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The **European Centre for the Development of Vocational Training** (Cedefop) is the European Union's reference centre for vocational education and training.
We provide information on and analyses of vocational education and training systems, policies, research and practice.
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Foreword

Europe hopes to emerge stronger and more cohesive from the current economic and financial crisis. The new European strategy for smart, sustainable and inclusive growth 'Europe 2020' (European Commission, 2010) aims to improve competitiveness, encourage economic growth, provide attractive job prospects, and promote social inclusion. Given the constraints on public finances, consistent and accurate information on investment and policy effectiveness is critical to policy decisions.

Cedefop produces skills forecasts to inform policy-makers and other stakeholders about future labour-market needs. Results are clear: skilled occupations are on the rise and individuals choose their education on the grounds of returns on investment. The (expected) rate of return; in the form of wage, guides their skills investment.

A wide consensus and a range of empirical evidence highlight the importance of investment in general education for economic growth and social inclusion, while little is yet known of the ability of vocational education and training (VET) to achieve comparable results.

Despite this lack of knowledge and research, the tendency is to consider investment in general and academic education superior to investment in VET. Cedefop has aimed to generate new empirical evidence to highlight the role of VET in producing wider benefits: economic growth, the social inclusion of disadvantaged groups, and a more cohesive and responsible society, as well as securing employment and income stability.

The important message conveyed by this publication is that investment in VET could be as effective for individuals as investment in general education.

I trust this research paper and Cedefop's future work on VET benefits will help in making the case for VET as a crucial pillar of European education systems.

Christian F. Lettmayr
Acting Director

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Executive summary

This report contains a quantitative analysis of the effects of vocational education and training (VET) on wages and employment status. It uses various comparable data sets from across the EU.

The study supports the view that education has a protective effect against the risk of unemployment. However, it is also found that (employer-provided) training has positive effect on the likelihood of being in employment.

The returns on educational choices across various forms of education and types of occupational trajectories (of equal length) are generally of similar magnitude.

Academic education has strong positive effects on wages and employment across all countries. The returns on one extra year of tertiary education are about 7%, for men and women alike (consistent with literature), and equal to the returns of one extra year of initial VET (IVET). This suggests that investments in general (tertiary) education and in IVET could be characterised by an equal rate of return. The returns on training (continuing VET [CVET], adjusted to account for its short duration) are also in the same range: on average 10% for men and 7% for women. Here too the returns on workplace training are in line with the returns on general education.

The effects of education on wages are larger for individuals with greater (unobserved) skills. This suggests complementarities between vocational and academic education and training, on the one hand, and unobserved skills on the other.

CHAPTER 1
Introduction

Investments in human capital are central to macroeconomic performance and long-term growth (Krueger and Lindahl, 2001). At microeconomic level, human capital, in the form of observable skills associated with investments in education and training, raises productivity, wages and employability (Card, 1999) and largely works through the effect of human capital on productivity (Chevalier et al., 2004). However, most research focuses on academic education, i.e. school or college based education which is often general and may have no specific vocational content. Academic education is generally focused on the attainment of qualifications and is progressive: it leads to successively more advanced qualifications. Its value may not lie in its detailed content but in developing generic skills associated with it. Such education is typically gained early in life before starting a full-time job. The typical quantitative study in the genre will incorporate measures of education based either on the duration (years of education) or on the achievement of qualifications levels, such as those associated with the completion of lower secondary schooling, upper secondary schooling, and then university or college. Among those many studies, few are specifically focused on cross-country comparisons (Denny et al., 2002). They typically use 'years of education' for the heterogeneity of qualifications across countries. The rationale is that 'years of education' is a summary measure of skills development, indicating the level of human capital accumulated by individuals and is broadly comparable across countries.

Our study investigated the economic benefits of vocational education and training (VET) for individuals ([1]):either institution- or workplace-based training focused on developing vocational skills. Such training is often acquired after the individual has completed academic education and before starting a full-time career. It may then be thought of as initial VET (IVET). Also, spells of VET often occur throughout an individual's working life, to develop or diversify vocational skills, in which case it might be thought of as continuing VET (CVET). Here, we attempt to distinguish between IVET and CVET. We think of IVET as a vocational education 'track' that some individuals take, soon after compulsory schooling and before starting work, at educational institutions, the workplace, or both, as in apprenticeships. We think of CVET as occurring during spells of work some time

([1]) Some training, we think of as investment in human capital, has no financial return but enriches life in some other way; for example, learning English to enjoy Shakespeare. Such investments are, in theory, similar to those considered here. Our concentration on financial returns does not deny the existence of such non-pecuniary returns.

after completing initial education, both academic and vocational. The interaction between initial education and subsequent CVET is important for our work but has largely been ignored in empirical literature. The conventional view considers training, CVET in particular, as compensation for poor previous skills. We also consider new training as complements to those skills. Skills are built, not taught in isolation. Therefore, foundations provided by initial academic education are important for how effectively new skills can be used, including skills developed from VET.

The idea that vocational training and academic schooling might be complements, contrasts sharply with the conventional vision that workers should acquire one or the other and that the young should be tracked, sometimes at an early age, into one or the other. Also, almost all developed (and developing) countries have rapidly expanded their academic schooling provision, encouraging much greater participation in higher education. If academic schooling and vocational training are, indeed, complementary skills in generating higher productivity workers, then the implication is that the expansion of academic schooling should raise the return on vocational training. Thus, the case for expanding vocational training partly depends on the (well documented) rise in the return on academic schooling. More generally, to the extent that both general and vocational education are complements to training, the Matthew effects (skills beget skills hypothesis) will play out, confirmed by the empirical regularity associating educational levels (regardless of the destination) to the probability of receiving training (Bassanini et. al 2005).

The type of benefits considered in the present study are economic ones associated with earnings and employment; they are benefits accruing to individuals receiving education and training and often called ‘private returns’. To date there have been no attempts to produce comparable cross-country estimates of the IVET and CVET effects on productivity, wages and employment. Quantitative studies of such effects are scarce even nationally, mainly because of the difficulty in quantifying operational measures in the VET varieties.

However, just as comparable estimates of the returns on general education can be obtained from a consistent proxy for human capital, for the same is true of VET. Here we exploit the proxies for various forms of VET in a unique data set that asks many individuals, across the EU, the same questions about their experience of education and training, among other things. We estimate the effects of these proxy variables on individual labour-market outcomes, wages and employment, not the effects of varieties of VET *per se*. If we assume that the correlation between these proxy variables and the unobserved true experience of VET is similar across countries, we can infer differences across countries in the labour-market effects of the unobservable forms of VET, even if we cannot necessarily infer the level of such effects. Making such inferences in cross-country studies is problematic if the nature of VET varies across countries. In the absence of being able to articulate such variation we have to be content with estimating the average effect of VET across countries. Below we report estimates of the average across all countries, and estimates within groups of countries where we feel that the VET system is reasonably homogenous ([2]).

We focus on IVET and CVET and are concerned with how these interact with initial academic education. Our approach is quantitative: we aim to consider the relative returns on academic education, and both IVET and CVET, across EU Member States. Our motivation is to inform policy.

The framework adopted for our analysis is developed from the human capital earnings function (HCEF) which is due to Becker (1964) and Mincer (1974) and explained in Chapter 2. In Chapter 2, we also explain the relevant theoretical ideas used to help understand the economic impact of VET. Theoretical literature made a strong distinction between general training, which affects productivity in all jobs, and specific training, which affects productivity in one's specific job but not in other jobs that one might do instead. There will be degrees of specificity: some training will be specific to the current job with the current employer, some may be specific to working in similar jobs with other employers within the same industry; and some might be completely general. The economic theory, developed to frame our understanding of the VET impact, is more complex than for general education. The simple theoretical ideas used to understand training make strong predictions about how training would be funded. These predictions are generally not supported by empirical evidence and economic models that are based on the idea that the labour market is competitive. They are superseded by research based on imperfectly competitive labour markets (Acemouglu and Pischke, 1998). Nonetheless, a strong implication of modern theory suggests that the market for training may not work well; left to themselves, firms and workers would engage in inefficiently low levels of training.

In Chapter 3 we show how this theory was turned into operational empirical specifications. In Chapter 4, we present a brief review of empirical evidence. While evidence on the effects of academic schooling including cross-country comparisons is extensive, systematic literature on training is scarce. There is a consensus on the limited effectiveness of training as remedial education. There is also broad agreement on the effectiveness, in promoting transitions from welfare to work, of active labour-market programmes that change individual incentives to work. To the extent that incentives are mediated through wages, training for the unemployed ought to raise their employability too. However, in literature on active labour-market policies there are examples, incorporating a training element, which do raise wages and employment; there are also many studies showing

([2]) The EU-LFS offers more detailed information on VET in a recent ad hoc survey which could be used to establish how consistent our proxies are across countries, although limited to young workers.

insignificant effects. This report is more directly concerned with IVET and CVET rather than training taking the form of active labour-market policies. Here, literature is sparse and piecemeal and motivates us to fill this gap. In Chapter 5, we briefly outline how our own empirical implementation captures the complementarity between training and general education, and explains how such relationship might be estimated.

In Chapter 6 we review the data sets that might be used to implement this specification. Our work is based on secondary analysis of large-scale survey data sets. We would like to address these empirical issues in various labour-market settings, so our investigations are based on data sets for as many EU Member States as possible. The data sets used are the European Community household panel (ECHP); the European Union statistics on income and living conditions (EU-SILC) and the International social survey programme (ISSP). Our analysis is limited by the degree to which the information on education and training, recorded in our data sets, corresponds to the variables that the theory suggests would be relevant. This is an important concern for quantitative research and a good reason to consider it alongside qualitative research based on detailed case studies and close examination of the processes involved when individuals acquire training and firms provide it.

In Chapter 7 we estimate simple specifications that incorporate the important issue, largely neglected in existing work, of the interaction between the effects of CVET on wages (and employment) and the skills of individuals, as in their level of initial training and education. This idea has a long history but has recently been brought to the fore by Heckman (2000) who notes that '[...] human capital has fundamental dynamic complementarity features. Learning begets learning. Skills acquired early on [in life] make later learning easier'. We use proxy variables to distinguish between IVET and CVET, between general and specific training, and between formal and informal training.

There are severe limitations to how each data set can be used. We explored ISSP data to capture the idea that vocational training and academic schooling may be complementary. Although the data is crude, the results generated support this idea. We explored the EU-SILC data. Eurostat divided the comprehensive producer database into a panel data set and a series of cross-section data sets. Both contain variables needed for our analysis but they cannot be merged. Therefore, we collapsed the two data sets into cells, defined by variables from both, and then finally merged them to produce a pseudo-panel. Each cell of this pseudo-panel data set contains information on the percentage of workers who received VET, together with information on wage and education. Despite a loss in precision, we found that by using appropriate estimation methods, the effects of recent training have no statistically significant effects on wages. These data, being much larger than the ISSP, are well suited to addressing the issue of complementarity. We find that recent training strongly affects females at the top of the wage distribution, but not at the bottom, while for men it increases wages across the whole wage distribution. However, interactions with observed education are weak.

Given the inadequacies of ISSP and EU-SILC, we pay most attention to ECHP data. ECHP is a long panel, compared to SILC, and we exploit this first to establish that the effect of training on wages is permanent: training five years ago has similar beneficial impacts on wage as recent training. We go on to explore some details on training in ECHP. These data are such that one can reliably estimate the effects of training for each country. A shortcoming of ECHP is that it does not code the level of education that provides an indication of IVET, so it is difficult to find a suitable proxy in this case.

Our final analysis, in Chapter 8, addresses the endogeneity of education using instrumental variable methods. We conclude in Chapter 9 where we bring together the results, comment on the cross-country differences, and draw attention to the weaknesses of the analysis. We also point to how better data, not always available, could be used to improve our understanding on the relationship between VET, wages and employment.

CHAPTER 2
The economic theory of human capital accumulation

To most people 'capital' means money in a bank, or a portfolio of stocks and shares, or the equity in one's home, or the value of one's pension fund. To a firm it means the physical equipment associated with production. These are all forms of capital in the sense that they are assets that yield income or profits over a long period. These tangible forms of capital are not the only forms. Schooling, an IT training course, and even some expenditure on medical care can also be considered capital because they can also yield a flow of income for the future through higher future earnings over an individual's lifetime.

Therefore, expenditure on education, training, medical care, etc., can be thought of as investment in human capital; it is called human capital because people cannot be separated from their knowledge, skills, or health, in the same way that they can be separated from their financial and physical assets. In human capital theory, education is an investment of resources: both the opportunity cost of time involved and any direct costs, in exchange for future higher wages.

There is a strong argument for thinking that returns received by individuals on their human capital investment, in the form of education and training, should broadly match the returns we observed, in practice, on investments in financial capital with a similar degree of risk. This intuition is based on the presumption that markets are sufficiently efficient to arbitrage away risk-adjusted differences in rates of return, across different sorts of investment, so that individuals (and firms) are indifferent, at the margin, between investing in extra training and investing in the bank. If financial markets are internationally integrated then there will be close correspondence to the returns on financial assets across countries which will then drive convergence in the returns on human capital across countries.

However, this efficient markets view may not be useful, in practice. There are good reasons for thinking that markets are not sufficiently efficient to generate the arbitrage required to make inferences about returns on human capital from the observed returns on physical and financial capital. Efficient market theory is just a guide that provides a framework for thinking about what the returns on a particular investment in human capital should be. When we need to be more specific, we need to resort to empirical research.

Most previous research primarily explained the role educational qualifications and training actions play in earnings determination. Analysis of the demand for education has been driven by the concept of human capital, pioneered by Becker (1964), Mincer (1964) and Schultz (1963. The workhorse specification is motivated by Becker's theory of human capital (Becker, 1964). This theory treats an investment in human capital as arising when individuals forgo the opportunity to earn in order to learn, and thence earn more in the future. In this view, human capital is similar to physical capital, such as factories and machines: one can invest in human capital (via education, training, or even medical treatment) and one's income depends (partly) on the rate of return on the human capital one owns.

Thus, human capital is a stock of intellectual assets that one owns, which allows one to receive a flow of income; this is akin to the interest earned from financial assets. As with physical capital, this stock will typically depreciate over time as it becomes worn out. Like physical capital, the stock depends on previous investments and the rate of depreciation since then. Unlike physical capital, human capital is, by nature, embodied in the investor. There can be no second-hand market in human capital. Moreover, this embodiment takes time. It takes time to learn new skills and the opportunity cost of that time is an important factor in acquiring human capital.

2.1. Generic economic principles

In the simplest version of this theory, individuals commit resources to education up to the point where the gain from the last euro invested in human capital just equals the gain that could have been had from investing those resources in financial markets, i.e. the market rate of interest. The proportionate wage gain from moving from one level of human capital to the next can be thought of as the rate of return on that qualification. Usually this is estimated by multivariate statistical methods which include controls for other factors that affect wages, and may be correlated with education, to isolate the effect of education holding everything else constant. For example, it is usual to control for age, race/ethnicity, gender, and region.

The simplest way of capturing the idea that human capital has a proportionate effect on wages is to model the relationship between (log) wages and a measure (or measures) of human capital (and include other control variables) ([3]). The effects on employment are captured by estimating a probability

([3]) This has the advantage that the estimated coefficients on the explanatory variables capture the effect of those variables on the proportionate wage differences, so a coefficient of 0.1 on a variable X, such as a qualification, says that a unit change in X (i.e. acquiring that qualification) raises wages by 10%. This simple specification is employed extensively in literature and it is this that is used, and built upon, throughout this report.

of being in employment as a function of human capital measures and other variables ([4]).

Much literature focuses only on general education, treated as years of schooling.

While this ignores many elements that may be important for policy analysis, it has allowed researchers to concentrate on the broad issues and has moved forward our knowledge of the economics of education considerably over the last 20 years. It has also led to significant methodological advances relevant for more detailed research. Leaving aside the details of how skills are measured, the earnings premium associated with additional units of human capital can be thought of as a rate of return on that investment (Ashenfelter et al., 1999). If the costs of acquiring a unit of human capital are small (and, even for higher education, it is still the case that the main costs of education are the earnings that you forgo when you continue your education instead of leaving school and joining the workforce), and if the working life is long (and since most education occurs early in life this is also approximately true) then the earnings premium is approximately a financial rate of return (Harmon et al., 2003). Thus an earnings premium of 10% per additional year of education corresponds to a (real) rate of return on that investment of 10% ([5]).

Since human capital is an asset (albeit one with the distinctive characteristic that it cannot be separated from its owner) the return on this asset should be broadly comparable with the return on other assets: if that were not true then it would be sensible to switch resources away from assets with low returns into assets with high returns. If individuals invest in the right level of education we would expect to see a modest return on education; this could be a real return of around 5% corresponding to real market interest rates. If we were to observe a higher (lower) return then this would either suggest that individuals are investing too little (much) in education, or that imperfections in the credit market prevented efficient investment decisions being made. If financial markets worked sufficiently well, .we would expect to see similar financial returns on financial assets across

([4]) In this report, we present the estimates of a linear probability model. The alternative is to estimate a non-linear model such as probit or logit, and then calculate the marginal effects at the mean of the explanatory variables. However, the results are close and we only report estimates from the linear probability model.

([5]) One might argue that one should allow for taxation and that this might be important when making cross country comparisons. However, while taxes reduce the returns for the individual, they also reduce the costs if the costs are forgone after tax earnings: if the tax system were a simple proportional one then the effects of tax would cancel out. While tax systems are typically not proportional, the degree to which they are not is sufficiently unimportant that we can ignore this complication; tax allowances are usually quite small and tax bands are typically quite long. Thus, the effect of adjusting for the tax system would be minor. See OECD (2002) for estimates of the rate of return on education that considers the impact of taxes, albeit using a methodology that does not account for the impact of other characteristics that affect relative wages and are correlated with education.

all countries – If individuals were free to make human capital investments that they felt were efficient, we should observe similar returns on human capital as on financial capital. In a financially well integrated world, we would expect to see similar returns on human capital across all countries. Evidence that private returns are disproportionately high on one investment, relative to others with similar degrees of risk, would suggest some 'market failure' preventing individuals implementing their personal optimal plans. This may then provide a role for intervention ([6]).

The 'theory of factor price equalisation' implicit in this efficient markets view of the world suggests that the easy mobility of labour, and of financial capital, would eventually result in any differentials across borders in the returns to investments disappearing through competition: this theory, in principle, applies to the returns on human capital investment. In these circumstances, wage differentials associated with differences in human capital should be relatively stable across countries. However, it seems that the costs of labour mobility (and/or job relocation) across even EU, countries are substantial, so significant differentials across countries can persist as a reflection of these mobility costs. Within each country, the wages that a particular level of human capital commands will depend on demand and supply factors; there is some variation according to institutional factors. If a particular skill is in short supply, the returns on that skill will be high. In the long term, supply should adjust through migration flows and through the decisions made by native workers: eventually the supply of the type of labour that was in short supply, and hence expensive, would expand up to the point that the returns matched those elsewhere. The same theory of price equalisation suggests that, in a well functioning labour market, the forces that work towards equalisation between the returns on education in two countries would also work to equalise the returns on vocational education to the returns on general education.

When financial markets are imperfect, individuals may be credit-constrained so that investments in human capital may be less than would be optimal. This occurs because human capital is poor collateral for a loan since it cannot be separated from its owner. However, firms have an interest in workers having the appropriate distribution of human capital. If the credit market fails to fund appropriate distribution, firms themselves may have an incentive to provide credit for training expenses. They could do so by paying workers more than their marginal product while training, to allow workers to make the investments required, and then pay them less thereafter to recoup the earlier overpayment. Firms will only be able to do this to the extent that they are able to enforce such

([6]) Another argument for intervention would be the existence of externalities associated with investments in human capital of individuals. For example, one worker's investments affect the productivity of other workers.

contracts; enforcement requires that workers are bonded to the firm until the overpayment is collected.

Research on the effects of years of education grossly simplifies the effect of the skills that individuals have. We would like to use a comprehensive vector of human capital measures rather than one summary measure. In practice, such a comprehensive vector of measures does not exist in any data set and, even if it did, it would be difficult to address the empirical difficulties we would face in deploying such a comprehensive measure. Moreover, there are significant differences across countries in how skills are measured and accumulated, so empirically implementing human capital theory in a cross-country context would require that the researcher standardise on measures that provide effective summaries of human capital relevant across countries.

The general principles that lie behind the economics approach to human capital suggest that, in the long term, cross-country differences in the wage differentials associated with differences in human capital should be small. In practice, there is immobility due to the costs (including those implied by the need for language acquisition) associated with moving from one country to another. There may also be institutional constraints that prevent movement that would otherwise occur, such as quotas on immigration or national restrictions on professional practice. There may be quantitatively important differences in the wage differentials associated with differences in human capital across countries, and such differentials may be relatively persistent. The extent to which this is true is an empirical question and requires that we adapt the theory to distinguish between the various forms of human capital. The challenge for this research is to operationalise the extension of the usual simple empirical specification to include measures of VET.

The micro theory of unemployment that dominates thinking on the determinants of employment is based on the idea that the probability of employment is driven by the difference between the expected wage and the ‘reservation’ wage. While the latter is the minimum one would be prepared to work for, and is derived from individual preferences, the former is determined by the human capital earnings function (HCEF). The signs on the variables that determine employment should reflect the signs on the same variables in the HCEF, or wage equations.

2.2. General and firm-specific human capital

So far, we have considered human capital in the abstract. We assumed that initial academic education differs from initial vocational education only in terms of curriculum content.

For Becker, human capital literature has made a sharp distinction between 'specific' and 'general' human capital (Becker, 1964). This dichotomy is used for emphasis: in practice all forms of human capital will lie somewhere between these two extremes. Specific human capital refers to skills or knowledge that is useful only to a single employer (or occupation or industrial sector), whereas general human capital (such as literacy or numeracy) is useful to all employers. We tend to think of general human capital as being skills associated with an academic curriculum that we normally think of as being delivered by an educational institution. Because of its general nature we normally think of this academic education as being delivered early in the lifetime. This is certainly true of very basic skills such as reading and writing. It is less so with more advanced skills such as IT skills where there are (probably) some jobs (still) where such skills do not generate an increase in productivity.

Firm specific human capital is inherently more risky since these skills are not transferable to another firm, sector or occupation if firm closes or the industry declines. If workers could insure against such unexpected events this would remove any distinction between the two forms of human capital. Differences in the return on different forms of human capital would, in equilibrium, exist and persist over time because of differences in their riskiness that would simply require that the market pay risk premia that were proportionate to the riskiness of the various forms of human capital. A firm would pay workers a risk premium sufficient to encourage them to invest in the form of human capital specific to that firm. If an insurance market existed that allowed workers to insure against their specific human capital becoming worthless, this wage differential would need to be sufficient to allow workers to pay such a premium. If such a market did not exist, the wage differential associated with firm-specific human capital would need to be large enough to encourage the worker to carry this uninsured risk. Either way, cross-country differences in the observed wage differentials across different types of human capital would not exist but there would be a higher wage differential, in all countries, associated with a unit of human capital which was firm specific than that associated with a unit of human capital which was not firm specific.

Literature has highlighted a 'market failure' associated with firm specific human capital by focusing on a model where firms recruit workers in a 'spot' market. Here, contracts last for just one fixed period, perhaps a day. In such a labour market model workers would not pay to invest in firm-specific human capital, as they would receive a reward for such an investment only if they work in a firm where the specific skills are valued. If contracts lasted a lifetime, there would be no additional risk in investing in a firm-specific skill since one could work in a firm that valued that skill for a lifetime. The market failure associated with firm-specific skills arises because there is a risk associated with acquiring firm-specific skills that does not apply for general human capital and this risk depends on how long jobs last. If job separations were costless, a worker with firm specific skills would quickly become reemployed in a similar form that also valued those skills. If they were not, workers with firm-specific skills would either have to accept a wage cut and work in a firm that did not value the firm-specific part of her human capital, or expend additional search costs looking for a job in a firm that did value such skills.

In a competitive labour market, where wages reflect productivity, firms will not pay for general human capital since they would not recoup the costs of their better trained workers whose productivity would be the same wherever they work. Since the best strategy is to wait for some other firm to train workers and then 'poach' them, no firm is willing to pay for the investment in general human capital. Therefore workers pay for the costs of their own general human capital.

Despite this strong theoretical prior, we do observe firms contributing to the costs of general training. In particular, where the costs of moving to another firm are sufficiently large, the incumbent firm might have an incentive to pay for training for which the worker cannot find credit to fund. It may also be possible for firms to bind the worker contractually to the firm for sufficiently long to recoup all or most of the costs: training provided through the military might be a case in point. The firm may be able to finance the general human capital accumulation through paying only a training wage: apprenticeships might be a second case in point.

Human capital accumulation that has a degree of firm-specificity also gives rise to potential market failure. Traditionally, specific training is interpreted as human capital accumulation that improves skills useful only to the current employer. For Stevens (1994) and Acemoglu and Pischke (1999a,b) the specificity of training could result from labour-market imperfections. In particular, monopsony power, asymmetric information, unions, and minimum wages may drive a wedge between worker productivity inside the firm and outside options, and this wedge may be increasing in the skill level of workers. When training is not completely general, however, there is no competitive market for trained workers: the training firm and the worker are likely to share the additional surplus created by the investment in specific skills. The costs should also be shared between the employer and the worker. Investments in specific training will be efficient only when costs are shared in proportion to the benefits (Hashimoto, 1981). Acemoglu and Pischke (1999a,b) show that, in oligopsonistic labour markets, the predictions of the human capital model are less clear cut. In particular, the wage returns on general training may be less than the productivity returns, so that firms may find it profitable to pay, at least something, for general training.

However, explicit cost sharing assumes that investments are contractible, that is, firms can make wages conditional on investments. Typically, however, investments in training may be difficult for a third party, like a court, to verify. In this case, training investments are non-contractible and explicit formal cost sharing becomes cumbersome if not impossible. Such training becomes vulnerable to a 'hold-up' problem ([7]) and theory predicts that, in equilibrium, the party that receives the largest share of the marginal return will do all the investment, whereas the other party will invest nothing (see proposition 4 in Acemoglu and Pischke, 1999b). Thus, literature is unclear about who will pay for specific human capital investments but the amount that is conducted is likely to be less than optimal.

2.3. Initial and continuing investments in human capital

So far, we did not distinguish human capital acquired early in life from that acquired later. In terms of the conventional theory of human capital, timing only makes a difference because life is finite – since this is true, it would be efficient to invest in human capital early in life to maximise the period over which a return can be earned. Since the return on investing in a unit of human capital depends only on its costs and the stream of resulting additional earnings, then the return on this investment is highest if it occurs at the beginning of life and the return falls (to zero) at the end of life.

This begs the question of why continuing human capital investment occurs at all. Economists seek an explanation in the form of unanticipated events and credit constraints. Credit constraints might imply that individuals cannot make the optimal early investments and so are forced to work and accumulate savings before funding further investments in skills required for late career development. If we could anticipate all our human capital needs it would make sense to satisfy them through investments early in life. However, unanticipated events occur and this gives rise to a need to respond to them when they arise. For example, an individual may invest in a form of human capital early in life that subsequently, and unexpectedly, becomes obsolete later in life. This obsolescence may then give rise to an opportunity to invest in new human capital that replaces the old. Thus, technological change gives rise to a flow of innovations and inventions that affect the returns on existing human capital skills, potentially driving them to zero. However, such changes often give rise to a need for new skills. Two sorts of workers should invest in newly demanded skills: young individuals who are

([7]) This refers to a situation where firm and employee would find it mutually advantageous to invest in training but refrain from doing so as they may give the other party increased bargaining power, and thereby reduce their own profits.

deciding what types of skills to develop, and those older workers whose skills have become obsolete and so whose time opportunity costs are similarly low.

Technological change should give rise to continual changes in the curriculum choices facing young people to reflect the changing demands of the labour market. The nature of the initial human capital will change over time to reflect the changing needs of the labour market: calligraphy gets replaced by typesetting, and typesetting gets replace by word processing. Successive cohorts of workers would embody successive vintages of human capital. Also, technological change should be accompanied by a need for continuing human capital acquisition, as the wage rate of a worker falls as skills become obsolete. Because such workers now face a low wage and a low time opportunity cost, as opposed to middle-aged workers whose skills are not obsolete, they will have an incentive to retrain in the new skills required by the market.

2.4. Informal, non-formal and formal VET

Literature also distinguishes between formal and informal VET. Here the distinction is less clear-cut: this partly refers to whether the VET is certified in the form of a qualification and partly to the mechanism whereby the VET was acquired. At one extreme, school-based learning is largely certified and conducted in a structured environment that is not associated with a workplace. At the other extreme, VET may be informal and come in the form of learning-by-doing associated with experience acquired while in a workplace. This may relate to the quality or speed of working that might be difficult to verify and hence certify.

CHAPTER 3
From theory to evidence

3.1. A generic difficulty with empirical implementation

A major concern with estimates of the effects of human capital on labour-market outcomes is that they may reflect differences in the 'ability' of individuals rather than the effect of human capital *per se*. Simple estimation of the relationship between labour-market outcomes, such as wages, and measures of human capital, however defined in practice, will attribute to human capital not only the effects of human capital *per se* but also the effect of factors omitted from the analysis but correlated with human capital. The traditional explanation of this bias is referred to as 'ability bias'. This explanation says that unobserved 'ability' is correlated with wages: more able people earn more, conditional on their human capital and more able individuals will generally have more human capital. Part of the returns on human capital observed in the data should be attributed to ability, so the return on human capital is biased upwards and simple statistical methods will exaggerate the true return.

This difficulty not only plagues simple specifications but also applies more generally to any research that attempts to be more realistic in the way human capital is measured.

This potential for bias reflects the possibility that part of the effect of human capital on wages might be attributable to a 'signalling' phenomenon ([8]) rather than to human capital *per se*. People with more human capital may earn more not because they have higher productivity in the labour market, but because they have higher ability which they 'signal' to employers through acquiring higher levels of human capital. People with less human capital can less easily do this. Attempts to disentangle these two competing explanations for why we observe a strong correlation between human capital and wages are fraught with difficulty. Both theories predict that there will be a positive correlation between human capital and wages, but for different reasons. However, attempts to distinguish between the two theories have tended to suggest that the idea that human capital generates improvements in worker productivity, reflected then in wages, dominates the alternative signalling model ([9]).

([8]) The theory is largely due to Spence (1973). Riley (2001) reviewed subsequent literature.

([9]) Since the two theories have the same first order implications for the relationship between wages and human capital, we need to look at second order implications of the theories to discriminate between them. One important implication of the signalling theory is that it is relative education that matters: one can only signal one has higher productivity than another if

3.2. An empirical typology of human capital forms

The discussion in Chapter 2 suggested that economic theory gives rise to some sharp distinctions between forms of human capital. These distinctions have clear implications. In practice, examples of education and training will seldom be as sharply delineated as in our theories. Hence, there are two reasons why it is difficult to operationalise these distinctions in empirical research. First, the distinctions in practice are not as clear cut as theory suggests: all forms of human capital investment have some degree of specificity. Second, even if the concepts were clearly defined in practice, it may be difficult to find exact empirical analogues to match those concepts.

It is useful to distinguish between initial human capital investments and continuing investments that occur in later life, where the latter arise either because of technology induced obsolescence or because of decisions made earlier in life as a result of credit constraints or mistakes. For example, new forms of machinery come along giving rise to a demand for new forms of human capital. This affects the content of human capital curricula available to young people and gives rise to a need and desire to retrain, replacing obsolescent skills in older workers with new ones.

Similarly, it is useful to distinguish between general human capital and firm-specific investments, where the latter provides a return only in one use, within a specific firm and not in any other. In practice the degree of specificity may be less than complete; skills may be sector or occupation specific rather than exactly firm specific. The distinction between the general and specific becomes effective when workers have finite contracts. There is then differential risk between the two forms of investment.

Economic approaches to training make sharp distinctions. Specific skills are a form of human capital almost invariably vocational in nature, relating to specific forms of work, or even to a specific workplace. This might be imparted early in life as initial vocational education and training (IVET). As these skills relate to a specific firm, they are often delivered in the workplace, for example through

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one has higher education. In contrast, the human capital model implies that a higher level of human capital causes higher productivity and wages, irrespective of the human capital level of anyone else. Thus, in the signalling theory an increase in the human capital level of individuals at the bottom of the distribution should raise the human capital levels of everyone above the lowest level because more able individuals will now have to acquire more human capital to maintain their signal to employers. Raising the bottom of the distribution should raise the whole distribution. Chevalier et al. (2004) investigate precisely this issue. They exploit the change to the minimum school leaving age that occurred in the UK in 1974 that raised the minimum from 15 to 16 and show that raising the minimum had almost no effect on the rest of the distribution; this suggests little signalling occurring in schooling decisions. The implication of this is that the appropriate way to interpret the estimated effect of the coefficient(s) on human capital variable(s) is as a human capital productivity effect.

apprenticeships. The degree of specificity of IVET can be highly variable: technological courses can lead to a broad range of occupational profiles but not be completely transferable across firms in the way that general human capital might be.

General human capital is conceptualised as transferable and should be acquired when the opportunity cost is lowest, early in life. In practice, some will occur later in life for several practical and efficient reasons. One reason could be time discounting and uncertainty: it may not be clear at an early age whether such training will be required in later life, so it is efficient to wait until the uncertainty resolves itself, which is reinforced by time discounting. Another reason could be the complementarities between initial education/training (or even some work experience) and some forms of general training that might make it worth postponing until later in life. For example, management skills might initially require mastery of subject-specific knowledge so that an MBA, for example, might be best completed later in life despite the higher opportunity cost. Thus CVET will often be specific training, but there may be training in generic skills such as teamwork, languages and other ‘soft’ skills that might have a high degree of transferability across jobs and even sectors.

Also, the degree of specificity of some skills may be less than complete. For example, some advanced IT skills may be required and valued by some sectors and not by others. In this case, a specific workplace may not be the right environment to deliver these skills and such a curriculum might be better delivered in an independent educational institution. It is easy to think of skills that are not firm-specific but have a degree of specificity that make them something different from basic academic skills. It may not be useful to distinguish education, as an academic process designed to promote broad skills, from training acquiring narrow but widely-used skills (e.g. basic IT skills). Therefore, the distinction between education and training is a subtle one, probably too subtle to serve much purpose with the kind of data that we are likely to have.

Similarly, the extent to which IVET is delivered in general educational establishments (such as schools or colleges) which also deliver basic general human capital, as opposed to specialised institutions such as training colleges that do not provide general education, is not important in practice. All education systems involve institutional structures that have a degree of specialisation within them, in the form of streaming into academic and vocational subject areas, as well as a degree of specialisation across them, in the form of varieties of schools and colleges. Some systems have a single variety and a degree of streaming within that single type of institution (such as the US high school and the ‘comprehensive’ schools in several EU Member states). Others have several types of schools each delivering a different curriculum; one delivers an academic curriculum while another delivers a vocational one, for example. Different educational systems imply different rigidities in transitions between different curricula that occur at different ages. Some countries adopted educational systems with a broad curriculum. Most young people, spending much of their youth in a single institution, are expected to master that broad curriculum. The US is probably the most extreme large example: human capital should be acquired at school, from the ages of 5 to 11 in elementary school, and 12 to 18 in junior and senior high school. There is a broad curriculum and a modest degree of streaming. Leaving school prior to 18 is regarded as 'dropping-out' and is usually indicative that human capital accumulation is completed ([10]). Other countries employ more extensive streaming and do so at an earlier age. One of the most extreme cases is the Germanic system whereby there is early specialisation by selection into schools of different types with different curricula. There are limited opportunities for transitions between them and differential options for further study beyond them. Young people tend to start work and have long job duration, even when young, because they already have a skill set that matches the need of specific occupations.

Attempting to construct a consistent set of measures of types of human capital across diverse educational systems is problematic, even if extensive data were available. Some progress can be made by adopting the Unesco categorisation of educational systems, ISCED-97 (Unesco, 2006), whose explicit goal is to provide a meaningful basis for international comparisons. Table 1 shows the broad descriptions of education associated with ISCED levels. This categorisation is further broken down into A, B and C: A refers mainly to general education and permits progression to the next level (usually at category A) until final exit into the labour market with a university degree or similar qualification; B implies a transition to the next level and may progress to advanced technical vocational qualifications before final exit into the labour market; C is a form of basic education that generally leads directly to the labour market and might have a high degree of vocational training to it. The exception is level 4 which is accessed mostly through levels 2B and 3C and largely comprises vocational training which may be conducted at a separate institution from the general academic training.

([10]) As a result, the US has extensive training that tries to deliver quite basic academic skills to adults who have failed to master them in their youth, such as the job training partnership Act (JTPA). The US also has a curriculum and testing programme for former drop-outs, known as general educational development (GED), meant to be broadly comparable to the skills acquired through to high school graduation at 18. Beyond 18, academic education can continue at conventional (four-year bachelor programme) universities and vocational training can continue at (usually two-year) 'community' colleges. Often the community college-based training is part-time, combined with work, and done later in life. Young people are well known to have a large number of relatively short-term jobs while they find the right match for their skills, but probably do not accumulate much specific capital.

Table 1. **ISCED categories**

ISCED level	Description	Typical schooling age
0	Pre-primary	<5
1	Primary	5-10
2	Lower secondary	11-15
3	Upper secondary	16-18
4	Post-secondary, non-tertiary	16+
5	First stage tertiary (undergraduate)	19-22
6	Second stage tertiary (postgraduate)	22+

While it is possible to infer the number of years of schooling corresponding to each level with some precision (although there are some overlaps across levels and important cross-country differences in the number of years), the degree of specificity of the human capital is not very clearly related to the A, B and C subcategories. This ISCED grouping is an imperfect measure for the purposes of empirically implementing the theoretical ideas of continuing versus initial, academic versus vocational, and general versus specific education suggested by economic theory. The need to decompose the categories into subcategories indicates the complexity of the systems in practice. While level 4 corresponds most closely to IVET there are clearly elements of vocational training elsewhere in this categorisation; some will occur at level 5, for example. Often, it will occur at post lower secondary so that ISCED 4 is likely to be preceded by ISCED 2 and that ISCED 3 and 4 might usually be alternatives; the distinction between level 3 and 4 may then be arbitrary and cross-country differences may reflect this. Thus, ISCED 4 cannot be used as a definitive and exclusive indicator of IVET and it is not likely to be a stable proxy for IVET to allow cross-country distinctions to be made.

3.3. Informal, non-formal and formal VET

Economic theory makes strong distinctions between general and specific human capital. It is efficient for human capital investments to take place as early in life as possible; then continuing education either will be retraining or skill updating if inadequate or obsolete ([11]), or will be complementary to IVET such as MBAs.

The places where such training occurs, and the extent to which the skills are tested and certified, is not something to receive a great deal of attention from economics. There is limited literature on how education systems contribute to locating human capital acquisition: in the workplace, in an educational

([11]) Young people may not be good at making efficient long-term decisions and there may also be a demand for remedial basic skills training at a later age as individuals attempt to compensate for the mistakes they made in the past.

establishment independent of any employer, or in a mix of the two. Also, certification itself is an economic goal only insofar as it serves to overcome imperfect information about the level of competence acquired in a particular skill. In principle, literature allows for the possibility that different individuals have taken the same course but mastered the associated skills to different degrees, so that certification might play a role in outcomes. Often, differing degrees of competence having an impact on labour-market outcomes can be contemplated (e.g. speed of shorthand), whereas in others it cannot (effectiveness at open heart surgery).

However, economics makes a strong distinction between human capital acquired on-the-job from accumulated experience (learning-by-doing, Arrow, 1962) or from human capital acquired with some training or course during a spell of work. The latter involves being withdrawn from the workplace for a (usually) short spell and then returning to the workplace better able to do the job or able to do, at the same workplace, a better job that entails higher responsibilities.

It is the relationship between labour-market outcomes, such as wages, and accumulated labour-market experience that best corresponds to the incidental and unstructured nature of 'informal' VET and CVET. In practice, this form of human capital acquisition occurs on-the-job, outside any formal educational establishment. Such skill formation is likely to arise from learning-by-doing or from peer effects and so be somewhat unstructured. There is extensive literature that derives profiles showing how earnings vary with age or work-experience or job-tenure from assumptions about how this learning takes place within the workplace (or sequence of workplaces associated with a sequence of jobs) over time. Strong assumptions are required to ease structural interpretations to the parameters estimated. There are some empirical difficulties, including that of separating the effect of age (or work experience) from cohort effects, and from technological progress that also raises the wages of workers as they age (Murphy and Welch, 1990).

Similar to the endogeneity of schooling, referred to in Section 3.1, job tenure might be an endogenous choice of firms and workers. Long-tenure workers may learn well on-the-job; their productivity, therefore, may rise faster. These workers may be best able to retain their jobs in the face of variations in the demand for the products they make or the services they deliver. Overcoming the bias associated with such endogeneity is likely to be difficult to achieve in a convincing way. Literature here is small and developing slowly because of those difficulties.

However, firms often provide training that can be non-formal, as it takes place inside the workplace but is structured and is likely to involve some interruption to the normal pace of work. Invariably, such training is paid for by the employer, the opportunity costs to workers may be close to zero as they remain on full pay; however, a training wage might be paid that effectively places the burden of the costs of the training back on the employee. Apprenticeship might be one form of such non-formal VET. These usually occur in the context of an employer and have a degree of specificity, if only at occupational, rather than firm, level. However, even for apprenticeship, the location of the activities associated with such training will vary. Most will involve some workplace based training which will have some unstructured characteristics, since the apprentice will often be associated with more experienced workers and so be subject to peer effects. They are also likely to involve activity away from the workplace, in the form of structured training at an educational institution. This training may contribute to certified vocational qualifications usually (but not always) distinct from academic qualifications obtained in an educational establishment. As apprenticeships exhibit little firm specificity, apprentices often receive lower training wages than their slightly older colleagues who completed their apprenticeships and now have a trade.

Similarly, firms might allow, encourage or force employees to participate in training outside the workplace. The arrangements for fees and costs are likely to vary with the degree of specificity of the training. Such training would normally have a degree of certification associated with it, if only to certify a basic level of competence associated with a 'pass'. There may be idiosyncratic reasons why training takes place within or outside the workplace that depend on happenstance. For example, training in the use of some machine might depend on whether it is already installed at the plant.

CHAPTER 4
Literature review

4.1. Background

There is a great deal of heterogeneity in education and training. While general education is fairly homogenous, the vocational element of IVET and the non-formal and formal components of CVET are likely to be quite heterogeneous. Also, different data sets have different measures. As data are scarce, there is little research on the returns on vocational education and little research comparable across countries. Literature on formal CVET focused largely on employer-paid training or remedial government-paid off-the-job training programmes. There is considerable evidence that the former is effective and it would be surprising if successful firms were not also successful at making good human capital decisions for their workers. However, evidence of the latter suggests that, on average, it is not successful but there is considerable heterogeneity within these types of training and it would be surprising if there were not a wide range of estimates. Literature on the effects of age and/or work experience most closely corresponds to CVET. The evidence on apprenticeships, which we view as an initial vocational form of training, that lies somewhere between formal and informal, is also somewhat mixed because of the heterogeneity of apprenticeship schemes across countries.

However, hundreds of previous studies have shown that education raises a person's income, even after netting out the direct and indirect costs of acquiring it, and even after adjusting for the fact that people with more education also tend to have higher IQs, be better educated parents, and display other unobserved advantages apart from their education. Evidence is now available for many years from over a hundred countries with different cultures and economic systems (Harmon et al., 2004).

Formal academic education is not the only way to invest in human capital. Workers also learn, and are trained, outside universities and schools, especially on-the-job. Even university graduates are not fully prepared for the labour market when they leave education, and they are usually provided with formal and informal training programmes once in work. The limited data indicates that on-the-job training is an important source of the large increase in earnings that workers get as they gain greater experience at work early in their careers. Some, such training may be reflected in the vocational and professional qualifications that workers earn.

The continuing growth in per capita incomes in many countries during the 19th and 20th centuries is partly due to the expansion of scientific and technical knowledge that raised labour productivity. The increasing reliance of industry on sophisticated knowledge greatly enhances the value of education, technical schooling, on-the-job training, and other human capital. New technological advances are of little value to countries with few skilled workers who know how to use them. Economic growth depends on the synergies between new knowledge and human capital, which is why large increases in education and training have accompanied major advances in technological knowledge in all countries with significant economic growth.

The outstanding economic records of Japan, Taiwan, other Asian economies, and Ireland in recent decades, suggest a strong role for human capital in contributing to growth. These countries lacked natural resources and, despite rising resource prices, they grew rapidly by relying on a well-trained, educated, hardworking, and conscientious labour force that made good use of modern technological developments (see Krueger and Lindahl [2001] which examine critically these macroeconomic studies).

4.2. The human capital earnings function specification

The workhorse specification used to model the variation in wages across individuals is known as the human capital earnings function (HCEF) due to Mincer (1974). The dependent variable is specified as log wage; this then allows us to interpret the coefficients of the explanatory variables as proportionate effects on wages. The variable used to measure work experience – age, job tenure or potential labour market experience (age, compulsory school years) – includes a linear term (i.e. age) and a quadratic term (i.e. Age^2). Such a specification can be derived from strong, but effectively arbitrary, assumptions about how individuals continually invest in on-the-job improvements in their human capital, but is best thought of as an empirical approximation that captures the idea that log wage growth is highest when workers are young. Thus, the workhorse HCEF explicitly incorporate a role for on-the-job informal CVET to the extent that this is proxied by age and its square (or work experience and its square) ([12]).The relationship between (log) wages and age or experience that

([12]) The crude empirical approximation to the human capital theoretical framework is then given by $Log\ w_i = \mathbf{X_i}'\boldsymbol{\beta} + \gamma x_i + \delta x_i^2 + rS_i + u_i$ where w_i is a wage measure for an individual *i* such as earnings per hour or week, S_i represents a measure of their schooling (which might be a vector of qualifications, or years of education), x_i is an experience measure, X_i is a set of other variables assumed to affect earnings (race, gender, location, etc.), and u_i is a disturbance term representing other forces which may not be explicitly measured such as unobserved skills, assumed independent of X_i, x_i and S_i. Experience is included as a quadratic term to capture the concavity of the earnings profile. Mincer's derivation of the empirical model implies that, under the assumptions made, investment in schooling equals the full-year potential earnings if there is no further investment (particularly no tuition costs), *r* can be considered the private might be attributed to learning-by-doing and informal skills accumulation is also affected by the depreciation and/or obsolescence of existing skills. There is no way of distinguishing between the two. Empirical estimates of age-earnings profiles are likely to provide an upper bound to the effect of informal skill accumulation through learning-by-doing and peer effects in the workplace. However, this specification of how wages vary over the lifecycle seems to capture gradual human capital improvements arising from cohort effects as well as learning-by-doing. Indeed, it is difficult, with available data, to separate lifecycle from cohort effects except if through a long panel of data or pooled cross section data sets over a wide range of years.

The microdata and the ease of estimation resulted in many studies, which estimate this simple Mincer specification. In the original study, Mincer (1974) used 1960 US census data and an experience measure known as potential experience (i.e. current age minus age left full-time schooling) and found that the returns on schooling were 10% p.a. with returns on work experience of around 8% p.a. Psacharopoulos and Layard (1979) used data from the UK general household survey 1972 and found returns on schooling of a similar level, around 10% (Willis, 1986; Psacharopoulos, 1994; Harmon et al. (2001, 2003) for many more examples of this simple specification). In the empirical work discussed below, the education measure is treated as exogenous, although education is clearly an endogenous choice variable in the underlying human capital theory. It is useful, therefore, to consider the implications of endogenous schooling. Within the human capital framework on which the original Mincer work was based, schooling is an optimising investment decision, based on future earnings and current costs: that is, on the (discounted) difference in earnings from undertaking and not undertaking education and the total cost of education including foregone earnings. Investment in education continues until the difference between the marginal cost and marginal return on education is zero.

Empirically ability bias, as argued in Section 3.1, should result in conventional regression methods overestimating the returns on human capital investments. In principle, the same arguments apply to all forms of human capital, although most literature is concerned with general initial forms; most of this literature uses a model where this is summarised by a single measure, years

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financial return on schooling as well as being the proportionate effect on wages of an increment to *S*. This interpretation would be correct also if the opportunity cost of one year of schooling were to amount to a percentage – q% – of full year potential earnings, because students can work during school breaks, and the other investments, such as tuition costs, would amount to (1-q)% of the full year earning potential (Chiswick 1997).

of schooling. Overcoming this bias is a major preoccupation with literature and several methods are used ([13]).

It would be inappropriate to summarise the whole of this literature here because it is only tangentially related to our core interests. Interested readers are referred to Harmon et al. (2001) who provides an extensive survey that shows a surprisingly wide variety in estimates of the effects of schooling years across European countries that seems to cast doubt on the power of the factor price equalisation theory, even in labour markets where barriers to cross-county mobility are decreasing over time. Most research refers to the returns on education where education is treated as a continuous and homogenous scalar – years. There are estimates of the effects of qualifications but these are piecemeal; we know of one study that has compared the effects of qualifications across countries (Heinrich and Hildebrand, 2005).

The notable recent study of von Middendorf (2008) exploits ECHP across EU Member States. However, ironically, this paper converts the ISCED (0-2, 3 and 5-7) categories into years of education using information from *OECD education at a glance* in an attempt to generate returns on years of schooling that is comparable to most research. Unfortunately, the imputation procedure seems likely to have induced considerable measurement error in years of schooling (the distribution of years of schooling is approximately by just three points) and this is likely to attenuate (i.e. bias towards zero) the estimated returns. It seems likely that this paper is an example where measurement error matters. Also, since the measurement error is likely to differ across countries, making cross-country comparisons based on this research is problematic.

Finally, the distinction between returns on general and vocational education when the highest qualification is considered is somewhat misplaced because educational careers could consist of a mixture of general and vocational

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([13]) There are several approaches to dealing with this problem. First, measures of ability are incorporated to proxy for unobserved effects. The inclusion of direct measures of ability should reduce the estimated schooling coefficient if it acts as a proxy for ability, so that the coefficient on schooling then captures the effect of education alone since ability is controlled for. Second, one might exploit within-twins (or, less credibly, within-siblings) differences in wages and education if one is prepared to accept the assumption that unobserved effects are additive and common within twins so that they can be differenced out by regressing the wage difference within twins against their education differences. Here the simplification afforded by using years of schooling as the summary measure for human capital makes it possible to operationalise the method. It seem unlikely, except with very large samples of twins, that one would be able to use the same method for more flexible ways of describing human capital investments. However, twins are used to estimate the returns on work experience which come close to capturing the effects of informal vocational forms of CVET (Altonji and Pierret, 2001). A final approach deals directly with the simultaneous relationship between schooling and earnings by specifying a two-equation system which is identified by exploiting instrumental variables that affect S but not w except via S. Again the simplicity offered by restricting attention to initial forms of academic CVET has proved a powerful stimulus to this literature and there are few examples where the method has been used to consider greater variety in measures of human capital investment.

educational spells. The returns on a given qualification are an average of the returns across all possible combination of VET and general education pathways leading to that qualification. This approach, recently adopted by one UK study (McIntosh, 2006), is data intensive, as it requires information on all educational qualifications attained (and not only the highest one).

4.3. Incorporating remedial training

For decades, many countries around the world used government-sponsored training programmes to improve the labour-market outcomes of the unemployed or economically disadvantaged. To do this, programmes offer services, ranging from basic classroom education and vocational training to various forms of job search assistance. The key question of interest to policy-makers is whether these programmes are sufficiently effective to justify their costs. Evaluating these programmes was the focus of much economics literature. Heckman et al. (1999) observe that 'few U.S. government programmes have received such intensive scrutiny, and been subject to so many different types of evaluation methodologies, as governmentally-supplied job training'. It would be inappropriate to summarise this literature here as it is only tangentially related to our core interests. Readers are referred to Lalonde (1986) who provides an extensive survey, which is pessimistic about the effectiveness of such programmes. Cedefop (2004) also reviews the results of evaluations of remedial training in its third research report.

Much evaluation research was directed towards the US Job Corps, a comprehensive and intensive programme for economically disadvantaged youths. The typical participant will live at a local Job Corps centre where they receive room, board, and health services while enrolled for an average of about eight months. During the stay, the individual should receive around 1 100 hours of vocational and academic instruction, equivalent to about one year in high school. The Job Corps is, therefore, expensive, at an average cost at about USD 14 000 per participant. Econometric evaluations of such programmes typically focus on their reduced-form impacts on earnings. Unfortunately, studying the effect on earnings leaves open the question of whether any earnings gains are achieved through raising individuals' wage rates (price effects) or hours of work (quantity effects). A training programme may lead to a meaningful increase in human capital, raising participant wages but it may have a pure labour supply effect: through career counselling and encouraging individuals to enter the labour force, a training programme may simply raise incomes by increasing the likelihood of employment, without any increase in wage rates. Assessing the impact of training programmes on wage rates is not straightforward because of the problem of sample selection; we observe wages for those in work. Standard methods for correcting for sample selection require exclusion restrictions that are hard to justify in this context: variables related to employment probabilities (i.e., sample selection) invariably also have a direct impact on wage rates. Even if there is random assignment of the 'treatment' of a training programme, as in an experiment, there may be an effect not only on wages, but also on the probability that a person's wage will even be observed. Even a randomised experiment cannot guarantee that treatment and control individuals will be comparable, conditional on being employed. Indeed, Standard labour supply theory predicts that wages will be correlated with the likelihood of employment, resulting in sample selection bias (an idea that goes back to Heckman, 1979). This missing data problem is especially relevant for analysing public job training programmes, which typically target individuals who have low employment probabilities.

4.4. On-the-job training

While most literature on remedial training effects suggests that they have little impact on economic outcomes for the individuals receiving them (referred to in literature as the effect of the treatment on the treated), literature on training that considers firm provided CVET, usually on-the-job (mostly non-formal), is more positive. Much of the early work was concerned with US workers: for example, Lynch (1992) and Blanchflower and Lynch (1994) find large positive effects on wages. Similarly large positive effects are found in UK studies: Arulampalam et al. (1997); Blundell et al. (1999) and Dolton et al. (1994). Studies for other European workers are more mixed, although still typically positive. For example, Groot et al. (1994) and Bjorklund (1994) find large positive effects for Dutch and Swedish workers respectively and comparable with the UK and the US studies. Pischke (2001) finds substantially smaller effects for German workers. Westergard-Nielsen (1993) and Goux and Maurin (2000) find effects close to zero for Danish and French workers respectively. The effect seems to be larger for those studies that use observational data compared to those attempting to exploit some exogenous variation in training incidence, or that use panel data methods to control unobserved heterogeneity. For example, the French work exploits the compulsory component of training in France that is a legislated minimum provision, while the Danish work uses panel methods. The implication is that, at least some, estimated effect is due to neglected unobserved heterogeneity. The French work also notes that training seems to extend job tenure, which is consistent with the idea that the firm is funding firm-specific training which may lead to higher wages in the longer term as a reward for longer tenure. All these studies measure the impact of recent training on current earnings and provide estimates of relatively short term effects. Further, none consider the interaction between on-the-job training and initial education and training.

While Brunello et al. (2007) describe cross-country differences in the distributions of education and training participation, there is no analysis of the effects of training. The only pan-European work that considers wages, training and education is that of Brunello (2004). This paper uses two waves of ECHP data and estimates only wage growth equations, but it is suggestive of a role for training, and one which may differ according to initial education.

CHAPTER 5
Study methodology

5.1. Operationalising the concepts

Chapter 3 makes it clear that operationalising any particular typology of VET is likely to be difficult because the typology itself may be vague and because observed variables in our data may not correspond closely to the concepts suggested by economic theory.

We can capture the effects of academic education through human capital measures related to academic qualifications, or stages of progress through academic institutions, or simply years of education; the last of these is likely to capture some IVET to the extent that such training is provided in educational institutions at upper secondary level. There is great deal of literature addressing this form of human capital measured in these ways (see e.g., Harmon et al., 2001, in a cross-county context). Obtaining measures that are comparable across countries is problematic but the ISCED grouping seems practical and informative and is likely to be more convincing than simply using years of education.

The distinction between initial and continuing is also vague in practice. One way of operationalising this is to consider IVET as that which occurs before the first spell of full-time work, or as the spell of continuous post-compulsory education that continues after compulsory schooling is completed. There may be difficulties in deciding whether a short spell of work between spells of VET might be regarded as indicatiing the end of a spell of IVET and the first spell of CVET. For example, in many countries it is common for young people to experience a spell of travelling, or volunteering after IVET and some subsequent VET: a ‘gap year’. This might be more complicated in countries where compulsory military service is required. There may be some discretion over the precise timing. Pragmatic, but ultimately arbitrary, decisions will need to be made and some robustness testing seems desirable. For example, one might define initial training as training that occurs before a particular age.

The distinction between formal, non-formal, and informal IVET is also less than clear cut. Institution-based IVET is likely to be formal, while workplace based will generally be a mix of non-formal and informal IVET. In contrast, the effects of informal CVET most closely correspond to the way in which earnings vary with age or accumulated work experience or tenure in the most recent and earlier jobs. There is considerable literature on this, although much of the empirical findings have not been given a strong structural interpretation that would be desirable in this context. Here, in our own empirical work, we provide estimates of the shape of earnings profiles and use these to infer what the effect of work experience on wages might be.

Ultimately, what matters for the purposes of this report is less the absolute value of the effects of each form of training but, rather, the differences in the effects of each form, across countries, on wages and employment. One way of thinking about our methodology is to regard our empirical analogues of the theoretical constructs as proxies for them. In each case our empirical analogue is positively correlated with the theoretical notion that we wish to capture. The coefficients that we then estimate are not the coefficients on the theoretically appropriate variables, but are proportional to those coefficients where the degree of proportionality is captured by the accuracy of the proxy. Since we do not observe the exact theoretically appropriate variable for each construct we can never know the degree of proportionality with the proxy. However, it seems plausible that the degree of proportionality is reasonably stable across countries and across time, so that we can make comparisons across countries of returns on forms of VET even though we may not be able to estimate the absolute levels of the returns.

5.2. Methodology

Because wages (and employment and other labour-market outcomes) are determined by many variables, some of which will be correlated with one another and with wages (and employment, etc.), we need to use multivariate regression methods to derive meaningful estimates of the effect on wages (and employment) of any one variable. This is particularly so for measures of human capital accumulation.

Our analysis begins with ordinary least squares regression (OLS) estimates. This is a useful starting point because OLS produces consistent estimates in the face of various statistical specification problems, such as measurement error in the dependent variable. However, there are several drawbacks to OLS. It only provides estimates of the effects of the explanatory variable at the mean of the distribution of the dependent variable, such as wage distribution: it tells us nothing about the effect of the explanatory variables towards the top, or towards the bottom of the wage distribution ([14]).

We may also be interested in the effect of the explanatory variables on those who have higher than average and lower than average unobserved skills. The

([14]) OLS tells us the effect on the average person controlling for observable differences, that is, someone with the average degree of unobservables. We can think of this residual being made up of some unobservable skills that are fixed over time for the individual, and some random shock that 'hits' individuals at a point in time and varies across both individuals and time.

quantile regression method can be used to provide such estimates. The quantile regression method effectively reweights observations so that the regression line is fitted through any user-determined percentile of the wage distribution. Since we are interested in the extent to which forms of CVET and IVET complement one another (or not) and complement (or not) unobserved skills, this is a useful estimation method. We are keen to explore the idea that skills beget skills, which should be revealed if training and/or education had a bigger impact on those with a high level of unobserved skills (those with high wages relative to their observed skills) than those with a low level of unobserved skills.

However, OLS (and quantile regression) is not robust to endogeneity problems such as those arising from unobserved ability correlated with both wages and education and/or training giving rise to ability bias. Moreover, such estimation is also not robust to measurement error in the explanatory variables (human capital variables in particular) ([15]).

A simple specification of the workhorse HCEF might have a specification, such as

$$\log w_{it} = \mathbf{\beta X}_i + \alpha S_i + \gamma T_{it} + \delta t + (u_{it} + e_i)$$

so that wages are determined by the level of observable initial skills (which may be a vector), *S*, that is fixed for an individual *i*; and there is an effect associated with the observed increment to those skills that occurs with an on-the-job training event for *i* at time *t*, T_{it}. Here *X* is a vector of characteristics that contribute to wage determination such as race, gender, etc., which varies across *i*, and *t* is a

([15]) The first suggested solution to such endogeneity problems is to attempt to isolate some source of exogenous variation. For example, suppose we had a simple model where we could summarise human capital by two variables: years of schooling, *S*, and whether individuals had received subsequent training, *T*. Suppose a variable, call it *Z*, affects *T* but does not directly affect wages except via *T*. That is, *Z* generates exogenous variation in *T* that can be used to identify the causal effect of *T*. While there are several examples of plausible instruments for *S* in literature (such as education reforms) it is, unfortunately, difficult to think of what could be a plausible instrument for *T*. A second solution is called for and is provided for by fixed effect or panel estimation (FE). This (arguably) eliminates the endogenous part of the observed variation in *T*, usually by time differencing, estimating the impact of *T* on the change in wages over time. The method relies on the endogeneity arising because *T* is only correlated with the permanent component of the unobservables that affect individual wages and not with the temporary component of the unobserved variation in wages due to shocks. The permanent component can be eliminated by time differencing and the temporary component is (assumed to be) independent of *T*. An important shortcoming of FE estimation is that it cannot identify the effects of any variables which do not change across time – such as *S*. It cannot easily be used to identify the effect of initial education since wages are not observed for individuals until they have left education and once this occurs it is usually permanent. In practice, FE estimation has most commonly been used to identify the causal effect of continuing forms of training, CVET, on wages because of the lack of plausible instruments and because wages can be observed before and after such training episodes. In contrast, since *S* is fixed once schooling is finished, it disappears from differenced specifications. Thus, one possible solution to the endogeneity of *S* and *T* is to instrument *S* to obtain an unbiased estimate of the rate of return on *S*, and to estimate a wage difference equation which will remove the endogeneity of *T* to the extent that it is correlated with only permanent unobservables (and which eliminates *S*).

time trend that captures the rate of overall productivity change in the labour force associated with technical change. There are two sources of unobservable determinants of wages u_{it} that are shocks and e_i which are skills that are fixed for *i*, and therefore are not correlated with the independent variables. One could difference this equation and so estimate a wage change equation

$$\Delta \log w_{it} = \gamma \Delta T_{it} + \delta + \Delta u_{it}$$

and so obtain the return on training, *γ*. In principle, if the residual in this equation is random (uncorrelated with *T*) then simple OLS estimation can be used. However, one thing this study focuses on is the possibility that the returns on *T* depend on existing skills, both observed and unobserved. We wish to explore a generalisation of the simple workhorse HCEF model that allows for an interaction between *S* and *T*; more generally, the idea that skills beget skills can be captured by allowing for interaction between *S* and *T* in the HCEF specification. Then the wage growth specification would yield

$$\Delta \log w_{it} = \eta S_i T_{it} + \gamma \Delta T_{it} + \delta + \Delta u_{it}$$

which can be estimated by OLS providing, as seems reasonable, *S* is uncorrelated with these shocks since they are transient.

The description above is deliberately simplified, for expositional purposes, in that it considers just *S* and *T*. In practice, we will distinguish, as much as the data allows us, between strictly vocational forms of IVET from usual academic schooling. We will attempt to distinguish between CVET that is retraining as a form of updating of skills (formal), distinct from on-the-job (non-formal) CVET which we think of being associated with accumulated work experience. Finally, in addition to variation in the nature of VET, variation in the duration and intensity of VET should be considered.

CHAPTER 6
Data

Only few data sets on survey-based individual level allow us to address the issues in a broadly comparable way across EU Member States. Table 2 presents the relevant content of these data sets.

6.1. LFS and ISSP

Potential sources of information include the national labour force surveys, from which the EU-LFS is assembled, and the International social survey programme (ISSP). The EU-LFS contains no income or earnings data; although many national data sets from which it derives do have this information, they are generally not readily available for researchers. This makes it more difficult to exploit this large and otherwise useful data set (not least, because it contains much more detail on ISCED 4).

Unfortunately, the only cross-section where ISSP records recent training episode is the 2005 surveys but selecting a sample of working, age 25-55, individuals yields only 7 787 males and 7 549 females across all 31 countries.

Table 2. **Measuring and classifying training by data source**

RECENT TRAINING			
ECHP	**SILC**	**EU-LFS**	**ISSP**
Refers to education/training since January last year	Refers to current education activity	Reference period: last four weeks	Ref period: last 12 months
Ever had any? Have you been in education and training since January last year [pt001]?: Y/N **Base:** all persons with completed questionnaire	Current education activity [pe010]? In or not in education. **Base:** all current household members 16 and over *The concept is whether the person is currently participating in an educational programme, as defined in ISCED-97. According to the documentation, the following adult programmes cannot be classified using ISCED-97:* • *vocational education organised by a firm without leading to an official award or certification* • *any non-formal education without leading to an official award or certification individual cultural activities for leisure.*	Student or apprentice in regular education during the last four weeks (formal education) EDUCSTAT	If currently working for pay: training to improve job skills [V48]: (Y/N). If not currently working for pay: training to improve job skills [V76]: (Y/N)

Kind of course Which kind of course was it [pt002]? General or higher education/ vocational or training/language or adult education. Base: pt001=Yes	**Kind of course** No clear distinction between general or vocational education (although were told that apprenticeship should be treated as 'in education' in pe010).	Level of this education or training EDUCLEVL Field of this education or training EDUCFILD (optional)	
For general education course [pt002=1,2,3,5]:			
Starting/finishing year/month Level of course: ISCED 1 or blow, 2, 3, 5, 6			
For vocational education course [pt002=1,2,4,6]:			
Starting/finishing year/month Type of course: Third level (such as technical college) Specific vocational training at vocational school/college Specific vocational training providing both work experience and complementary instruction elsewhere Specific voc training in a working environment Overall duration of course (days, weeks, months) Course paid for (organised) by employer [pt017]? Course ft/pt/correspondence? Number of hours if pt Improving skills (job prospects) one of the reasons you took the course? Useful for improving skills (job prospects)	ISCED level currently attended [pe020]: levels 0-5	Attendance to taught learning activities (non-formal education) in the last four weeks COURATT; Number of hours spent on all taught learning activities within the last four weeks COURLEN; Purpose of the most recent taught learning activity COURPURP (optional) ; Field of the most recent taught learning activity COURFILD (optional); Did the most recent taught learning activity take place during paid working hours? COURWORH (optional)?	

General Training

ECHP	SILC	EU-LFS	ISSP
Ever had any? Have you had formal training and education that has given you skills needed for your present type of work [pe021]? Yes/No **Base:** main economic activity (self-defined) working 15+ hours per week: as paid employee, self-employed, or unpaid in family enterprise [pe001=1, 4, 5].	Not available	Not available in regular EU-LFS *The 2000 ad-hoc module on 'transition from school to working life' targets people who left full-time education in the last 5-10 years and collects detailed information surrounding their first significant job, including spell of job search and how long they stay in the first job.* *The 2003 ad-hoc module on 'lifelong learning' asks up to three training over the past 12 months.*	Not available
How much has this training contributed to present work? How much has this training contributed to your present work [pe022]? A lot/fair amount/not very much/not at all. **Base:** pe021=Yes			
How is it financed? How are you paid for your apprenticeship or training? Wage/SSB or retraining allowance Base: [pe001=2,3], only for apprentices or special training schemes			
Education/training provided by employer Education/training provided by employer (free or subsidised) [pe028]? Yes/No Base: [pe001=1,2,3]			

General Education Background

ECHP	SILC	EU-LFS	ISSP
Highest level of general or higher education completed [pt022]: (ISCED 5-7, 3, 0-2)	Highest ISCED level attained [pe040]: 0-5	Highest level of education or training successfully completed HATLEVEL	Years of schooling EDUCYRS

Age when completed [pt023]	Year when highest level of education was attained [pe030]	Field of highest level of education or training successfully completed HATFIELD	Highest education level DEGREE
Age when f-t education was stopped [pt024]		Year when highest level of education or training was completed HATYEAR	
Mother tongue [pt025]			
Second language: • handled well enough to converse in routine situations [pt026]? Y/N • handled well enough to converse in most social contexts [pt027]: Y/N • handled well enough to read basic info [pt028] • handled well enough to read complex info [pt029] Main language used in main work 2nd language used in main work		*Both the most recent training and the highest level of education or training use the full range of the ISCED code. For some countries, there is a distinction between the academic and vocational routes (denoted by suffix a/b).*	

OTHER USEFUL INFORMATIONS			
ECHP	**SILC**	**EU-LFS**	**ISSP**
Total number of hours per week	Total number of hours per week		
Main reason for working <30 hours: 1=undergoing education/training	Main reason for working <30 hours [pl120]: 1=undergoing education /training		
Occupation (24 categories) Main activity of local unit (19 cat.)	Occupation: two digits		
No. of regular employees (6 cat.)	No. regular employees: four cat.		
Private/public sector			
Job status: supervisory/intermediate	Job status: supervisory/non-supervisory		
Year/month started current job	Year/month started current job		
Means by which informed about the job			
Existence of unemployment period and duration (for new employees)			
Feel having skills to do a more demanding job			
Foreign languages used in job (up to 3)			
Type (and length) of contract	Type of contract		
Job satisfaction (earnings/job security/type of work/hours/working time/conditions/commuting)			
Days absent in the last four weeks	When began 1st reg job [pl190]		
Age began working life [pe039]	No. yrs spent in paid work [pl200]		

6.2. EU-SILC

Statistics on income and living conditions (SILC) data only focus on the 'formal' training in CVET. There is no clear distinction between general or vocational education, although it may be reasonable to think of ISCED 4 (not available in ECHP) as capturing some aspects of IVET. An important deficiency of SILC is that it is not generally possible to merge the cross-section files with the panel data set. Eurostat keeps separate variables in these separate files so it is not possible to merge together a comprehensive data set. This has meant 'collapsing' the two sources of SILC data by several key variables available in both data sets, allowing us to merge the collapsed data sets of cell means. Fortunately, the number of cells in this collapsed data set is large so the loss of precision implied by the procedure may not be very large. However, there is a potential advantage in that the procedure averages across the unobserved heterogeneity that would otherwise be a nuisance in estimation.

Education variables only exist in the public-use SILC cross-section data sets ([16]). Training variables only exist in the panel data set. Unfortunately, the longitudinal and cross-sectional data sets of SILC cannot be linked using the key identification variables in the data (for anonymity reasons). However, it is possible to match the data at a more aggregate level, by collapsing both the cross-section and the longitudinal data into cells (we take the average of cells) defined by survey year, country, region, gender, year and month of birth. Our analysis collapses both data sets into cell means, where the cells are defined by survey year-country-region-gender-year born-month born since these variables exist in both data sets. We construct a pseudo panel by matching 2005 and 2006 cross-sectional data with the 2006 longitudinal data cell means. The same age range (25-55) and selection criteria are then imposed to make the regression results comparable to those based on longitudinal data alone. The only difference in the model specification is in the inclusion of %*T*, i.e. the fraction receiving any education or training currently (only available in the cross-sectional data sets).

Figure 1 distributes men and women by level of highest education, while Figure 2 shows the log wages by highest education and gender. Upper secondary and tertiary dominate the data. However, Figure 2 suggests very small education differentials in wages except at tertiary level. Whether this is true, or is simply spurious because of other differences across individuals with different levels of highest education, must await the multivariate statistical analysis below.

([16]) Such as pe010 (current education activity), pe020 (ISCED level currently attended) and pe030 (year when highest level of education was attained).

Figure 1. **Highest education level (ISCED) by gender (%)**

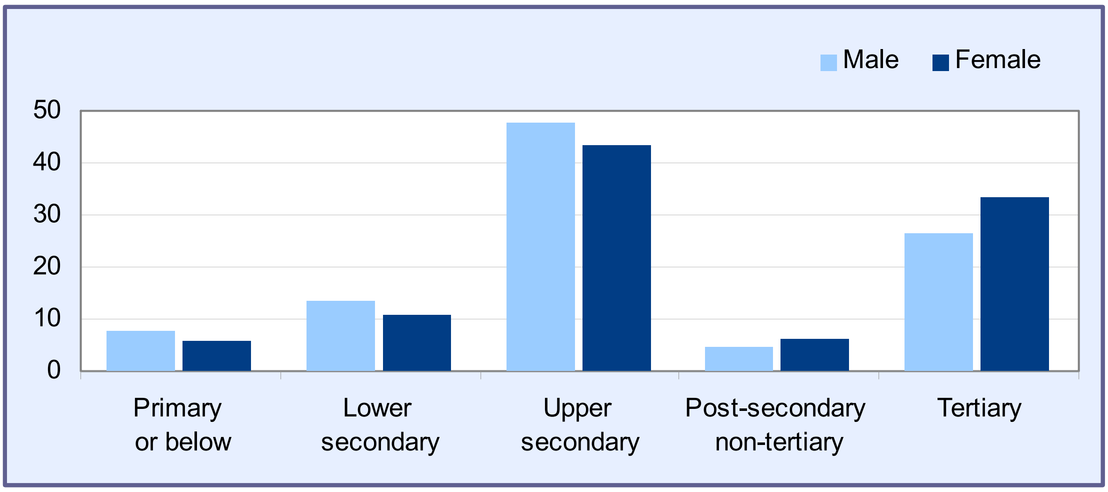
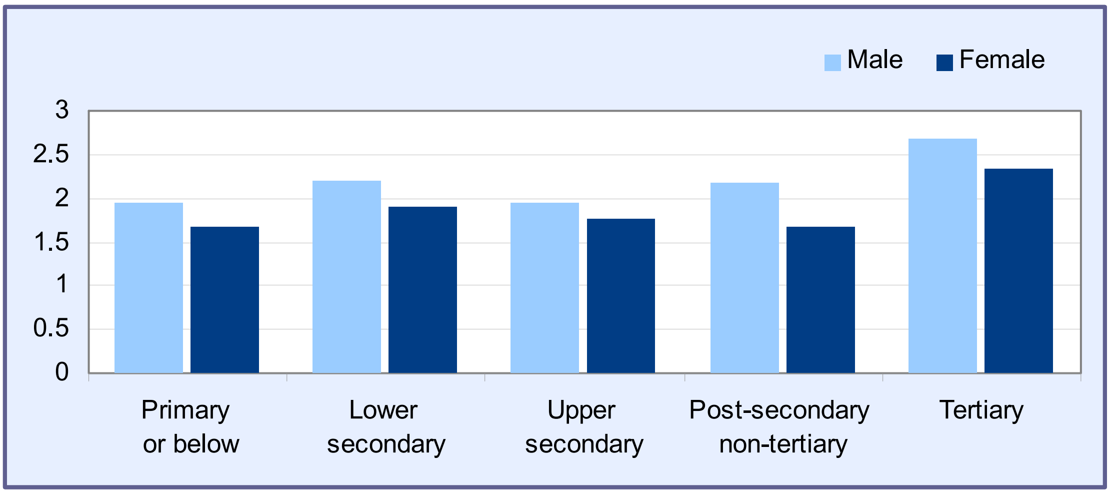


Figure 2. **Log gross hourly wage by ISCED and gender**



6.3. ECHP

The European Community household panel (ECHP) is described in detail by Peracchi (2002) and used in Brunello (2004) for analysing wage growth and in Brunello et al. (2007) for analysing participation in education and training. In several countries there are national samples as well as ECHP samples; we merged the two to generate larger sample sizes. We are concerned with the effects of VET on both employment and wages conditional on employment. We constructed separate samples to tackle these two issues since wages are only observed for those in employment. The ECHP participation sample contains everyone aged 16-60 inclusive with non-missing highest education qualifications (pt022). We have also dropped full-time students and military service personnel. Of these 762 343 observations (person waves), 71.1% are in employment, based on self-defined main economic status (pe001) ([17]).

The definition and measurements of the key variables are as follows. Income variables are constructed as log real gross hourly wage (in PPP EUR) to be used as the dependent variable in the log wage equation ([18]). We dropped all observations with non-positive wages and dropped the top and bottom 1% within each gender by country by wave cell (to reduce the influence of outliers). The resulting wage sample contains 453 663 observations. Appendix Table A1 shows the breakdown of the data across countries and waves. The cell means for gross hourly wage (by gender and country and wave) look sensible (Appendix Table A2).

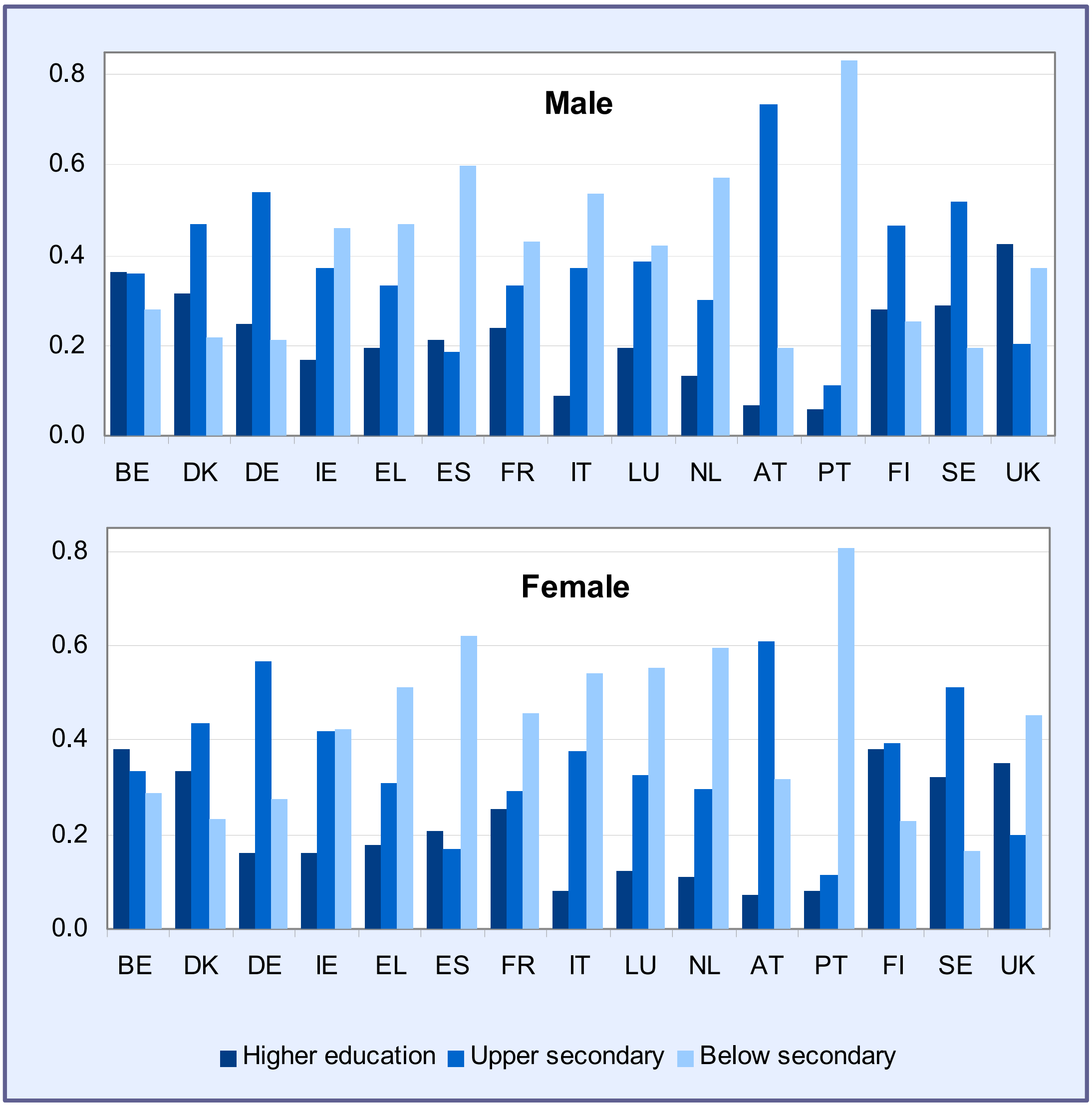
The education variable is given by pt022 (highest level of general/higher education completed) where only 1% is missing. However, there are only three categories, shown in the figures as higher education (ISCED 5-7), upper secondary (ISCED 3), and below secondary (ISCED 0-2) ([19]). Figure 3 shows the percentages in each class by country.

([17]) The indicator for 'in employment' (working) is equal to one if the respondent is in paid employment, apprenticeship/training, self-employment and unpaid work in a family enterprise, regardless of whether working 15+ hours a week.

([18]) There is no perfect income measure, pi111 (wage/salary earnings) is net, national currency, total year prior to survey, except for France and Finland where the measure is gross and we decided to use the derived variable current wage and salary earnings – gross monthly (pi211mg). However, for Sweden and Luxembourg (national data only) where pi211mg are missing, we use the derived variable pi110 (total net income from work). In principle, the use of log wages as the dependent variable makes the coefficients independent of the units of measurement, so country fixed effects will remove any inconsistencies in definition across countries. We use pe005a (total hours working per week in main+ additional jobs) so that the hourly wage = pi211mg/(pe005a*4.33) except for Sweden/Luxembourg (national) where hourly wage = pi110/(pe005a*4.33*12). We converted nominal hourly wage in national currency to PPP EUR using the official PPP rates in the ECHP country file (for the previous year as pi111 measures annual salary in total year prior to survey). The use of PPP rates rather than the fixed rate is in accordance with official recommendations.

([19]) All the alternative education measures in ECHP have serious missing value problems. For example, pt023 (age when the highest level of general or higher education was completed), has 33% missing, including all missing for Luxembourg (national), the Netherlands and Spain. After imputation using information from later waves, we still have 27% missing. pt024 (age when full-time education was completed) has 72% missing, including the first four waves. Even after imputation using information from later waves, we would still have some 50% missing.

Figure 3. **Distribution of education across countries (ECHP)**



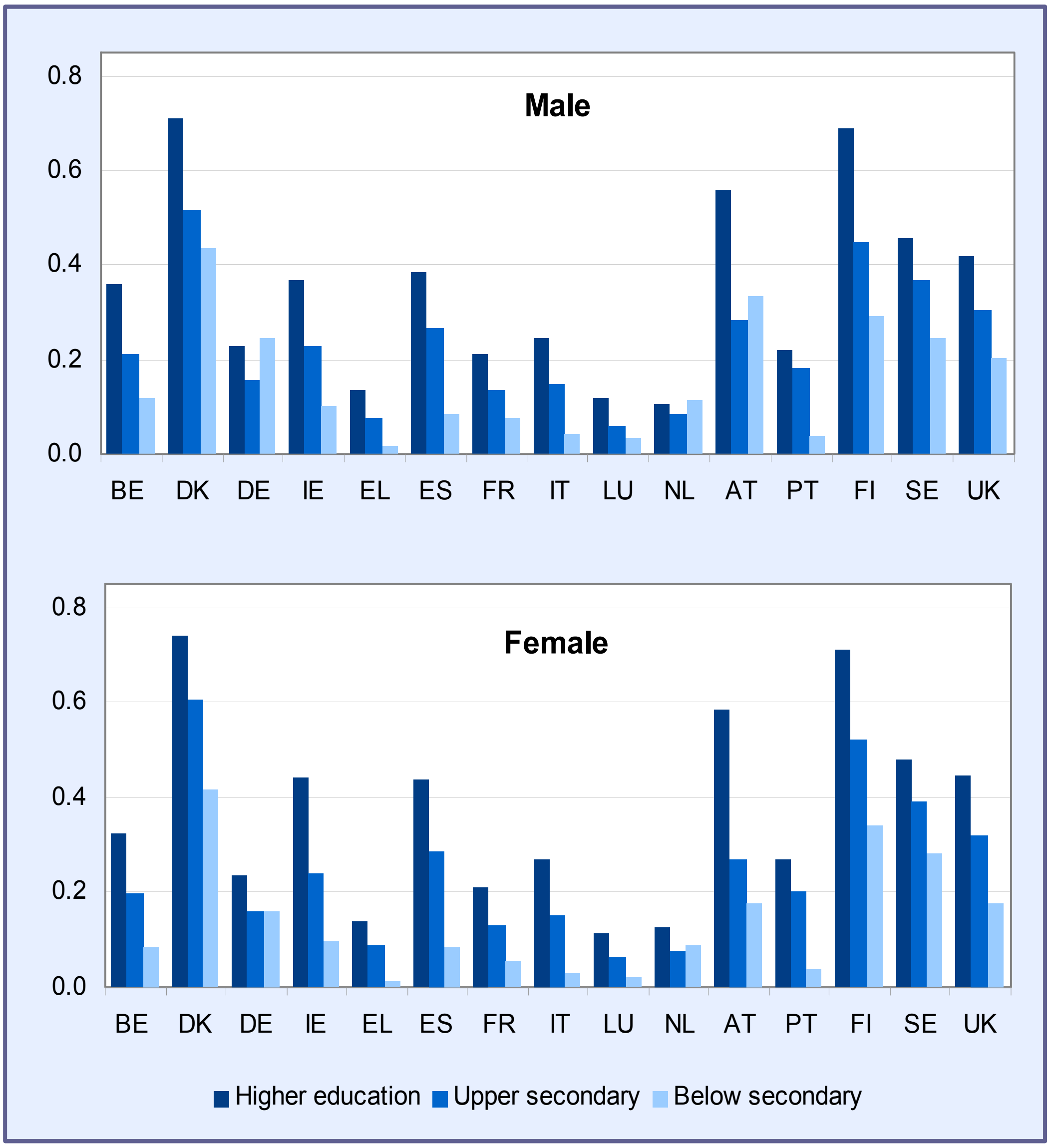
NB: the three columns add up to 100% for each country. Higher Education is ISCED 5-7, Upper Secondary is ISCED 3, Below Secondary is ISCED 0-2.

The training variables available are as follows: have you had formal training/education that has given you skills needed for your present type of work? (pe021 in the database); was the training/education provided by employer, free or subsidised? (pe028); have you been in education/training since January last year? (pt001) ([20]). For the last, we can also distinguish between general education or language or other adult training course (pt002=3,5,7); general education and VET (pt002=1,2); VET with or without language or other adult training course (pt002=4,6). Figure 4 shows the percentage receiving any VET

([20]) The pe021 and pe028 are missing for the Netherlands (no variation), Sweden and Luxembourg (national data set only).

across countries by gender and confirms the greater propensity to train for workers with higher levels of education.

Figure 4. **Distribution of TLY (pt001) by education level (ECHP)**



In the participation sample (i.e., the full-sample), 147 049 (19.3%) say they were in education/training last year (pt001=1). Of those in education/training last year, we can distinguish between general education and VET, based on pt002: 91 543 (62.6%) are found to be doing (pure) VET (pt002=4,6) while 10 573 (7.2%) are doing general education and VET (pt002=1,2). The remainder accounts for general education and or language training (see below). Of those who did (pure) VET last year, we can distinguish further between formal and non-formal (informal), based on pt012; 40 269 (44.0%) were doing formal VET (pt012=1,2,3), 26 817 (29.3%) were doing non-formal VET (pt012=4,5) while the remaining 24 457 (26.7%) were not specified. Of the 10 573 who did general education and VET, 6 356 (60.1%) were doing formal, 1 305 (12.3%) were doing non-formal and the remaining 27.5% unspecified. Non-formal includes ‘specific vocational training in a working environment, or other’ as opposed to formal training which includes ‘more structured training at technical colleges, vocational schools or within a system providing both work experience and a complementary instruction elsewhere’.

To distinguish approximately between IVET and CVET we define IVET as TLY (trained last year) that occurred before age 25 or by individuals who have never worked (based on pe039: age began working life), while CVET is defined as TLY instances that occurred from age 25.

For those who did either (pure) VET or general education and VET (pt002=1,2,4, 6), ECHP also asks: was the vocational training course paid for or organised by the employer? (pt017). Of the 74 747 observations for whom we can distinguish between formal versus non-formal training, 46 927 (62.8%) were organised (and paid for) by the employer. We think that employer-paid training provides a good proxy for the critical general versus specific VET distinction (i.e. if the employer paid for the training then the training is more likely to be specific training). The reference category of general training now includes people not in employment. The advantages of including those not in employment in general training are that we can obtain a larger sample size and a useful control group in the statistical analysis. Summary statistics for the full-information samples are given in Tables 3 and 4.

In the following, we will focus on these 74 747 observations (of 38 214 distinct individuals) who have received VET in the past year and for which we have information on the nature of training, i.e. we can distinguish between general and specific, as well as formal and non-formal VET. 38 364 (51.3%) of these are men. Also, we will compare the basic characteristics of this subsample (defined by trainfi=3, N=74 747) such as labour-market participation, real log wage, and age. We compare these with those on VET but for whom full information is not available (trainfi=2, N=27 369), which we think of as those observations where the training information is missing, with those on general education and/or language training last year (trainfi=1, N=44 805), and with those not in training last year (trainfi=0, N=615 422). The results suggest that those for whom we have training information and the group with missing data are very similar in labour-market participation rates and age, however wages are much lower in the latter group (reflecting large cross-country differences in the incidences of ‘unspecified VET’). Those receiving general education and/or language training are younger, while those not in training at all last year are older. Data on the duration and intensity of training was collapsed into a single measure indicating that the duration exceeded two weeks because the cell sizes become too small when one attempts to use more detailed information.

Table 3. **Summary statistics of wages and employment by training: ECHP men**

ISCED levels	IVET/ CVET	Formal/ non-formal	Employer pay for training?	Duration of training (long=2+ weeks)	Frequency	Percentage working	Mean log real gross hourly wage
HIGH (5-7)	CVET	Formal	Yes	Short	3 007	99.0	2 746
				Long	1 285	99.1	2 637
			No	Short	522	96.2	2 582
				Long	747	87.3	2 333
		Non-formal	Yes	Short	3 080	99.1	2 637
				Long	1 178	99.6	2 552
			No	Short	342	96.8	2 494
				Long	429	77.6	2 332
	IVET	Formal	Yes	Short	103	96.1	2 163
				Long	143	93.0	1 975
			No	Short	18	77.8	2 005
				Long	283	67.8	1 747
		Non-formal	Yes	Short	59	98.3	2 067
				Long	61	86.9	2 132
			No	Short	16	75.0	1 826
				Long	65	49.2	1 672
INTERMEDIATE (3)	CVET	Formal	Yes	Short	2 359	99.0	2 545
				Long	1 009	97.7	2 415
			No	Short	490	91.0	2 346
				Long	923	81.1	2 091
		Non-formal	Yes	Short	3 249	98.7	2 385
				Long	1 198	99.0	2 351
			No	Short	342	95.3	2 175
				Long	423	79.4	2 087
	IVET	Formal	Yes	Short	208	97.6	2 132
				Long	597	94.0	1 767
			No	Short	74	79.7	1 860
				Long	1 236	76.3	1 647
		Non-formal	Yes	Short	266	95.9	2 056
				Long	221	90.5	1 924
			No	Short	38	78.9	1 734
				Long	165	68.5	1 743
LOW (0-2)	CVET	Formal	Yes	Short	689	98.3	2 354
				Long	399	97.0	2 337
			No	Short	228	92.5	2 043
				Long	444	70.0	1 981
		Non-formal	Yes	Short	1 325	98.6	2 295
				Long	451	97.1	2 273
			No	Short	190	88.9	1 926
				Long	210	65.7	1 878
	IVET	Formal	Yes	Short	117	92.3	1 804
				Long	635	93.7	1 442
			No	Short	30	86.7	1 773
				Long	1 146	76.4	1 190
		Non-formal	Yes	Short	95	93.7	1 802
				Long	159	91.8	1 556
			No	Short	17	64.7	1 663
				Long	215	54.9	1 252
TOTAL					30 486	93.1	2.316

NB: We use the sample for which the data records full VET information (16-60 year olds).

Table 4. **Summary statistics of wages and employment by training: ECHP women**

ISCED levels	IVET/ CVET	Formal/ non-formal	Employer pay for training?	Duration of training (long=2+ weeks)	Frequency	Percentage working	Mean log real gross hourly wage
HIGH (5-7)	CVET	Formal	Yes	Short	2 861	97.5	2 573
				Long	1 238	98.5	2 479
			No	Short	622	87.6	2 488
				Long	1 061	75.0	2 189
		Non-formal	Yes	Short	3 084	98.1	2 398
				Long	971	97.3	2 375
			No	Short	350	89.4	2 354
				Long	467	69.8	2 069
	IVET	Formal	Yes	Short	135	95.6	2 096
				Long	156	96.2	2 062
			No	Short	70	74.3	2 021
				Long	458	64.2	1 698
		Non-formal	Yes	Short	115	93.0	2 057
				Long	67	97.0	1 824
			No	Short	25	64.0	1 855
				Long	96	50.0	1 621
INTERMEDIATE (3)	CVET	Formal	Yes	Short	2 012	97.0	2 421
				Long	868	95.4	2 286
			No	Short	483	737	2 228
				Long	1 100	64.5	1 964
		Non-formal	Yes	Short	2 741	97.9	2 205
				Long	732	96.6	2 193
			No	Short	291	87.3	2 131
				Long	614	62.1	1 938
	IVET	Formal	Yes	Short	235	95.7	2 008
				Long	356	87.1	1 722
			No	Short	92	73.9	1 870
				Long	1 447	63.6	1 554
		Non-formal	Yes	Short	261	96.9	1 928
				Long	139	91.4	1 800
			No	Short	44	70.5	1 691
				Long	194	55.2	1 576
LOW (0-2)	CVET	Formal	Yes	Short	647	96.9	2 163
				Long	333	93.1	2 100
			No	Short	164	68.3	2 006
				Long	524	46.4	1 791
		Non-formal	Yes	Short	970	96.3	2 038
				Long	270	93.0	1 995
			No	Short	157	70.7	1 750
				Long	278	47.1	1 726
	IVET	Formal	Yes	Short	109	88.1	1 687
				Long	314	91.1	1 396
			No	Short	35	57.1	1 550
				Long	1 025	64.4	1 169
		Non-formal	Yes	Short	73	95.9	1 786
				Long	62	95.2	1 320
			No	Short	25	44.0	1 638
				Long	169	46.2	1 212
TOTAL					**28570**	**85.6**	**2 168**

NB: We use the sample for which data records full VET information (16-60 year olds).

CHAPTER 7
Empirical results

7.1. ISSP

The ISSP data is relatively crude but is, nonetheless, a good starting point for the analysis. A simple specification, designed to capture the possibility of skills begetting skills, is estimated for the EU-15 Member States using OLS on the levels of log wages (ISSP is not a panel). The results are given in Table 5. We used the ISSP data to investigate whether there is complementarity between training and observed skills, as measured by academic education. We controlled for *S* as a vector of ISCED controls, where ISCED 3 (broadly equivalent to high school graduation) is the omitted base category. We choose ISCED 3 to be the omitted category because it can be separately identified (from 0-2) in ECHP data (while ISCED 2 cannot). It is also useful because level 3 can then be directly compared to level 4, since they can be considered alternative career tracks.

The data set is far too small to permit disaggregation by country, so our estimates need to be interpreted as averages across all countries. ISCED 5 (a degree) adds to wages by an average of 28% ([21]) for men and 29% for women relative to high school graduation; assuming a four-year period to obtain a degree (starting from an ISCED 3 qualification) this figure translates into a yearly rate of return on tertiary education of 7%, broadly consistent with evidence elsewhere (we will return on this point later on). ISCED 0-2, which corresponds to leaving school before the end of senior secondary schooling, perhaps at the minimum school leaving age at around the age of 16 (broadly speaking, a high school dropout) reduces wages by 18% for men and 15% for women relative to ISCED 3 (high school graduation); again this is consistent with evidence. The effect of ISCED 4 relative to ISCED 3 is 4% for men and 11% for women. However, this return may be of little relevance since ISCED 2 seems to be the more appropriate metric when thinking about the marginal return on ISCED 4 investment. The effects of ISCED 4 over ISCED 2 would be 22% for men and 26% for women. Assuming that ISCED 4 study lasts around three years and that this qualification is mainly vocational in nature (both strong assumptions that hide a considerable amount of heterogeneity), the returns on an additional year of vocational

([21]) Since in our specification the dependent variable is log wage, a coefficient of 0.10 on a explanatory variable implies that a unit change in that variable has a 10% effect on wages. Throughout the text we refer to the percentage effect on the level of wages by multiplying the coefficient by 100.

education at this ISCED level are in the order of 7%, very much in line with the returns on general (tertiary) education.

While having received training (last year), *T*, has a positive effect on wages for the base category of ISCED 3 by 5% for men and 9% for women, only the latter is statistically significant. The interactions are collectively statistically significant. Training for those with ISCED 5 adds to wages only 1% for men but reduces 4% for women in addition to the 5% and 9% base case. Similarly, for those with ISCED 4 there is an additional effect of training last year on wages of 14% for men and 2% for women on top of the base case. It seems that training provides some compensation for those with low initial qualifications (ISCED<3) of 11% for men but (an insignificant) 4% for women. There is also some suggestion here that skills beget skills, at least for men where the coefficient on the interaction effect between *T* and ISCED 4 is large, although there seems to be no effect of the interaction between *T* and ISCED 5.

Table 5. **Results of effects of ISCED and recent training on wages: ISSP**

	Men		Women	
	Coefficient	**Standard error**	**Coefficient**	**Standard error**
Trained last year (T)	0.045	0.029	0.089	0.029
ISCED 5+ (degree)	0.275	0.038	0.291	0.033
ISCED 5* T	0.014	0.047	-0.041	0.042
ISCED 4	0.044	0.042	0.112	0.036
ISCED 4* T	0.135	0.055	0.016	0.045
ISCED 0-2 (high school dropout)	-0.182	0.026	-0.152	0.029
ISCED 0-2* T	0.106	0.038	0.041	0.040

NB: Sample sizes: 2 609 men,; 2 744 women. Controls include age, age squared, married, ethnicity and country dummies. ISCED 3 is the omitted category.

7.2. SILC estimates

7.2.1. Effects of training on wages (conditional on being in employment) in SILC

It is not possible to provide estimates based on SILC microdata which limit what is possible. Instead, the data is collapsed into cell means and formed into a pseudo panel. While we lose precision from this procedure it has some advantages: it is no longer true that the initial education differences out of fixed effects estimation so we can, in principle, estimate the effect of initial education; and the averaging across individuals within each cell will average out (at least some of) the unobserved heterogeneity and hence reduce the possibility of bias in OLS estimation. SILC is substantially larger than ISSP and this allows us to provide both OLS estimates, which show the effects of training, etc., on average, and quantile regression estimates, that show the effects across the distribution of unobserved skills. Our idea here is to investigate the extent to which the complementarity of training extends to unobserved skills, as well as observed, skills.

Table 6 presents estimates of the ICSED level effects (omitted category is ISCED 3). ISCED 5 has a 30% wage premium for men and 32% for women using OLS estimation relative to ISCED 3, similar to the ISSP analysis. ISCED 4 has a 15% premium for men and 14% for women, relative to ISCED 3; ISCED 3 versus ISCED 2 is 13% for men and 19% for women; and ISCED 3 versus ISCED 1 is 25% for men and 39% for women. The fixed effects estimates are all badly determined (have high standard errors indicating that the estimated coefficients are not precise). These coefficients are estimated using only the very small number of individuals whose ISCED level changes across the two waves, so these fixed effects coefficients on the ISCED 1, 2 and 5 should be disregarded ([22]). In contrast, it seems possible that ISCED 4 could change from wave to wave and here the estimate of ISCED 4 indicates the wage effects of such changes at around 7%. This yearly rate of return is in line with our previous estimate using a different data set and a different methodology. Assuming that this extra year is a year in vocational education, the result suggests that investments in vocational education are characterised by yearly rates of return comparable to those of general (tertiary) education.

The training variable is now the proportion within the cell that received training last year, which we refer to as %*T*. Since we select a sample of 25-55 year olds, the training is highly likely to be CVET rather than IVET. The OLS male training effect estimate is 16%, similar to the female effect (12%). There are strong age effects which we interpret as largely arising from improvements in worker productivity associated with on-the-job learning, i.e. informal CVET. However, the OLS estimates of *T* are likely to suffer from bias associated with endogeneity,– ability bias - so we have grounds for thinking that these estimates are upper bounds on the true causal effects of T, and the fixed effects estimates confirm this. However, the effects of %*T* in the fixed effects columns are not only somewhat smaller but also imprecisely estimated and turn out not to be statistically significantly different from zero.

([22]) This is best understood with an example. Assuming that the average ISCED 4 course of study lasts four years and that a worker holds an ISCED 3 degree in one wave (say time *t*) and an ISCED 4 degree in the next wave (time *t+1*). So in year *t* this worker must have been already three years in the ISCED 4 course of study. It is likely that the wage of this worker in year *t* incorporates parts of the reward for the year of education not yet undertaken. It is not unusual that last year university students are hired in jobs requiring a university degree, with a wage not too different from the wage earned by a colleague with a university degree, on the mutual agreement that the students will finish the university degree. When this happens the returns on the extra year of education leading to the ISCED 4 degree are underestimated.

Table 6. **OLS/fixed effects estimates of the effect on wages: SILC men and women**

Variable	Men OLS	Men Fixed effects	Women OLS	Women Fixed effects
ISCED 1	-0.254	-0.043	-0.386	-0.113
	0.023	*0.035*	*0.029*	*0.045*
ISCED 2	-0.127	-0.017	-0.194	-0.038
	0.011	*0.017*	*0.012*	*0.022*
ISCED 4	0.145	0.067	0.138	0.065
	0.014	*0.021*	*0.013*	*0.021*
ISCED 5	0.301	0.150	0.324	0.082
	0.021	*0.034*	*0.020*	*0.040*
%*T*	0.155	0.011	0.124	-0.026
	0.044	*0.050*	*0.042*	*0.052*
Age	0.059	0.120	0.045	0.125
	0.005	*0.027*	*0.005*	*0.031*
Age^2	-0.001		-0.000	
	0.000		*0.000*	
N	10 735	10 735	10 168	10 168

NB: ISCED 3 is the omitted category. Figures in italic are standard errors. Sample of 25-55 year olds
N= number of observations.

Table 7. **Interaction between training and education. OLS/fixed effects estimates of the effect on wages: SILC men and women**

Variable	Men OLS	Men Fixed effects	Women OLS	Women Fixed effects
ISCED 1	-0.244	-0.045	-0.376	-0.119
	0.023	*0.036*	*0.030*	*0.046*
ISCED 2	-0.122	-0.016	-0.189	-0.028
	0.011	*0.018*	*0.012*	*0.022*
ISCED 4	0.169	0.087	0.135	0.053
	0.016	*0.022*	*0.015*	*0.024*
ISCED 5	0.319	0.155	0.346	0.081
	0.022	*0.036*	*0.022*	*0.042*
%*T*	0.290	0.075	0.208	-0.027
	0.060	*0.067*	*0.061*	*0.077*
%*T* * ISCED 1	-0.344	0.133	-0.366	0.537
	0.264	*0.260*	*0.289*	*0.402*
%*T* * ISCED 2	-0.124	-0.029	-0.158	-0.326
	0.117	*0.131*	*0.135*	*0.161*
%*T* * ISCED 4	-0.433	-0.323	0.009	0.133
	0.128	*0.133*	*0.107*	*0.125*
%*T* * ISCED 5	-0.273	-0.108	-0.245	0.021
	0.114	*0.131*	*0.101*	*0.118*
Age	0.060	0.120	0.046	0.126
	0.005	*0.027*	*0.005*	*0.031*
Age^2	-0.001	-0.000	-0.000	-0.000
	0.000	*0.000*	*0.000*	*0.000*
Prob(joint sig of interaction)	**0.005**	**0.153**	**0.082**	**0.066**
N	**10 735**	**10 735**	**10 168**	**10 168**

NB: ISCED 3 is the omitted category. Figures in italic are standard errors
N= number of observations

Table 7 shows estimates for the more general specification that allows for interactions between training and ISCED levels in an attempt to capture complementarity between *T* and observed skills, proxied by the ISCED levels.

ISCED 5+ (a degree) remains large and significant relative to ISCED 3: 32% for men and 35% for women. Even the fixed effects estimates of ISCED 5 are significant: 16% for men and 8% for women relative to ISCED 3. These are smaller than the OLS estimates, suggesting a degree of ability bias in those estimates. The omitted category remains ISCED 3, so interpreting the %*T* coefficients is relative to the ISCED 3 group. The OLS estimates remain large as before. Now the fixed effects estimate of %*T* is positive, although still not significant, for men (8%) and small and negative, although not significant, for women. The estimates of the training interactions are generally insignificant for women, but they suggest that, for men, ISCED 4 and 5 receive a large wage penalty with training. However, the fixed effects estimates of the interaction terms are not jointly significantly different from zero according to formal tests for either men or women. Thus, there is no support here for the idea that the effects of CVET are magnified by earlier skills investments.

Table 8. **Quantile regression estimates of effects on wages: SILC men and women**

Percentile Variable	Men						Women					
	10th	**30th**	**50th**	**70th**	**90th**	**OLS**	**10th**	**30th**	**50th**	**70th**	**90th**	**OLS**
ISCED 1	-0.232	-0.255	-0.247	-0.277	-0.260	-0.254	-0.428	-0.328	-0.307	-0.320	-0.375	-0.386
	0.039	*0.023*	*0.018*	*0.020*	*0.026*	*0.023*	*0.049*	*0.027*	*0.027*	*0.027*	*0.040*	*0.029*
ISCED 2	-0.108	-0.120	-0.130	-0.132	-0.146	-0.127	-0.200	-0.178	-0.186	-0.200	-0.156	-0.194
	0.019	*0.011*	*0.008*	*0.009*	*0.013*	*0.011*	*0.020*	*0.011*	*0.011*	*0.011*	*0.016*	*0.012*
ISCED 4	0.151	0.122	0.122	0.120	0.163	0.145	0.111	0.123	0.119	0.122	0.135	0.138
	0.024	*0.014*	*0.011*	*0.013*	*0.016*	*0.014*	*0.021*	*0.012*	*0.012*	*0.012*	*0.018*	*0.013*
ISCED 5	0.136	0.243	0.302	0.340	0.417	0.301	0.283	0.312	0.335	0.379	0.327	0.324
	0.035	*0.021*	*0.017*	*0.018*	*0.024*	*0.021*	*0.033*	*0.019*	*0.019*	*0.019*	*0.027*	*0.020*
%*T*	0.031	0.007	0.086	0.091	0.131	0.155	-0.011	0.058	0.063	0.130	0.186	0.124
	0.075	*0.044*	*0.035*	*0.040*	*0.052*	*0.044*	*0.070*	*0.039*	*0.039*	*0.039*	*0.054*	*0.042*
Age	0.069	0.062	0.062	0.049	0.038	0.059	0.070	0.061	0.041	0.033	0.029	0.045
	0.009	*0.005*	*0.004*	*0.004*	*0.006*	*0.005*	*0.009*	*0.005*	*0.005*	*0.005*	*0.007*	*0.005*
Age^2	-0.001	-0.001	-0.001	-0.000	-0.000	-0.001	-0.001	-0.001	-0.000	-0.000	-0.000	-0.000
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
N	10 735						10 168					

NB: ISCED 3 is the omitted category. Figures in italic are standard errors
N= number of observations

While the OLS estimates in Tables 6 and 7 show the effects on average, Table 8 shows the estimates resulting from using quantile regression methods across deciles of the unobserved skill distribution for men and women. The purpose of these estimates is to relax the assumption in OLS that the effects are the same across the distribution of unobservable skills that account for the variation in wages conditional on the control variables. Reading across the %*T* row, it can be seen that the training (and degree) effect gets substantially larger at higher deciles, where unobservable skills are greatest. These results are consistent with the skills beget skills hypothesis; in this case it is the unobserved skills that affect wages that raise the returns on *T*. The same is true for women.

In Table 8 we explore the idea that the effects of CVET might be magnified by unobservable skills. Those with the greatest unobserved skills will be higher up the wage distribution: evidence of complementarity between CVET and unobserved skills would be if the coefficient on our CVET variable, %*T*, was greater for higher deciles of the wage distribution. Looking across the %*T* row in Table 8 there are larger effects for higher deciles from the median (50%) and upwards, significantly so for both men and women.

Table 9 combines these ideas, incorporating interactions and estimates using a quantile regression method across deciles of the wage distribution. Reading across the %*T* row, these suggest larger effects of training higher up the distribution of unobserved skills for women, but a non-monotonic pattern for men. The interactions with education are generally badly determined so the effects are not usually statistically significant, but there is some suggestion that, at the bottom of the wage distribution, the interaction effect is negative for men.

Table 9. **Quantile regression estimates of effects on wages including interactions: SILC men and women**

Variable	Men						Women					
	10th	30th	50th	70th	90th	OLS	10th	30th	50th	70th	90th	OLS
ISCED 1	-0.217	-0.248	-0.245	-0.277	-0.247	-0.244	-0.370	-0.321	-0.305	-0.320	-0.372	-0.376
	0.041	*0.022*	*0.017*	*0.021*	*0.029*	*0.023*	*0.050*	*0.026*	*0.027*	*0.028*	*0.040*	*0.030*
ISCED 2	-0.100	-0.114	-0.127	-0.127	-0.140	-0.122	-0.200	-0.181	-0.185	-0.201	-0.153	-0.189
	0.020	*0.011*	*0.008*	*0.010*	*0.014*	*0.011*	*0.021*	*0.011*	*0.011*	*0.012*	*0.016*	*0.012*
ISCED 4	0.187	0.146	0.139	0.140	0.182	0.169	0.098	0.124	0.121	0.119	0.140	0.135
	0.028	*0.015*	*0.011*	*0.015*	*0.020*	*0.016*	*0.026*	*0.014*	*0.014*	*0.015*	*0.021*	*0.015*
ISCED 5	0.170	0.274	0.306	0.345	0.434	0.319	0.276	0.313	0.370	0.402	0.360	0.346
	0.038	*0.021*	*0.016*	*0.021*	*0.028*	*0.022*	*0.037*	*0.019*	*0.020*	*0.021*	*0.029*	*0.022*
%*T*	0.247	0.155	0.184	0.143	0.270	0.290	-0.021	0.059	0.155	0.167	0.311	0.208
	0.109	*0.059*	*0.043*	*0.054*	*0.069*	*0.060*	*0.109*	*0.053*	*0.055*	*0.058*	*0.083*	*0.061*
%*T* * ISCED 1	-0.555	-0.214	-0.149	-0.013	-0.485	-0.344	-0.833	-1.462	-0.153	-0.141	-0.526	-0.366
	0.275	*0.249*	*0.189*	*0.235*	*0.211*	*0.264*	*0.390*	*0.223*	*0.258*	*0.214*	*0.243*	*0.289*
%*T* * ISCED 2	-0.347	-0.148	-0.113	-0.094	-0.118	-0.124	-0.059	0.077	-0.017	0.013	-0.133	-0.158
	0.199	*0.112*	*0.084*	*0.106*	*0.129*	*0.117*	*0.240*	*0.112*	*0.121*	*0.122*	*0.164*	*0.135*
%*T* * ISCED 4	-0.638	-0.530	-0.389	-0.233	-0.277	-0.433	0.093	-0.010	-0.032	0.029	-0.104	0.009
	0.228	*0.122*	*0.092*	*0.118*	*0.157*	*0.128*	*0.187*	*0.094*	*0.096*	*0.101*	*0.136*	*0.107*
%*T* * ISCED 5	-0.483	-0.285	-0.194	-0.059	-0.236	-0.273	0.023	-0.008	-0.294	-0.234	-0.331	-0.245
	0.180	*0.108*	*0.081*	*0.110*	*0.144*	*0.114*	*0.175*	*0.088*	*0.091*	*0.097*	*0.137*	*0.101*
Age	0.068	0.061	0.062	0.049	0.039	0.060	0.070	0.060	0.043	0.035	0.029	0.046
	0.009	*0.005*	*0.004*	*0.004*	*0.006*	*0.005*	*0.009*	*0.005*	*0.005*	*0.005*	*0.007*	*0.005*
Age^2	-0.001	-0.001	-0.001	-0.000	-0.000	-0.001	-0.001	-0.001	-0.000	-0.000	-0.000	-0.000
	0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
Prob (joint sig of interaction)	0.009	0.000	0.000	0.377	0.068	0.005	0.255	0.000	0.023	0.115	0.064	0.082
N	10 735						10 168					

NB: ISCED 3 is the omitted category. Figures in italic are standard errors
N= number of observations

Finally, Tables 10 breaks down the overall results of Table 6 by country group where this is possible. France and Italy are dropped because of missing variables and ISCED 1 is missing in some countries. UK and Ireland are dropped due to very small sample sizes. Unfortunately that means omitting all the major economies of Europe. Our primary interest is in ISCED 4 and %*T*. Benelux seems to experience a lower than EU average return on ISCED 4 for men, while Central/Eastern Europe experiences a larger than average return for men and women. Surprisingly, the effects of %*T* differ more, although the results are now imprecise because of the small sample sizes and none of these differences are statistically significant.

Table 10. **Effect of training on wages by country groups: SILC men and women**

	Variable	ES, PT, EL/CY	Scandinavia	AT	Benelux	Central/Eastern Europe
MEN	ISCED 1	-0.325 *0.023*	-0.656 *0.228*		-0.305 *0.087*	-0.379 *0.207*
	ISCED 2	-0.161 *0.016*	-0.115 *0.048*	-0.126 *0.042*	-0.110 *0.026*	-0.128 *0.015*
	ISCED 4	0.114 *0.024*	0.133 *0.044*	0.137 *0.034*	0.063 *0.029*	0.253 *0.024*
	ISCED 5	0.230 *0.026*	0.467 *0.107*	0.278 *0.101*	0.191 *0.046*	0.492 *0.039*
	%*T*	0.136 *0.055*	0.196 *0.181*	-0.184 *0.135*	-0.016 *0.151*	0.160 *0.088*
	Age	0.070 *0.008*	0.038 *0.019*	0.027 *0.014*	0.066 *0.013*	0.055 *0.007*
	Age^2	-0.001 *0.000*	-0.000 *0.000*	-0.000 *0.000*	-0.001 *0.000*	-0.001 *0.000*
	N	3 237	1 792	702	822	4 200
	Adjusted R^2	0.234	0.199	0.125	0.354	0.281
WOMEN	ISCED 1	-0.472 *0.037*			-0.102 *0.108*	-0.265 *0.131*
	ISCED 2	-0.246 *0.023*	-0.164 *0.055*	-0.167 *0.035*	-0.117 *0.026*	-0.172 *0.016*
	ISCED 4	0.125 *0.030*	0.086 *0.027*	0.077 *0.059*	0.101 *0.026*	0.229 *0.021*
	ISCED 5	0.316 *0.031*	0.228 *0.059*	0.172 *0.169*	0.250 *0.036*	0.537 *0.049*
	%*T*	0.121 *0.068*	0.043 *0.115*	-0.082 *0.204*	-0.140 *0.120*	0.183 *0.077*
	Age	0.070 *0.012*	0.047 *0.014*	0.010 *0.018*	0.023 *0.011*	0.034 *0.007*
	Age^2	-0.001 *0.000*	-0.000 *0.000*	0.000 *0.000*	-0.000 *0.000*	-0.000 *0.000*
	N	2 778	1 774	670	830	4 122
	Adjusted R^2	0.213	0.238	0.061	0.258	0.194

NB: ISCED 3 is the omitted category. Figures in italic are standard errors.
N= number of observations

7.2.2. Effects of training on the probability of being in employment in SILC

SILC data can be used to estimate the effects of the same explanatory variables used above on employment. Table 11 shows some basic results. Education (ISCED) raises the probability of being in employment. The effects of training last year (%*T*) are negative for men, and insignificantly different from zero for women. ISCED 4 has a positive effect. The fixed effects estimates are rather imprecise.

Table 11. **OLS/fixed effects estimates of the effect of training on employment probability: SILC men and women (linear probability models)**

Variable	Men		Women	
	OLS	fixed effects	OLS	fixed effects
ISCED 1	-0.003 *0.008*	-0.019 *0.014*	-0.089 *0.013*	-0.058 *0.017*
ISCED 2	-0.039 *0.004*	-0.009 *0.007*	-0.073 *0.005*	-0.026 *0.008*
ISCED 4	0.011 *0.005*	-0.005 *0.008*	0.047 *0.006*	0.009 *0.008*
ISCED 5	0.030 *0.008*	-0.016 *0.014*	0.191 *0.009*	0.077 *0.015*
%*T*	-0.042 *0.017*	-0.067 *0.020*	0.016 *0.019*	0.030 *0.020*
Age	0.032 *0.002*	0.030 *0.011*	0.037 *0.002*	0.031 *0.012*
Age^2	-0.000 *0.000*	-0.000 *0.000*	-0.000 *0.000*	-0.000 *0.000*
N	**10 735**	**10 735**	**10 168**	**10 168**

NB: ISCED 3 is the omitted category. Figures in italic are standard errors.
N= number of observations

Table 12 shows the effects broken down by country group. Here ISCED 4 effects, relative to ISCED 3, are positive for women and reasonably stable across country groups. The results are less precise and more variable for men.

7.3. ECHP

We wish to examine the effects of training on both employment and log wages conditional on employment. We use OLS estimation and fixed effects estimation to exploit those repeated observations to eliminate bias associated with unobservable factors (to the extent that those factors are additive and fixed).

7.3.1. Effects of training on wages conditional on employment in ECHP

ECHP is a far larger data set and is a longer panel than SILC. It allows us to explore the effects of training using richer specifications. As an initial attempt to explore this data we wanted to establish whether training had permanent effects on wages; this is possible because it is a longer panel. From a present value perspective it is important to establish whether the effect of training depreciates over time.

Table 12 **Effect of training and education on employment probability by country groups: SILC (linear probability models)**

	Variable	EL, ES, CY, PT	Scandinavia	AT	Benelux	UK, IE	Central/ Eastern Europe
MEN	ISCED 1	-0.015 *0.011*	-0.106 *0.044*		-0.052 *0.045*		-0.115 *0.086*
	ISCED 2	-0.028 *0.008*	-0.027 *0.009*	-0.091 *0.018*	-0.011 *0.014*	-0.054 *0.036*	-0.062 *0.006*
	ISCED 4	-0.003 *0.012*	0.022 *0.009*	0.022 *0.015*	0.014 *0.015*	-0.071 *0.076*	0.028 *0.010*
	ISCED 5	0.015 *0.012*	0.094 *0.021*	0.092 *0.044*	0.053 *0.024*		0.059 *0.016*
	%*T*	-0.061 *0.026*	-0.048 *0.035*	0.069 *0.059*	0.015 *0.079*	-0.063 *0.357*	-0.008 *0.036*
	Age	0.031 *0.004*	0.022 *0.004*	0.041 *0.006*	0.041 *0.007*	0.050 *0.013*	0.032 *0.003*
	Age2	-0.000 *0.000*	-0.000 *0.000*	-0.001 *0.000*	-0.001 *0.000*	-0.001 *0.000*	-0.000 *0.000*
	N	**3 237**	**1 792**	**702**	**822**	**58**	**4 200**
	Adjusted R^2	**0.234**	**0.199**	**0.125**	**0.354**	**0.385**	**0.281**
WOMEN	ISCED 1	-0.057 *0.018*			-0.122 *0.073*		-0.091 *0.063*
	ISCED 2	-0.052 *0.011*	-0.024 *0.017*	-0.045 *0.019*	-0.084 *0.018*	-0.017 *0.045*	-0.082 *0.008*
	ISCED 4	0.058 *0.014*	0.028 *0.008*	0.022 *0.032*	0.079 *0.018*	0.048 *0.087*	0.045 *0.010*
	ISCED 5	0.203 *0.015*	0.127 *0.018*	0.375 *0.090*	0.224 *0.024*		0.155 *0.024*
	%*T*	0.034 *0.032*	-0.065 *0.036*	0.031 *0.108*	-0.089 *0.081*	-0.131 *0.345*	0.109 *0.037*
	Age	0.003 *0.006*	0.031 *0.004*	0.040 *0.010*	0.025 *0.008*	0.003 *0.018*	0.067 *0.003*
	Age2	-0.000 *0.000*	-0.000 *0.000*	-0.000 *0.000*	-0.000 *0.000*	-0.000 *0.000*	-0.001 *0.000*
	N	**2 778**	**1 774**	**670**	**830**	**58**	**4 122**
	Adjusted R^2	**0.128**	**0.106**	**0.061**	**0.250**	**-0.074**	**0.293**

NB: ISCED 3 is the omitted category. Figures in italic are standard errors.
N= number of observations

In Table 13, we allow for training last year (TLY) to have an immediate effect, an effect the year after, and the four years after that, for a sample of 25-55 year olds not in general education or doing language courses. Since we use a sample that leaves out the 16-24 year olds we imagine that TLY is effectively capturing only CVET. It is not possible to estimate this model by fixed effect estimates, because we wish to explore the lagged effects in particular, but here we are interested in exploring the extent to which the effect of a training incident on wages depreciates or appreciates over time. We do that by entering TLY into the specification, as before, and also entering TLY for the year before, and the year before that up to four further years. If the effect depreciates (appreciates) we should see the coefficients falling (rising) with time. The effect tends to rise over time for both men and women: a recent training spell raises future wages more than current ones. For men the effect rises from 3.5% in the first subsequent year to 7%, while for women it rises from an initial 4% to 6%. It is not clear what the long-term effect is because we only have sufficient waves in the data to estimate the effect over the last four years. It seems likely that, for men, the effect is continuing to rise and that the long-term effects might be close to the strong effects that we estimate in SILC data in Table 6. A test that the effects are constant over time is rejected by the estimates but the pattern of estimates suggests that the effect does not grow steeply. This is a remarkable finding, since most incidences of CVET (%*T* here is likely to be dominated by CVET as we exclude workers below 25) will involve relatively small one-off costs, certainly an order of magnitude smaller than the costs associated with ISCED 5+, for example. Even if the effect of an average TLY incident is modest, in the order of just a few percent, if the effects are long-lasting and the one-off costs are small, this will imply that, on average, TLY investments will have a very large rate of return for the individual. Having established that the effect is permanent, we feel justified in capturing a lower bound to the long-term effect by estimating the instantaneous impact only.

Table 13. **Effect of education and training on wages allowing for longer-term effects of training, by gender: OLS estimates using the ECHP**

Variable	Men	Women
Age	0.052 *0.003*	0.039 *0.004*
Age2	-0.000 *0.000*	-0.000 *0.000*
ISCED 5+	0.298 *0.008*	0.292 *0.009*
ISCED < 3	-0.175 *0.006*	-0.227 *0.007*
TLY (trained last year)	0.035 *0.006*	0.040 *0.007*
TLY lagged 1 further year	0.046 *0.005*	0.043 *0.006*
TLY lagged 2	0.051 *0.005*	0.062 *0.006*
TLY lagged 3	0.058 *0.005*	0.063 *0.006*
TLY lagged 4	0.068 *0.006*	0.063 *0.006*
TLY missing	0.186 *0.077*	0.344 *0.075*
Prob (TLY=TLY-1= TLY-2=TLY-3=TLY-4)	**0.003**	**0.026**
N	**55 237**	**43 232**
Adjusted R^2	**.531**	**.453**

NB: 25-55 year olds. ISCED 3 is the omitted category. ISCED 4 is not recorded. Figures in italic are standard errors allowing for clustering at household level
N= number of observations.

Table 13 provides estimates that are an average across countries ([23]). The impact of education (especially the one relative to ISCED 5) is again remarkably similar to that obtained before using different data sets and methodologies. This suggests that the implicit return on general education of about 7% per extra year of (tertiary) education is a remarkably robust result.

Table 14. **Effects of recent training on wages: ECHP by country group**

	Variable	EL, ES, PT	Scandinavia	DE, AT	Benelux	IE, UK	FR	IT	All countries
MEN	ISCED 5+	0.284	0.255	0.252	0.291	0.253	0.350	0.303	0.279
		0.012	*0.008*	*0.012*	*0.009*	*0.013*	*0.016*	*0.017*	*0.004*
	ISCED < 3	-0.300	-0.111	-0.031	-0.093	-0.159	-0.167	-0.176	-0.156
		0.009	*0.011*	*0.011*	*0.008*	*0.012*	*0.012*	*0.008*	*0.004*
	TLY	0.132	0.083	0.054	0.067	0.114	0.069	0.086	0.092
		0.009	*0.007*	*0.008*	*0.008*	*0.008*	*0.011*	*0.009*	*0.003*
	Age	0.068	0.035	0.045	0.070	0.080	0.076	0.049	0.061
		0.004	*0.004*	*0.004*	*0.004*	*0.005*	*0.006*	*0.004*	*0.002*
	Age2	-0.001	-0.000	-0.000	-0.001	-0.001	-0.001	-0.000	-0.001
		0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	N	**42 440**	**27 964**	**36 174**	**38 113**	**26 120**	**17 421**	**20 095**	**208 327**
	Adjusted R^2	**0.449**	**0.394**	**0.136**	**0.259**	**0.222**	**0.329**	**0.319**	**0.450**
WOMEN	ISCED 5+	0.427	0.187	0.230	0.285	0.290	0.373	0.277	0.293
		0.013	*0.008*	*0.013*	*0.011*	*0.014*	*0.016*	*0.018*	*0.005*
	ISCED < 3	-0.440	-0.088	-0.108	-0.093	-0.189	-0.203	-0.303	-0.210
		0.012	*0.012*	*0.012*	*0.010*	*0.012*	*0.015*	*0.011*	*0.005*
	TLY	0.084	0.112	0.088	0.054	0.139	0.023	0.117	0.102
		0.010	*0.007*	*0.010*	*0.009*	*0.008*	*0.012*	*0.010*	*0.004*
	Age	0.075	0.040	0.023	0.039	0.034	0.061	0.050	0.042
		0.005	*0.005*	*0.005*	*0.005*	*0.005*	*0.007*	*0.005*	*0.002*
	Age2	-0.001	-0.000	-0.000	-0.000	-0.000	-0.001	-0.000	-0.000
		0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	N	**28 085**	**27 043**	**28 427**	**28 859**	**25 499**	**14 566**	**13 462**	**165 941**
	Adjusted R^2	**0.516**	**0.403**	**0.102**	**0.124**	**0.237**	**0.300**	**0.362**	**0.388**

NB: 25-55 year olds. ISCED 3 is the omitted category. ISCED 4 is not recorded. TLY is trained last year. Figures in italic are standard errors allowing for clustering at household level
N= number of observations.

However, ECHP is large enough to allow us to disaggregate across countries. Table 14 provides estimates of a simple specification across groups of countries and, in the final column, the estimates for all countries on average (this specification includes country controls). Countries were grouped to provide

([23]) There is a large heterogeneity in the returns on education across countries (from 4% to 14%) when imputed average years of education are used instead of the highest educational attainment (Heinrich and Hildebrand, 2005). Returns on education react to aggregate unemployment level, also within countries (Ammermueller et al. (2009). In addition, attempts to correct the estimated returns on education to account for the different cost of education across countries have shown that these are often small (less than 10% of the estimated return) and are large only for Luxembourg and Austria (Heinrich and Hildebrand, 2005). Finally, as a rule of thumb correcting for the selection bias, the bias arising from better able individuals to enrolling more often in education and earning higher wages than less able individuals, would add about 2% points of the estimated returns on education (Aakvik et al 2010).

sufficient sample sizes but with a view to the similarities in their VET systems. The effects of ISCED 5+, relative to ISCED 3, are similar across countries and close to 30% for both men and women, consistent with existing evidence. The large returns in Spain and Portugal were noted in the PURE project evidence (Harmon et al., 2001). The effects of ISCED 3, relative to less than ISCED 3, are also large in most countries. The larger returns in Spain and Portugal and smaller in Germany were noted in the PURE project evidence (Harmon et al., 2001). The effects of TLY are much better determined than for SILC because we are using the microdata rather than grouped data. The ECHP dataset itself is much larger. Now the country estimates of the effect of TLY are relatively close to the all-country average effect (significant difference only for men in Germany and women in France). Also, the estimated effects are large.

ECHP is not only larger but also provides more detail on the nature of the training. We are now interested in attempting to discriminate between CVET and IVET in more detail, between formal, non-formal and informal, between general and specific, and duration. The ECHP user database contains education and training information within the same files, so there is no need to group the data: we should obtain better determined estimates. However, it has no information on ISCED 4 but has data on TLY (i.e. pt002=1,2,4,6).

To attempt to distinguish approximately between IVET and CVET we define IVET as TLY that occurred before age 25 or by individuals who have never worked (based on pe039: age began working life), while CVET is defined as TLY instances that occurred from age 25. For those who underwent VET in the previous 12 months in the ECHP (i.e. pt002=1,2,4,6), we can differentiate between formal (pt012=1,2 or 3) and informal and non-formal (pt012=4 or 5). The first category includes all college or school-based training while the others includes training in the working environment. Unfortunately, there is insufficient information in the data that would enable us to differentiate non-formal from informal. However, we also report estimates of the effects of age as a crude way of capturing non-formal CVET that occur while doing one’s job over time, which we feel captures the ideas of learning by doing and peer effects.

Table 15 **OLS/fixed effects estimates of VET effects on wages: ECHP men and women**

Log wage variable	Men		Women	
	OLS	Fixed effects	OLS	Fixed effects
General Education	-0.017 *0.005*	-0.044 *0.003*	0.003 *0.005*	-0.038 *0.003*
CVET	0.096 *0.004*	0.001 *0.002*	0.102 *0.004*	-0.001 *0.003*
IVET	-0.267 *0.009*	-0.057 *0.005*	-0.217 *0.009*	-0.046 *0.006*
Age	0.077 *0.001*	0.086 *0.001*	0.063 *0.001*	0.081 *0.001*
Age2	-0.001 *0.000*	-0.001 *0.000*	-0.001 *0.000*	-0.001 *0.000*
ISCED 5+	0.274 *0.004*	0.058 *0.003*	0.285 *0.005*	0.054 *0.004*
ISCED < 3	-0.174 *0.003*	-0.029 *0.003*	-0.220 *0.004*	-0.031 *0.003*
N	**253 160**	**253 160**	**200 503**	**200 503**

NB: Standard errors in italic. General training includes language. We also include, but do not report, a dummy variable to capture missing CVET characteristics
N= number of observations.

The results are reported in Table 15. The age effect is nonlinear: though the effect of age on wages will depend on age, the squared term is small and we can ignore it so that, to a first approximation, it seems like there are strong effects of age on productivity and wages of the order of 8% p.a. The ISCED 5+ effect (relative to the omitted category, ISCED 3) is large, consistent with the earlier results; and the effect of ISCED 3 relative to <3 is again large. Our CVET variable is our attempt to capture more formal CVET instances that occurred some time after completion of education. The OLS figures are consistent with earlier results but may be thought of as an upper bound because they are contaminated by ability bias. The fixed effects are badly determined as before: it seems likely that measurement error in the explanatory variables in the wage growth equation that lies behind these fixed effects estimates are attenuating the coefficients. The IVET variable is strongly negative and it is not clear why this is so. Because it is defined with reference to the age of individuals IVET may be picking up some specification error, associated with how age and birth cohort affect wages, that is not captured by our simple quadratic relationship.

Table 16 shows the pattern of results across countries broadly in line with the pooled results. However, the sizes of the effects of CVET, IVET and ISCED tend to be larger for South European countries.

Table 16 **Cross-country effect of training on log wages**

		EL, ES, PT	Scandinavia	DE, AT	Benelux	IE, UK	FR	IT
MEN	General education	0.059	-0.073	-0.086	-0.086	0.043	-0.086	0.011
		0.012	*0.014*	*0.009*	*0.018*	*0.012*	*0.021*	*0.015*
	CVET	0.152	0.075	0.068	0.083	0.106	0.100	0.118
		0.011	*0.008*	*0.010*	*0.008*	*0.009*	*0.012*	*0.011*
	IVET	-0.224	-0.129	-0.460	-0.231	-0.157	-0.322	-0.107
		0.021	*0.020*	*0.020*	*0.026*	*0.017*	*0.034*	*0.027*
	Age	0.065	0.065	0.083	0.092	0.095	0.080	0.047
		0.002	*0.003*	*0.003*	*0.003*	*0.003*	*0.004*	*0.002*
	Age2	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.000
		0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	ISCED 5+	0.297	0.248	0.249	0.293	0.242	0.351	0.319
		0.011	*0.008*	*0.011*	*0.009*	*0.011*	*0.015*	*0.017*
	ISCED < 3	-0.272	-0.142	-0.142	-0.103	-0.148	-0.157	-0.172
		0.008	*0.010*	*0.009*	*0.007*	*0.010*	*0.011*	*0.007*
	Intercept	0.198	0.780	0.420	0.346	0.116	0.297	1.012
		0.037	*0.056*	*0.047*	*0.053*	*0.046*	*0.075*	*0.045*
	N	**53 476**	**33 447**	**45 339**	**43 265**	**34 222**	**19 663**	**23 748**
	Adjusted R^2	**0.491**	**0.396**	**0.353**	**0.350**	**0.350**	**0.379**	**0.362**
WOMEN	General Educ	0.040	-0.028	-0.040	-0.071	0.034	-0.106	0.053
		0.012	*0.013*	*0.011*	*0.018*	*0.012*	*0.022*	*0.015*
	CVET	0.123	0.088	0.079	0.061	0.139	0.056	0.138
		0.012	*0.007*	*0.014*	*0.010*	*0.009*	*0.013*	*0.012*
	IVET	-0.239	-0.057	-0.364	-0.224	-0.176	-0.257	-0.130
		0.022	*0.020*	*0.023*	*0.026*	*0.017*	*0.041*	*0.043*
	Age	0.060	0.053	0.070	0.078	0.070	0.065	0.045
		0.003	*0.003*	*0.003*	*0.003*	*0.003*	*0.004*	*0.003*
	Age2	-0.001	-0.001	-0.001	-0.001	-0.001	-0.001	-0.000
		0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	ISCED 5+	0.422	0.182	0.225	0.287	0.268	0.369	0.289
		0.012	*0.007*	*0.013*	*0.011*	*0.012*	*0.015*	*0.017*
	ISCED < 3	-0.392	-0.108	-0.181	-0.106	-0.190	-0.195	-0.285
		0.010	*0.011*	*0.010*	*0.009*	*0.010*	*0.014*	*0.010*
	Intercept	0.165	0.860	0.521	0.655	0.493	0.480	1.003
		0.052	*0.054*	*0.052*	*0.062*	*0.047*	*0.082*	*0.062*
	N	**34 874**	**32 035**	**35 694**	**32 975**	**32 940**	**16 394**	**15 591**
	Adjusted R^2	**0.513**	**0.404**	**0.250**	**0.190**	**0.272**	**0.315**	**0.386**

NB: Standard errors in italic. General training includes language; dummy for missing CVET characteristics; ISCED 3 is the omitted category.
N= number of observations

Another question that ECHP allows us to address is the extent to which the effects of CVET are occupation specific. Normally one would be wary of adding additional control variables that were potentially endogenous. However, VET may have a degree of specificity: in a simple model with competitive labour markets, we would not expect specific training to have an effect on wages across occupations. In Tables 17 we disaggregate the countries into those with dual VET systems (where apprenticeships are common) and the rest. Controlling for occupation would allow us to examine this proposition. Effects of CVET should fall when occupation controls are included since in such a specification the VET variables pick up the effect of VET within an occupation. While IVET continues to have a negative effect on wages, which could result from wrongly specified age and cohort effects, the CVET variable has a smaller effect when we control for occupation. The suggestion here is that a significant proportion of CVET is general training (or not occupation specific) and affects wages: in competitive markets specific training should not affect wages. Including occupation controls reduces the effect of ISCED variables because part of the return of greater education is to permit higher occupational attainment, affecting wages within occupations. Similar results apply for women and for men.

Finally, we explore in more detail the greater information that ECHP provides on the characteristics of training incidences. We include variables indicating whether training was formal or not, whether the employer paid for training as proxy for specificity and duration of training (whether training exceeds two weeks full-time equivalent) ([24]). The models also include a common base set of control variables: ages and age squared which we include to capture the effects of CVET: ISCED 5+ and ISCED<3 to capture education effects, with ISCED 3 as the omitted category; and country and wave dummies (which are not reported). Table 18 shows the returns on VET using OLS estimation in ECHP without and with controls for the characteristics of the training. General education ([25]) is estimated to have a small negative effect on male wages (-2%) but no effect on female wages. When we include the controls we find that longer training has a smaller effect than shorter at 2% less for men and 4% less for women. Similarly formal is less than informal (5% less for men and 3% less for women) and employer-paid greater than not employer-paid (15% more for men and women).

([24]) The ECHP includes information on duration and intensity of the course. However, the data set is not large enough to allow us reliably to exploit this detail; therefore we concentrate on this simplified specification.

([25]) This corresponds to pt002=3,5,7, i.e. general or higher education or language or other adult education courses, without any VET elements.

Table 17. **Effect of controlling for occupation on wages, by VET system: ECHP men and women**

	Log wage variable	Dual VET system countries		Other countries	
		No occupation	Occupation dummies	No occupation	Occupation dummies
MEN	General education	-0.074 *0.008*	-0.111 *0.007*	0.014 *0.007*	-0.021 *0.006*
	CVET	0.065 *0.006*	0.021 *0.005*	0.114 *0.005*	0.082 *0.005*
	IVET	-0.344 *0.014*	-0.319 *0.014*	-0.199 *0.011*	-0.174 *0.011*
	Age	0.084 *0.002*	0.080 *0.002*	0.072 *0.001*	0.064 *0.001*
	Age2	-0.001 *0.000*	-0.001 *0.000*	-0.001 *0.000*	-0.001 *0.000*
	ISCED 5+	0.242 *0.006*	0.140 *0.006*	0.295 *0.006*	0.143 *0.005*
	ISCED < 3	-0.109 *0.006*	-0.089 *0.005*	-0.200 *0.004*	-0.129 *0.004*
	Intercept	0.318 *0.033*	0.437 *0.033*	0.584 *0.024*	0.836 *0.023*
	N	**99 111**	**99 111**	**154 049**	**154 049**
	Adjusted R^2	**0.412**	**0.437**	**0.534**	**0.583**
WOMEN	General Education	-0.041 *0.008*	-0.083 *0.008*	0.023 *0.007*	-0.022 *0.006*
	CVET	0.077 *0.006*	0.019 *0.006*	0.108 *0.005*	0.056 *0.005*
	IVET	-0.297 *0.014*	-0.268 *0.014*	-0.156 *0.012*	-0.125 *0.011*
	Age	0.066 *0.002*	0.062 *0.002*	0.064 *0.002*	0.051 *0.001*
	Age2	-0.001 *0.000*	-0.001 *0.000*	-0.001 *0.000*	-0.001 *0.000*
	ISCED 5+	0.197 *0.006*	0.098 *0.006*	0.334 *0.006*	0.159 *0.006*
	ISCED < 3	-0.117 *0.006*	-0.071 *0.006*	-0.272 *0.005*	-0.132 *0.005*
	Intercept	0.510 *0.034*	0.556 *0.034*	0.162 *0.029*	0.404 *0.028*
	N	**84 850**	**84 850**	**115 653**	**115 653**
	Adjusted R^2	**0.345**	**0.386**	**0.473**	**0.557**

NB: Countries with dual system include Denmark, Germany, the Netherlands, Austria, Sweden and Finland. Omitted occupation category: Armed forces, 5-Miscellaneous (ECHP-specific code), missing or not applicable.
N= number of observations

Table 18. **Log wage model, OLS: ECHP**

Log wage variable	Men (1)	Men (2)	Women (1)	Women (2)
General education	-0.017 *0.005*	-0.017 *0.005*	0.003 *0.005*	0.004 *0.005*
CVET	0.096 *0.004*	0.017 *0.009*	0.102 *0.004*	0.017 *0.009*
IVET	-0.267 *0.009*	-0.189 *0.012*	-0.217 *0.009*	-0.133 *0.012*
Age	0.077 *0.001*	0.077 *0.001*	0.063 *0.001*	0.063 *0.001*
Age2	-0.001 *0.000*	-0.001 *0.000*	-0.001 *0.000*	-0.001 *0.000*
ISCED 5+	0.274 *0.004*	0.275 *0.004*	0.285 *0.005*	0.285 *0.004*
ISCED < 3	-0.174 *0.003*	-0.174 *0.003*	-0.220 *0.004*	-0.220 *0.004*
Formal training		-0.052 *0.006*		-0.027 *0.007*
Employer paid		0.144 *0.008*		0.151 *0.008*
High duration		-0.018 *0.006*		-0.041 *0.007*
Intercept	0.470 *0.019*	0.474 *0.019*	0.608 *0.022*	0.610 *0.022*
N	**253 160**	**253 160**	**200 503**	**200 503**
Adjusted R^2	**0.493**	**0.494**	**0.415**	**0.417**

NB: Standard errors in italic. General education includes language; dummy for missing CVET characteristics; high duration is more than two weeks.
N= number of observations

Table 19. **OLS returns on 'ever had IVET': ECHP**

Variable	Men	Women
General education	-0.028 *0.020*	0.028 *0.019*
CVET	0.044 *0.012*	0.032 *0.014*
Ever had IVET	0.039 *0.013*	0.036 *0.015*
Age	0.140 *0.081*	0.073 *0.097*
Age2	-0.002 *0.001*	-0.001 *0.002*
ISCED 5+	0.191 *0.013*	0.258 *0.014*
ISCED < 3	-0.090 *0.011*	-0.171 *0.014*
Intercept	-0.300 *1.167*	0.650 *1.404*
N	**12 667**	**10 918**
Adjusted R^2	**0.498**	**0.444**

NB: Standard errors in italic. General education includes language; dummy for missing CVET characteristics; ISCED 3 is the omitted category. Sample of people aged 26-32 who have been observed at least once before age 25.
N= number of observations

These effects are statistically significant.

The IVET effects continue to be negative and we test the idea that this could result from misspecification for how age and cohort effects affect wages by redefining our IVET variable so that it captures whether individuals had ever had VET. These results are shown in Table 19 and this clearly shows that the CVET effects are smaller and the IVET effects are now positive and approximately equal to the CVET effect.

It is possible to do a back-of-envelop calculation of returns on IVET and CVET using the standardised duration of training. We think Table 22 is least susceptible to misspecification for how age and cohort effects affect wages because it uses 'ever had IVET' rather than 'IVET last year'. It is based on a subsample of people who were first observed between the age of 19 and 25 (because IVET was somewhat arbitrarily defined as VET before age 25) and last observed between age 27 and 32 (see below). The average standardised duration for IVET is 33.4 weeks while that for CVET is 17.5 weeks. It is also reassuring that the patterns are similar across gender and that length of duration of CVET seems independent of whether the respondent has ever had IVET. Assuming that the average school year last 39 weeks (i.e. nine months), we can roughly convert the average spell of IVET and CVET into 0.856 and 0.449 school year equivalents respectively.

Therefore, the return on CVET for men in Table 19 can be derived as the ratio between the OLS coefficient of 0.044 and the imputed length of 0.449 year. This gives an estimate of annual return of 0.098, or 9.8%. The annual return on CVET for women is 0.032/0.449=0.071, or 7.1%. Similarly, the annual return on 'ever had IVET' for men is 0.039/0.856=0.046, or 4.6%. The annual return on 'ever had IVET' for women is 0.036/0.856=0.042, or 4.2%. We interpret the effect of CVET as transitory, although Table 14 suggests that effect is persistent. However, the effect of 'ever had IVET' is regarded as permanent, much like that of ISCED.

7.3.2. Effects of training on the probability of being in employment in ECHP

The ECHP data also allows us to estimate the impact of training variables on the probability of being in employment. We can use OLS but run the risk of having the estimates contaminated by some ability bias, or we can use fixed effects estimation that effectively looks at how changes in training affect the transition into or out of work. The problem with fixed effects estimation is that the results tend to be imprecise. Table 20 shows the estimates for a simpler specification that we used to model wages. We find large CVET effects: – undertaking training raises the probability of employment by 7% for men and 22% for women.

Table 20. **OLS/fixed effects estimates of effect of training on the probability of being in employment: ECHP men and women (linear probability models)**

Employment variables	Men		Women	
	OLS	fixed effects	OLS	fixed effects
General education	0.005 *0.003*	-0.015 *0.002*	0.048 *0.004*	-0.019 *0.003*
CVET	0.066 *0.002*	0.011 *0.002*	0.219 *0.003*	0.038 *0.002*
IVET	0.025 *0.006*	-0.004 *0.004*	-0.087 *0.007*	-0.034 *0.005*
Age	0.051 *0.001*	0.068 *0.001*	0.023 *0.001*	0.040 *0.001*
Age2	-0.001 *0.000*	-0.001 *0.000*	-0.000 *0.000*	-0.000 *0.000*
ISCED 5+	0.034 *0.002*	0.015 *0.003*	0.112 *0.004*	0.030 *0.003*
ISCED < 3	-0.047 *0.002*	-0.001 *0.002*	-0.121 *0.003*	-0.012 *0.002*
N	**374 726**	**374 726**	**387 617**	**387 617**

NB: Standard errors in italic. General education includes language; dummy for missing CVET characteristics.
N= number of observations

The patterns for OLS are similar to those for wages: stronger effects of VET for women than men; negative effects of IVET; and strong effects of education level. Table 21 includes the more extensive controls for the characteristics of training. We find similar results to wages: formal has an adverse effect relative to informal/non-formal; employer paid has a positive effect relative to not employer paid; and high duration has a negative effect relative to low.

How we define IVET is again important, with the sign moveing from negative to positive (zero for men) when we define IVET as ever had IVET in Table 22. Otherwise the effects are predictable: more education is better than less, the middle-aged are more likely to be employed, and CVET has a beneficial effect.

Finally, Table 23 shows the pattern of results across countries: CVET has broadly similar positive and significant effects across countries, as do the effects of higher ISCED levels.

Table 21. **Employment linear probability model, OLS: ECHP**

Employment Variable	Men		Women	
	(1)	(2)	(1)	(2)
General education	0.005 *0.003*	0.005 *0.003*	0.048 *0.004*	0.050 *0.004*
CVET	0.066 *0.002*	0.019 *0.004*	0.219 *0.003*	0.129 *0.006*
IVET	0.025 *0.006*	0.072 *0.007*	-0.087 *0.007*	0.002 *0.009*
Age	0.051 *0.001*	0.051 *0.001*	0.023 *0.001*	0.023 *0.001*
Age2	-0.001 *0.000*	-0.001 *0.000*	-0.000 *0.000*	-0.000 *0.000*
ISCED 5+	0.034 *0.002*	0.034 *0.002*	0.112 *0.004*	0.112 *0.004*
ISCED < 3	-0.047 *0.002*	-0.047 *0.002*	-0.121 *0.003*	-0.121 *0.003*
Formal		-0.025 *0.003*		-0.039 *0.005*
Employer paid		0.103 *0.004*		0.198 *0.006*
High duration		-0.045 *0.003*		-0.062 *0.005*
Intercept	-0.043 *0.014*	-0.040 *0.014*	0.293 *0.017*	0.296 *0.017*
N	**374 726**	**374 726**	**387 617**	**387 617**
Adjusted R^2	**0.096**	**0.098**	**0.151**	**0.155**

NB: Standard errors in italic. General education includes language; dummy for missing CVET characteristics; ISCED 3 is the omitted category.
N= number of observations

Table 22. **Linear probability model of 'ever had IVET' on labour-market participation: ECHP men and women**

Variable	Men	Women
General Education	-0.033 *0.011*	0.047 *0.014*
CVET	0.022 *0.007*	0.128 *0.011*
Ever had IVET	-0.001 *0.011*	0.059 *0.014*
Age	-0.039 *0.057*	-0.061 *0.079*
Age2	0.001 *0.001*	0.001 *0.001*
ISCED 5+	0.010 *0.008*	0.094 *0.012*
ISCED < 3	-0.055 *0.009*	-0.166 *0.014*
Intercept	1.319 *0.828*	1.542 *1.134*
N	**17 393**	**18 259**
Adjusted R^2	**0.041**	**0.108**

NB: Standard errors in italic. General education includes language; dummy for missing CVET characteristics; ISCED 3 is the omitted category. Sample of people aged 26-32 who have been observed at least once before age 25.
N= number of observations

Table 23. **Cross-country effect of training on employment probabilities: ECHP**

		EL, ES, PT	Scandinavia	DE, AT	Benelux	IE, UK	FR	IT
MEN	General education	-0.033	-0.012	0.046	0.021	0.026	-0.069	-0.044
		0.007	*0.008*	*0.005*	*0.009*	*0.007*	*0.014*	*0.012*
	CVET	0.046	0.112	0.046	0.047	0.058	0.033	0.095
		0.006	*0.005*	*0.005*	*0.004*	*0.005*	*0.007*	*0.006*
	IVET	-0.131	0.015	0.112	0.093	-0.054	0.035	-0.052
		0.016	*0.012*	*0.009*	*0.015*	*0.013*	*0.024*	*0.038*
	Age	0.045	0.035	0.045	0.064	0.029	0.069	0.089
		0.001	*0.002*	*0.002*	*0.002*	*0.002*	*0.003*	*0.002*
	Age2	-0.001	-0.000	-0.001	-0.001	-0.000	-0.001	-0.001
		0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	ISCED 5+	0.048	0.020	0.060	0.040	0.005	0.022	0.017
		0.005	*0.004*	*0.005*	*0.005*	*0.005*	*0.008*	*0.009*
	ISCED < 3	-0.032	-0.057	-0.052	-0.066	-0.090	-0.063	-0.058
		0.005	*0.007*	*0.007*	*0.006*	*0.007*	*0.009*	*0.007*
	Intercept	0.065	0.225	0.159	-0.208	0.350	-0.422	-0.793
		0.025	*0.033*	*0.030*	*0.040*	*0.032*	*0.052*	*0.045*
	N	**92 725**	**43 683**	**59 218**	**54 180**	**51 336**	**29 885**	**43 699**
	Adjusted R^2	**0.076**	**0.082**	**0.133**	**0.155**	**0.058**	**0.123**	**0.144**
WOMEN	General education	0.017	0.006	0.112	0.034	0.102	-0.048	0.026
		0.008	*0.009*	*0.008*	*0.014*	*0.010*	*0.015*	*0.015*
	CVET	0.176	0.213	0.204	0.200	0.229	0.180	0.335
		0.010	*0.007*	*0.009*	*0.009*	*0.007*	*0.010*	*0.010*
	IVET	-0.173	0.010	0.065	-0.149	-0.158	-0.034	-0.389
		0.017	*0.015*	*0.014*	*0.019*	*0.015*	*0.028*	*0.034*
	Age	0.027	0.037	0.014	0.005	0.008	0.052	0.040
		0.002	*0.002*	*0.002*	*0.003*	*0.002*	*0.003*	*0.003*
	Age2	-0.000	-0.000	-0.000	-0.000	-0.000	-0.001	-0.001
		0.000	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*
	ISCED 5+	0.180	0.036	0.141	0.197	0.055	0.085	0.097
		0.009	*0.005*	*0.010*	*0.010*	*0.009*	*0.012*	*0.016*
	ISCED < 3	-0.127	-0.096	-0.106	-0.079	-0.130	-0.142	-0.231
		0.008	*0.008*	*0.009*	*0.008*	*0.008*	*0.012*	*0.011*
	Intercept	0.059	0.036	0.500	0.677	0.591	-0.292	-0.110
		0.033	*0.038*	*0.042*	*0.049*	*0.039*	*0.065*	*0.054*
	N	**94 710**	**43 676**	**60 853**	**58 250**	**55 140**	**31 215**	**43 773**
	Adjusted R^2	**0.137**	**0.116**	**0.114**	**0.156**	**0.130**	**0.102**	**0.136**

NB: Standard errors in italic. General education includes language; dummy for missing CVET characteristics; ISCED 3 is the omitted category.
N= number of observations

CHAPTER 8

Instrumental variables estimates

'Ability bias' in estimated effects of education on wages is an important issue in literature. The estimated coefficients on the education variables capture not just the effect of those variables but also the effects of omitted factors that affect wages but are correlated with the education variables. The solution to this problem is to exploit the possible existence of variables that affect those education variables but do not, directly, affect wages. Such instrumental variables only affect wages via their effect on education though it is usually difficult to think of such variables and to test for whether they only have indirect effects.

Several studies have exploited the timing of changes to the minimum school leaving age as instrumental variables; the reforms affect the education decisions that individuals make but such reforms are unlikely to affect wages except via their effects on education. Here we exploit the changes to minimum schooling laws that have taken place at different time in different countries, finding that the reforms affect education decision. We exploit those induced changes in education in the estimates of the wage difference equations in Table 24. The results show insignificant effects of CVET in the last year on how wages have changed for ISCED 3 women, and small negative effects on men. The effects are strongly positive for women with ISCED 5+ and strongly negative for women with ISCED <3, although the effect for low ISCED men is mildly positive. Complementarity is suggested for women but results for men seem weak.

Table 24. **IV estimates of training-education complementarity in log wages**

Variable	Men	Women
ΔT	-0.025 *0.009*	-0.014 *0.007*
ΔT * ISCED 5+	0.044 *0.019*	0.126 *0.034*
ΔT * ISCED<3	0.030 *0.014*	-0.119 *0.035*
Intercept	0.056 *0.001*	0.051 *0.001*
Number of observations	**145 561**	**109 314**

NB: Standard errors are bootstrapped with 100 replications and are reported in italic. Country and wave controls also included. Omitted category is ISCED 3.

CHAPTER 9
Conclusions

This report is a quantitative analysis of the effects of VET using various comparable data sources from across the EU. The research focuses particularly on identifying possible interactions between initial education (and unobservable skills) and subsequent CVET, which has been ignored in empirical literature. The motivation for this focus is the idea that skills are built, not taught in isolation, so that the foundations provided by initial academic education (and unobserved skills such as social skills) are important for how effectively new skills can be used, including skills developed from VET. We explicitly consider the possibility that new training complements existing skills, in contrast with the conventional view of training, particularly CVET, where it is often seen as a device for compensating for poor existing skills. If academic schooling and vocational training are complementary skills in generating higher productivity workers, the expansion of academic schooling should raise the return on vocational training. Thus, expanding vocational training depends, in part, on the (well-documented) rise in the return on academic schooling.

Our analysis shows strong positive effects of academic education on wages and employment across all countries, consistent with research. We find robust evidence using different data sets and estimation techniques that the returns on one extra year of tertiary education are about 7%, for men and women alike. This is the same rate of return on education found in other studies (Harmon et al., 2003; DGEAC, 2005; von Middendorf, 2008).

Based on assumptions about the typical duration of a course of study, average returns on additional years of IVET could also be around 7% on a yearly basis (beyond secondary level). This suggests that investments in VET and general (tertiary) education could be characterised by an equal rate of return.

These results must be considered preliminary and should be taken with care because of the heterogeniety in years of schooling that characterise the passage from one education level to the next. This is also the reason that renders these calculations more difficult for low educational qualifications (below upper secondary level).

Education effects on wages are larger for women than men, which also supports literature, and the effects seem larger for the upper part of the residual wage distribution (that captures unobserved skills). Also, we find strong positive effects of age on wages and employment which we think of as capturing informal CVET through peer effects in the workplace and learning-by-doing. Ever having received IVET has a 3% effect on wages.

However, if we adjust the returns on training to account for its short duration (on average 17 weeks) we find that the yearly returns for CVET average 10% for men and 7% for women; the yearly returns for initial vocational training are in excess of 4% for men and women alike. The returns on workplace training also seem to be in line with those for general education. Similar results, with rates of returns on post-school investment around 9% across various occupational career paths, have been found for the US (Freeman and Hirsh 2001). In the Netherlands the economic returns on an additional year of vocational education are just as high as those from an extra year of work experience (Oosterbeek and Webbink 2007). The principle that equalises returns on education across all forms of education and types of occupational trajectories (of equal length) might be at work. The results that the returns on general VET are of about the same size should not come as a surprise.

The rates of returns on CVET might be biased upwards because of the correlation between skills and training opportunities. If the more able are also more likely to receive CVET, part of the return on training is from ability (Heckman, 2000). This same observation suggests that the returns on investment in human capital are highest for the young: to the extent that skill begets skill, the sooner skills are built the larger the return from the investment.

The analysis of the return on education across the quantiles of wage distribution suggests that there might be potential complementarities between vocational training and academic education and between training and unobserved skills.

Where there is comprehensive information about the characteristics of this CVET we find formal and high duration training have negative effects on both wages and employment probability, while employer paid for training have positive effect. Across countries, in contrast with academic education, there is no sign that the returns on vocational training are harmonised across countries; we find negative effects of IVET on wages but ascribe this result to the specification error associated with age and birth cohort wage effects not captured by our simple quadratic relationship. When we use an alternative measure of IVET, the returns from this form of training become positive (and statistically significant).

Our analysis was severely limited by the nature of the data. The EU-LFS collects detailed information on earnings in most countries but this data is not released to researchers. The sheer size of the LFS makes this a disappointing outcome: if this data were available, much more precise estimates would be possible. We recommend that attempts be made to access the complete EU-LFS in a way that protects confidentiality but serves this purpose. The complete EU-SILC data is also not available: the fact that the education data is in one file and the training data in another, to protect anonymity, severely compromises the prospects for good research on this topic. Only ECHP data were sufficiently detailed to allow broad conclusions to be reached.

Despite these shortcomings the results suggest that, in developed countries, the returns on investment in VET beyond secondary level could be of the same order of magnitude as in general tertiary education. This reinforces the message that VET is a crucial pillar in Europe's education systems.

Abbreviations list

CVET	continuing vocational education and training
ECHP	European Community household panel
EU-SILC	European Union statistics on income and living conditions
HCEF	human capital earnings function
ISSP	International social survey programme
IVET	initial vocational education and training
LFS	labour force survey
OLS	ordinary least squares regression
PPP	purchasing power parity
TLY	trained last year

References

Aakvik, A. et al. (2010). Measuring heterogeneity in the returns to education in Norway using educational reforms. *European Economic Review*, No 54, p. 483-500.

Acemoglu, D.; Pischke, J-S. (1999b). The structure of wages and investment in general training. *Journal of Political Economy*, Vol. 107, No 3, p. 539-572.

Acemoglu, D.; Pischke, J-S. (1999a) Beyond Becker: training in imperfect labour markets. *Economic Journal*, Vol. 109, No 453, p. F112-F142.

Acemoglu, D; Pischke, J-S. (1998). Why do firms train? Theory and evidence. *Quarterly Journal of Economics*, Vol. 113, No 1, p. 78-118.

Altonji, J.G.; Pierret, C.R. (2001). Employer learning and statistical discrimination. *Quarterly Journal of Economics*, Vol. 116, No 1, p. 313-350.

Ammermueller A. et al. (2009). Aggregate unemployment decreases individual returns to education. *Economics of Education Review*, Vol. 28, Issue 2, p. 217-226.

Arrow, K.J. (1962). The economic implications of learning by doing. *Review of Economic Studies*, Vol. 29, No 3, p. 155-173.

Arulampalam, W. et al. (1997). Work-related training and earnings growth for young men in Britain. *Research in Labor Economics*, Vol. 16, p. 119-147.

Ashenfelter, O. et al. (1999). A review of estimates of the schooling/earnings relationship, with tests for publication bias. *Labour Economics*, Vol. 6, N°4, p. 453-470.

Bassanini, A. et al. (2005). Workplace training in Europe. Bonn: IZA – Institute for the Study of Labour (IZA discussion paper, No 1640).

Becker, G.S. (1964). Human capital: a theoretical and empirical analysis, with special reference to education. New York: National Bureau of Economic Research (General series, No 80).

Bjorklund, A. (1994). Evaluations of labour market policy in Sweden. *International Journal of Manpower*, Vol. 15, Issue 5, p. 16-31.

Blanchflower, D.G.; Lynch, L.M. (1994). Training at work: a comparison of US and British youths. In: Lynch, L.M. (ed.). *Training and the private sector*. Cambridge, MA: National Bureau of Economic Research (NBER Book series Comparative labor markets).

Blundell, R.W. et al. (1999). Human capital investment: the returns from education and training to the individual, the firm and the economy. *Fiscal Studies*, Vol. 20, No 1, p. 1-23.

Brunello, G. (2004). Labour market institutions and the complementarity between education and training in Europe. In: Checchi, D.; Lucifora, C. (eds) *Education, training and labour market outcomes in Europe.* MacMillan.

Brunello, G. et al. (2007). *Education and training in Europe*. Oxford: University Press.

Card, D. (1999). The causal effect of Education on earnings. In: Ashenfelter, O.; Card, D. (eds). *Handbook of Labor Economics, Vol. 3*, Amsterdam: Elsevier.

Cedefop (2004). *The foundations of evaluation and impact research: third report on vocational training research in Europe: background report.* Luxembourg: Publications Office of the European Union.

Cedefop (2005). *Annual report 2005*. Luxembourg: Publications Office.

Chevalier, A. et al. (2004). Does education raise productivity, or just reflect it? *Economic Journal*, Vol. 114, Issue 499, p. F499-F517.

Chiswick, B.R. (1997). *Interpreting the coefficient of schooling in the human capital earnings function*. Washington: World Bank (Policy Research working paper series, No 1790).

Christensen, J.J.; Westergard-Nielsen, N. (1999). Wages and human capital: the Danish evidence. In: Asplund, R.; Pereira, P.T. (eds). *Returns to human capital in Europe.* Helsinki: ETLA, Research Institute of the Finnish Economy.

Denny, K. et al. (2002). Cross country evidence on the returns to education: patterns and explanations. London: Centre for Economic Policy Research (CEPR Discussion Paper, No 3199).

DGEAC (2005). *Study on: the returns to various types of investment in education and training.* Brussels: European Commission, DGEAC.

Dolton, P.J. et al. (1994). The Youth Training Scheme and the School-to-Work Transition. *Oxford Economic Papers, Special issue on vocational training*, Vol. 46, No 4, p. 629-657.

European Commission (2010). *Communication from the Commission: Europe 2020: a European strategy for smart, sustainable and inclusive growth.* Luxembourg: Publications Office (COM(2010) 2020)

Freeman, J.A.; Hirsh, B.T. (2001). Do returns to human capital equalize across occupational paths? In: Polacheck, S. (ed.). *Worker wellbeing in a changing labor market*. Amsterdam: Elsevier, p. 217-242 (Research in Labor Economics, Vol. 20).

Goux, D.; Maurin, E. (2000). The decline in demand for unskilled labor: an empirical analysis method and its application to France. *Review of Economics and Statistics*, Vol. 82, Issue 4, p. 596-607.

Groot, W. et al. (1994). Costs and revenues of investment in enterprise-related schooling. *Oxford Economic Papers, Special issue on vocational training*, Vol. 46, No 4, p. 658-675.

Harmon, C. et al. (2001). *Education and earnings in Europe: a cross country analysis of the return to education.* Edward Elgar.

Harmon, C. et al. (2003) The returns to education: microeconomics. *Journal of Economic Surveys*, Vol. 17, No 2, p. 115-156.

Hashimoto, M. (1981). Firm-specific human capital as a shared investment. *American Economic Review*, Vol. 71, Issue 3, p. 475-482.

Heckman, J.J. (1979). Sample selection bias as a specification error. *Econometrica*, Vol. 47, No 1, p. 153-161.

Heckman, J.J. (2000). Policies to foster human capital. *Research in Economics*, Vol. 54, Issue 1, p. 3-56.

Heckman, J.J. et al. (1999). The economics and econometrics of active labor market programs. In: Ashenfelter, O.; Card, D. (eds). *Handbook of Labor Economics, Vol. 3.* Amsterdam: Elsevier, p. 1865-2097.

Heinrich, G.; Hildebrand, V. (2005). Returns to education in the European Union: a re-assessment from comparative data. *European Journal of Education*, Vol. 40, Issue 1, p. 13-34.

Krueger, A.; Lindahl, M. (2001). Education for growth: why and for whom? *Journal of Economic Literature*, Vol. 39, No 4, p. 1101-1136.

Lalonde, R. (1986). Evaluating the econometric evaluations of training programs with experimental data. *American Economic Review;* No 76, p. 604-620.

Lynch, L.M. (1992). Private-sector training and the earnings of young workers. *American Economic Review*, Vol. 82, Issue 1, p. 299-312.

McIntosh, S. (2006). Further analysis of the returns to academic and vocational qualifications. *Oxford Bulletin of Economics and Statistics*, Vol. 68, Issue 2, p. 225-251.

Mincer, J. (1974). *Schooling, experience and earnings.* New York: Columbia University Press.

Murphy, K.M.; Welch, F. (1990). Empirical age-earnings profiles. *Journal of Labor Economics*, Vol. 8, No 2, p. 202-229.

OECD (2002). *Education at a glance 2002.* Paris: OECD.

Oosterbeek, H.; Webbink, D. (2007). Wage effects of an extra year of basic vocational education. *Economics of Education Review*, Vol. 26, Issue 4, p. 408-419.

Peracchi, F. (2002). The European Community household panel: a review. *Empirical Economics*, Springer, Vol. 27, No 1, p. 63-90.

Pischke, J-S (2001). Continuous training in Germany. *Journal of Population Economics*, Vol. 14, Issue 3, p. 523-548.

Psacharopoulos, G. (1994). Returns to investment in education: a global update. *World Development*, Vol. 22, Issue 9, p. 1325-1343.

Psacharopoulos, G.; Layard, R. (1979). Human capital and earnings: British evidence and a critique. *Review of Economic Studies*, Vol. 46, No 3, p. 485-503.

Riley, J.G. (2001). Silver signals: twenty-five years of screening and signaling. *Journal of Economic Literature*, Vol. 39, No 2, p. 432-478.

Schultz, T.W. (1963). *The economic value of education*. New York: Columbia University Press.

Spence, M. (1973). Market signaling. *Quarterly Journal of Economics*, Vol. 87, p. 355-374.

Stevens, M. (1994). A theoretical model of on-the-job training with imperfect competition. *Oxford Economic Papers*, Vol. 46, Issue 4, p. 537–562.

Unesco (2006). *International standard classification of education: ISCED 1997.*

von Middendorf, T. (2008). *Returns to education in Europe: detailed results from a harmonized survey*. Berlin: Rheinisch-Westfälisches Institut für Wirtschafts-forschung (RWI working paper, 08/2008).

Willis, R. (1986). Wage determinants: a survey and reinterpretation of human capital earnings functions. In: Ashenfelter, O.; Card, D. (eds). *Handbook of Labor Economics, Vol. 1.* Amsterdam: Elsevier, p. 525-560.

Appendix

Table A1. **Frequencies by country and wave**

		1	2	3	4	5	6	7	8	Total
MEN	BE	1 441	1 338	1 252	1 159	1 227	1 164	1 107	1 014	9 702
	DK	1 593	1 513	1 415	1 298	1 238	1 159	1 102	1 097	10 415
	DE	6 240	6 186	5 875	3 345	3 178	3 151	3 022	2 811	33 808
	IE	2 003	1 717	1 472	1 411	1 452	1 267	1 032	894	11 248
	EL	1 840	1 764	1 652	1 520	1 430	1 375	1 343	1 372	12 296
	ES	3 302	3 009	2 867	2 786	2 665	2 650	2 558	2 520	22 357
	FR	3 043	2 900	2 808	2 539	2 009	2 121	2 106	2 137	19 663
	IT	3 402	3 310	3 203	2 895	2 965	2 735	2 729	2 509	23 748
	LU	582	2 517	2 142	1 554	1 678	1 691	1 525	1 549	13 238
	NL	2 547	2 539	2 523	2 500	2 574	2 532	2 594	2 516	20 325
	AT	0	1 908	1 865	1 761	1 651	1 563	1 423	1 360	11 531
	PT	2 215	2 329	2 378	2 381	2 429	2 404	2 358	2 329	18 823
	FI	0	0	1 716	1 652	1 670	1 640	1 351	1 332	9 361
	SE	0	0	0	2 779	2 702	2 756	2 723	2 711	13 671
	UK	4 423	3 943	3 720	2 154	2 226	2 184	2 181	2 143	22 974
	Total	32 631	34 973	34 888	31 734	31 094	30 392	29 154	28 294	253160
WOMEN	BE	1 202	1 084	1 047	993	1 056	1 056	994	955	8 387
	DK	1 492	1 411	1 270	1 210	1 153	1 113	1 056	1 057	9 762
	DE	4 855	4 766	4 667	2 674	2 599	2 630	2 541	2 435	27 167
	IE	1 502	1 258	1 120	1 107	1 161	1 043	884	792	8 867
	EL	1 114	1 045	966	924	934	822	865	922	7 592
	ES	1 746	1 686	1 597	1 580	1 615	1 600	1 586	1 661	13 071
	FR	2 532	2 355	2 335	2 038	1 688	1 793	1 826	1 827	16 394
	IT	2 120	2 113	2 139	1 936	1 949	1 853	1 785	1 696	15 591
	LU	389	1 389	1 157	834	933	945	876	944	7 467
	NL	1 989	2 065	2 086	2 087	2 173	2 186	2 285	2 250	17 121
	AT	0	1 324	1 346	1 312	1 199	1 180	1 091	1 075	8 527
	PT	1 504	1 659	1 667	1 751	1 852	1 893	1 955	1 930	14 211
	FI	0	0	1 773	1 749	1 706	1 684	1 369	1 360	9 641
	SE	0	0	0	2 546	2 518	2 533	2 524	2 511	12 632
	UK	4 491	4 103	3 880	2 273	2 387	2 360	2 302	2 277	24 073
	Total	24 936	26 258	27 050	25 014	24 923	24 691	23 939	23 692	200 503

Table A2. **Gross hourly wage (in PPP EUR)**

	Wave	1	2	3	4	5	6	7	8	Total
MEN	BE	10.8	11.4	11.5	12.2	12.3	12.8	12.7	13.7	12.1
	DK	10.7	11.7	12.1	13.2	13.5	14.4	15.2	15.8	13.1
	DE	10.0	10.5	11.1	10.8	11.0	11.1	11.9	12.6	10.9
	IE	9.4	10.3	10.9	10.5	10.9	10.7	11.4	11.9	10.6
	EL	5.9	5.8	6.1	6.4	6.6	7.1	7.2	7.2	6.5
	ES	7.5	7.7	8.0	8.0	8.1	8.2	8.6	9.0	8.1
	FR	9.7	8.6	8.7	9.4	10.2	10.5	10.7	11.3	9.8
	IT	8.5	8.5	8.6	8.9	9.1	9.4	9.7	9.7	9.0
	LU	14.7	13.3	13.6	13.7	13.6	13.7	15.1	15.6	14.0
	NL	12.9	13.0	13.5	14.1	15.0	15.3	15.6	15.4	14.4
	AT		9.6	8.9	9.4	9.7	10.0	10.9	11.5	9.9
	PT	4.1	4.3	4.3	4.5	4.7	4.9	5.2	5.6	4.7
	FI			9.5	10.0	9.9	10.0	10.2	11.0	10.1
	SE				5.9	6.1	6.3	6.5	6.7	6.3
	UK	9.9	10.3	10.3	10.6	11.1	11.4	11.8	12.6	10.8
	Total	9.3	9.6	9.8	9.6	9.9	10.1	10.5	10.9	9.9
WOMEN	BE	9.4	10.0	10.2	10.7	11.0	11.3	11.0	11.9	10.7
	DK	7.6	8.2	8.6	8.5	8.8	8.8	9.4	9.9	8.6
	DE	9.6	10.2	10.6	11.7	12.0	12.5	13.2	13.8	11.5
	IE	8.0	8.7	9.1	9.0	9.5	9.2	9.7	10.1	9.1
	EL	5.1	5.0	5.3	5.9	6.0	6.4	6.5	6.3	5.8
	ES	6.7	6.7	7.1	7.1	7.1	7.3	7.5	7.7	7.1
	FR	8.2	7.4	7.4	8.3	8.8	9.2	9.3	9.7	8.4
	IT	8.0	8.1	8.1	8.4	8.6	8.8	9.2	9.3	8.5
	LU	12.4	10.0	10.3	10.1	10.0	10.0	10.9	11.5	10.5
	NL	10.0	10.0	10.5	11.0	11.8	12.2	12.6	12.1	11.3
	AT		7.6	7.2	7.5	7.8	8.0	8.6	9.1	7.9
	PT	3.8	3.9	4.0	4.1	4.7	4.8	5.1	5.4	4.5
	FI			7.7	8.0	8.1	8.2	8.5	9.1	8.2
	SE				5.0	5.2	5.3	5.3	5.5	5.2
	UK	7.4	7.6	7.6	8.1	8.4	8.8	9.2	9.9	8.2
	Total	7.8	7.9	8.1	8.0	8.3	8.5	8.9	9.2	8.3

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This report examines the economic return on vocational education and training (VET) for individuals across the EU. The benefits analysed are the private ones that accrue to individuals who receive training. We find that returns on secondary (but non-tertiary) initial VET are of the same order of magnitude as those characterising tertiary general education. These benefits are in terms of earnings and the probability of being in employment. The methodology involves econometric analysis of large comparable data sets drawn from across the EU. Some attention is given to the problem of establishing the causal effect of VET. In addition to considering the overall impact of training, as far as the data allows, the report attempts to distinguish between initial VET, academic education and continuing VET. An important focus of the research is to investigate the extent to which continuing training complements initial VET (the 'skills beget skills' hypothesis), rather than the conventional view of training compensating for low levels of initial education.

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