 90 percent level, for all models.

These findings imply that an employment-unemployment transition significantly increases the probability to follow the qualification stream. We can not dismiss the idea that a change in employment status can have serious short run effects on track choices. However, these unemployment effects hold only when track choice is made at the normal age (14). Later choices are no longer affected by employment status (notice that the employment effect on later choices is the sum of father’s unemployment and the interaction term coefficients).

Results are also interesting with mother’s activity status. For all activity groups, estimated coefficients are negative (even though often non-significant) implying that a mother who stays at home could influence positively children’s preferences for education. This idea is further strengthened by the fact that the coefficient for a mother who has always been at home (“Mother never worked × housewife now”, Table 2.5.3) is negative and statistically significant. The results are somewhat different from those presented in Norberg-Schönfeldt (2008), one of the few papers we found, that deal with the issue. They find that full-time working mothers as well as non-working mothers have negative impact on their children’s school performance, compared to part-time work-
In the Belgian education system, students are asked to decide between a vocational and a general education track as early as the age of 14. This choice has serious implications for future educational choices such as continuing to tertiary education and also for future careers. Similar studies have shown strong correlations between parental income and school choices, but in general dismiss the idea of causality.

Here we approach this issue from two sides. To correct for any biases due to unobserved family effects and prove causality we estimate sibling fixed effects models. This approach confirms the idea that short run income has no causal effect on track choices.

In a second step, we explore the relationship between parental activity and track choices, based on the assumption that not only the level but the source of income matters. Results for parental activity are more interesting. An unemployed father has significant short run effects on track choices, even after controlling for income. Even though our results are significant at 90 percent confidence level, a bigger sample would probably correct for this. Results for mothers are very different, implying that the qualitative aspect of mother–child relationship (time spent at home) can positively affect children’s choices.

For policy makers these results show that income interventions at the age of track choice might have minimal or no results at all. However, here we have not discussed possible permanent income effects and how earlier interventions could affect track choices. Alternatively, findings on parental activity show that increasing father’s employment can affect and improve track choices in the short run.
2. Do parental jobs and money buy higher schooling? Evidence from track choice in Belgium.

2.A Tables from section 2.4

Table 2.A.1: Family income by track choice

<table>
<thead>
<tr>
<th>Track Type</th>
<th>Mean Overall</th>
<th>Between</th>
<th>Within(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qualification</td>
<td>1.146</td>
<td>0.508</td>
<td>0.548</td>
</tr>
<tr>
<td>Transition</td>
<td>1.478</td>
<td>0.571</td>
<td>0.541</td>
</tr>
<tr>
<td>All</td>
<td>1.362</td>
<td>0.570</td>
<td>0.531</td>
</tr>
</tbody>
</table>

(1) When we deal with panel data it is useful to decompose the standard deviation into the between and within components. “Overall” refers to the whole dataset. “Between” to the variation of the means to each individual (across time periods). “Within” refers to the variation of the deviation from the respective mean to each individual.

Table 2.A.2: Correlation between family income and qualification stream by birth order

<table>
<thead>
<tr>
<th>Track Type</th>
<th>First born</th>
<th>Second born</th>
<th>Last born</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family income</td>
<td>-0.2953</td>
<td>-0.2492</td>
<td>-0.2704</td>
</tr>
</tbody>
</table>

Table 2.A.3: Correlations between educational choices, family income and parental activity, $S_1 - S_2$

Table 2.A.4: Correlations between educational choices, family income and parental activity, $S_2 - S_3$

Table 2.A.5: Correlations between educational choices, family income and parental activity, $S_3 - S_1$
## 2.B Complete tables from section 2.5.1

Table 2.B.1: Family income effects on attending the qualification stream, Belgian students, PSBH 1992-2002. Linear probability models, st.errors in parenthesis

<table>
<thead>
<tr>
<th>Variables</th>
<th>model 1</th>
<th>model 2</th>
<th>model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>income</td>
<td>-0.504 (0.063)</td>
<td>-0.476 (0.061)</td>
<td>-0.352 (0.067)</td>
</tr>
<tr>
<td>income square</td>
<td>0.080 (0.014)</td>
<td>0.076 (0.014)</td>
<td>0.070 (0.013)</td>
</tr>
<tr>
<td>no grade repetitions</td>
<td>-0.171 (0.046)</td>
<td>-0.147 (0.044)</td>
<td></td>
</tr>
<tr>
<td>log</td>
<td>0.109 (0.028)</td>
<td>0.122 (0.027)</td>
<td></td>
</tr>
<tr>
<td>first born</td>
<td>-0.073 (0.020)</td>
<td>-0.081 (0.027)</td>
<td></td>
</tr>
<tr>
<td>income (\times) (age&gt;14)</td>
<td>0.219 (0.031)</td>
<td>0.213 (0.030)</td>
<td></td>
</tr>
<tr>
<td>father absent</td>
<td>0.171 (0.061)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>father education:</td>
<td>0.108 (0.044)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mother education:</td>
<td>0.049 (0.043)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>primary</td>
<td>0.252 (0.049)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>secondary</td>
<td>0.025 (0.033)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>family type</td>
<td>0.077 (0.055)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>father nationality:</td>
<td>0.193 (0.081)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>European</td>
<td></td>
<td>-0.316 (0.123)</td>
<td></td>
</tr>
<tr>
<td>Non-European</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mother nationality:</td>
<td>0.111 (0.123)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>European</td>
<td>-0.139 (0.072)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-European</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>region:</td>
<td>-0.262 (0.044)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brussels</td>
<td>-0.241 (0.028)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wallonie</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family wealth:</td>
<td>0.068 (0.040)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>medium</td>
<td>0.012 (0.038)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td>0.844 (0.065)</td>
<td>0.874 (0.067)</td>
<td>0.959 (0.098)</td>
</tr>
<tr>
<td>no.obs</td>
<td>897</td>
<td>897</td>
<td>897</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.0921</td>
<td>0.2091</td>
<td>0.3544</td>
</tr>
<tr>
<td>percent correctly predicted</td>
<td>67.20</td>
<td>75.32</td>
<td>78.32</td>
</tr>
</tbody>
</table>

*(in bold): statistically significant at 95 percent confidence level
*(in italics): statistically significant at 90 percent confidence level
2. Do parental jobs and money buy higher schooling? Evidence from track choice in Belgium.

Table 2.C.1: The effects of family income changes on the probability of attending the qualification stream, Belgian students, PSBH 1992-2002. Linear probability models (st.errors in parenthesis)

<table>
<thead>
<tr>
<th>Variables</th>
<th>model 1</th>
<th>model 2</th>
<th>model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>income</td>
<td>-0.126 (0.113)</td>
<td>-0.132 (0.108)</td>
<td>-0.072 (0.115)</td>
</tr>
<tr>
<td>income square</td>
<td>0.096 (0.025)</td>
<td>0.086 (0.024)</td>
<td>0.028 (0.025)</td>
</tr>
<tr>
<td>income$\times$(age&gt;14)</td>
<td>0.169 (0.045)</td>
<td>0.171 (0.045)</td>
<td>0.165 (0.047)</td>
</tr>
<tr>
<td>no grade repetitions</td>
<td>-0.171 (0.047)</td>
<td>-0.165 (0.047)</td>
<td></td>
</tr>
<tr>
<td>boy</td>
<td>0.129 (0.030)</td>
<td>0.129 (0.030)</td>
<td></td>
</tr>
<tr>
<td>first born</td>
<td>-0.078 (0.023)</td>
<td>-0.074 (0.024)</td>
<td></td>
</tr>
<tr>
<td>father absent</td>
<td></td>
<td>0.162 (0.104)</td>
<td></td>
</tr>
<tr>
<td>family type</td>
<td></td>
<td>-0.151 0.096</td>
<td></td>
</tr>
<tr>
<td>Family wealth:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td></td>
<td>0.002 (0.054)</td>
<td></td>
</tr>
<tr>
<td>medium</td>
<td></td>
<td>-0.041 (0.052)</td>
<td></td>
</tr>
<tr>
<td>constant</td>
<td>0.423 (0.109)</td>
<td>0.495 (0.109)</td>
<td>0.548 (0.124)</td>
</tr>
<tr>
<td>no.obs</td>
<td>897</td>
<td>897</td>
<td>897</td>
</tr>
<tr>
<td>R-sq (within)</td>
<td>0.0948 0.1279 0.1316</td>
<td></td>
<td></td>
</tr>
<tr>
<td>percent correctly predicted (1)</td>
<td>63.90 67.75 67.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>percent correctly predicted (2)</td>
<td>84.06 87.22 87.74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Fitted values: $x_{ij}b$
2 Fitted values including fixed effect, $x_{ij}b + Z_j$
(in bold): statistically significant at 95 percent confidence level
(in italics): statistically significant at 90 percent confidence level
Table 2.C.2: The effects of parental activity changes on the probability of attending the qualification stream, Belgian students, PSBH 1992-2002. Linear probability models (st.errors in parenthesis)

<table>
<thead>
<tr>
<th>Variables</th>
<th>model 4</th>
<th>model 5</th>
<th>model 6</th>
<th>model 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>father unemployed</td>
<td>0.188 (0.110)</td>
<td>0.208 (0.127)</td>
<td>0.181 (0.108)</td>
<td>0.176 (0.101)</td>
</tr>
<tr>
<td>mother unemployed</td>
<td>-0.089 (0.081)</td>
<td>-0.118 (0.083)</td>
<td>-0.046 (0.081)</td>
<td>-0.032 (0.081)</td>
</tr>
<tr>
<td>mother housewife</td>
<td>-0.143 (0.122)</td>
<td>-0.142 (0.124)</td>
<td>-0.189 (0.116)</td>
<td>-0.160 (0.118)</td>
</tr>
<tr>
<td>mother inactive</td>
<td>-0.109 (0.084)</td>
<td>-0.094 (0.085)</td>
<td>-0.045 (0.080)</td>
<td>-0.026 (0.081)</td>
</tr>
<tr>
<td>interaction mother never worked x housewife now</td>
<td>-0.371 (0.195)</td>
<td>-0.391 (0.197)</td>
<td>-0.366 (0.187)</td>
<td>-0.377 (0.188)</td>
</tr>
<tr>
<td>father unemployed x (age&gt;14)</td>
<td>-0.056 (0.230)</td>
<td>-0.236 (0.249)</td>
<td>-0.124 (0.236)</td>
<td>-0.136 (0.255)</td>
</tr>
<tr>
<td>income</td>
<td>-0.157 (0.114)</td>
<td>-0.139 (0.109)</td>
<td>-0.091 (0.118)</td>
<td></td>
</tr>
<tr>
<td>income square</td>
<td>0.009 (0.025)</td>
<td>0.036 (0.024)</td>
<td>0.031 (0.025)</td>
<td></td>
</tr>
<tr>
<td>income x (age&gt;14)</td>
<td></td>
<td></td>
<td></td>
<td>0.168 (0.024)</td>
</tr>
<tr>
<td>no grade repetitions</td>
<td>-0.154 (0.048)</td>
<td>-0.150 (0.047)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>boy</td>
<td></td>
<td></td>
<td></td>
<td>0.125 (0.030)</td>
</tr>
<tr>
<td>first born</td>
<td></td>
<td></td>
<td></td>
<td>0.128 (0.030)</td>
</tr>
<tr>
<td>father absent</td>
<td>0.263 (0.109)</td>
<td>0.240 (0.110)</td>
<td>0.194 (0.104)</td>
<td>0.186 (0.102)</td>
</tr>
<tr>
<td>family type</td>
<td>-0.128 (0.098)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family wealth:</td>
<td></td>
<td></td>
<td></td>
<td>0.001 (0.055)</td>
</tr>
<tr>
<td>low</td>
<td></td>
<td></td>
<td></td>
<td>-0.044 (0.052)</td>
</tr>
<tr>
<td>medium</td>
<td></td>
<td></td>
<td></td>
<td>0.004 (0.055)</td>
</tr>
<tr>
<td>constant</td>
<td>0.329 (0.033)</td>
<td>0.353 (0.120)</td>
<td>0.397 (0.118)</td>
<td>0.574 (0.130)</td>
</tr>
<tr>
<td>no.obs</td>
<td>897</td>
<td>897</td>
<td>897</td>
<td>897</td>
</tr>
<tr>
<td>R-sq (within)</td>
<td>0.0309</td>
<td>0.0357</td>
<td>0.1474</td>
<td>0.1545</td>
</tr>
<tr>
<td>percent correctly predicted (1)</td>
<td>60.00</td>
<td>65.23</td>
<td>69.52</td>
<td>70.12</td>
</tr>
<tr>
<td>percent correctly predicted (2)</td>
<td>89.60</td>
<td>91.50</td>
<td>90.98</td>
<td>93.92</td>
</tr>
</tbody>
</table>

1 Fitted values: $x_{ij}b$
2 Fitted values including fixed effect, $x_{ij}b + Z_j$
(in bold): statistically significant at 95 percent confidence level
(in italics): statistically significant at 90 percent confidence level
Chapter 3

General education versus vocational training: How do they affect individual labour market performance?

3.1 Introduction

During the Lisbon European Council in 2000, the European Union set as one of its basic goals to become the most competitive and dynamic knowledge based society in the world\(^1\), while the Barcelona European Council, in 2002\(^2\), reaffirmed this important role. To this end, the development of general and vocational education, the harmonisation of education systems through the Bologna process, the introduction of new learning systems such as distance learning, the development of lifelong learning are some of the intermediate goals as well tools to the accomplishment of the final goal.

We want to show here what are the individual gains from varying forms of education for Belgium. We will try to show which kind of education is more profitable for individuals, i.e. general or vocational education? Initial education or lifelong learning?

We follow the basic lines of the traditional human capital model (Becker, 1975) and estimate the earnings equation developed by Mincer (1974). However our model differs in a number of points; first instead of using only years of schooling

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3. General education versus vocational training: How do they affect individual labour market performance?

as a measure of education we distinguish between years of general and years of vocational education while at school and we also introduce vocational life-long education and training. In such way we get a clearer idea about the effect of different kinds of education on earnings.

Secondly we go further to estimate separately the effect of education on monthly wages, on labour supply and on unemployment. The sum of these three separate effects is the total effect of education on individual annual earnings. This last characteristic of our model is an extension to the human capital model, since it implies that individual gains from education come not only from increased wages but also from better career prospects. Our findings suggest that the gains in terms of time in the labour market and employment are significant for better-educated individuals.

Thirdly we introduce a number of other explanatory variables such as occupation, sector of activity and family background, in comparison with the traditional Mincer equation that only controls for schooling years and experience.

The second basic element of the chapter is that it attempts to control for potential endogeneity bias in the results. The most common problem in similar studies is the correlation between unobserved individual effects, such as ability or personal ambitions and explanatory variables (here education). The data we use here is from the Panel Study of Belgian Households (PSBH), a longitudinal database rich in individual information. Both traditional panel data estimators, the within (fixed) and the random effects, are inadequate for estimation here, each for different reasons. The random effect estimator produces inconsistent and biased estimates in the case of correlation between the unobserved individual effects and the explanatory variables. The within estimator always produces consistent estimates; however, all time-invariant variables are eliminated by the within transformation. Here the main variable under examination, education, is time-invariant.

A possible answer to both problems is the Hausman-Taylor estimator. The idea behind is that it combines fixed effects, random effects and IV estimation techniques to eliminate the correlation with unobserved individuals effects and provide estimates for time-invariant variables. We first divide explanatory variables into four groups, depending on their time variability and their relation to the unobserved individual effects. Then we use the deviations from the means (within estimators) of the exogenous variables to instrument endogenous time invariant variables. One positive aspect of the HT estimator is that the exogeneity assumption of the variables does not need to be based on a priori assumptions, but can be tested.

Our results show a large positive effect of initial education both on earnings and on employment; however, this positive effect is smaller for those who follow secondary vocational or technical education. On the other hand, continuing vocational training and life-long learning generally result to extra gains on top
The multiple dimensions of education

of the gains from initial education; these gains depend on the initial education a person has received. There is a similar picture in the effect of education on unemployment time and labour supply, but the majority of the estimates are not statistically different from zero.

In the following, Section 3.2 we briefly present some basic characteristics of the Belgian education system and discuss findings in the literature on the relationship between general and vocational education. In Section 3.3 we present the connection between annual income, monthly earnings, labour supply and unemployment. In section 3.4 we discuss the econometric model and in Section 3.5 we present in detail the sample and the construction of the variables. Section 3.6 presents and discusses the results. Section 3.7 concludes.

3.2 The multiple dimensions of education

3.2.1 The Belgian education system

Belgium is a federal State with multiple levels of power resulting in a division of the way education is administered and financed. There exist three linguistic communities (Flemish-, French- and German-speaking) and three geographical regions (Flemish, Walloon and Brussels). The structure of the education system is not significantly different between the communities on its characteristics, such as the duration of each level of education, the minimum school leaving age or early tracking while in secondary education. These similarities make the educational system comparable between the communities. However, there exist differences in the administration and financing that lead many to argue that the quality and effects of education, especially vocational and lifelong, will differ substantially among the communities. We will examine that issue further in the following.

Initial (school) education is divided into three main levels:

a. Basic education that includes pre-school and primary education. Primary education lasts 6 years from the age of 6 to 12.

b. Secondary education, from the age of 12 to 18. Up to 1971, secondary education was organised into two 3-year cycles (lower and upper secondary education). In 1971 secondary education was reformed and is now organised into three 2-year cycles (a common or foundation cycle which is common to all students, an orientation cycle and a determination cycle). A fourth cycle is organised in full-time advanced vocational education in several schools for specific fields such as medical and psychiatric hospital nursing.

The new system, was gradually adopted by all schools in all three communities. The main purposes of the reform were to postpone up to the age of 15/16, pupils’ educational and career choices (assuming they would make their choices after completing the second cycle) and to keep pupils one further year to secondary education. There exist four different tracks in secondary education: general, artistic, technical and vocational. The selection
of a certain track, strongly affects post-school and career choices. After the age of 15/16 pupils can also enter part-time secondary education.

c. **Tertiary education** is organised in short type non-university education, long type non-university education and university education. Until 1990 several short type education courses were organised as two year courses; however due to changes in the European Union requirements for recognition of certificates, all short type courses are now of duration of at least three years. Short type education offers mainly practical knowledge and skills and prepares students for working life. Long type non-university education is organised in 4– or 5–year courses and leads to advanced scientific and/or technological qualifications. They award *candidatures* and *licenses* in the same way as universities.

University education has three cycles:

a. first cycle studies (*candidature*), that last two to three years and opens the door to the second cycle of university studies,

b. second cycle studies (*licence*), that last two to three years and ends with the submission of a dissertation and
c. third cycle studies that can last several years. This last cycle includes advanced, specialised studies and research and leads to degrees such as a Doctorate (equivalent to a PhD) or a DEA (diplôme des études approfondies) equivalent to a Master’s degree.

Vocational adult education and training is provided by a number of agents and institutions and targets several population groups such as young school drop-outs, young secondary education graduates, employees who want to improve their skills and keep up with new technologies, unemployed, SME owners, civil servants etc.

Young people who leave school at the age of 15/16 and up to the age of 25, can enter *alternance* education, that includes both classroom courses and firm training.

Continuing vocational training includes initiatives by the employers, the authorities, social advancement education and individuals. It promotes improved vocational, social, cultural, and scholastic integration; it addresses the training needs and requests of companies, administrations and the education system (Eurydice, 2001). Education for social advancement is organised at the secondary and tertiary education levels. Several public institutions and employment services are involved in training and accreditation in each community and region. Such institutions include FOREM for the Walloon region, VDAB for the Flemish region, Bruxelles-Formation for Brussels and the Arbeitsamt der Deutschsprachigen Gemeinschaft, for the German-speaking community.

The Belgian education system is rather complicated both because of the special
structure of the Belgian state, but also because of the existence of multiple education tracks (a characteristic in most European Union’s countries). We chose here to present it in detail because the construction of our variables highly depends upon its characteristics.

3.2.2 The different types of education in the literature

Given the multiple tracks of education, one may wonder what is the evidence in the literature in favour of each one of them. There are several questions to answer: Is it preferable to follow general or vocational education at school? After secondary education, should a student continue with university or follow some vocational training? Could lifelong education prove useful to those who have already acquired a high level of initial education?

Mane (1999) argues that from those pupils who do not continue to tertiary education, those with vocational courses in their high-school curriculum do considerably better than those with only general courses. The positive effects of vocational courses for pupils who do not continue to college are considerable, both in terms of working time and wages, but seem to diminish with time in the labour market. On the other hand, European (including UK) surveys report extra gains for individuals with academic qualifications compared to individuals with the same years of schooling but with vocational qualifications (McIntosh, 2004; Conlon, 2001; Dearden et al., 2000). However there is a strong argument that better performance in the labour market is not a result of academic qualifications, but rather an indication of self-selection bias, since abler individuals usually follow general education (Malamud & Pop-Eleches, 2008; Bennet, 1996).

Stern et al. (1997) find, using US data, that when high-school and two-year college students work in a school supervised job\(^3\) they do better at school, they develop a better connection between school and work and do better (although this effect diminishes) in the labour market compared to those who work in a non-school supervised job or do not work while at school. Youngs who had some on-the-job training in the form of apprenticeships have a smoother training-to-job transition compared to those who only followed classroom based vocational education, but these effects do not extend to wages or subsequent careers (Parey, 2008).

The economic benefits to non-university post secondary education also vary depending on several factors, such as the duration and completion of the course, the field of studies and its relevance to the labour market (Grubb, 1997). These findings are confirmed also for the UK. Dearden et al. (2004) report that academic qualifications are more profitable for those who acquire a skilled job, while McIntosh (2004) reports differences in vocational and academic premia depending on whether the individual works in the private or public sector. Furthermore they both find that there exist gender differences; men and women with vocational qualifications do not do equally well in all sectors. Men re-

\(^3\)Similar to the Belgian “alternance system” and the German “dual system”.

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3. General education versus vocational training: How do they affect individual labour market performance?

Receive the largest labour market benefits for professional qualifications such as accountancy, while for women the vocational qualifications with the highest benefits are nursing and teaching.

The labour market benefits for vocational and general education also depend on the form of the education system. Cooke (2003) discusses that during the 1980’s when the German education system was highly stratified with limited between-tracks transitions, post secondary vocational education did not have any significant economic effects. During the 1990’s, when the education system became more flexible and students turned more towards general education, graduates with after school vocational education earned much more than graduates with no vocational education. Some further findings suggest that apprenticeship in a firm (dual system) is more effective compared to other vocational courses and that the effects of vocational education become obsolete relatively quick, providing in that way an argument for lifelong learning.

The findings in the literature highly dependent on the educational system, the specific assumptions and questions in each survey and on the datasets, which very often provide very limited information on the complete education and labour market profiles of individuals.

3.3 Monthly or annual earnings? A decomposition story

When we want to estimate the economic benefits of education, does it make any difference whether we choose annual, monthly, weekly or hourly earnings? Do possible differences have any economic interest and meaning? These questions are not often discussed. The choice of time frame over which to measure earnings is usually dictated by necessity; different datasets include information on different earnings’ measures (Card, 1999).

However, the reported effects of schooling on annual earnings are usually higher than the effects on monthly or hourly earnings (see for example Card (1999) and Mincer (1974)). A possible explanation is relatively easy to give. Just think how we arrive to calculate annual income: annual income = (hourly wages) \times (hours worked per day) \times (days worked per month) \times (months worked per year).

There is therefore a time element that we often overlook: individual earnings are more than the amount of money received; they are also a reflection of the time spent in employment. If we want to go a step further we should see that an individual receives income a) when he is in the labour market i.e. is not in education or retirement or military service etc and b) when he is not unemployed.

But is employment time affected by education? If the answer was negative, the effects of education would be the same, independently of which time measure of income we used in the calculations. This is not the case however, so employment time should enter explicitly into our problem.
The education effect on working time is usually positive, in other words, more educated individuals work more, so this explains why the education coefficients for annual earnings are higher than the education coefficients for monthly (hourly, etc) earnings.

The education/working time relationship is positive either because labour supply increases with schooling level or because more educated individuals become less frequently unemployed and/or spend less time in unemployment. Both of these explanations are plausible. Table 3.3.1 reports OECD data (2003) for Belgian males and females on labour force participation (LFS) and unemployment by education level.

Table 3.3.1: Labour force participation and unemployment rates by education, Belgium

<table>
<thead>
<tr>
<th>Education level</th>
<th>Below upper secondary (≤ 12 yrs)</th>
<th>Upper secondary and post-secondary (12-14 yrs)</th>
<th>Tertiary non-university (13-14 yrs)</th>
<th>Tertiary university and post-graduate (≥ 18 yrs)</th>
<th>All levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour force participation rates (2001) by education and gender for 25 to 64 year-olds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>69</td>
<td>81</td>
<td>81</td>
<td>84</td>
<td>60</td>
</tr>
<tr>
<td>Females</td>
<td>39</td>
<td>69</td>
<td>81</td>
<td>84</td>
<td>60</td>
</tr>
<tr>
<td>Unemployment rates (2001) by education and gender for 25 to 64 year-olds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>7.4</td>
<td>4.4</td>
<td>2.5</td>
<td>2.5</td>
<td>4.8</td>
</tr>
<tr>
<td>Females</td>
<td>10.4</td>
<td>6.9</td>
<td>2.4</td>
<td>3.8</td>
<td>6.3</td>
</tr>
</tbody>
</table>

Source: OECD (2003) Extracts from Tables A12.1 and A12.2

Differences in unemployment rates and labour force participation rates by level of education are significant for both men and women. A difference of six years in education (less than upper secondary education to university) implies an increase in labour force participation of 33% (around 5.5 percentage points per year) and a decrease in unemployment by 66% (11 percentage points per year) for males. The differences are smaller once we compare university education with other tertiary education types or with upper secondary education, but they are still important.

There are several reasons why education improves labour market experiences of individuals. Just to mention a few, there are technological changes (Nickell & Bell, 1995; Bartel & Lichtenberg, 1987), screening from employers (Holzer, 1996), more efficient on- and off-the-job searching (Mincer, 1991a), psychological and sociological reasons (discouragement and exit from labour force for less skilled workers, family decisions such as the raising of children).

No matter what the reasons behind better labour market performance for the high skilled are, we are interested in estimating the gap between education effects on annual and monthly earnings and see which part of this gap can be attributed to higher labour force participation and which part to less unemployment. As far as we know these estimations are not available up to now for Belgium.
We use the model developed by Ashenfelter & Ham (1979) (from now on referred as A&H). A&H assume that labour supply $h^*$ is the sum of employed ($h$) and unemployed ($u$) months $h^* = u + h$. All months spent in activities other than in a job or in an active search of a job (i.e. unemployment) are assumed as a part of an individual’s decision not to offer his labour into the market. This is true to the extent that no compulsory schooling laws and other restrictions (e.g. compulsory military service) influence a person’s available time for work or job search. With a monthly wage $w$, desired earnings are then:

$$wh^* = w(h + u) \Rightarrow wh^* = wh(1 + u/h) \quad (3.3.1)$$

where $wh$ are annual realised earnings from work and $u/h$ is the fraction of unemployment to employment months. By taking logs the relationship becomes:

$$\ln wh = \ln w + \ln h^* - \ln(1 + u/h) \quad (3.3.2)$$

Equation (3.3.2) is a decomposition of annual earnings into wages, labour supply and unemployment/ employment ratio. However it works only in cases where income from work exists, i.e. it excludes individuals with $h = 0$ and $u = 12$, who receive some replacement income (unemployment benefits, pre-pension benefits etc). It is a common practice in the literature to include in the estimations only those who receive wages; however as we will comment further below, such exclusions probably overestimate the effect of education on earnings (the well-known selection bias problem).

By differentiating (3.3.2) an immediate result is:

$$\frac{\partial \ln wh}{\partial S} = \frac{\partial \ln w}{\partial S} + \frac{\partial \ln h^*}{\partial S} - \frac{\partial \ln (1 + u/h)}{\partial S} \quad (3.3.3)$$

where $S$ is a measure of schooling, usually years.

Equation (3.3.3) decomposes the effect of schooling into its parts, i.e. the effect of schooling on wages, labour supply and $u/h$. Assuming that annual and monthly income, labour supply and unemployment are all linear functions of schooling and a vector of explanatory variables as equation (3.3.4) suggests, then all we need is a method that produces consistent estimates of the $\beta$’s and the $\gamma$’s so as to estimate the gap between education returns on annual and monthly earnings and determine its source.

$$\ln y_i = \alpha_i + \beta_i S + x_i' \gamma + \epsilon_i \quad (3.3.4)$$

---

4A&H talk about unemployment and employment hours and use hourly earnings in their estimations. This is preferable than the approach we use here (i.e. to use months and monthly wages), because hours and hourly earnings is the lowest level of decomposition possible. Our monthly wages still include the time effect of hours worked. However we have no detailed data on hours worked and hourly wages during throughout each year of the survey.

5A&H actually use the relationship $\ln wh = \ln w + \ln h^* - (u/h)$ instead of (3.3.2). The simplification $\ln(1+u/h) \approx u/h$ they use is true for small values of $u/h$, namely for $u/h < 0.1$. This is a plausible assumption for 1979 when the A&H paper was written and one can assume that individuals spent only a small fraction of their time in unemployment. However today’s experience shows that we can have $u/h$ ratios very much above 0.1 (for example an individual with 10 months of unemployment and 2 months of employment has a $u/h$ ratio equal to 5). This implies that the simplification of A&H may distort our results, therefore we will not use it in our estimations.
where $\ln y$ represents $\ln wh$, $\ln w$, $\ln(1 + u/h)$\(^6\) and $\ln h^*$ and $x$ is a vector of explanatory variables.

Any consistent estimates of the return to schooling (but also of the other variables) in (3.3.4) will satisfy the relationship

$$
\hat{\beta}_{wh} = \hat{\beta}_w + \hat{\beta}_{h^*} - \hat{\beta}_{u/h}
$$

(3.3.5)

which is equivalent to (3.3.3). Then we have four possible cases that explain the difference between monthly and annual earnings. The first is the trivial one that $\hat{\beta}_{wh} - \hat{\beta}_w = 0$ implying that education has no effect on time spent on employment and we have already mentioned that the literature concludes otherwise. Secondly $\hat{\beta}_{wh} - \hat{\beta}_w = \hat{\beta}_{h^*}$ would imply that education does not affect unemployment experiences of individuals and all the difference between annual and monthly earnings is due to the effect that education has on labour supply. The third case is the opposite one namely $\hat{\beta}_{wh} - \hat{\beta}_w = -\hat{\beta}_{u/h}$, implying that labour supply is independent of schooling and the last case is that all components of equation (3.3.5) are different from 0 and so the difference between annual and monthly earnings can be explained from the effect of education on labour supply as well as unemployment.

\subsection*{3.4 The model}

We are using here longitudinal data, which, compared to cross section data, allow for control for omitted or unobservable individual specific effects in the specification of an econometric model.

The two traditional panel data estimators are the within (fixed effect) and random effects (RE) estimator. In the within estimator, data are transformed into deviations from individual means and OLS is performed in the transformed data. This method always produces consistent estimators irrespectively of potential correlation between unobserved individual effects and the explanatory variables. However the within estimator has a major defect: all time invariant variables are eliminated by the transformation. This problem is of great importance here since the main variable of interest (schooling) is time invariant.

On the other hand the random effects estimator is a weighted average of the within and between (data are transformed into individuals means) estimators. This implies that the random effect estimator is inconsistent in case of correlation between the explanatory variables and the unobserved individual effect. The Hausman specification test, allows for testing for correlation by comparing within and random effects estimators. Correlation between the effects and the variables are a common phenomenon in the estimation of education returns; schooling can be correlated with individual ability and ambition (unobserved effects).

As an alternative to these, Hausman & Taylor (1981) (hereafter HT) have

\[^6\text{From now on, instead of } (1 + u/h) \text{ we will use } u/h \text{ for notational convenience.}\]
proposed an instrumental variable estimator that produces estimates for time invariant variables and at the same time is consistent. Under their assumptions, their estimator is an efficient GMM estimator. Let us consider a specific model:

\[ y_{it} = X_{it}\beta_i + Z_i\gamma + \alpha_i + u_{it} \]  

(3.4.1)

where \( i = 1 \ldots N \), and \( t = 1 \ldots T \). The \( X_{it} \) are individual time variant variables and \( Z_i \) are individual time invariant variables. \( \alpha_i \) is IID(0, \( \sigma^2_\alpha \)) and may be correlated with parts (but not all) of \( X \) and \( Z \). \( u_{it} \) is IID(0, \( \sigma^2_u \)) and is assumed to be uncorrelated with both the explanatory variables and the unobserved effects.

HT split \( X = [X_1, X_2] \) and \( Z = [Z_1, Z_2] \), with \( X_1 \) and \( Z_1 \) assumed exogenous and not correlated with \( \alpha_i \) and \( u_{it} \), while \( X_2 \) and \( Z_2 \) are uncorrelated with \( u_{it} \) but correlated with \( \alpha_i \). \( X_1 \) is \( NT \times k_1 \), \( X_2 \) is \( NT \times k_2 \), \( Z_1 \) is \( NT \times g_1 \) and \( Z_2 \) is \( NT \times g_2 \). The main idea then behind the HT estimator is that the exogenous time variant within estimators (\( X_1 \)) are used as instruments for estimating time invariant endogenous coefficients (\( Z_2 \)). Deviations from individual means are used as instruments for \( X_1 \) and \( X_2 \) (since they are time variant) and \( Z_1 \) are used as their own instruments (since they are exogenous).

We use the following notation for projections. For any matrix \( A \), its projection onto the column space of \( A \) is defined as: \( P_A = A(A^TA)^{-1}A^T \) and \( Q_A = I - P_A \) is defined as the projection onto the null space of \( A \). More intuitively, \( P_A \) transforms a vector of variables into individual means and \( Q_A \) into deviations from means. Finally, we define \( V \), a \( NT \times T \) matrix of individual-specific dummy variables. The model in 3.4.1 can be written as:

\[ y = X\beta + Z\gamma + V\alpha + u \]  

(3.4.2)

The HT partition of the variables into the four groups described below and their exogeneity assumptions imply the following orthogonality conditions:

\[ E[X'_{it}(\bar{y}_i - \bar{X}'_{it}\beta - Z'_i\gamma)] = 0 \]  

(OC1) \n
\[ E[Z'_{it}(\bar{y}_i - \bar{X}'_{it}\beta - Z'_i\gamma)] = 0 \]  

(OC2) \n
\[ E[(y_i - X'_i\beta) \otimes X_{it}] = 0 \]  

(OC3) \n
where the asterisks imply that the variables are expressed as deviations from means. These orthogonality conditions along with the disturbance covariance matrix \( \Omega \), which is analysed below, are used in a method of moments procedure.

The disturbance covariance matrix \( \Omega = \text{cov}(V\alpha + u) = \sigma^2_V I_TN + T\sigma^2_u P_V \) is a block-diagonal matrix that has the random effects structure. HT show how we can obtain consistent estimates of \( \sigma^2_\alpha \) and \( \sigma^2_u \).

Another assumption for efficient estimation is the system homoskedasticity assumption \( E(u_iu'_i/Z_i) = E(u_iu'_i) \). For it to hold we use the non-singular matrix \( \Omega^{-1/2} = Q_V + \theta P_V \), where \( \theta^2 = \sigma^2_\alpha(\sigma^2_u + T\sigma^2_u)^{-1} \) to transform the error.

\(^7\)For unbalanced panels \( \theta \) is expressed as \( \theta^2 = \sigma^2_\alpha(\sigma^2_u + T\sigma^2_u)^{-1} \) depending on the individual number of observations (Gardner, 1998)
covariance matrix into a scalar matrix: $\Omega^{-1/2} \Omega^{-1/2} = \sigma^2 I$. Transforming equation 3.4.2 by $\Omega^{-1/2}$ is equivalent to a differencing of the observations:

$$\Omega^{-1/2} y = \Omega^{-1/2} X \beta + \Omega^{-1/2} Z \gamma + \Omega^{-1/2} (V \alpha + u)^8 \quad (3.4.3)$$

Then with an instrument set $I$, based on the partition of the explanatory variables into endogenous and exogenous, 2SLS is performed on F1 taking $X_1$ and $Z_1$ as exogenous.

This yields estimators of the form:

$$\begin{bmatrix} \hat{\beta} \\ \hat{\gamma} \end{bmatrix} = [(X, Z)^\prime \Omega^{-1/2} P_A \Omega^{-1/2} (X, Z)]^{-1} (X, Z)^\prime \Omega^{-1/2} P_A \Omega^{-1/2} y \quad (3.4.4)$$

The HT estimator uses as instrument set: $I = Q_V X_1, Q_V X_2, P_V X_1, Z_1$. The order condition for the HT to exist is $k_1 \geq g_2$ (i.e. the exogenous time variant variables to be at least as many as endogenous time invariant) (Cornwell & Rupert, 1988). In case where $k_1 = g_2$ the model is just identified and the HT estimator is the within estimator for the time-variant variables, while when $k_1 > g_2$, the model is over-identified and the HT estimator is more efficient than the within estimator.

Compared to conventional IV estimators, in the HT estimator the $k_1$ exogenous time variant variables, which are the only candidates for identifying instruments are included in the structural equation 3.4.2. As HT point out, this works because only the time invariant component of the disturbance is correlated with $X_2$ and $Z_2$.

Aneliya & MacCurdy (1986) (AM) and Breusch et al. (1989) (BMS) have proposed improved versions of the HT estimator, using different sets of instruments, and they prove that their estimators are at least as efficient as the HT. However, because of stricter requirements as to the instruments and the fact that they can be estimated only for balanced panels, we will continue only with the estimation of the HT. Moreover, as pointed out by Baltagi & Khanti-Akom (1990), when the instruments are legitimate, the gains in efficiency from using the stricter AM and BMS estimators, are rather small.

The HT estimator is quite appealing when we deal simultaneously with time invariant and endogenous variables. However, a serious drawback is how to find the appropriate instruments. The authors themselves have used experience, bad health and previous year unemployment, to estimate schooling effects on income. Other instruments used in similar papers are weeks of work, place of work, etc.

---

8More precisely, we are dealing here with a system consisting of a single structural equation and two multivariate reduced form equations:

$$\Omega^{-1/2} Y_{it} = \Omega^{-1/2} X_{it} \beta + \Omega^{-1/2} Z_{it} \gamma + \Omega^{-1/2} u_{it} \quad (F1)$$
$$X_{2it} = X_{1it} \pi_{11} + Z_{it} \pi_{12} + Q_V \pi_{13} + \epsilon_{1it} \quad (F2)$$
$$Z_{2i} = X_{1it} \pi_{21} + Z_{it} \pi_{22} + Q_V \pi_{23} + \epsilon_{2it} \quad (F3)$$
residence, marital status (Cornwell & Rupert, 1988), occupation and industry and demographic characteristics (Baltagi & Khati-Akom, 1990). The exogeneity of the variables is tested with some test of overidentifying restrictions; in early papers they most usually use the well known Hausman test, while more recent papers rely on the Hansen or Sargan tests (see Arcand et al. (2005)).

However, a usual argument against the HT estimator is that that the selected variables can be weak instruments, that is to be poorly correlated to the variable of interest (here education). The problem of weak instruments was not a major concern at the time the HT estimator was introduced, hence we find no relevant discussion in the works of that period. Arcand et al. (2005) discuss that the combination of the HT instruments with some demand side instruments, such as parental education, can be the best choice of instruments compared to instruments that introduce schooling variation from the supply side (as for example school proximity).

3.5 The sample

3.5.1 The construction of variables

To estimate our models we use data from waves 4 to 10 (years 1995-2001) of the Panel Study on Belgian Households (PSBH). Despite the valuable information it contains, PSBH has also some very important drawbacks. We had to omit the first three waves because their structure and the content of the questionnaires are very different than subsequent waves and thus not easily comparable. PSBH is also highly unbalanced both because individuals drop out or are added in each wave and due to non response. The estimation methods used here are robust to unbalancedness. When we estimated models using only a balanced sample we came up with similar and not statistically different results.

From the initial PSBH population (waves 4-10) we excluded individuals less than 18 and more than 65 years old. We also excluded those who spent all seven waves in inactivity (retirement, housework or other) or education and those who were still at school even for some waves. Hence, years of schooling is a time invariant variable. However, the sample includes individuals who during the survey engaged in some form of lifelong education, at the workplace or elsewhere. Vocational after school training thus varies with time within the sample. The effects of initial and continuing education are separately examined.

Finally, we include individuals who had received some income from work (wages, salaries, paid apprenticeships) during each wave of the survey. Excluding unemployed individuals \((u = 12 \text{ and } h = 0)\), results to a reduced sample and further unbalancedness. However, the most significant problem is that we probably introduce some sample selection bias and we will discuss this point below.

The final sample includes 10,811 observations (2,765 individuals). 15.41% of the sample is followed throughout all seven periods and another 10% is followed
throughout six periods.

We constructed four major variable groups:

i. The education group, that includes variables on initial (school) education, both general and vocational, and on lifelong (after school) vocational education as well as interaction variables. To construct education variables we combined information on year of birth, the education system at the time individuals went to school and highest level of education completed (self-reported).

ii. The income group, that includes the two variables on annual income and monthly wages.

iii. The time variables group. This includes the variables measuring months on employment, unemployment and labour supply.

iv. The control variables group. They are time variant (marital status, age cohort, health, experience and experience square, sector of employment, profession and region) and time invariant (sex, nationality, father and mother education).

In Appendix 3.A we describe in detail the variables used as well as how we constructed them.

3.5.2 Descriptive statistics

We want to get a first picture of sample characteristics and the relations between variables. Table 3.5.1 summarises the income and time variables by years of schooling, while Table 3.5.2 summarises explanatory variables.

Table 3.5.1: Income and employment by years of education

<table>
<thead>
<tr>
<th>Education groups</th>
<th>annual income</th>
<th>monthly income (1)</th>
<th>unemployment ratio (u/h) (2)</th>
<th>labour supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 yrs</td>
<td>462,092 (173,750)</td>
<td>40,311 (12,983)</td>
<td>0.14 (0.97)</td>
<td>11.72 (1.35)</td>
</tr>
<tr>
<td>7-9 or 10 yrs (general)</td>
<td>547,657 (225,302)</td>
<td>46,832 (17,928)</td>
<td>0.07 (0.52)</td>
<td>11.81 (1.14)</td>
</tr>
<tr>
<td>7-9 or 10 yrs (vocat.)</td>
<td>487,010 (185,363)</td>
<td>41,983 (13,763)</td>
<td>0.16 (1.04)</td>
<td>11.80 (1.13)</td>
</tr>
<tr>
<td>10-12 yrs (general)</td>
<td>587,058 (255,335)</td>
<td>50,628 (21,150)</td>
<td>0.05 (0.50)</td>
<td>11.65 (1.58)</td>
</tr>
<tr>
<td>10-12 yrs (vocational)</td>
<td>510,115 (209,827)</td>
<td>44,977 (15,940)</td>
<td>0.07 (0.50)</td>
<td>11.71 (1.42)</td>
</tr>
<tr>
<td>13-14 or 15 yrs (short)</td>
<td>612,745 (326,001)</td>
<td>52,105 (26,474)</td>
<td>0.03 (0.40)</td>
<td>11.83 (1.09)</td>
</tr>
<tr>
<td>16 yrs (long)</td>
<td>625,973 (233,103)</td>
<td>53,146 (18,496)</td>
<td>0.04 (0.52)</td>
<td>11.85 (0.96)</td>
</tr>
<tr>
<td>14-18 yrs (university)</td>
<td>826,139 (394,224)</td>
<td>69,939 (31,889)</td>
<td>0.05 (0.57)</td>
<td>11.86 (0.93)</td>
</tr>
<tr>
<td>All education levels</td>
<td>619,295 (304,725)</td>
<td>52,847 (24,497)</td>
<td>0.06 (0.59)</td>
<td>11.86 (1.16)</td>
</tr>
</tbody>
</table>

(1) Annual and monthly income are expressed in BEF, in fixed 1995 prices (1 Euro = 40.34 BEF)
(2) Employment, unemployment and labour supply are expressed in months (standard deviation in parentheses)

Because we excluded individuals who were unemployed or inactive throughout the year, we get relatively small u/h ratios, probably underestimating the unemployment effect. However the unemployment ratio is significantly larger for less educated workers. Secondly we get average labour supply close to 12, even though less educated individuals exhibit greater variation, implying larger moves in and out of the labour market.

Income, both annual and monthly, rises with education, and general education
implies larger income compared to vocational education. Individuals with 6 or
less years of education earn 76.2% of the average monthly income of the whole
sample, compared to individuals with university education that earn 132% of
the average annual income. The income divergence between education groups
is even higher when we compare annual instead of monthly earnings. The dif-
fferences among education groups are around 1-2 percentage points higher, due
to the effect of education on unemployment and labour supply.

An individual with primary education spends around 4.5 less days per year
in the labour market compared to a university graduate. At the same time has
about 9% higher unemployment to employment ($u/h$) ratio. Again individu-
als with vocational education have higher $u/h$ ratios, compared to those with
general education, but we see no significant differences in labour supply.

Table 3.5.2 summarises all variables (dependent, independent and controls).
With respect to categorical variables we present three different percentages:
overall, between and within. “Overall” corresponds to percentage of observa-
tions, “between” corresponds to percentage of individuals and “within” cor-
responds to the percentage of individuals who have not changed their answer
throughout the survey, i.e it is a measure of the variation of the variable and
as a consequence time invariant variables have a within percent equal to 100.
The last column identifies which variables in our sample are time variant (TV)
and which are time invariant (TI).
A significant proportion of the sample has followed after school vocational education (41.46%). Data shows that generally individuals with higher initial education engage more often in after school vocational education and training (30.56% of those with general education compared to 10.90% of with vocational education); a first indication on the complementarity between initial and after school education.

The majority of individuals follows courses organised at school or other academic establishment (18.66%), and second mostly chosen are the courses organised by employment services (13.26%). These second ones, target mainly the unemployed. Therefore, they exhibit special features and should be examined differently from the other categories. Individuals seem to follow less often vocational education at the workplace (8.37%) or under an alternating scheme (7.35%). This is a somewhat counter-intuitive result since these courses are usually better connected to the labour marker. We can however explain it if we associate it with course availability.
3. General education versus vocational training: How do they affect individual labour market performance?

Most of individuals in the sample are married, have good health, are Belgian citizens of age 30 to 45, they work in the services sector and live in the Flemish region. Most of them had parents with secondary education, although the percentage of individuals with a low educated mother is very high as well.

From calculations that are not presented here, but are readily available upon request, we conclude that experience and education are negatively correlated, probably because better educated enter the labour market at a later stage in life. Finally, age plays an important role in the time variables. More specifically, individuals in the first age cohort spend considerably more time in education and unemployment than the older ones, while individuals in the third cohort are more time inactive and out of the labour market.

3.6 Estimation results

3.6.1 Education and economic performance

In this section we estimate the effects of different education tracks (general and vocational, initial and lifelong) on annual and monthly earnings. Following the A&H decomposition, possible differences between annual and monthly effects are attributed either on labour supply or unemployment differences. This approach treats the issue of education effects in a more complete way, in the sense that it combines various types of education and various labour market outcomes, compared to similar works in the literature that usually focus on one aspect. We use the Hausman–Taylor estimation method, which as described above addresses the problem of correlation between time invariant explanatory variables and unobserved individual effects. In Appendix 3.B we present random effects and OLS estimators for comparison and further discussion.

After testing for different sets of exogenous variables, we concluded to the model HT1 in Table 3.6.1. The exogenous time variant variables group (\(X_1\)) includes age cohorts, marital status and health variables, while exogenous time invariant variables (\(Z_1\)) are gender, nationality, father and mother education. The variables on lifelong vocational education and the interactions between initial and lifelong education, the variables on experience, sector, profession and region dummies are included in the time variant endogenous variables (\(X_2\)). The main group of interest in the estimations is the time invariant endogenous variables (\(Z_2\)) that includes years of education and the vocational education variables described analytically in Section (3.5.1).

Education is grouped in initial and lifelong, while we include interactions between initial and lifelong education. All education variables are endogenous. The depended variables are the logarithms of monthly wages, annual earnings, labour supply months and unemployment to employment months’ ratio.
Table 3.6.1: Hausman-Taylor estimations (HT1). (Standard errors in parentheses)

<table>
<thead>
<tr>
<th>Variable</th>
<th>annual income</th>
<th>monthly wages</th>
<th>annual labour supply</th>
<th>unempl/empl</th>
</tr>
</thead>
<tbody>
<tr>
<td>initial education</td>
<td>0.193 (0.042)</td>
<td>0.098 (0.029)</td>
<td>0.0409 (0.015)</td>
<td>-0.048 (0.015)</td>
</tr>
<tr>
<td>vocational education</td>
<td>-0.078 (0.024)</td>
<td>-0.056 (0.015)</td>
<td>-0.018 (0.011)</td>
<td>0.0024 (0.012)</td>
</tr>
</tbody>
</table>

TV endogenous (X1):

<table>
<thead>
<tr>
<th>Followed adult education after:</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>general education</td>
<td>0.2519</td>
<td>0.024 (0.007)</td>
<td>0.004 (0.008)</td>
<td>-0.007 (0.008)</td>
</tr>
<tr>
<td>vocational education</td>
<td>-0.068 (0.026)</td>
<td>-0.013 (0.014)</td>
<td>-0.005 (0.015)</td>
<td>0.050 (0.015)</td>
</tr>
</tbody>
</table>

TV exogenous (X1):

<table>
<thead>
<tr>
<th>Married</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>good health</td>
<td>0.005 (0.011)</td>
<td>0.012 (0.006)</td>
<td>-0.008 (0.006)</td>
<td>0.0015 (0.006)</td>
</tr>
<tr>
<td>age group 18-30</td>
<td>0.004 (0.018)</td>
<td>0.027 (0.009)</td>
<td>0.028 (0.010)</td>
<td>0.025 (0.010)</td>
</tr>
<tr>
<td>age group 46-65</td>
<td>0.037 (0.016)</td>
<td>0.019 (0.008)</td>
<td>0.025 (0.009)</td>
<td>-0.005 (0.009)</td>
</tr>
<tr>
<td>constant</td>
<td>10.155 (0.582)</td>
<td>5.577 (0.428)</td>
<td>1.781 (0.249)</td>
<td>0.779 (0.248)</td>
</tr>
<tr>
<td>observations</td>
<td>10.81</td>
<td>10.81</td>
<td>10.81</td>
<td>10.81</td>
</tr>
<tr>
<td>Sargan test**</td>
<td>χ²(2) = 0.221</td>
<td>χ²(2) = 0.158</td>
<td>χ²(2) = 0.381</td>
<td>χ²(2) = 0.142</td>
</tr>
</tbody>
</table>

1 The degrees of freedom are d = k1 − g2 = 2.

(in bold): statistically significant at 95 percent confidence level

(in italics): statistically significant at 90 percent confidence level

It is easy to check that for all estimated coefficients, Equation (3.3.5) from Section 4 approximately holds. Especially for education coefficients, what is left after calculating (3.3.5), 

\[
(0.193 - 0.098 - 0.0409 + (-0.048)) = -0.0061,
\]

is very small and not statistically significant. These results confirm the initial hypothesis that the effect of education on earnings can be decomposed to the effect on monthly wages and employment time or stated differently, that the difference between annual and monthly earnings education coefficients results from the increased time in the labour market and employment for the high skilled.

We tested for correlation between education (time invariant) variables and unobserved individual effects using the Sargan test of overidentifying restrictions. The Sargan statistics are given in the last row of Table 3.6.1. The null
3. **General education versus vocational training: How do they affect individual labour market performance?**

The hypothesis is not rejected for the three out of the four models (at 90 percent confidence level), implying that the choice of instruments (X1 group) is legitimate (though at a margin). For the labour supply model, the null hypothesis is rejected. However, our interest here is more on the interrelations between the four models as a system; therefore we retain the labour supply model, despite the relatively high Sargan test statistic. Our efforts to find some better instruments for all four models were unsuccessful, confirming the difficulties to apply the Hausman–Taylor estimator. The task of finding good instruments would have been easier if we dealt with each one of the models separately.

Compared to initial vocational education, general education implies better incomes, less unemployment, and more time in the labour market. These results are somewhat different compared to similar US surveys. There the evidence suggests that individuals who do not continue to higher education are better off when they follow vocational courses while at high school (Mane, 1999). However these findings are specific to US education system, which in general gives fewer opportunities for post-school non-university education than European education systems. Surveys based on European (including UK) data, (Dearden et al., 2004; Cooke, 2003; Conlon, 2001) also speak in favour of general education.

The effects of vocational after school education vary considerably depending on completed schooling. There are considerable gains from after school education for those who have completed general education (at secondary or tertiary level). These results imply that general and adult education can be complements as academic knowledge and analytical skills are combined with practical skills. Finally, vocational after school education does not really affect individuals who already completed vocational education at school implying that these types of education are mainly substitutes. Similar results are found in Cooke (2003) where post-school vocational education is much more profitable when individuals have completed the “Abitur” rather than vocational secondary education.

A first conclusion is that at least up to secondary education level, general skills and knowledge are more useful to students, while specialisation and training is something that should come at a later stage in life. A second conclusion is that, because adult education is usually market oriented, it is of more use to those who have high levels of theoretical knowledge and have never received similar vocational skills before (such as university graduates).

Comparing different types of vocational adult education, only courses that combine both theoretical knowledge and practice at the workplace have some positive significant impact on annual income. The rest of the courses have positive effects on income but these are not different from 0. Furthermore the type of vocational education does not affect significantly unemployment time, while labour supply is only affected by years of initial education and not by after school education, types of courses etc. Finally, duration of vocational course has a negative effect on income, but this can be attributed to foregone
earnings, as here we measure the effect of course duration on current and not on future income.

The rest of the explanatory variables do not exhibit any strange features. Working as a professional and at the services sector implies better income and less unemployment compared to other occupations and sectors. Contrary to what someone might think, those with Belgian nationality seem to earn less than non-Belgians. This could be explained if one takes into account the large number of well paid administrators from the EU and other countries who work in the various EU and international organisations (both private and public) that exist in Belgium. However, Belgians experience less unemployment.

3.6.2 The probability of unemployment and sample selection bias

The primary goal of this chapter was not to estimate education effects on unemployment, but rather to decompose the education effects on earnings into an income and a time component and show how these effects differ by types of education. For the decomposition to work we omitted from the sample those workers who received no income from work. Therefore we excluded all those who were unemployed (or inactive) throughout the year. In that way, the education coefficients for the unemployment and inactivity models, are probably biased estimates of the true education effect.

We estimated the education effects on the probability of having an unemployment spell and on the number of unemployment months, for the sub-sample of workers who had some income from employment and the extended sample that included both those who had income from work and not. This was to give us an idea of the extend of the bias\(^9\). The coefficient on years of schooling was slightly smaller for the extended sample, implying that our results were in fact overestimating the education effect. However, the effects of types of education were significantly different for the two samples. The coefficients on general (vocational) education tracks were positive(negative) and significantly larger(smaller) for the extended sample\(^{10}\). These results imply that with the smaller sample we underestimate the positive effects of general education on unemployment.

3.6.3 Education effects for men and women

In results that we do not present here but are available upon request, we have estimated the effects of education separately for males and females. There are a few points to comment. First the effects of initial general education are higher for women than for men for all of our four models. The gender difference is very small in the wage model but is substantially larger in the labour supply and unemployment models. This implies that education is more important for

\(^9\)Estimation results are omitted but are available upon request  
\(^{10}\)With the exception of alternance adult education
participation in the labour market for women than it is for men but it does not affect very differently the wages of men and women.

Secondly, vocational initial education implies lower wages and consequently earnings for both genders, but it hurts women more than men. Lifelong vocational education does not affect very differently men and women, even though the effects for women are somewhat larger. Separate gender regressions show that vocational courses organised by unemployment services significantly reduce unemployment for men but not for women. The rest of the results and the analysis do not change.

3.6.4 Education effects by age

The econometric model we have chosen helped us overcome two main sets of problems namely the time invariance of education and the endogeneity of our explanatory variables. However, everything comes at a cost, which here is a computationally demanding model. To get robust results in all our four models for all initial and lifelong education variables, we included in the sample a quite broad age band (18-65 years). We have tried to control for age effects by including in the regressions age dummies and we constructed the education variables taking in consideration changes that occurred in the education system throughout the years. However, some of the bias coming from the fact that individuals belong to different age cohorts may still exist.

Therefore, we replicated our models for three age groups: individuals who were born before 1945, between 1946 and 1965 and between 1966 and 1983. As expected the samples were dramatically reduced and most of the variables of interest were insignificant. The main conclusion we could draw is that education affects mainly younger cohorts. Vocational after school education has a greater impact for the youngest individuals and almost no effect for the oldest ones, both in terms of earnings and time.

Finally we estimated our models excluding completely the oldest individuals (born before 1945), since the behaviour of individuals close to retirement is usually different than the behaviour of the rest of the labour force. This difference in behaviour may be another source of bias. The change in the results once we exclude individuals close to retirement is not dramatic. The sign of the effects remain the same; however the positive effects of general and vocational education on earnings and employment are larger.

3.6.5 Education effects by region

Belgium is an interesting case because of its geographical and linguistic division. Despite the fact that the education system is comparable across the country, it is a common belief that its efficiency and effects differ significantly. To address these issues we estimated our models separately for each of the three regions that we have data: the metropolitan area of Brussels, the Flemish and the Walloon regions.
Initial general education affects positively and significantly mainly those who live in Brussels and in Flanders. The positive effects of initial education are much smaller for Wallonia. Moreover, in Wallonia there is a much stronger negative effect of initial vocational education compared to Flanders where this effect is still negative but smaller and Brussels where initial vocational education has a small positive effect on earnings (however, statistically insignificant). These results indicate that schools in the regions of Brussels and Flanders can be more efficient and provide their students with better skills than the Wallonian schools; however the reasons for that should be further examined.

There are also differences across regions in the effects of lifelong vocational education. Specifically, the return of after school vocational education is higher for Wallonia. It is slightly lower in Flanders and much lower in Brussels, even though not different from 0. The most efficient with respect to wages and earnings, types of vocational education for Wallonia are those organised at the workplace and under the alternance system. For Flanders the two most efficient courses are those organised under the alternance system and from employment services. Finally for Brussels, the most efficient courses are those organised at school and at the workplace.

3.6.6 Hausman–Taylor, random effects and OLS estimators

In this section we compare Hausman–Taylor, random effects and OLS estimators and discuss some features for the HT estimator. In Table 3.6.2 we jointly report the years of initial education and interaction coefficients \(Z_2\) group of HT, RE and OLS. Full RE and OLS estimates are found in Appendix 3.B (Tables 3.B.1 and 3.B.2).

Table 3.6.2: HT, RE and OLS education coefficients (standard errors in parentheses)

<table>
<thead>
<tr>
<th>Variable</th>
<th>annual income</th>
<th>monthly wages</th>
<th>annual labour</th>
<th>unempl/empl supply</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education coefficient estimated by Hausman Taylor (HT)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>years</td>
<td>0.193 (0.042)</td>
<td>0.098 (0.029)</td>
<td>0.0409 (0.018)</td>
<td>-0.048 (0.015)</td>
</tr>
<tr>
<td>vocational educ.</td>
<td>-0.078 (0.024)</td>
<td>-0.056 (0.015)</td>
<td>-0.018 (0.011)</td>
<td>0.0024 (0.012)</td>
</tr>
<tr>
<td>(p-value)</td>
<td>(0.920)</td>
<td>(0.928)</td>
<td>(0.830)</td>
<td>(0.911)</td>
</tr>
<tr>
<td>Sargan test</td>
<td>(\chi^2(2)=0.221)</td>
<td>(\chi^2(2)=0.158)</td>
<td>(\chi^2(2)=0.381)</td>
<td>(\chi^2(2)=0.142)</td>
</tr>
<tr>
<td></td>
<td>(0.960)</td>
<td>(0.924)</td>
<td>(0.830)</td>
<td>(0.911)</td>
</tr>
<tr>
<td>Education coefficient estimated by Random Effects (RE)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>years</td>
<td>-0.054 (0.003)</td>
<td>-0.045 (0.002)</td>
<td>0.001 (0.001)</td>
<td>-0.004 (0.0015)</td>
</tr>
<tr>
<td>vocational educ.</td>
<td>-0.007 (0.002)</td>
<td>-0.007 (0.0014)</td>
<td>-0.0003 (0.0009)</td>
<td>-0.0005 (0.0009)</td>
</tr>
<tr>
<td>(p-value)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Hausman test</td>
<td>(\chi^2(20)=125.38)</td>
<td>(\chi^2(20)=195.32)</td>
<td>(\chi^2(20)=31.92)</td>
<td>(\chi^2(20)=30.26)</td>
</tr>
<tr>
<td></td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Education coefficient estimated by Ordinary Least Squares (OLS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>years</td>
<td>0.047 (0.002)</td>
<td>0.044 (0.001)</td>
<td>0.0007 (0.0007)</td>
<td>-0.0026 (0.0008)</td>
</tr>
<tr>
<td>vocational educ.</td>
<td>-0.007 (0.001)</td>
<td>-0.007 (0.0008)</td>
<td>-0.0003 (0.0004)</td>
<td>-0.00005 (0.0005)</td>
</tr>
<tr>
<td>(p-value)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Observations</td>
<td>10,811</td>
<td>10,811</td>
<td>10,811</td>
<td>10,811</td>
</tr>
</tbody>
</table>

(in bold): statistically significant at 95 percent confidence level

As is shown in Table 3.6.2, the Sargan test of overidentifying restrictions does not reject the hypothesis of no correlation for three out of the four equations estimated by the HT method (at 90 percent confidence level). On the contrary
3. **General education versus vocational training: How do they affect individual labour market performance?**

The null hypothesis is rejected for all RE models. The proximity between RE and OLS coefficients implies that OLS estimators are not consistent either.

Before going any further in comparing RE (and OLS) to HT we would like to discuss briefly a relatively recent block of literature that questions either the Mincerian framework or the usual econometric techniques (OLS, IV) as the most appropriate ways to estimate the returns to education. First of all there is the critique that the schooling coefficient in the Mincer equation equals the marginal internal rate of return to education only under certain (quite restrictive) assumptions. More specifically it is assumed that education and experience are separable, foregone earnings are the only costs of education, the earnings measure used captures the whole benefit of the investment of education etc. (Björklund & Kjellström, 2000). Heckman et al. (2003) argue that the data from the 1940s and 1950s provide some support for the Mincer model but data from later decades are inconsistent with it. When they relax functional form assumptions of the Mincer equation and also account for non-linearity in schooling, taxes and tuition and non-separability between education and experience they conclude that the internal rate of return of education should be much higher than predicted by the Mincer model.

On the other hand, on the issue of endogeneity of education, Heckman & Vytlacil (2000) argue that education and ability are literally inseparable. This implies that it is impossible to separate and estimate the main effects of education, even if ability were fully observable. Moreover in the literature, people mostly try to deal with the correlation between cognitive skills and education, and usually oversee the important role of non-cognitive skills and how they affect educational and labour market performance (Carneiro & Heckman, 2003). The non-separability between education and abilities and the possible non-linearity of the wage equation to education make not only OLS but also IV techniques ill-equipped to estimate accurately the returns to education. More sophisticated techniques such as non-parametric or semi-parametric econometric models or structural dynamic models of schooling decisions along with wage regressions that account for skill heterogeneity, non-linearity in schooling, education–experience separability and heteroskedasticity are more appropriate (Belzil, 2004; Belzil & Hansen, 2002). These techniques usually result to education estimates, which are much smaller than OLS/ IV estimates (Belzil & Hansen (2002) report average returns to education from less than 0.010 to 0.12 and Belzil (2004) reports similar lower and upper bounds).

However, the empirical works using these new techniques are still limited and the validity of results remains to be confirmed. We can not overlook the fact that depending on the issue each survey addresses, the results are so different; for example Heckman et al. (2003) who work on a more flexible functional form of the Mincer equation, report much higher education coefficients than OLS/IV estimates. Belzil & Hansen (2002) and Belzil (2004) on the other hand arrive at substantially lower estimates of the return to education. On the other hand, the relative simplicity of the Mincer equation as well as of the OLS/IV techniques keeps them still appealing.
Going back to the discussion on the RE (OLS) and HT estimators relationship, we see that the HT estimators here are considerably higher than the RE and OLS, implying that when we are using estimation methods that control for individual unobserved effects, the true effect of education on earnings is larger. This is consistent with the literature both on HT (Baltagi & Khanti-Akom, 1990; Cornwell & Rupert, 1988; Hausman & Taylor, 1981), and IV estimation (see Card (1999) for a review). The higher estimates reported in the literature when unobserved individual effects are controlled for, are somewhat counter-intuitive. If we assume that individual characteristics and schooling are positively correlated, RE (OLS) estimators should be upward biased, but the empirical results suggest otherwise.

Card (1999) summarises a number of potential explanations for the gap between OLS and the traditional IV estimators (e.g. measurement error that biases downwards OLS estimators, publication bias i.e. because researchers search for a statistically significant IV estimator, they are more likely to select a model specification that produces a large point estimate of the return of education). Another popular explanation is the LATE (Local Average Treatment Effect) interpretation of the IV; each instrument used (proximity to university, family background, compulsory schooling laws etc) affects a different group, so the estimates show the effect of schooling for the group affected in each case by a particular instrument, rather than the average effect. However, the LATE interpretation applies only in the case of a unique instrument. When using more than one instrument (as here) we can not define a unique group that is affected. Moreover, the HT procedure, compared to traditional IV, can produce schooling coefficients, closer to the average effects. This happens since the instruments used for the HT procedure may affect more uniformly the education decisions through the distribution of schooling (Arcand et al., 2005, pp.14).

So, how can the gap between Random Effects/ OLS and HT estimators be explained? In the literature, while all realise the existence of this gap, which is even larger than the OLS/traditional IV gap, no explanation seems to be provided. In their seminal article Hausman and Taylor refer to the issue with the following: “All methods which control for correlation with the latent individual effects increase the schooling coefficient over those which do not; and this is certainly not the direction that many people concerned about ability bias would have expected” (Hausman & Taylor, 1981, pp.1393). The references in the rest of the literature do not seem more convincing.

One could suggest that the true effects of education are underestimated in case that education acts as a cover and substitute for low ability, correcting individual deficiencies. To take ability and schooling to be substitutes (instead of complements as is the usual practice) requires some extreme assumptions such as that the majority of individuals have less than average levels of ability or that individuals with exceptional IQ levels, ambition or talents leave education earlier in order to pursue their goals in the labour market or that they follow forms of education that are not registered or followed by surveys (e.g.
3. **General education versus vocational training: How do they affect individual labour market performance?**

out of school music lessons, or sport practices). These ideas do not seem very convincing and better answers require further research.

A second issue to be discussed is that the gap between annual and monthly earnings and consequently the effects of education on labour supply and unemployment are much larger than implied both by RE / OLS estimations and descriptive statistics. Part of this increase can of course be attributed to the general inflation of HT estimators, but we see that controlling for ability does not affect education coefficients for all variables the same. Assuming that we accept that the HT estimates are more consistent compared to RE (OLS) and more efficient than the within estimates, the true gap between annual and monthly earnings is much larger. In other words, the true effect of education on earnings is much larger and broader than when we consider only the amount of money a person receives per unit of time; the time the person receives it plays an important role that should not be overseen.

### 3.7 Conclusions

Not many studies estimate the effect of education on earnings and employment time in the way that it is done here. We have shown that education improves significantly not only the income of individuals but also the experiences they have in the labour market. This improvement is much larger than traditional estimation methods predict.

The results also shed some light on the relative labour market benefits of general and vocational education. The gains, both in terms of income and employment, are higher for those who have followed general education at school, even after controlling for individual ability. It is therefore important for individuals to acquire and develop general skills while at school and while they are at the stage in life when they form their personality. Vocational education and training is a better choice after school.

The assumption of complementarities between initial and after school education is confirmed. The positive effects of after school education are significantly higher for those with higher (and general) initial education.

We have also found some evidence that education, both initial and lifelong improves the experience in the labour market more for younger individuals than for older ones. Education also has a greater effect on the labour supply of women than of men, while does not imply significant wage gaps. Finally our findings suggest regional differences in the returns of different forms of education on earnings and labour market experiences, which should be further examined.

Based on the results presented here, individuals should be encouraged to receive education, because it implies better income prospects and more successful labour market experiences. When at school, children are better to acquire
general knowledge and develop their personal skills and competences. Specialisation and practical skills further improve individual prospects but are more useful to individuals who have learned how to process knowledge and information and have strong theoretical background. In a word, we could say that educational policies should take a turn towards forming complete personalities of children at school and building solid backgrounds for them and then providing them with continuous and updated specialised and labour market tailored knowledge.
3. General education versus vocational training: How do they affect individual labour market performance?

3.A Construction of variables and connection to the PSBH questionnaire.

3.A.1 Education variables

Along with the detailed description of the construction of our variables we also mention the relevant PSBH questions we used. The codes of PSBH questions are of the form pixxxx and wiaxxxx (where i= 410 the wave number and xxxx is a four digit number).

3.A.1.1 Initial education (general and vocational).

In the PSBH, individuals are asked which is the highest education level they have completed, (questions p0i3820), at what age they have completed their full time education (p0i3815), and at what age they have completed the highest education level (p0i3840). We decided to use information on the highest completed level of education instead of age of education completion. This decision was mainly based in two facts: first the self-reported age of education completion is highly inaccurate. Individuals do not report any breaks they had from school to the labour market and then back to school, while many individuals report only the highest education level completed and not their age at the time. Secondly, we want to avoid problems with repeated education years or years that did not lead to a degree. Grade repetitions would underestimate education effects, if included in the total years of schooling.

The construction of the education variables also takes into consideration the two changes in the Belgian education system, described in detail in section 3.2.1. The first change affected secondary education. The new system started in 1971, even though there has been a long transition period. However here we assume that the new system was fully implemented in 1971, so it affected individuals born after 1959 (=1971-12). Students who entered secondary education up to 1971 have followed two 3-year cycles. These cycles were called lower and upper secondary education respectively. After the reform of 1971, secondary education comprises of three 2-year cycles, so now those who have completed lower secondary education have had 4 years of secondary education (compared to 3 before 1971).

The second reform affected tertiary short type education. Up to 1990 (individuals who were born till 1972) short type tertiary education included only 2-year courses. After 1990 short type education lasts 3 years (and 4 in some specialisations).

Taking all these into consideration “education” variable then takes the following values:

i. Education=6 if individual completed up to primary education (p0i3820==1)

ii. Education=9 if individual was born before 1959 (so followed secondary education before 1971) and completed lower secondary education (all tracks,
Construction of variables and connection to the PSBH questionnaire.

iii. Education=10 if individual was born after 1959 (so followed secondary education after 1971) and completed lower secondary education (cycles 1 and 2 of the reformed system, all tracks, pi3820=2, 3, 4, 5).

iv. Education=12 if individual completed upper secondary education, all tracks (pi3820=6, 7, 8,9), regardless of his year of birth.

v. Education=14 if individual was born before 1972 (so followed tertiary education before 1990) and completed a short type tertiary education course, either pedagogical, economic or other (pi3830=1, 2, 3).

vi. Education=15 if individual was born after 1972 (so followed tertiary education after 1990) and completed a short type tertiary education course, either pedagogical, economic or other (pi3830=1, 2, 3).

vii. Education=16 if individual has followed a long-type non-university tertiary education course (pi3830=4).

viii. Education=14 if individual has a diplôme de candidatures (pi3830=5).

ix. Education=16 if individual has acquired a diplôme de licences (pi3830=6).

x. Education=18 if individual has acquired a doctorat, maîtrise ou diplôme de 3ème cycle (pi3830=7).

Moreover, to distinguish between general and vocational secondary education we created a dummy variable: \( \text{voc\_degree} = 1 \) if individual has completed technical or vocational secondary education. The variable interaction that is used in the regressions is the product of education and voc\_degree variables and measures the effect of years in vocational secondary education.

3.A.1.2 Vocational (after school) education

i. \( \text{voc\_educl} = 1 \) if pi3850=1. Indicates whether the individual ever had at least one vocational course.

ii. \( \text{voc\_school} = 1 \) if pi3870=1. The vocational course was organised at school or similar education establishment (college etc).

iii. \( \text{voc\_educl\_work} = 1 \) if pi3890=1. The individual has followed a vocational education at workplace.

iv. \( \text{voc\_educl\_altern} = 1 \) if pi3880=1. The individual has completed a vocational course under the alternance system (school and workplace).

v. \( \text{voc\_educl\_forem} = 1 \) if pi3910=1. The individual has followed some course within an employment programme (e.g. FOREM, ORBEM etc).
It is obvious that an individual may have followed more than one types of vocational courses and all these variables are time variant by construction of the sample.

To capture the effect of after school education by level of education we also created the following variables, that measure interactions:

i. \( \text{gen_voc} = 1 \) if \( \text{voc_educ} = 1 \) & the individual has completed general education (secondary or tertiary).

ii. \( \text{voc_voc} = 1 \) if \( \text{voc_educ} = 1 \) & the individual has completed vocational education.

Finally the variable \( \text{voc_train} \) measures the duration in weeks of vocational course undertaken during the period of the survey. We combined PSBH questions \( \text{pi1540} \) (“Have you followed a vocational education course since last year?”), \( \text{pi1550} \) (“What was the total duration of that course?”), \( \text{pi1590} \) (“Starting year of the course”), \( \text{pi1610} \) (“Finishing year of the course”), \( \text{pi1600} \) (“Starting month of the course”) and \( \text{pi1610} \) (“Finishing month of the course”).

3.A.2 Income variables

Information on income pertains to the economic year previous to each wave. PSBH has questions on both gross and net monthly amounts. Here we only use net income which is the usual practice when measuring private returns to education. Gross income is not preferred because it includes also social returns.

The monthly wage variable (only for those who received income from work and not from business activity or investment) consequently is: net monthly income=pi1890. In case pi1890 is missing and only gross monthly wage (variable pi1880) is available, we calculated net monthly wage as a second degree function of gross monthly income of the form: net monthly wage = \( a \) (gross monthly wage) + \( b \) (gross monthly wage)\(^2\) + \( c \). By regressing net wage on gross wage and its square the estimates for \( a \), \( b \) and \( c \) were: \( \hat{a} = 0.47 \) \( \hat{b} = 6.86 \) \( \hat{c} = -0.08 \) and \( \hat{c} = 12.354 \).

The annual income variable is: “net monthly income×\( \text{pi1900} \)”, where \( \text{pi1900} \) is the number of months that a person received reported net monthly income. Finally, all income variables are in fixed 1995 prices (we used relevant data from “Belgostat” (www.belgostat.be)).

3.A.3 Time variables

In PSBH, individuals are asked about their main activity month by month (questions \( \text{pi1710} \), \( \text{pi1720} \), \( \text{pi1730} \) (…) \( \text{pi1820} \)). The sum of their answers gave us months spent in employment, unemployment, education and inactivity each year. Moreover, in the estimations we are using only individuals who report months in employment equal to \( \text{pi1900} \) (months received reported net monthly
Construction of variables and connection to the PSBH questionnaire.

In such way we want to minimise errors in the calculation of annual income and employment/unemployment months.

3.A.4 Other variables

i. \( \text{Experience} = \text{Age} - \text{pi3770} \), where pi3770 is the age of the first regular full-time job. Experience is measured in years.

ii. \( \text{services} = 1 \) if individual is occupied in the service sector. The classification into sector of activity was done using the NACE classification system.

iii. \( \text{professional} = 1 \) if the individual belongs to legislators, senior officials and corporate managers or professionals. The classification followed the ISCO classification system.

iv. \( \text{woman} = 1 \) if wia006=2 ("Sex").

v. \( \text{nation} = 1 \) if pi3550=1 ("What is your present nationality?").

vi. \( \text{father education} = \text{wi060} \).

vii. \( \text{mother education} = \text{wi061} \).

viii. \( \text{ms} = 1 \) if pi3620=1 ("What is your present official family situation?")

ix. \( \text{health} = 1 \) if pi3390=1 or 2 ("How is your general health situation?").

Finally we used information on age to construct three age cohorts and information on region of residence.
3. General education versus vocational training: How do they affect individual labour market performance?

3.B Estimations using random effects and OLS

Table 3.B.1: Random effects estimators (standard errors in parentheses)

<table>
<thead>
<tr>
<th>Variable</th>
<th>annual income</th>
<th>monthly wages</th>
<th>annual labour supply</th>
<th>unempl/empl supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial education years</td>
<td>0.054 (0.003)</td>
<td>0.049 (0.002)</td>
<td>0.001 (0.001)</td>
<td>-0.004 (0.0015)</td>
</tr>
<tr>
<td>Initial education at age 18-20</td>
<td>-0.007 (0.002)</td>
<td>-0.007 (0.0014)</td>
<td>-0.0003 (0.0009)</td>
<td>-0.0005 (0.0009)</td>
</tr>
<tr>
<td>Followed adult education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General education</td>
<td>0.024 (0.012)</td>
<td>0.017 (0.007)</td>
<td>0.003 (0.006)</td>
<td>-0.006 (0.006)</td>
</tr>
<tr>
<td>Vocational education</td>
<td>-0.033 (0.029)</td>
<td>0.006 (0.013)</td>
<td>-0.007 (0.010)</td>
<td>0.035 (0.010)</td>
</tr>
<tr>
<td>Adult education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Took place at workplace</td>
<td>0.020 (0.019)</td>
<td>0.009 (0.010)</td>
<td>0.002 (0.009)</td>
<td>-0.004 (0.009)</td>
</tr>
<tr>
<td>Took place at school &amp; workplace</td>
<td>0.018 (0.017)</td>
<td>0.008 (0.010)</td>
<td>0.004 (0.009)</td>
<td>-0.004 (0.009)</td>
</tr>
<tr>
<td>Services</td>
<td>-0.034 (0.018)</td>
<td>-0.026 (0.011)</td>
<td>-0.004 (0.008)</td>
<td>0.007 (0.009)</td>
</tr>
<tr>
<td>Duration (weeks) of recent course</td>
<td>-0.0012</td>
<td>-0.00024</td>
<td>-0.00024</td>
<td>0.0007</td>
</tr>
<tr>
<td>Experience</td>
<td>0.0435</td>
<td>0.024 (0.002)</td>
<td>0.015 (0.001)</td>
<td>-0.003 (0.001)</td>
</tr>
<tr>
<td>Experience square</td>
<td>-0.0008</td>
<td>-0.0004</td>
<td>-0.00036</td>
<td>0.00005</td>
</tr>
<tr>
<td>Services</td>
<td>0.015 (0.009)</td>
<td>0.001 (0.004)</td>
<td>0.007 (0.003)</td>
<td>-0.008 (0.003)</td>
</tr>
<tr>
<td>Professionals</td>
<td>0.074 (0.010)</td>
<td>0.031 (0.008)</td>
<td>0.022 (0.005)</td>
<td>0.0058 (0.005)</td>
</tr>
<tr>
<td>Residence</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brussels</td>
<td>0.026 (0.027)</td>
<td>0.002 (0.018)</td>
<td>0.031 (0.011)</td>
<td>0.008 (0.012)</td>
</tr>
<tr>
<td>Wallon region</td>
<td>-0.063 (0.018)</td>
<td>-0.037 (0.013)</td>
<td>-0.0046 (0.0076)</td>
<td>0.017 (0.008)</td>
</tr>
<tr>
<td>Woman</td>
<td>-0.405 (0.017)</td>
<td>-0.035 (0.012)</td>
<td>-0.034</td>
<td>0.020 (0.007)</td>
</tr>
<tr>
<td>Belgian</td>
<td>-0.043 (0.037)</td>
<td>-0.054 (0.027)</td>
<td>-0.015 (0.016)</td>
<td>-0.028 (0.016)</td>
</tr>
<tr>
<td>Father education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td>0.009 (0.023)</td>
<td>0.011 (0.017)</td>
<td>-0.009 (0.010)</td>
<td>-0.016 (0.010)</td>
</tr>
<tr>
<td>Elementary or less</td>
<td>-0.013 (0.024)</td>
<td>-0.012 (0.017)</td>
<td>0.004 (0.009)</td>
<td>0.014 (0.010)</td>
</tr>
<tr>
<td>Mother education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher</td>
<td>0.043 (0.029)</td>
<td>0.028 (0.021)</td>
<td>0.004 (0.010)</td>
<td>-0.009 (0.012)</td>
</tr>
<tr>
<td>Elementary or less</td>
<td>-0.055 (0.023)</td>
<td>-0.057 (0.016)</td>
<td>0.004 (0.012)</td>
<td>0.030 (0.010)</td>
</tr>
<tr>
<td>Married</td>
<td>0.039 (0.013)</td>
<td>-0.050 (0.008)</td>
<td>0.011 (0.006)</td>
<td>-0.029 (0.007)</td>
</tr>
<tr>
<td>Good health</td>
<td>0.020 (0.010)</td>
<td>0.015 (0.006)</td>
<td>0.003 (0.005)</td>
<td>-0.004 (0.005)</td>
</tr>
<tr>
<td>Age group 18-20</td>
<td>-0.015 (0.016)</td>
<td>-0.002 (0.009)</td>
<td>0.016 (0.008)</td>
<td>0.033 (0.008)</td>
</tr>
<tr>
<td>Age group 46-65</td>
<td>0.034 (0.014)</td>
<td>0.025 (0.008)</td>
<td>0.007 (0.007)</td>
<td>0.065 (0.008)</td>
</tr>
<tr>
<td>Constant</td>
<td>12.213 (0.071)</td>
<td>10.05 (0.050)</td>
<td>2.309 (0.031)</td>
<td>0.144 (0.031)</td>
</tr>
<tr>
<td>Observations</td>
<td>10.811</td>
<td>10.811</td>
<td>10.811</td>
<td>10.811</td>
</tr>
<tr>
<td>Hausman test</td>
<td>(\chi^2(20) = 125.38)</td>
<td>(\chi^2(20) = 195.32)</td>
<td>(\chi^2(20) = 31.92)</td>
<td>(\chi^2(20) = 30.26)</td>
</tr>
</tbody>
</table>

*(in bold): statistically significant at 95 percent confidence level
*(in italics): statistically significant at 90 percent confidence level
Table 3.B.2: OLS estimators (standard errors in parentheses)

<table>
<thead>
<tr>
<th>Variable</th>
<th>annual income</th>
<th>monthly wages</th>
<th>annual supply</th>
<th>labour</th>
<th>unempl/empl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial education years</td>
<td>0.047 (0.002)</td>
<td>0.044 (0.001)</td>
<td>0.0007 (0.0007)</td>
<td>-0.0026</td>
<td>(0.0008)</td>
</tr>
<tr>
<td>Vocational education</td>
<td>-0.007 (0.001)</td>
<td>-0.007 (0.0008)</td>
<td>-0.0003 (0.0004)</td>
<td>-0.0005</td>
<td>(0.0005)</td>
</tr>
</tbody>
</table>

Followed adult education:
- General education after:
  - at workplace: 0.030 (0.016) 0.041 (0.012) -0.001 (0.006) 0.001 (0.007)
  - at school & workplace: -0.015 (0.016) -0.005 (0.012) -0.002 (0.007) 0.008 (0.007)
  - organised by employer services: -0.085 (0.014) -0.055 (0.010) -0.010 (0.007) 0.020 (0.006)
- Duration (weeks) of most recent course: -0.001 (0.0004) -0.0004 (0.0003) -0.00036 (0.00015) 0.00008 (0.00002)
- Experience: 0.035 (0.0018) 0.022 (0.001) 0.010 (0.0007) -0.002 (0.0008)
- Experience square: -0.0006 (0.00004) -0.0004 (0.00003) -0.00023 (0.00002) 0.00004 (0.00002)
- Services: 0.014 (0.008) -0.013 (0.006) 0.009 (0.003) -0.018 (0.004)
- Professionals: 0.166 (0.010) 0.144 (0.007) 0.012 (0.004) -0.010 (0.004)
- Residence: 0.030 (0.014) 0.031 (0.010) 0.009 (0.005) 0.010 (0.006)
- Wallon region: -0.021 (0.009) -0.018 (0.006) 0.006 (0.003) 0.005 (0.003)

Belgian: -0.053 (0.019) -0.073 (0.014) -0.006 (0.008) -0.025 (0.008)

Father education:
- Higher: -0.013 (0.011) 0.0004 (0.008) 0.004 (0.0045) -0.004 (0.004)
- Elementary or less: -0.020 (0.011) -0.021 (0.008) -0.006 (0.005) 0.015 (0.005)

Mother education:
- Higher: 0.035 (0.013) 0.026 (0.009) 0.006 (0.005) -0.003 (0.006)
- Elementary or less: -0.006 (0.010) -0.021 (0.008) 0.002 (0.004) 0.016 (0.005)

Married: 0.006 (0.009) -0.018 (0.007) 0.0002 (0.004) -0.021 (0.004)

Good health: 0.064 (0.011) 0.041 (0.008) 0.012 (0.005) -0.011 (0.005)

Age group 18-30: -0.062 (0.016) -0.023 (0.012) -0.004 (0.007) 0.034 (0.007)

Age group 46-65: 0.048 (0.015) 0.057 (0.010) 0.0005 (0.006) 0.009 (0.006)

Constant: 12.333 (0.040) 10.106 (0.029) 2.356 (0.016) 0.128 (0.018)

Observations: 10,811 10,811 10,811 10,811

(in bold): statistically significant at 95 percent confidence level
(in italics): statistically significant at 90 percent confidence level
Chapter 4

Retirement, education and the role of pension benefits

4.1 Introduction

The modern, developed societies we live in, are getting older. In the past decades, Western Europe has experienced a dramatic drop in birth rates. On the other hand, medical progress, the absence of war and improvement in living conditions, raised significantly the average age expectancy in Europe. Falling birth rates and increased life expectancy led to a significant ageing of the population. According to the European Commission, from 2010 the EU15 will start experiencing a fall in the total working age population and from 2020 a fall in the total population (EC, 2003a).

At the same time, employment and labour force participation of workers in the age group 55+ drops. Generous retirement benefits schemes and incentives for older workers to retire in order to deal with youth unemployment issues, have aggravated the problems. Europe falls significantly behind Japan and the US but also within Europe differences are important. Among European countries, Belgium holds one of the last positions (EC, 2003a) in employment and participation of older workers, while the Nordic countries perform significantly better.

These demographic changes cause major headaches to policy makers and economists. The social security and medical care systems are expected to be mostly hurt (EC, 2003a). Other implications are significant wage–productivity gaps (Hellerstein et al., 1996) that lead to increased labour costs, drops in the productivity, shortages in the labour force and uncovered vacancies in the European economies (EC, 2003b). For policy makers the answer to these problems is to increase labour force participation and employability of older workers; in
other words to postpone retirement and exit from the labour force for the age group 55+ (EC, 2003a,b, 2002). They propose education and training as means to keep older workers longer in the labour market.

So far, human capital has not been adequately examined as a factor that affects retirement decisions. The literature has mainly focused on the role of institutions, such as pension benefits or early retirement schemes (Pestieau, 2003; Dellis et al., 2001; Lumsdaine & Mitchell, 1999; Pestieau & Stijns, 1997), health care systems (Gruber & Madrian, 2002; Currie & Madrian, 1999), and on the role of several demand side factors, such as involuntary dismissal of older workers (for a good review of demand side factors see Lumsdaine & Mitchell (1999)). Lately the literature also deals with the effects of family structure and joint decisions within a couple (Gustman & Steinmeier, 2004; Blau, 1998), or by health condition of individuals (Currie & Madrian, 1999). Less attention has been drawn on the human capital–retirement relationship, despite the fact that they can be used relatively easy and without much political and social cost as a means to increase employability of older workers. The limited relevant works (Ferreira & Pessoa, 2007; Echevarria & Iza, 2006) discuss the effects of longevity (mortality) on both education and worklife duration. Then high skilled workers retire later but only because they have entered the labour market later.

Here we approach the education–retirement–benefit schemes relationship from a different perspective. Individuals get more education not because they discount future wages and future pension benefits and thus they prolong their stay in education as in Echevarria & Iza (2006), but because they have higher ability. Hence all workers enter the labour market at the same time but have acquired different levels of human capital. This is crucial, as in our model, postponing retirement implies a true increased duration of working lives rather than an increased age of leaving the labour market. We present analytically and expand a lifecycle model of human capital and earnings with endogenous retirement, initially developed by Alders (1999) (Section 4.3). Secondly we change the initial assumptions on retirement benefits and see how education affects retirement decisions under different pension schemes. The main result is that, in most cases, human capital postpones individual retirement decisions. However, the magnitude of this effect changes significantly from one pension scheme to the other, depending on the assumptions made on retirement benefits. When retirement benefits are strongly and positively connected to past earnings, the effect of human capital on time in the labour market is only marginally positive and may even become negative (Section 4.4.1.1). The more independent from past earnings are pension benefits the more incentives have high skilled workers to retire later (Section 4.4.3).
4.2 Some facts on retirement decision and pension systems

There are three different trends that are not easy to reconcile. On the one hand we have low and dropping labour force participation rates for older workers and low average exit age from the labour market (Duval, 2003; Blöndal & Scarpetta, 1999). On the other hand, the educational level of the population is continuously rising. Finally, policy makers insist that education and training will increase employability of older workers and keep them longer in the labour market. With these three elements the question simply has to be how the probability of being employed at a certain age has evolved through years and what was the role of education on it.

We used data from the Belgian Census for 1961 and 2001 to estimate probabilities of employment and examine the evolution through time. The sample includes males in the age group 50 to 65. We used a rather wide age group in order to get more observations, without changing the final results. The estimated model includes three variables: i) “year”, a dummy for 1961 or 2001, ii) “school”, for education years(1) and iii) “comb” ≡ year × school, to measure the joint effect of education and year. The reference year is 1961. Table 4.2.1 presents the coefficients and odds ratios and Table 4.2.2 presents the estimated employment probabilities for different levels of education. Figure 4.2.1 below shows graphically employment probabilities for different education levels.

Table 4.2.1: The effect of schooling on employment for males 50-65 (logit regression), Belgian Census 1961 and 2001

<table>
<thead>
<tr>
<th>variable</th>
<th>coefficient</th>
<th>st.error</th>
<th>odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>year</td>
<td>-2.401</td>
<td>0.128</td>
<td>0.091</td>
</tr>
<tr>
<td>school</td>
<td>0.051</td>
<td>0.015</td>
<td>1.053</td>
</tr>
<tr>
<td>comb</td>
<td>0.100</td>
<td>0.016</td>
<td>1.106</td>
</tr>
<tr>
<td>constant</td>
<td>0.803</td>
<td>0.109</td>
<td>1.09</td>
</tr>
<tr>
<td>sample size</td>
<td>14,169</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.2.2: Employment probabilities for different education levels, males 50-65, Belgian Census 1961 and 2001

<table>
<thead>
<tr>
<th>education</th>
<th>1961</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.752</td>
<td>0.335</td>
</tr>
<tr>
<td>9</td>
<td>0.780</td>
<td>0.442</td>
</tr>
<tr>
<td>12</td>
<td>0.805</td>
<td>0.556</td>
</tr>
<tr>
<td>15</td>
<td>0.828</td>
<td>0.664</td>
</tr>
<tr>
<td>17</td>
<td>0.842</td>
<td>0.728</td>
</tr>
</tbody>
</table>

1The “school” variable gets five different values: 6,9,12,15 and 17, each one corresponds to an education level
4. Retirement, education and the role of pension benefits

There are two issues to discuss here. First, between 1961 and 2001 there has been a dramatic drop in the employment probability for older workers for all education levels. This is shown in the downward shift in the employment probabilities curve in Figure 4.2.1 as well as in the negative “year” coefficient (Table 4.2.1). Between 1961 and 2001 the drop in the probability of being employed after the age of 50 has dropped on average by nine percentage points.

The second important issue is that between 1961 and 2001 we notice a significant increase in the human capital effect on employment probability. The increase results in a steeper probability curve for 2001. Human capital increases the probability of remaining in the labour market after the age of 50 and the effect is statistically significant both in 1961 and 2001. Moreover in 2001 there is an extra education gain in the probability of employment.

In the sections below we develop a theoretical model that helps explain why education keeps workers longer in the labour market and why this effect is stronger in 2001 than in 1961. Before concluding the paper we will briefly discuss the drop in employment for all education levels; however we will not go into depth since this is not the primary issue here.
4.3 A lifecycle model of earnings with endogenous retirement.

4.3.1 Individual utility and the budget constraint

We assume retirement to be an endogenous decision. Individuals work full-time while at the labour market; after retirement all of their free time is consumed as leisure. These assumptions rule out the possibility of a full-time work/part-time work/retirement transition path, as well as the possibility of multiple transitions from the labour market to retirement and vice versa. These assumptions contrast the classical works in the field (Ben-Porath, 1967) where retirement is assumed exogenous and therefore not affected by human capital. Also contrary to the classical literature, where they maximise individual wealth, here we maximise individual lifetime utility.

The value function is:

\[
\int_0^{T_r} U(c, 0)e^{-\beta t} dt + \int_{T_r}^{T} U(c, 1)e^{-\beta t} dt
\]  

(4.3.1)

where \(c(t)\) is consumption at time \(t\)
\(U(c, l)\) is individual utility function
\(T\) is the moment of physical death
\(T_r\) is the moment of retirement
\(\beta\) is the rate of time preference. The utility function is strictly concave both in consumption and the period of retirement \((T - T_r)\). Moreover the utility function is continuous in \(T_r\).

We follow the simplifying assumption of Alders (1999) about the utility and consumption functions to facilitate computational work. First we assume that the utility function is separable in leisure and consumption

\[
U(c, 1) = u(c) + \nu(1)
\]  

(4.3.2)

The utility function of consumption if of the form

\[
\nu(t) = \frac{1}{1 - 1/\rho} c(t)^{1-1/\rho}
\]  

(4.3.3)

where \(\rho\) is the rate of intertemporal substitution and \(0 \leq \rho \leq \infty\). Smaller values of \(\rho\) imply a bigger preference for the present. Finally, consumption at each moment \(t\) is:

\[
c(t) = c(0)e^{\rho(r-\beta)t}
\]  

(4.3.4)

where \(r\) is the credit market interest rate. The slope of the consumption function depends on \(\rho(r - \beta)\). When \(r > \beta\), the consumption path of goods slopes upwards.

Individuals optimise their value function (4.3.1) under a budget constraint. We assume a perfect credit market, where individuals can borrow freely, at an
interest rate $r$. However, at the end of their lifetime (at $T$) individuals must have zero assets; therefore, they cannot die in debt nor leave a bequest.

The individual budget constraint is a function of the time of retirement, since retirement is endogenous. It is also divided in two parts: before and after retirement.

While at the labour market, the individual receives income from work and accumulated assets (excluding human capital) and spends on consumption. Therefore his asset accumulating function before retirement is:

$$\dot{a}(t) = wH(t)(1 - s(t)) + ra(t) - c(t) \quad (4.3.5)$$

where $a(t)$ are assets
$r$ is the interest rate
$w$ is the effective net wage
$H(t)$ is the stock of human capital and
$s(t)$ is schooling, with $0 \leq s(t) \leq 1$.

We see that labour income depends on three factors $w, H(t)$ and $s(t)$. $w$ is a fixed wage which implies that there is no heterogeneity among jobs. The net wage is $w = \hat{w}(1 - \tau)$, where $\hat{w}$ is the effective gross wage and $\tau$ the tax rate on wage income. Even though there is no heterogeneity among workers through $w$, high skilled workers receive more money from work because they have a higher $H$. Finally, there is a trade-off between work and education as workers with higher $s$ have lower income from work.

After retirement, individuals receive some form of retirement benefits and the budget constraint becomes:

$$\dot{a}(t) = b(t) + ra(t) - c(t) \quad (4.3.6)$$

where $b(t)$ are retirement benefits. We assume that $b(t)$ is a function of time, paid after the mandatory retirement age. This setting does not exclude the possibility of other social security payments paid before the mandatory retirement age. However, any retirement benefits paid before or after mandatory retirement has to be independent of human capital. This exclusion implies that retirement benefits are independent of past income history, which is not a very realistic assumption. In most European social security systems, including Belgium, retirement benefits depend on past individual income and therefore on human capital. For now we follow Alders’ assumption of retirement benefits independent from human capital and relax this assumption later.

As we mentioned before, at the end of his life, the worker may have no debts neither leave any positive assets. Therefore $a(T) = 0$. We also assume that $a(0) = a_0$ and $a(T_r) = a_{T_r}$. We will now proceed with the discussion of the production and accumulation of human capital which is the central point of this model.
4.3.2 Human capital accumulation and production

At the beginning of his life an individual is full time in education. When entering the labour market at time 0 he is endowed with human capital $H(0)$.

After entering the labour market, the employee shares his time between work and learning (on the job training - OJT). Human capital is accumulated by OJT along the lines of the Ben-Porath model. Besides OJT the human capital is also accumulated by “learning-by-doing”. In the Alders model only jobs and sectors differ in the rate of “learning-by-doing” and not individuals. An employee accumulates human capital when using existing and new technologies at work. The stock of human capital is subject to an exogenous (here) rate of depreciation. Depreciation is a result of two different factors. First, as workers grow older they forget knowledge and their physical condition deteriorates. Second, new technologies make human capital obsolete.

The human capital accumulation function is then:

$$\dot{H}(t) = [g(s(t)H(t)) + kH(t)] - \delta H(t)$$

(4.3.7)

where $k$ is the rate of learning-by-doing
$\delta$ is the exogenous depreciation rate and
$g(sH)$ is the human capital production function.

The human capital function is strictly concave. For analytical convenience we assume that

$$g(sH) = \alpha_o(sH)^2$$

(4.3.8)

A simplifying assumption here is that individual learning efficiency on the job equals individual learning efficiency during the schooling period.

The stock of human capital at each point in time $t$ is the solution of the differential equation (4.3.7) using (4.3.8) and an expression for $(sH)$ . The analytical solution is presented in the next Section 4.3.3 and in Appendix 4.A.

4.3.3 The retirement decision

After discussing the main variables and equations of the model we are going to solve the maximisation problem of the individual and discuss retirement decisions. The individual maximises his value function (4.3.1) subject to the budget constraint (4.3.5), (4.3.6) and the human capital accumulation function (4.3.7). The Langrangian is then:

$$\mathcal{L} = \int_0^T \left\{ U(c, 0)e^{-\beta t} - \mu[H - g(sH) - Hk + \delta H] - \lambda[\dot{a} - wH(1 - s) - ra + c] \right\} dt$$

$$+ \int_{T_r}^T \left\{ U(c, 1)e^{-\beta t} - \lambda[\dot{a} - b + ra + c] \right\} dt$$

(4.3.9)
Assuming an interior solution to the problem the first order conditions with respect to $H, c, sH, a$ and $T_r$ are:

$$\dot{\mu} = (\delta - g's - k)\mu - \lambda w(1 - s), \quad (t < T_r) \quad (4.3.10)$$

$$U_c e^{-\beta t} - \lambda = 0 \quad (4.3.11)$$

$$\mu g' - \lambda w = 0, \quad (t < T_r) \quad (4.3.12)$$

$$\dot{\lambda} = -r\lambda \quad (4.3.13)$$

$$(U(c(T_r,0)) - U(c(T_r,1)))e^{-\beta t} + \lambda(T_r)(wH(T_r)(1 - s(T_r)) - b(T_r)) = 0 \quad (4.3.14)$$

The first order conditions (4.3.10), (4.3.11), (4.3.12) and (4.3.13) are easy to get from (4.3.9). The f.o.c with respect to $T_r$ demands more computations, which we present in Appendix (4.A.1).

The first order condition with respect to $T_r$ gives us the individual retirement decision. We use (4.3.11), (4.3.2), (4.3.3) and (4.3.4), to rewrite the f.o.c with respect to $T_r$ as:

$$v(1)e^{(r - \beta)T_r} = c(0)^{-1/\rho}(wH(T_r) - b(T_r)) \quad (4.3.15)$$

At the moment of retirement, the utility of leisure (retirement) equals the utility of additional consumption when prolonging the working period. If the utility from leisure is larger than the utility of continuing working, then the worker retires. Otherwise he remains in the labour market. As we can see from (4.3.15), the retirement decision depends on human capital, both through the consumption profile and the shadow price in terms of consumption of continuing work. To ensure that work precedes retirement we need $wH(t) \geq b(t)$ for $t \leq T_r$ to hold.

Before going deeper into the analysis of the effect of human capital on the retirement decision we derive specific expressions for $s(t)H(t)$, the demand for investment in human capital, $H(t)$, the stock of human capital and $c(0)$. We begin with the demand for human capital.

From (4.3.12) we get that: $\mu g' = \lambda w$. Substituting this expression into (4.3.10), we get:

$$\dot{\mu} = (\delta - k)\mu - \lambda w \quad (4.3.16)$$

We define the ratio of the shadow price of human capital to the shadow price of assets by $\sigma(t)$:

$$\sigma(t) = \frac{\mu(t)}{\lambda(t)} \quad (4.3.17)$$

Differentiating expression (4.3.17) with respect to $t$ and using the expressions for $\dot{\mu}$ and $\dot{\lambda}$ from (4.3.16) and (4.3.13) we get:

$$\dot{\sigma}(t) = (r + \delta - k)\sigma(t) - w \quad (4.3.18)$$
A lifecycle model of earnings with endogenous retirement.

Solving the differential equation (4.3.18) we get the general solution for $\sigma(t)$:

$$\sigma(t) = \frac{w}{r + \delta - k} [1 - e^{(r + \delta - k)(t - T_r)}]$$ (4.3.19)

From (4.3.19) we get an expression for the relative price of human capital in terms of non-human capital. It is easy to check that for $t \leq T_r$ $\sigma(t)$ declines monotonically with age.

The next step is to get an explicit expression for the demand function for investment in human capital $s(t)H(t)$. In Section 4.3.2 we defined the human capital production function as: $g(sH) = \alpha_o(sH)^2$ (see 4.3.8), which is strictly concave and where $\alpha_o$ is individual learning ability. Using the fact that $g(sH)$ is differentiable in $sH$ and the equations (4.3.12), (4.3.17) and (4.3.19) we can easily get an expression for $sH$:

$$s(t)H(t) = \frac{\frac{1}{4}\alpha_o^2}{(r + x)^2} [1 - e^{(r + x)(t - T_r)}]^2$$ (4.3.20)

where, $x = \delta - k$ is the net rate of depreciation. We assume that $r + x > 0$, which guarantees a positive investment in human capital. As we show in Appendix (4.A.4), the demand function for investment in human capital depends on the relative shadow price of human capital. It is monotonically decreasing in $t$ and because $\sigma(T_r) = 0$, $s(T_r)H(T_r) = 0 \Rightarrow s(T_r) = 0$ since at the moment of retirement the stock of human capital is different from zero. Differentiating (4.3.20) twice with respect to $t$ we can easily see that the investment in human capital is concave when $t < \frac{1}{(r+x)} \log \frac{1}{2} + T_r$ and convex when $t > \frac{1}{(r+x)} \log \frac{1}{2} + T_r$.

The investment in human capital does not depend on the wage rate $w$, because an increase in $w$ increases linearly both the return on human capital and the opportunity cost of training.

There are two forms of heterogeneity in human capital between individuals: they differ in learning efficiency during schooling (initial human capital) and learning efficiency in OJT. We assume here that learning efficiency during schooling, equals learning efficiency in the labour market, $\alpha_o$. Hence, from equation (4.3.20), we get that for $t = 0$, i.e. when entering the labour market, $H(0) \approx (\alpha_o)^2(6)$.

Now that we have an explicit expression for the investment in human capital $s(t)H(t)$, we can solve differential equation (4.3.7) to get the stock of human capital at each point in time $t$. The solution to (4.3.7)(7) is:

$$H(t) = e^{-xt} \int_0^t \frac{\frac{1}{4}\alpha_o^2}{(r + x)^2} [1 - e^{(r + x)(u - T_r)}] e^{ru} du + H(0)e^{-xt}$$ (4.3.21)

4See solution for differential equation in Appendix (4.A.3)
5See the explicit solution in Appendix (4.A.4)
6At $t = 0$, $s(0) \approx 1$ and $x \approx 0$. Also $0 \leq r \leq 1$
7See Appendix (4.A.5)
4. Retirement, Education and the Role of Pension Benefits

Equation (4.3.21) gives us the accumulated human capital at each age. The first part in the RHS is the human capital that the worker has accumulated from the moment he enters the labour market until his present age, due to OJT and learning by doing. The second part of the RHS is the human capital that the worker has when he enters the labour market. Therefore it is the human capital from initial education (schooling). As we also said before, both initial and after school human capital differ among agents, due to heterogeneity in learning ability \( \alpha \).

Finally we need an expression for initial consumption \( c(0) \). From the budget constraint (4.3.5) and (4.3.6) and the human capital equation (4.3.21) we can rewrite the total budget of the individual as:

\[
\frac{c(0)}{r - \rho(r - \beta)} [1 - e^{(\rho(r-\beta) - r)T}] = \\
\int_0^{T_r} \left[w[H(t) - \frac{1}{(r + x)^2} \left[1 - e^{(r+x)(t-T_r)}\right]^2]e^{-rt} dt + \int_{T_r}^{T} b(t)e^{-rt} dt + a(0)\right] \\
\text{(4.3.22)}
\]

Let us also rewrite (4.3.15) as a function of \( T_r \) and \( c(0) \):

\[
f(T_r, c(0)) = c(0)^{-1/\rho}(wH(T_r) - b(T_r)) - v(1)e^{(r-\beta)T_r} \\
\text{(4.3.23)}
\]

Replacing for \( c(0) \) from (4.3.22) we have a function in one variable \( T_r \). The sign of (4.3.23) determines whether the employee is retired or in the labour market. With \( f(T_r, c(0)) > 0 \) the marginal utility of consumption of prolonging the working period is higher than the marginal utility of retirement.

To examine the effect of human capital on retirement decisions it is sufficient to examine the effect of learning skills on retirement. We have discussed thoroughly in the previous (4.3.2) and the present section the heterogeneity in learning skills \( (\alpha) \) and how it affects the stock and the flow of human capital. We have underlined that for computational ease we assume that efficiency in learning is the same during schooling years and OJT. Using the expression \( H(0) \approx \alpha_0^2 \), and equations (4.3.21) and (4.3.22) we see that the effect of \( \alpha_0 \) on \( f(T_r, c(0)) \) is: \( ^8 \)

\[
\frac{\partial f}{\partial \alpha_0} = -1/\rho \int_0^{T_r} wH(t)(1-s(t))e^{-rt} dt \\
\text{(4.3.24)}
\]

High skilled workers retire later when \( \frac{\partial f}{\partial \alpha_0} > 0 \), that is when \( ^9 \):\n
\[
-1/\rho \int_0^{T_r} wH(t)(1-s(t))e^{-rt} dt + \int_{T_r}^{T} b(t)e^{-rt} dt + a(0) > 0 \\
\text{if} \ wH(T_r) - b(T_r) > 0 \\
\text{(4.3.25)}
\]

\( ^8 \) see Appendix (4.A.5)  
\( ^9 \) By dividing (4.3.24), with: \( \frac{2}{wH(T_r)}(wH(T_r) - b(T_r))c(0)^{-1/\rho} \)
Retirement decisions under different retirement benefits schemes

The first term (4.3.25) (excluding $1/\rho$) is the ratio of lifetime work income to total lifetime earned income. It is an income effect and it is easy to check that it is negative and smaller than 1 in absolute value. This income effect implies that high skilled workers have a higher lifetime income. For them, leisure is less expensive in terms of consumption and they have a higher demand for leisure. If the income effect prevails then high skilled workers leave the labour market earlier.

The second term is a substitution effect and more specifically it is the ratio of wages to wage premium at the moment of retirement. It is again easy to see that the substitution effect is positive and larger than one. High skilled workers earn at each point in time better wages. As a result, retirement implies a higher opportunity cost making leisure more expensive in terms of consumption. When the substitution effect prevails, high skilled workers retire later.

Which one of the two effects is stronger depends on the level of $\rho$, that is the level of the intertemporal rate of substitution. For $\rho > 1$ the substitution effect is larger. This holds also for lower levels of $\rho$ as long as retirement benefits or initial assets are positive. Only for levels of $\rho$ close to zero (that is when workers have a very strong preference for the present) the income effect is stronger and high skilled workers retire earlier.

For ease of interpretation and later comparison between different retirement benefit schemes we rewrite equation (4.3.25). We set:

$CEI_A \equiv \int_0^{T_r} w(t)(1 - s(t))e^{-rt}dt$, the accumulated earned income from labour,

$CB_A \equiv \int_0^{T_r} b(t)e^{-rt}dt$, accumulated retirement benefits,

$IA \equiv \alpha(0)$, initial wealth (not earned from work)

$EI_A \equiv wH(T_r)$, income from labour at the moment of retirement

$B_A \equiv b(T_r)$, retirement benefits received upon retirement. Moreover, we set:

$CRR_A \equiv \frac{CB_A}{CEI_A}$, the cumulated replacement rate and

$RR_A \equiv \frac{B_A}{EI_A}$ the replacement rate.

Following this notation we rewrite (4.3.25):

$$-\frac{1}{\rho} \frac{1}{1 + CRR_A + \frac{IA}{CEI_A}} + \frac{1}{1 - RR_A} > 0 \quad (4.3.26)$$

This simplified notation will make it easier to compare the effect of education on retirement decisions under different pension benefit schemes. In the sections below we relax the assumption of uniform retirement benefits.

4.4 Retirement decisions under different retirement benefits schemes

Human capital, here, affects retirement decisions through wage income. High skilled workers receive higher wages. They form their retirement decisions comparing the opportunity cost of retirement with the smaller price of leisure in
4. Retirement, education and the role of pension benefits

terms of consumption due to higher lifetime income.

Up to now, we have assumed uniform retirement income across workers. However retirement benefits in real life usually depend on past and present income; therefore they also depend on human capital. Especially for Belgium, retirement pensions are a complicated function of past income, years in the labour market and family structure. There are also “floors” and “ceilings” in pensions. For detailed descriptions on the Belgian social security system and its consequences on retirement benefits, one should refer to the “Office National des Pensions” (www.onprvp.fgov.be), to Dellis et al. (2001) and Pestieau & Stijns (1997).

First we assume that retirement benefits are a linear combination of a fixed and a variable part that depends on previously earned labour income. For simplicity, here the variable part of retirement benefits depends on income at the moment of retirement and not on past income history. Under these assumptions retirement benefits are:

\[ b(t) = \lambda \hat{b}(t) + (1 - \lambda)\gamma(t)wH(t), \quad \hat{b}(t) \in [\underline{b}, \bar{b}] \quad \text{and} \quad 0 \leq \lambda \leq 1 \]  

(4.4.1)

For \( \lambda = 1 \) we return to the Alders model above. Retirement benefits then depend only on the time and not on individual income and human capital.

For \( \lambda = 0 \) \( b(t) = \gamma(t)wH(t) \). Retirement benefits are an increasing function of worker’s income and thus human capital. In section 4.4.1.1 we discuss this case.

The third case is when \( 0 < \lambda < 1 \). We discuss it in section 4.4.1.2.

Finally, we discuss the case of “floors” and “ceilings” in section 4.4.2, by assuming that replacement rate is negatively related to past income. For analytical purposes we use the uniform benefits model as a benchmark (which we call “Alders” model for convenience, since we base our analysis on the relevant paper). In each case we do not replicate the whole model but just use the relevant equations.

4.4.1 Retirement benefits with a constant replacement rate

Let us first discuss here shortly the replacement rate \( \gamma \). By definition, \( \gamma \) is the share of wage income the worker receives as retirement benefits and formally we set \( \gamma(t) \equiv \frac{b(t)}{wH(t)} \). First we discuss the case when \( \gamma \) is exogenous and constant. Below we introduce “floors” and “ceilings” in retirement benefits and we will show how this assumption leads to variable \( \gamma \) dependent on individual income.

4.4.1.1 Retirement decisions with \( \lambda = 0 \) and \( \gamma(t) \equiv \gamma \)

We examine first the case with a constant replacement rate and only a variable part. That is, retirement benefits are a constant share of the worker’s wage: \( b(H(t)) = \gamma wH(t) \). Since \( \gamma \) is independent of human capital, human capital affects retirement benefits only via wage income. For simplicity we take only
the last wage into account when we calculate the amount of retirement benefits. In reality, the calculations for the retirement benefits are based on the income of several years prior to retirement (in Belgium it is the weighted average of the five years prior to retirement); however this would complicate our model, without adding much.

Let us see how the initial model changes with the assumption that pensions are a constant share of individual income. Here, human capital affects workers’ wages; moreover it affects retirement income. High skilled workers receive higher wages and higher pension benefits. Inevitably, this also affects their retirement decisions.

The individual utility function remains the same as in equation (4.3.1). The assumptions we made on the utility and consumption functions also remain the same (see 4.3.2, 4.3.3 and 4.3.4). However, we shall rewrite the individual budget constraint, as:

\[ \dot{a}(t) = wH(t)(1 - s(t)) + ra(t) - c(t) \quad \text{for} \quad t \leq T_r \]  
\[ \dot{a}(t) = \gamma wH(t) + ra(t) - c(t) \quad \text{for} \quad t > T_r \]

The solution of the model is equivalent to the Alders solution. We skip here the analytical presentation of the formulas. This is done in Appendix 4.B. Following the simplified notation we set in the previous section we get:

\[ -1/\rho + \frac{1}{C_{ElC} + C_{H_C}} + 1 > 0 \] (4.4.4)

The first term in the LHS is the income effect, which is now larger than in the Alders case. High skilled workers have a higher full income not only because they receive higher wages during their working careers, but also because they receive higher benefits when they retire. Leisure (retirement) is less costly in terms of consumption compared to the Alders model of uniform retirement benefits. As a result, high skilled workers have a higher incentive to retire earlier when they receive a constant share of their wages as old-age pension.

The second term in the LHS is the substitution effect. Contrary to the Alders case where the substitution effect was larger than one, here it equals unity, i.e. it is smaller. In the Alders model, high skilled workers faced a higher opportunity cost of retirement due to higher wages. Here high skilled workers do not face such a cost. All workers, irrespective of their education, loose the same share i.e. \((1 - \gamma)\) of their past income. Therefore, the substitution effect is 1, implying that it is independent of human capital.

When do high skilled workers retire later? In the case of non-zero initial assets \((IA > 0)\), condition (4.4.4) holds clearly for \(\rho \geq 1\). For \(\rho < 1\), high skilled workers can also choose to retire later as long as initial assets are adequately high. In the case of \((IA = 0)\), high skilled workers retire earlier for \(\rho < 1\) and later for \(\rho > 1\). A special case is when \((IA = 0)\) and \(\rho = 1\). Then \((\dot{\psi}_f - \dot{\psi}_a)C = 0\)
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and human capital has no effect on retirement decisions. The income and substitution effects exactly offset each other because with a constant \( \gamma \), human capital introduces no heterogeneity among workers. They all receive a fixed share of their past income when they retire.

Clearly the analysis above showed that when we relax the assumption of uniform retirement benefits and we introduce retirement benefits as constant share of past income, high skilled workers retire later in significantly less cases compared to the Alders model. The assumptions we make on the structure of the pension system are critical for the results.

4.4.1.2 Retirement decisions when \( b(t) = \lambda \hat{b}(t) + (1 - \lambda) \gamma w H(t) \)

We examine now the general case, when retirement benefits have two parts: one that is constant and one that is dependent on past income and human capital\(^{10}\) (see equation 4.4.1). The results now will be a combination of the Alders case and the case in section 4.4.1.1.

The income effect should be larger than in the Alders case because high skilled workers have higher full income due to higher wages and higher retirement benefits. However, it should be smaller than in the case with only a variable term since \( 0 < \lambda < 1 \).

The substitution effect should be smaller than in the Alders case since high skilled workers receive higher retirement benefits and the opportunity cost of retirement is lower for them. On the other hand, since part of retirement benefits is independent of past earnings, the substitution effect should be larger than in the Section 4.4.1.1.

The analytical solution of this model is equivalent to the methodology we followed in both previous sections. Appendix 4.C presents the analytical expression of the retirement decision. Therefore, we omit most of the details here. Solving \( \frac{\partial L}{\partial \alpha_o} \) for \( b(t) = \lambda \hat{b}(t) + (1 - \lambda) \gamma w H(t) \), high-skilled workers retire later when:

\[
-1/\rho \left[ 1 - (CRR_A - \lambda CRR_A) + \frac{1}{CRR_A + \frac{\lambda}{CRI}} \left( 1 + \frac{(RR_A - \lambda RR_A)}{1 - RR_A} \right) > 0 \quad (4.4.5) \right.
\]

One can easily check that \( CRR_A = \lambda CRR_A + (1 - \lambda) CRR_C \) and equivalently for \( RR \). This is an immediate consequence from the construction of the retirement benefits. Again we cannot determine what is the sign of the above expression unless we make specific assumptions for \( \rho \). We can say however, that the first part in expression 4.4.5 i.e. the income effect is negative and smaller than 1 (in absolute value). The substitution effect is positive and larger than 1. We can easily check that for \( 0 < \lambda < 1 \) the results are in between the Alders model and the variable retirement benefits case. We can say that high skilled workers have more incentives to stay longer in the labour market with fixed retirement

\(^{10}\)We assume constant replacement rate.
benefits, and more incentives to retire earlier when retirement benefits depend on past earnings. Under a pension scheme partly fixed and partly dependent on past earnings, high skilled workers stay longer in the labour market compared to fully variable retirement benefits case and retire earlier than in the Alders case.

4.4.2 Variable replacement rate

As a general rule replacement rates in Belgium are independent of past income (Desmet et al., 2003; Dellis et al., 2001; Pestieau & Stijns, 1997). For example a private sector employee receives 75 per cent of his past income if he is in a single earner household and 60 per cent if he is in a two-earners household. However, there are floors and ceilings to the amount of money a worker may receive as retirement benefits. As a result, the assumption of a constant replacement rate holds only for $\gamma w H(t) \in (b, B)$. For $\gamma w H(t) < b$ workers always receive $b$ implying higher replacement rates for low wage earners. Similarly, for $\gamma w H(t) \geq B$, workers receive $B$, resulting to lower replacement rates for high wage earners.

To include this into the analysis, we assume that $b(t) = \gamma (H(t)) w H(t)$, with $\frac{\partial \gamma(H(t))}{\partial H(t)} < 0$. Human capital now affects individual retirement benefits via past income and the replacement rate. Again we present here the simplified form of retirement decisions. The analytical solution is in appendix 4.D. Again human capital positively affects time spent in the labour market when:

$$\frac{-1}{\rho} \left( \frac{1 + CRR_V + \left[ \int_{T_v}^{T} w H(t) \frac{\partial \gamma}{\partial H} e^{-rt} dt \right]}{1 + CRR_V + \frac{IA}{CEV}} ight) + 1 - \frac{H(T_v) \frac{\partial \gamma}{\partial H}}{1 - RR_V} > 0 \hspace{1cm} (4.4.6)$$

This expression is clearly more complicated compared to the previous cases. Again the first part in the LHS is the income effect and the second part is the substitution effect. Let us remind here that: $\frac{\partial \gamma}{\partial H} < 0$, therefore the substitution effect is clearly positive and larger than 1. As high skilled workers receive a smaller part of their work income when retired, compared to the low skilled, they have an incentive to stay longer in the labour market. On the other hand, as long as $0 < CRR_V + \left[ \int_{T_v}^{T} w H(t) \frac{\partial \gamma}{\partial H} e^{-rt} dt \right] < 1$, the income effect is negative and smaller than 1. In the following section we compare the three retirement systems (uniform benefits, constant replacement rate and variable replacement rate).

4.4.3 Comparing retirement incentives for high skilled workers under different benefit schemes

Human capital affects retirement decisions, but the sign and magnitude of this effect depends on several factors such as the rate of intertemporal substitution $\rho$, the size of initial assets $a(0)$ and the pension benefits scheme.

$\rho$ changes the magnitude of the income compared to the substitution effect.
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According to the results above, high skilled retire later for \( \rho \geq 1 \) and also for \( \rho < 1 \), as long as initial assets or retirement benefits are non-zero. High skilled could be retiring earlier when the intertemporal substitution of consumption for future leisure is close to zero. While some works have estimated the intertemporal substitution to be very low and even close to zero (Hall, 1988), most empirical works in the field report much larger \( \rho \)'s, above 0.5 and some are even close to 1 (Koskievic, 1999; Hahn, 1998; Kugler, 1988; Barro & King, 1985). These estimates are large enough, so we can safely expect that high skilled will retire no earlier than the low skilled. We keep this in mind in the discussion below.

Initial assets \( a(0) \) also change the magnitude of the income effect. Higher values of initial assets imply that income from work has a smaller share in full income. Therefore the income effect shrinks. What this means is that for the same level of initial assets high skilled workers have more incentives to retire later than the low skilled. However employees with higher levels of initial assets will retire earlier, since the utility of consumption from additional working is smaller for them. For the present analysis, we focus on the first effect of initial assets.

What we want to discuss now is how the three benefit cases (Alders case, constant replacement rate and variable replacement rate) compare to each other depending on the incentives they create for high skilled to retire. For the fourth case \( 0 < \lambda < 1 \) we can easily see that it lies somewhere between the Alders case and the constant replacement rate case.

To compare the three cases we use here the simplified equations (4.3.26), (4.4.4) and (4.4.6). As we are only interested in the relative position of the three regimes as to one another we can safely also set the rate of intertemporal substitution to be the same for all cases and equal to 1, and that there are no initial assets. In that way the algebraic expressions are significantly simplified with no loss of generality. The effect of human capital on retirement for the three regimes becomes:

**Alders model**

\[
\left( \frac{\partial f}{\partial a_o} \right)_A = -\frac{1}{1+CRR_A} + \frac{1}{1-RR_A}
\]

**Constant replacement rate**

\[
\left( \frac{\partial f}{\partial a_o} \right)_C = 0
\]

**Variable replacement rate**

\[
\left( \frac{\partial f}{\partial a_o} \right)_V = -\frac{1+CRR_V + \int_{T_{ret}}^T \frac{w_{H}(t) \frac{\partial h}{\partial a_o} - r t}{1-CR_H} dt}{1+CRR_V} + (1 - \frac{H(T_r) \frac{\partial H}{\partial a_o}}{1-RR_V})
\]

The first point to comment is that the constant replacement rate regime gives the least incentives for high skilled to postpone retirement. Here, coincidently the effect is 0 which allows us to clearly see this point. Intuitively, with this regime, all workers receive a fixed share of their past income when they retire, which is clearly shown by the substitution effect being 1. Heterogeneity among high and low skilled is only due to the income effect. Then compared to the
other two regimes, heterogeneity from human capital is minimal.

In the other two regimes human capital introduces some sort of heterogeneity that makes leisure more expensive in terms of consumption for better educated workers. In the Alders case high skilled workers receive a human capital premium in their wages but they loose this premium once they retire (uniform retirement benefits). In the variable replacement rate case, they receive a higher lifetime income, and they can integrate part of this human capital premium (but not all) to their pensions.

We can not easily determine whether it is the Alders model or the variable replacement rate regime that create more incentives for high skilled workers to leave the labour market later. This is because in the variable replacement rate case we end up with a larger income effect than in the Alders case. High skilled workers have a higher lifetime income because they receive a part of their wage income in their pension benefits (even though at a diminishing rate). Compared to the Alders case, high skilled workers have more incentives to exit the labour market earlier. On the other hand the substitution effect is larger in the variable replacement rate regime. At the moment of retirement, high skilled workers receive a smaller share of their past income as retirement benefit compared to low skilled workers. As a result they have more incentives to stay longer in the labour market compared to the Alders regime. Which of the two effects prevails depends on the specific form of $\gamma(H(t))$ and the magnitude of $\vartheta\gamma(H(t))/\vartheta H(t)$. In general if the replacement rate falls sharply with human capital (i.e. the larger is $\vartheta\gamma(H(t))/\vartheta H(t)$), the magnitude of the income effect becomes smaller and the magnitude of the substitution effect becomes larger and the variable replacement rate regime gives more incentives for high skilled workers to retire later.

Summarizing the order of the magnitude of the human capital effects on retirement decisions for the different retirement schemes we get: $(\vartheta f/\vartheta a)_C < (\vartheta f/\vartheta a)_A < (\vartheta f/\vartheta a)_V$ OR $(\vartheta f/\vartheta a)_C < (\vartheta f/\vartheta a)_V < (\vartheta f/\vartheta a)_A$.

If we relax the assumptions on $\rho$ and we allow it to be quite small and the human capital effects to become even negative, then the above relations between the three regimes still hold. The discussion however changes, since now under the constant replacement rate, high skilled have more incentives to quit the labour market earlier compared to the other two schemes.

The work we did so far in estimating the education effect on retirement under different pension schemes helps explain the rising in the slope of the probabilities curve estimated in Section 4.2, (see Tables 4.2.1, 4.2.2 and Figure 4.2.1). According to the theory described above, the rise in the education effect on employment probability can possibly be explained in general by a drop in the replacement rate for high skilled workers.

We did not manage to find comparable data on replacement rates and pen-
4. Retirement, education and the role of pension benefits

Blöndal & Scarpetta (1999) calculate replacement rates for a 55-year old worker, using gross income. They report a 0.69 gross replacement rate (GRR) for a worker with 66% of average earnings and 0.60 GRR for a worker with 100% of average earnings in 1961. For 1995 the GRR is 0.60 for both income groups. These results are in contrast with the theoretical findings. According to our model, education has a bigger positive effect on employment probabilities in 2001, because the old age pension benefit system gave more incentives to less skilled workers to retire. However, as we mentioned above these are only gross replacement rates. In their paper, Pestieau & Stijns (1997) show that net replacement rates (NRR) are significantly larger than gross replacement rates but they are decreasing with income. That is because taxation in Belgium is income progressive, old age benefits are favourably taxed compared to wage income and furthermore because there are floors and ceiling in received benefits. More specifically they report that the NRR for a single worker who earned only the two thirds of average income was around 0.91 in 1991. The same replacement rate was 0.80 for a worker who earned 100% of average earnings and 0.60 for someone who earned double the average earnings. Assuming that the relationship between GRR and NRR was similar also for 1961 and 2001, then high skilled workers have been facing significantly lower NRRs compared to low skilled workers and the gap should have widened further in 2001.

Going back to the Blöndal & Scarpetta (1999) paper, they also report disability benefit replacement rates (gross). In 1961 these replacement rates were around 0.40 for all workers. In 2001 this replacement rate was 0.53 for low earners and only 0.45 for high earners. At the same time disability and other non-work benefit schemes have become the path to early retirement for Belgian workers. While in 1961 only around 35% of workers 55 and above received some form of old age benefit (work or non-work), this percentage rose to over 65% in 1995. This result was mainly because it became easier for workers to exit the labour market earlier than the normal retirement age by claiming some sort of disability benefit or mandatory retirement benefits. These paths to early retirement became mainly available to those working in low skilled sectors such as manufacturing, mining, construction etc. Thus we get another possible explanation why the human capital effect on employment has risen between 1961 and 2001.

4.5 The downward shift in employment probabilities for older workers

Up to this point we have discussed extensively the reasons why the effect of education on employment probabilities has risen during the past forty years. When high skilled workers are “penalised” by receiving lower share of their past
The downward shift in employment probabilities for older workers

income as pension, then they usually postpone their decision to retire and stay longer in the labour market. However, between 1961 and 2001 the probability of being at work after the age of 50 has dropped significantly for all education groups and the rise in the education effect was not capable to cover the gap, even for the best educated groups.

The Alders model gives some possible answers to this dramatic drop in employment of older workers. We will discuss it briefly, since the main focus is on the slope rise and the education effects. We turn to equation 4.3.23:

\[ f(T, c(0)) = c(0) - \frac{1}{\rho} (w H(T) - b(T) - v(1)e^{(r-\beta)T}). \]

We remind that the sign of \( f(T, c(0)) \) determines whether a worker is retired or not. It is easy to check that \( \frac{\partial f}{\partial b} < 0 \), so a (positive) shock in \( b(t) \) increases incentives to retire. Workers receive more income after retirement, so the value of extra consumption decreases and furthermore the incentives for extra working decrease.

Things are not as simple as to say that the level of retirement benefits rose in Belgium between 1961 and 2001. However, there were several factors that made retirement more attractive to workers irrespective of their education level.

Let us summarise here briefly the characteristics of a pension system that help shape individual retirement decisions. The first that we discussed here in extent is the replacement rate i.e. the share of past income a worker receives after retirement. In their working paper Pestieau & Stijns (1997) report that the net replacement rate has sharply increased after 1984, even though the gross replacement rate has remained relatively stable (Pestieau & Stijns, 1997) or even decreased (Blöndal & Scarpetta, 1999).

A second decisive factor that shapes incentives to retire is the pension accrual rate, i.e. the gain from extending working for an additional period. According to Blöndal & Scarpetta (1999), in 1967 a 55-year old worker would expect a gain of 32 percentage points in his pension replacement rate from extending his working period for 10 years; in 1995, this gain dropped to 15 percentage points.

The third point we want to mention is the actuarial adjustment to pensions. By actuarial adjustment is meant the adjustment in the pension income (positive or negative) when some flexibility is allowed in the age of retirement (early or deferred withdrawal). We found no comparable data in the actuarial adjustment between 1961 and 2001, however Pestieau & Stijns (1997) cite that staying in the labour market after the normal retirement age of 60 in 1997 implied a loss of benefit income.

All factors described above can be summarised as old age pension wealth, i.e. the discounted value of old age benefits minus the discounted cost of obtaining them. In total, a 55-year old worker in Belgium 1967 would expect a 0.2% increase in his old-age pension wealth when postponing his retirement until the age of 64. A similar 55-year old worker would expect a 2.3% drop in 1995 (Blöndal & Scarpetta, 1999). Retirement was much more attractive during the
4. Retirement, education and the role of pension benefits

1990’s than what it was in the 1960’s which can explain why the probability of employment for older workers fell rapidly between those forty years.

4.6 Conclusions

Does human capital affect individual retirement decisions? If yes, then how?

The relationship between human capital and retirement cannot be simply positive and linear. If that was the case then between 1961 and 2001 when the average education level of the population level has significantly risen (for example it has risen on average three years in Belgium), the participation rate of older workers would have also risen. However this is not the case.

We described here a theoretical model that shows that human capital affects the moment of retirement for individuals, but the sign of this effect depends on a number of factors. Assuming that higher human capital implies higher earnings, high skilled workers have earned more money throughout their lives and leisure (retirement) is cheaper in terms of consumption (income effect). On the other hand, retirement includes a higher opportunity cost for them, and this induces them to stay longer in the labour market (substitution effect). Which one of the two effects is stronger depends on the parameters of the model and more specifically on the rate of intertemporal substitution. Alders (1999) shows that in most cases, the substitution effect prevails and high skilled workers retire later.

When we relax the assumption made in Alders (1999) of uniform old age benefits, the effects of human capital on retirement also change. When high skilled workers can fully receive their education premium also when they retire (constant replacement rate), then they have more incentives to exit the labour market earlier. The other two old age pension benefits schemes we examined “penalise” in a sense high skilled workers and deprive them of a part of their premia, and on the same time are more favorable to less skilled workers. As a result they offer more incentives to high skilled workers to remain in the labour market. We presented some data that indicate that between the 1960’s and today, old age pension benefit schemes changed to make retirement less attractive to high skilled workers compared to low skilled ones.

At the same time retirement became more attractive for all education levels resulting in low probabilities of being in the labour market after the age of 50.

Here we assumed that human capital affects retirement only via higher wages, and did not examine other possible effects, for example how education affects retirement via pleasure from work. Introducing such assumption would probably strengthen the conclusion that high skilled workers remain longer in the labour market.

The main conclusion drawn in this chapter is that human capital affects in-
Conclusions

dividual retirement decisions. However, in order to design solid policies one should carefully take into account the existing old age pension benefit schemes and adjust accordingly.
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4.A Analytical solution of Alders’ model

4.A.1 The first order condition with respect to $T_r$

To obtain (4.3.14) in Section (4.3.3) we have to differentiate (4.3.9) with respect to $T_r$. We follow the differentiation rule, stated by Chiang (1984a), pp.30:

Defining the integral to be:

$$ J(b,a) = \int_a^b F(t,x)dt $$

we have the following pair of derivative formulas:

$$ \frac{\partial J}{\partial b} = F(t,x)|_{t=b} = F(b,x) $$

$$ \frac{\partial J}{\partial a} = -F(t,x)|_{t=a} = -F(a,x) $$

Applying this differentiation rule to 4.3.9 and taking in mind that the shadow price of human capital at the moment of retirement $\mu(T_r)$ is zero we get 4.3.14.

4.A.2 Analytical solution of equation (4.3.18)

Differentiating (4.3.17) with respect to $t$ we get:

$$ \dot{\sigma}(t) = \dot{\mu}(t)\lambda(t) - \mu(t)\dot{\lambda}(t) $$

Using the expression (4.3.16) for $\dot{\mu}$, the expression (4.3.13) for $\dot{\lambda}$ and the fact that $\sigma(t) = \frac{\mu(t)}{\lambda(t)}$ we get (4.3.18)

4.A.3 Solving differential equation (4.3.18)

Equation (4.3.18) is a non homogeneous first order differential equation. The solution of these group of equations is found in Chiang (1984b), pp 472-473.

The solution of a differential equation of the form: $\dot{y} + \alpha y = b$ is $y(t) = y_c + y_p$, where $y_c = Ae^{-\alpha t}$ is called the complementary function, with $A$ being a constant and $y_p = \frac{b}{\alpha}$ for $\alpha \leq 0$, is called the particular function.

In our case here, $y \equiv \sigma$, $\alpha \equiv -(r + \delta - k)$ and $b \equiv -w$. Therefore, $\sigma_c = Ae^{-(r+\delta-k)t}$ and $\sigma_p = \frac{w}{r+\delta-k}$. Our next step is to find an initial condition, so that we can get $A$. By assumption, the shadow price of human capital at the moment of retirement is $\mu(T_r) = 0$. Because, $\lambda(T_r) \neq 0$, we have that $\sigma(T_r) = 0$. Therefore $A = -\frac{w}{r+\delta-k}e^{(r+\delta-k)(t-T_r)}$.

4.A.4 The demand for human capital function

From the f.o.c. with respect to $sH$ (4.3.12) we get:
Analytical solution of Alders’ model

\[ g' = \frac{1}{w} w \Rightarrow g' = \frac{w}{\sigma}. \]

On the other hand, differentiating 4.3.8 with respect to \( sH \) we get:

\[ g' = \frac{1}{2} \alpha_o (sH)^{-1/2}. \]

Combining these two expressions we get:

\[ s(t)H(t) = \left( \frac{1}{2} \alpha_o \right)^2 \left( \frac{\sigma}{w} \right)^2. \]  (4.3.2)

Substituting \( \sigma \) from (4.3.19) we easily arrive at 4.3.20.

4.A.5 Solving for the stock of human capital \( H(t) \)

Using (4.3.8) and (4.3.20) the human capital flow equation becomes:

\[
\dot{H}(t) = \left[ \frac{1}{2} \alpha_o \right]^2 \left( \frac{r}{r + x} \right) [1 - e^{(r+x)(t-T_r)}] + xH(t).
\]  (4.A.3)

where \( x \equiv \delta - k \) the net rate of depreciation.

This is a first order linear differential equation with a variable coefficient and a variable term. Its general solution is (Chiang (1984b), pp 480-481):

\[
H(t) = e^{-xt} \int_0^t \frac{1}{r + x} [1 - e^{(r+x)(u-T_r)}] e^{ux} du + A e^{-xt},
\]  (4.A.4a)

where \( A \) and \( B \) are both arbitrary constants, they are not equal. The relation between \( A \) and \( B \) is:

\[
B = A - F(0),
\]

where \( F(0) \) is \( \int_0^t \frac{1}{r + x} [1 - e^{(r+x)(u-T_r)}] e^{ux} du \) evaluated at its lower limit 0.

Setting \( B = H(0) \) (which is an arbitrary constant) we get equation (4.3.7).

4.A.6 Retirement decisions and heterogeneity in learning skills

Differentiating (4.3.21) with respect to \( a_o \) we get:

\[
\frac{\partial f}{\partial a_o} = -\frac{1}{\rho} \frac{\partial (\alpha_o)}{\partial a_o} c(0)^{-1/\rho} (wH(T_r) - b(T_r)) + c(0)^{-1/\rho} w \frac{\partial H(T_r)}{\partial a_o}. \]  (4.A.5)

From expression (4.3.21) we calculate \( \frac{\partial H(T_r)}{\partial a_o} ;

\[
\frac{\partial H(T_r)}{\partial a_o} = e^{-xt} \int_0^t \frac{a_o}{r + x} [1 - e^{(r+x)(t-T_r)}] e^{xt} dt + 2a_o e^{-xt}
\]

\[
= \frac{2}{a_o} e^{-xt} \left[ \int_0^t \frac{1}{r + x} [1 - e^{(r+x)(t-T_r)}] e^{xt} dt + e^{-xt} H(0) \right]. \]  (4.A.6)

\[
= \frac{2}{a_o} H(t).
\]
From (4.3.22) we get \( \frac{\partial c(0)}{\partial a_o} \):

\[
\frac{\partial c(0)}{\partial a_o} = \frac{r - \rho(r - \beta)}{1 - e^{(r - \beta - \rho)T}} \int_0^{T_r} w(\frac{\partial H(T_r)}{\partial a_o}) - \frac{1}{\rho(1 - e^{(r - \beta)T})} (1 - e^{(r - \beta)(T - T_r)}) e^{-rt} dt
\]

\( = \frac{2}{\rho} \frac{r - \rho(r - \beta)}{1 - e^{(r - \beta - \rho)T}} \int_0^{T_r} w(H(T_r))(1 - s(T_r)) e^{-rt} dt
\]

(4.A.7)

Substituting (4.A.6) and (4.A.7) into (4.A.5) and after some algebraic manipulation we get (4.3.24):

\[
\frac{\partial F}{\partial a_o} = -\frac{1}{\rho} \left( \int_0^{T_r} w(H(t)(1 - s(t)) e^{-rt} dt + \int_0^{T_r} b(t)e^{-rt} dt + \alpha(0)e^{1/(\nu H(T_r) - tT_r)} \right)
\]

\[
+ \frac{2}{\rho} w(H(T_r)c(0)^{-1/\rho}
\]

4.B Analytical solution of Alders model for \( \lambda = 0 \) and \( \gamma(t) \equiv \gamma \)

We present here the functions and equations that change compared to Alders and focus on the retirement decision. Equation (4.3.15) which is the foc with respect to \( T_r \), the total (lifetime) budget of the individual (equation (4.3.22)) in Section 4.3.3) now becomes:

\[
v(1)e^{(r - \beta)T_r} = c(0)^{-1/\rho}(wH(T_r)(1 - \gamma))
\]

(4.B.1)

We can rewrite (4.B.1) as:

\[
f(T_r, c(0)) = c(0)^{-1/\rho}(wH(T_r)(1 - \gamma)) - v(1)e^{(r - \beta)T_r}
\]

(4.B.2)

The assumptions we made on retirement benefits do not alter human capital accumulation (4.3.7) and stock (4.3.21) functions. That is because human capital is accumulated before retirement decisions are made. Again we assume that individuals differ in their learning ability \( a_o \), which determines both the amount of human capital they possess when they enter the labour market and the human capital they accumulate during their working careers. Learning ability \( a_o \) also affects individual retirement decisions. More specifically, high skilled workers retire later when: \( \frac{\partial F}{\partial a_o} < 0 \).

Before we solve analytically for \( \frac{\partial F}{\partial a_o} \) we need to discuss one more element of the problem. The total (lifetime) budget of the individual (equation (4.3.22)) in Section 4.3.3) now becomes:

\[
\frac{c(0)}{r - \rho(r - \beta)} \int_0^{T_r} w(H(t)(1 - s(t)) e^{-rt} dt + \int_0^{T_r} \gamma w(H(t)e^{-rt} dt + \alpha(0)
\]

(4.B.3)

Replacing (4.B.3) in (4.B.2), the retirement decision becomes:

\[
\frac{\partial F}{\partial a_o} = -\frac{1}{\rho} \left( \int_0^{T_r} w(H(t)(1 - s(t)) e^{-rt} dt + \int_0^{T_r} \gamma w(H(t)e^{-rt} dt + \frac{\alpha(0)}{\rho} \right)^{-1/\rho}(wH(T_r)(1 - \gamma))
\]

\( + \frac{2}{\rho} \frac{c(0)^{-1/\rho}}{wH(T_r)(1 - \gamma)}
\]

(4.B.4)
Analytical solution of Alders model with $0 < \lambda < 1$ and $\gamma(t) \equiv \gamma$

High skilled workers stay longer in the labour market, $\frac{\partial f}{\partial a_o} > 0$ when\(^{11}\):

$$-1/\rho \int_0^{T_f} wH(t)(1 - s(t))e^{-rt}dt + \int_0^{T_f} \gamma wH(t)e^{-rt}dt$$

$$+ 1 > 0 \quad (4.B.5)$$

4.C Analytical solution of Alders model with $0 < \lambda < 1$ and $\gamma(t) \equiv \gamma$

Solving $\frac{\partial f}{\partial a_o}$ for $b(t) = \lambda \hat{b}(t) + (1 - \lambda)\gamma wH(t)$ we get that high skilled workers retire later when:

$$-1/\rho \int_0^{T_f} wH(t)(1 - s(t))e^{-rt}dt - \int_0^{T_f} (1 - \lambda \gamma wH(t)e^{-rt}dt$$

$$+ \int_0^{T_f} [\lambda \hat{b}(t) + (1 - \lambda)\gamma wH(t)e^{-rt}dt + \alpha(0)$$

$$+ \frac{wH(T_r) - (1 - \lambda)\gamma wH(T_r)}{wH(T_r) - \lambda \hat{b}(t) - (1 - \lambda)\gamma wH(T_r)} > 0$$

$$\quad (4.C.1)$$

4.D Analytical solution with a variable replacement rate

For $b(t) = \gamma(H(t))wH(t)$, equations (4.3.24) and (4.B.4) become:

$$\frac{\partial f}{\partial a_o} = -1/\rho \int_0^{T_f} wH(t)(1 - s(t))e^{-rt}dt + \int_0^{T_f} \gamma wH(t)e^{-rt}dt + \int_0^{T_f} wH(t)\frac{\partial H(t)}{\partial a_o}$$

$$\quad (4.D.1)$$

The first part in the RHS of (4.D.1) is again the income effect. The second and third term of the RHS now make the substitution effect. At the moment of retirement, high skilled workers now have a greater cost for substituting income from work with retirement benefits because they receive a smaller part of their income as pension. Solving analytically equation 4.D.1 we get:

$$\frac{\partial f}{\partial a_o} = -1/\rho \int_0^{T_f} wH(t)(1 - s(t))e^{-rt}dt + \int_0^{T_f} \gamma wH(t)e^{-rt}dt + \int_0^{T_f} wH(t)\frac{\partial H(t)}{\partial a_o}$$

$$\quad (4.D.2)$$

high skilled workers retire later when $\frac{\partial f}{\partial a_o} > 0$, that is when\(^{12}\):

$$\int_0^{T_f} wH(t)(1 - s(t))e^{-rt}dt + \int_0^{T_f} \gamma wH(t)e^{-rt}dt + \int_0^{T_f} wH(t)\frac{\partial H(t)}{\partial H}$$

$$\quad (4.D.3)$$

\(^{11}\)we divide (4.B.4) by $\frac{\partial a_o}{\partial a_o}c(0)^{1-\gamma/wH(T_r)}(1 - \gamma)$

\(^{12}\)We divide (4.D.2) by $\frac{\partial a_o}{\partial a_o}c(0)^{-\gamma/wH(T_r)}(1 - \gamma(H(T_r)))$
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Bibliography


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