# Human Capital Policy for Europe 

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## 1 Low Skills - A Problem for Europe

We live in a time of turbulence. ${ }^{1}$ There are large flows of individuals, capital and information and knowledge across the world. There are constant and rapid changes to which individuals need to adapt everyday. In such a world the abilities to process information and to be flexible will sell at a large premium, while inflexibility and ignorance are a recipe for a most likely failure. In such a world, it is important to be highly skilled. In this paper I argue that there is a skill problem in Europe and I present some basic principles that should be in the background of a human capital strategy for Europe.

Gottschalk and Smeeding (1996) analyze trends in income inequality around the world and they conclude that in the last twenty-five years there has been an increase in inequality in many countries of the western world. In anglo-saxon countries, in particular in the US, the increase in inequality is much larger than in continental Europe. Bertola (2001) argues that many continental european

[^0]countries did not experience any increase in inequality. Figure 1 is taken from Bertola (2001), and in the top panel it displays the ratio of the 50th to the 10th percentiles of the earnings' distribution across time for different groups of countries. The bottom panel shows 90-10 earnings differentials across countries. There is only a consistent increase in earnings inequality across time for the set of countries in the first graph of each panel, which are precisely the anglo-saxon countries. However, figure 2, also from Bertola (2001), shows that the countries with the smallest increases in inequality have on average experienced the large increases in unemployment. Bertola argues that labor market institutions in these countries have prevented large changes in earnings inequality at the expense of employment. Once you take this into account it is not clear whether the change in inequality in anglo-saxon countries has been smaller or larger than the change in inequality in continental Europe, since in figure 1 we only use individuals who are employed. Blundell, Reed and Stoker (2003) show how accounting for unemployment can dramatically change inferences about trends in aggregate wage growth in the UK. Accounting for the trend in unemployment is bound to also affect any inference we make about changes in inequality.

This increase in inequality, either in earnings or in employment, comes at a time of substantial economic growth. In the US, individuals at the bottom ten percentile of the wage distribution have experienced losses in real wages over the last thirty years, while those at the top benefit from large wage increases (see, for example, Juhn, Murphy and Pierce, 1993). In the UK, individuals at the bottom end of the wage distribution have stagnant wage growth while the those at the top experience wage increases (see Gosling, Machin and Meghir, 2000). Rebecca Blank (1996), discussing the problem of pverty in the US, argued that recent economic growth is very different from past economic growth. In particular, the post-WWII period was a period of rapid growth both in western Europe and in the US, but its benefits were spread across the earnings distribution. Growth was driven by the reconstruction of Europe and the motor of economic growth was the manufacturing sector. Even low skilled workers could experience increases in employment and earnings since good
unskilled manufacturing jobs were becoming increasingly available. In such a world, the major poverty alleviation program is economic growth. However, recent growth has mainly benefited skilled individuals. Machin and Van Reenen (1998) present evidence that recent economic growth in seven OECD countries has been driven by skill-biased technical change, with important consequences for the wage structure of these countries. There are however countries, such as the US and the UK, where unemployment rates are low and the low skilled can find jobs. However, such unskilled jobs tend to be in the service sector which has grown enormously in recent years, and these are low paying jobs with slim chances of growth. Table 1, from Nickell and Bell (1996), documents that the difference between unemployment rates of low and high skilled individuals has increased across OECD countries between the early and the late 1980s. The skill premia has also generally increased across countries, and the largest increases are in the US and the UK.

As a response to the rise in the demand, the supply of skill has increased across the western world. Figure 3, from OECD (1997), shows cross country educational attainment for two different cohorts of individuals in 1995. In all countries shown there has been an increase in educational attainment of the population across cohorts. This increase was especially large in Belgium, Korea, Greece and Spain. In contrast, it was basically zero in the US, and it was small in many other european countries. Figure 4, from Carneiro and Heckman (2003), plots educational attainment by cohort in the US. It shows a secular growth in educational attainment up to the cohort born in 1950. After this cohort college participation rates and high school dropout rates become flat, in spite of large increases in the returns to schooling across cohorts. In the UK we observe a similar pattern of stagnation in educational attainment for the recent cohorts. Figure 5, from Blanden and Machin (2004) shows that the age participation index is roughly flat from 1970 to the late 1980s when there is a large increase in university participation, which is not sustained later on. Similarly, after many years of rapid growth in rates of participation in post-compulsory education, staying on rates become flat after 1990. Stagnation of educational attainment is worrisome if one believes education
is an important motor of growth, as is standard in modern growth theory (see, for example, Lucas, 1988, Becker, Murphy and Tamura, 1993). Furthermore, at a time of increasing demand for skill stagnation of educational attainment increases the vulnerability of individuals at the bottom end of the skill distribution who are unable to benefit from economic growth. Carneiro and Heckman (2003) interpret these findings as evidence that there is a large increase in the demand for skill and supply is not keeping up with demand. Even in the countries where educational attainment has not reached a halt the earnings and employment returns to schooling are rising rapidly.

Figure 3 also shows that there is an enormous degree of heterogeneity in educational attainment across countries. In an attempt to get a better picture of differences in student quality and labor force quality across OECD countries (and a few others) a set of literacy tests has been developed and administered to adolescents and adults across countries. Education systems can differ across different countries and these comparable tests may provide a better measure of the stock of skills of a country, at least for the purpose of international comparisons. ${ }^{2}$ Hanushek and Kimko (2001) use these tests as a measure of the quality of the labor force and argue that these are an important determinant of economic growth. Figure 6, from OECD (2000), shows the percentage of adults in different quantitative literacy levels in different countries. These results can be replicated for other types of literacy, as measured by the International Adult Literacy Survey. In more than half of the countries shown in this figure $40 \%$ or more of their labor force scores in the bottom two levels of literacy. Figure 7 shows that there is a large gap in literacy for individuals in different levels of education. The levels of literacy for individuals with less than secondary schooling in countries such as the United States and Portugal is particulary worrisome. Across countries there is not much difference in the literacy skills of those with a tertiary education. The differences across countries emerge mostly for those who have low educational attainment. This pattern is observed even within

[^1]a younger cohort of individuals who are 20-25 years of age at the date of this test. Figure 8 shows that the problem of the low skilled is not less dramatic for this younger cohort. Table 3, from Nickell (2003), documents that the problem of low literacy is not getting much better in the adult population across a variety of countries. In fact, for countries such as the US and the UK it is getting worse. He also shows that there is a strong association between inequality in literacy scores and inequality in income across countries. Table 4, also from Nickell (2003), shows that the countries with the higher level of literacy inequality, such as the anglo-saxon countries and Portugal, also have the highest levels of income inequality.

The problem of the low skilled in Europe has long been recognized. The European Commission has sponsored the NEWSKILLS Programme of Research which was developed to document and analyze the supply and demand of low skilled workers in Europe. McIntosh and Steedman (2001) summarize the findings of this project in a report entitled "Low Skills: A Problem for Europe", a title I also borrowed for this section. They describe that across countries there has been a steady decrease in the supply of low skilled workers. At the same time there is also a sharp decrease in the demand for such workers that surpasses the decrease in supply, generating stagnating or falling wages and increased unemployment among the low skilled (with the exception of Portugal). Their study emphasize two important themes of this paper, that will be further developed in the next section. First, the problem of low skills does not consist only of a deficiency in cognitive skills, but also of a deficiency in what they call soft skills. Several skills are important in the labor market and a broader view of what constitutes skill is needed. Second, low skill individuals receive little or no amounts of training on the job, either because they opt out of it when it is offered to them, or because employers choose to offer training to workers with better skills. This is illustrated in figure 9, from OECD (2000), which shows the proportion of people at each literacy level who receive job training. As emphasized by Carneiro and Heckman (2003), Carneiro, Cunha and Heckman (2004) and in the next section of this paper, there are strong complementarities between early human capital
investments and adult human capital investments. Low skilled workers have difficulty in benefiting from adult training because they have a low stock of human capital on which adult investments can build on and be productive. This says that remediation investments in adulthood may be very costly and ineffective for low skilled individuals. Preventive investments that take place earlier in the life-cycle of individuals are bound to generate much larger returns.

The recent increase in inequality and in unemployment in Europe coincides with an rise in social unrest in several dimensions, even at a time of rapid economic growth, as illustrated in figure 10 (OECD, 2001). Figure 11 starts by documenting that the percentage of children living in poverty is well above $10 \%$ for most countries in Europe and North America. Figure 12 documents an upward trend in the incidence of lone parenting, figure 13 shows a rise in drug related deaths in the European Union countries, and figure 14 shows a general rise in crime victimization rates in the 1990s (with the exception of Canada and the US). The incidence of poverty and social unrest tends to be more dramatic on the population of the unskilled. Charles Murray (1999) calls attention to the emergence of a British underclass. This warning is echoed for the rest of Europe by the evidence assembled in this paper. Carneiro (2002) calls for a comprehensive minimum learning platform for all, a set of skills that not only allows each individual to participate fully in the process of economic development, but that also promotes civic behavior and social stability.

I end this introduction with a note on heterogeneity. Anyone who looks at international data realizes that there is a large degree of heterogeneity across countries. Europe is no exception. Literacy levels, educational attainment, income inequality and so many other variables are widely different across countries. The recent debate in development economics emphasizes that this heterogeneity is very important, and that it is wrong to think of general best practices or policies that will have similar effects across countries. This paper will be concerned with general principles of the process of skill formation but the application of such principles to different countries has to be moderated by each country's set of problems and opportunities. Furthermore, understanding the sources of
heterogeneity is likely to lead to important insights for the design of new policies. Similarly, at a more micro level, heterogeneity has been found to be pervasive and important in all aspects of economic life (Heckman, 2001). The recent literature on policy evaluation emphasizes that different policies have different effects on different individuals, and that the effectiveness of a policy depends dramatically on the characteristics of the target population. How to account for heterogeneity in policy design and evaluation has to be a major theme any policy debate, whether this heterogeneity is at the micro or macro level.

In the next section I summarize recent work by Carneiro and Heckman (2003) and Carneiro, Cunha and Heckman (2004) on the technology of skill formation. Although the evidence underlying this work is primarily for the US, there are important general lessons we can draw on for Europe. Furthermore, similar work is being developed in Europe and part of my own goal with this paper is to begin to assemble similar evidence for European countries. In this section I will also review the effectiveness of some policies that act on different stages of the life-cycle of an individual. In the third section of this paper I review some specific european problems and in the fourth section I review what I known by the Lisbon Strategy. The last section of this paper presents a small summary and conclusion.

## 2 The Technology of Skill Formation

This section, taken from Carneiro, Cunha and Heckman (2004), presents formal models of child development that capture the essence of recent findings from the empirical literature on child development. The goal is to provide theoretical frameworks for interpreting the evidence from a vast empirical literature, for guiding the next generation of empirical studies and for formulating policy.

Recent empirical research in a variety of fields has substantially improved our understanding of how skills and abilities are formed over the life cycle. The early human capital literature (Becker,

1964, Mincer, 1974) viewed human capital as a rival explanation for human ability and emphasized that acquired human capital could explain many features of earnings distributions and earnings dynamics that models of innate cognitive ability could not. This point of view underlies many recent economic models of family influence (e.g. Aiyagari, Greenwood, Seshadri, 2002; Laitner, 1992, 1997). Later work (Ben-Porath, 1967 and Griliches, 1977) emphasized that innate ability was an input into the production of human capital, although it was ambiguous about its effect on human capital accumulation. More innate ability could lead to less schooling if all schooling did was teach one what an able person could learn without formal schooling. On the other hand, more innate ability might make learning easier and promote schooling. The signalling literature made the latter interpretation in developing models of schooling that emphasized that higher levels of schooling signalled higher innate ability. In one extreme form, this literature suggested that there was no learning content in schooling.

The entire literature assumed that ability is an innate, scalar, invariant measure of cognitive skill. Except for work by Marxist economists (see, e.g. Bowles and Gintis, 1976 and Edwards, 1976), noncognitive traits like motivation, persistence, time preference and self control were neglected and treated as peripheral to the skill formation and earnings determination process.

The literature in economics focuses on liquidity constraints and heritability as the principal sources of parental influence on child development. Becker and Tomes $(1979,1986)$ initiated a large literature that emphasizes the importance of credit constraints, family income and inherited ability on the schooling and earnings of children. Important developments of this work by Laitner (1992, 1997), Benabou (2000, 2002), Aiyagari, Greenwood, Seshadri (2002) and Seshadri and Yuki (2003), emphasize the role of credit constraints and altruism in forming the skills of children. Ability is treated as exogenously determined and the lifecycle of the child at home is collapsed into a single period so that there is no distinction between early and late investments in children. Becker and Tomes (1986) suggest that there may be no trade-off between equity and efficiency in government
transfer policy because the return to human capital investment is high due to the presence of credit constraints.

Recent research, summarized in Carneiro and Heckman (2003), presents a much richer picture of schooling, life cycle skill formation and earnings determination. It recognizes the importance of both cognitive and noncognitive abilities in explaining schooling and socioeconomic success. These abilities are themselves produced by family and personal actions. Both genes and environments produce these abilities and environments affect genetic transmission mechanisms (See Turkheimer et al., 2003). This interaction has important theoretical and empirical implications.

The following conclusions emerge from the recent empirical literature on child development. Cognitive ability is affected by environmental influences (including in utero experiences) and is formed relatively early (by age 8 or so). It is hard to change IQ after this age. Noncognitive skills (motivation, self-discipline, time preference) associated with development of the child's prefrontal cortex can also be affected by environmental interventions. These skills remain more malleable at later ages than cognitive skills. Noncognitive skills are valued in the market place and also affect academic and social achievement.

Complementarity of investments and self productivity, two distinct ideas folded into one in our previous analyses, are essential features of the skill and ability formation process. ${ }^{3}$ Skill begets skill; ability begets ability. Strong complementarity leads to a trade-off between efficiency and equity in considering investments in human capital. Diminishing returns would argue in favor of equalization of investment across persons. Complementarity and self productivity are forces toward specialization of investments made after the early years to certain groups. Disadvantaged young adults with low levels of cognitive and noncognitive skills have lower rates of return to schooling and job training than more advantaged young adults. Due to complementarity, remediation for neglected investment

[^2]is costly, and may be prohibitively so for the most disadvantaged.
One contribution of our analysis is to place the child development process in a multiperiod context, disaggregating the one period of family influence assumed in a variety of current models into multiple periods. Complementarity and self-productivity of human capital imply an equityefficiency trade-off for late child investments but no equity-efficiency trade-off for early investments. This has important consequences for the design and evaluation of public policies toward families. In particular, the returns to late childhood investment and remediation for persons from disadvantaged backgrounds is low.

A second contribution of our analysis is to emphasize the secondary importance of credit constraints in the college going years, as traditionally conceived in applied economics in explaining child schooling attainment. Permanent income plays an important role, not income in adolescent years. Carneiro and Heckman $(2002,2003)$ present evidence for American society that only a small fraction (at most 8\%) of American children are credit constrained in making college decisions. The important constraints facing children are ones on their early environment-parental background and motivation and the like. The important market failure is the inability of children to buy their parents and not the inability of families to secure loans for a child's education. This has major implications for the way family policy should be designed, and how to remedy deficits in low income and disadvantaged populations.

Controlling for cognitive ability, in American society with current meritocratic policies in place, family income plays only a minor role in determining college enrollment decisions although much public policy is predicated on the opposite point of view. Yet ability itself seems to be determined by early family environments. Permanent income matters in determining schooling and ability, but "cash in advance" credit constraints facing parents in the child's teenage years do not. Ability has both environmental and genetic components, and environments affect the expression of the genes. Evidence from interventions on disadvantaged populations demonstrate that interventions can raise
measured ability but their major impact is on noncognitive abilities. These features are missing from the current literature in economics on child development and our aim is to redress these gaps. They are also ignored in current empirical studies of family and genetic influence. Measured ability is determined in part by environmental factors.

### 2.1 The Technology

This section draws heavily on the work of Carneiro, Cunha and Heckman (2004). In it we emphasize some features of the human capital accumulation technology that are important. Some of them have not yet been fully incorporated in economic models. We provide some empirical examples that illustrate the empirical importance of these features. A more complete review of this evidence is provided by Carneiro and Heckman (2003).

Human capital accumulation and skill formation are dynamic processes. The skills acquired in one stage of the life cycle affect both the initial conditions and the technology of learning at the next stage. Human capital is produced over the life cycle by families, schools, and firms, although most discussions of skill formation focus on schools as the major producer of abilities and skills, despite a substantial body of evidence that families and firms are also major producers of abilities and skills. Skill formation starts in the womb and takes place throughout the whole life of the individual. Over one half of lifetime human capital is acquired through post-school investments (Heckman, Lochner and Taber, 1998).

A major determinant of successful schools is successful families. Schools work with what parents bring them. They operate more effectively if parents reinforce them by encouraging and motivating children. Job training programs, whether public or private, work with what families and schools supply them and cannot remedy twenty years of neglect. Children from disadvantaged families may suffer from a lack of resources invested in them, or they may have parents that lack the information necessary to make adequate investments in their children, even if resources are made available (for
example, through state programs), because of poor education or the like. It is easier to compensate for low current funds (if parents borrow against future consumption to finance current investments in their children) than against low parental human capital.

Abilities are both inherited and created. As summarized in Shonkoff and Phillips (2000), the "long standing debate about the importance of nature versus nurture, considered as independent influences, is overly simplistic and scientifically obsolete". They write: "Scientists have shifted their focus to take account of the fact that genetic and environmental influences work together in dynamic ways over the course of development. At any time, both are sources of human potential and growth as well as risk and dysfunction. Both genetically determined characteristics and those that are highly affected by experience are open to intervention. The most important questions now concern how environments influence the expression of genes and how genetic make-up, combined with children's previous experiences, affects their ongoing interactions with their environments during the early years and beyond." Hansen, Heckman and Mullen (2003) show that schooling affects cognitive ability. Becker and Mulligan (1997) argue that parents can invest in and manipulate their children's discount rate, which can be broadly interpreted as another type of ability.

A study of human capital policy grounded in economic and scientific fundamentals improves on a purely empirical approach to policy evaluation that relies on evaluations of the programs and policies in place or previously experienced. Although economic policy analysis should be grounded in data, it is important to recognize that the policies that can be evaluated empirically are only a small subset of the policies that might be tried. If we base speculation about economic policies on economic fundamentals, rather than solely on estimated "treatment effects" that are only weakly related to economic fundamentals, we are in a better position to think beyond what has been tried to propose more innovative solutions to human capital problems.

Carneiro and Heckman (2003) investigate the study of human capital policy by placing it in the context of economic models of life cycle learning and skill accumulation rather than focusing
exclusively on which policies have "worked" in the past. This paper extends their analysis by presenting formal models of the investment process.

Figure 15 summarizes the major finding of Carneiro and Heckman and the motivation for this paper. It plots the rate of return to human capital at different stages of the life cycle for a person of given abilities. The horizontal axis represents age, which is a surrogate for the agent's position in the life cycle. The vertical axis represents the rate of return to investment assuming the same amount of investment is made at each age. Ceteris paribus the rate of return to a dollar of investment made while a person is young is higher than the rate of return to the same dollar made at a later age. Early investments are harvested over a longer horizon than those made later in the life cycle (Becker, 1964). In addition, because early investments raise the productivity (lower the costs) of later investments, human capital is synergistic. Learning begets learning; skills (both cognitive and noncognitive) acquired early on facilitate later learning. Early deficits make later remediation difficult. Finally, young children's cognition and behavior are more easily malleable than cognition and behavior in adults: even in the absence of dynamic complementarity, early investments are more productive than late investments. For an externally specified opportunity cost of funds $r$ (represented by the horizontal line with intercept $r$ in figure 1), an optimal investment strategy is to invest less in the old and more in the young. At any age, investment is more profitable for persons with higher innate ability. Figure 16 presents the optimal investment quantity counterpart of figure 15.

Carneiro and Heckman (2003) develop an alternative interpretation of figure 15 as an empirical description of the economic returns to investment at current levels of spending in the American economy. The return to investment in the young is high; the return to investments in the old and less able is quite low. A socially optimal investment strategy would equate returns across all investment levels. A central empirical conclusion of their analysis is that at current investment levels, efficiency in public spending would be enhanced if human capital investment were directed more toward the young and away from older, less-skilled, and illiterate persons for whom human
capital is a poor investment.

### 2.2 Multiple Skills, Plasticity, Self-Productivity and Dynamic Complementarity

In the rest of this section we examine in more detail three important features of the technology of skill formation: 1) multiple skills; 2) plasticity; 3) self-productivity and dynamic complementarity. By multiple skills we mean that there exists a multiplicity of skills which are important for an individual's success in life. By plasticity, we mean that the malleability an individual's IQ and behavior traits changes (decreases) as people age. By self-productivity and dynamic complementarity we mean that skill begets skill. Late investments are complements with early investments in the production of human capital. Without early investments late investments are unproductive. Conversely, complementarity also implies that early investments that are not followed up by later investments may not be productive either.

The analysis in Carneiro and Heckman (2003) and in this paper challenges the conventional point of view that equates skill with intelligence. It draws on a body of research that demonstrates the importance of both cognitive and noncognitive skills in determining socioeconomic success. Heckman, Hsee and Rubinstein (2001) and Heckman and Rubinstein (2002) provide evidence of the importance of noncognitive skills from an analysis of the GED program. GED recipients are high school dropouts who get a high school certification through the GED. In terms of cognitive ability, they are as smart as regular high school graduates. This is shown in figure 17, that plots AFQT distributions for high school graduates and GED recipients for different demographic groups in the NLSY. However, table 5 presents the coefficients of a log wage regression on GED recipiency and high school graduation and shows that GED recipients have much lower wages than high school graduates. Furthermore, they have lower wages than regular high school dropouts with the same level of cognitive ability. This means they lack some other skill, which we interpret as a non-cognitive
skill. Table 6 shows that GED recipients are also more likely to exhibit disruptive behavior in school and work, and higher turnover rates on the job, than either high school graduates or high school dropouts. They lack skills such as motivation and discipline. These skills are important in the labor market. Gaps in non-cognitive measures (such as anti-social behavior) by family income appear very early in the life-cycle, as documented in figure 18 and in the work of Carneiro and Heckman (2003).

Current educational policy and economic analysis focuses on tested academic achievement as the major output of schools. Proposed systems for evaluating school performance are often premised on this idea. Economic models of signaling and screening assume that predetermined cognitive ability is an important determinant, if not the most important determinant, of academic and economic success. Recent evidence challenges this view. No doubt, cognitive ability is an important factor in schooling and labor market outcomes. At the same time, noncognitive abilities, although harder to measure, also play an important role.

Recent studies in child development (e.g. Shonkoff and Phillips 2000) emphasize that different stages of the life cycle are critical to the formation of different types of abilities. When the opportunities for formation of these abilities are missed, remediation is costly, and full remediation is often prohibitively costly. These findings highlight the need to take a comprehensive view of skill formation over the life cycle that is grounded in the best science and economics so that effective policies for increasing the low level of skills in the workforce can be devised.

Both cognitive and noncognitive skills are affected by families and schools, but they differ in their malleability over the life cycle, with noncognitive skills being more malleable than cognitive skills at later ages. This finding is supported by studies of early childhood interventions that primarily improve noncognitive skills, with substantial effects on schooling and labor market outcomes, but only weakly affect cognitive ability. Table 7 shows that the well known early childhood programs have short lasting effects on IQ but long lasting effects on achievement and behavioral outcomes of disadvantaged children. Mentoring programs in the early teenage years can also affect these
skills (see Carneiro and Heckman, 2003). Current analyses of skill formation focus too much on cognitive ability and too little on noncognitive ability in evaluating human capital interventions, and in formalizing the skill formation process.

Differences in levels of cognitive and noncognitive skills by family income and family background emerge early and persist. If anything, schooling widens these early differences. The work of Carneiro, Heckman and Masterov (2003) on sources of racial skill differential is illustrative of this claim. As shown in figure 19, test score gaps across race groups emerge very early (the graph displays the density of math scores at age 5 for white males in different race groups, using the Children of NLSY). Figure 20 plots the effect of schooling on test scores for different demographic groups in the NLSY. Test scores grow at a much slower rate for blacks than for whites as children from both race groups progress through school.

The idea of self-productivity of human capital investments is rather old in economics and is developed in the work of Ben-Porath (1967) who specifies a production function where the stock human capital increases the productivity of additional investments in human capital: human capital is a crucial input in the production of more human capital. Becker and Tomes (1986) specify a production function where innate ability increases the productivity of parental investments in the child's human capital. The stock of ability and human capital, and further investments in human capital are complementary inputs in the production of skill. Complementarity also means that the costs of remediating the neglect of early investments in human capital can be very high, if remediation investments have no solid (human capital) base to build on. It also means that if early investments are not followed up by later investments then their effect on the amount of skill accumulated by early adulthood may be small.

Carneiro and Heckman (2003) summarize a body of evidence that suggests that complementarity is empirically important. Table 8, from their paper, shows that white males in the High School and Beyond with higher levels of cognitive ability have higher returns to college than individuals with
lower levels of cognitive ability. ${ }^{4}$ Those who know more to start with benefit more from the college experience. This finding is replicated in other datasets. Table 9 shows that individuals with higher ability and education are more likely to participate in company training than those with lower ability and education levels. Individuals with higher levels of human capital receive higher investments through company training than those with low levels of human capital. This is a common finding in the job training literature. A final example comes from the work of Currie and Thomas (1995) who study the Head-Start program and conclude that the overall effects of this program on test scores are lower for black than for white children, as seen in table 10 (the relevant parameter is the coefficient on Head Start participation from the set of columns that include mother fixed effects, in panel A). In fact, the panel $B$ of table 11 shows that the effect of the program on test scores at the age the program ends is about the same for blacks and whites (the direct effect of Head Start). There is no difference on the effect of Head Start participation on PPVT scores between blacks and whites at the age they leave the program (see the third column of the first line of panel B of this table). However the fade out effects after exit from Head Start are much larger for black children. That is why a few years after these children have left the program we still see some impact on test scores for whites but no impact of Head Start on test scores for blacks (as shown in table 10). These fade out effects are estimated from the interaction of Head Start participation with age, and presented in the second line of panel B of this table. In another paper, Currie and Thomas (2000) suggest that these differential fade out effects may be due to the fact that black Head Start children go on to attend much lower quality schools than white Head Start children. Head Start investments are followed up by very poor schooling for black children and therefore it is not surprising that the final effect of Head Start on test scores of blacks is small. ${ }^{5}$ The productivity of early investments that are

[^3]not followed up by later investments can be very small. There is another aspect to complementarity that should be emphasized: early deficits are hard to remediate with later investments, and the cost of remediation can be prohibitively high because the productivity of late investments is very small in the absence of early investments. The whole literature on public job training shows that it is hard to remediate the neglect of skill investment in childhood and adolescence (see e.g. Lalonde, 1995, Heckman, Lalonde and Smith, 1999, and Carneiro and Heckman, 2003).

The ideas put forth so far can be formalized in a simple two period CES production function (easily generalizable to multiple periods):

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H=A\left[\gamma_{0}\left(K_{0}\right)^{\phi}+\gamma_{1}\left(K_{1}\right)^{\phi}\right]^{\frac{\rho}{\phi}} h^{\alpha}
$$

where $H$ is the final human capital of the child, $A$ is ability, $h$ is the human capital of parents, $K_{0}$ and $K_{1}$ are early and late investments. Later we can allow $H, K_{0}$ and $K_{1}$ to be vectors of skills and vectors of investments and therefore have multiple skills. The Ben-Porath (1967) technology is a special case of the one we have here. $\gamma_{0}$ and $\gamma_{1}$ are the plasticity parameters. If $\gamma_{1}$ is smaller than $\gamma_{0}$ then plasticity is smaller at later ages than at early ages. The term $\frac{1}{1-\phi}$ is the elasticity of substitution. When $\phi$ is zero we have a Cobb-Douglas technology. As $\phi$ approaches $-\infty$ the technology gets closer and closer to the Leontieff function. In the appendix we embed this technology in a dynastic model of human capital investment and simulate the model. Figure 21 (which comes from the simulation of this model) illustrates how the costs of late remediation of poor early investments change when the elasticity of substitution changes. When complementarity increases, remediation costs increase as well.

In Carneiro, Cunha and Heckman (2004) we use this technology in a parental investment model where we allow investment to take place in multiple periods. This is a simple but important extension
of the traditional model of Becker and Tomes (1979, 1986). We develop an overlapping generations model with altruism, with human capital investment, uncertainty and credit constraints. In this model parents are altruistic and can invest in children over two (or more) periods: early childhood and adolescence. Parental human capital (and family and neighborhood environments) is an input into the production of the child's human capital, as are the child's innate ability and the resources invested in the child in both periods. Early investments may be limited by several reasons, such as low parental human capital, or low availability of funds for early investments. Scarcity of funds at early ages can be compensated if parents face rising income and can postpone their consumption until the end of the early childhood of their child (substitute present and future consumption). ${ }^{6}$ Low parental human capital cannot be easily substituted at early ages. A family can be credit constrained in both investment periods, or in only one of them. This model operationalizes the idea of short run and long run credit constraints of Cameron and Heckman (1998, 2001) and Carneiro and Heckman (2002). The government can intervene to remedy poor investments and poor environments in disadvantaged families. Interventions can come in early childhood and in late adolescence. Remediation of poor early investments in these families is very costly but my be granted on the grounds of equity. Interventions in early childhood may be both efficient and equitable.

### 2.3 Summary

Carneiro, Cunha and Heckman (2004) present formal models of child development that capture the essence of recent findings from the empirical literature on child development. The goal is to provide theoretical frameworks for interpreting the evidence from a vast empirical literature, for guiding the next generation of empirical studies and for formulating policy. We start from the premise that skill formation is a life-cycle process. It starts in the womb and goes on throughout most of the adult life. Families and firms have a role in this process that is at least as important as the role of

[^4]schools. There are multiple skills and multiple abilities that are important for adult success. Abilities are both inherited and created, and the traditional debate of nature versus nurture is outdated and scientifically obsolete. The technology of skill formation has two additional important characteristics. The first one is that IQ and behavior are more plastic at early ages than at later ages. Furthermore, behavior is much more malleable than IQ as individuals age. The second is that human capital investments are complementary over time. Early investments increase the productivity of later investments. Early investments are not productive if they are not followed up by later investments. The returns to investing early in the life cycle are high. Remediation of inadequate early investments is difficult and very costly.

### 2.4 Human Capital Policy Over the Life-Cycle

Carneiro and Heckman (2003) review the evidence on human capital policy over the life-cycle. They analyze the effectiveness of different human capital interventions that take place a different ages of an individual's life, and interpret the literature in view of the model developed above. Early childhood interventions directed towards disadvantaged children have proven to be successful, although much of their impact is on non-cognitive skills of the treated children. Non-cognitive skills are important not only for future engagement in risky and criminal behavior, but also for educational attainment and labor market outcomes. Similarly, mentoring programs directed toward underperforming teenagers and teenage parents have had important effects on their lifes primarily through their impact of their non-cognitive skills. More traditional interventions aimed at improving school quality (such as class size reductions or increases in expenditure per pupil) have not been very effective. ${ }^{7}$ The apparent reason for such policy failure is our general lack of knowledge of the relative effectiveness of different imputs in the education production function. One exception is the evidence on the importance of teachers, which has been recognized in the literature for more than thirty years. Teachers are a

[^5]very important determinant of quality, but it is still not well known what are the characteristics of a teacher that we should look for or that we should promote to raise the quality of our schools. Teacher quality is crucial for a successful educational experience but information about teacher quality is not easily available. Local information on individual's teacher practices and results (information that is generally unavailable in survey data) is likely to be very relevant for evaluating a teacher's performance, and if that is the case, a decentralized system of school administration and education choice that can better acquire and use such local information is called for. With this in mind, some researchers have advocated more administrative autonomy for schools and more choice for parents, even though the evidence on the effectiveness of either is still weak. A movement in this direction would probably lead to a larger emphasis of the role of market forces in education, which are almost absent in most countries education systems. Such a movement may lead to better local incentives for teachers and schools and to an increase in private expenditure in education. Figure 22, from OECD (2003), shows that the level of private investment in education is very low compared to the level of public investment, especially at lower levels of education. In a time of tight public budgets, turning to private investment is likely to be an attractive way to increase investment in children.

As shown in the first section of this paper, several individuals reach young adulthood with a serious lack of skills to triumph in the modern labor market. In response to this problem, governments around Europe and the US have tried to design and implement a set of remediation programs such as publicly provided job training for the unemployed. Unfortunately, the evidence points to the general ineffectiveness of these remediation investments, with some exceptions. The framework suggested by Carneiro, Cunha and Heckman (2004) and presented above rationalizes this finding: remediation investments that build on a childhood and adolescence where skill formation was neglected may not amount to anything significant, because there is very little to build on.

We end this section with a provocative illustration. Figure 23, from OECD (2003), displays the level of expenditure per student in different levels of schooling relative to expenditure per student
at the primary level. We realize that the prices of investment at different ages are very different and even if the quantity invested at different ages is similar the overal expenditure will be different. Nevertheless, this evidence may be suggestive of the current trends in schooling investments. Across countries, expenditures per student at the university level are much higher than expenditures per student at earlier levels of schooling. In some countries, expenditures per student at the pre-school level are even lower than expenditures per student at the primary level. There is a lot of heterogeneity across countries. For example, in Norway the level of expenditure per student at the pre-school level if similar to expenditure per student at the tertiary level. In this paper we call for better investments at earlier ages as an effective way to improve the skills of the labor force, especially for individuals at risk of becoming low skilled. Investments at later ages are also necessary, but a better balanced portfolio of investments may be more productive than the one we have today. Furthermore, the pattern of investments displayed in figure 23 is highly regressive, since primary and secondary school (where investments per student are small) is usually universal, while tertiary school (where investments per student are high) is generally attended by students coming from richer families. A shift of resources towards earlier ages may lead to a more efficient and more equitable allocation of public education resources.

## 3 Human Capital in Europe

Human capital policy is a major concern of every economy in the modern world. In the Lisbon European Council held in March 2000, Heads of State and Government from the EU set a goal for 2010: "to become the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion". ${ }^{8}$ Subsequent councils have reinforced these aspirations, and a large emphasis has been put on human

[^6]capital policy.
There has been a large concern with promoting mobility of workers across Europe. Such mobility may be essential for achieving an efficient allocation of human resources across Europe and for the success of economic policy set at the European level. This mobility is impaired by institutional differences and language disparities across countries. There also has been preoccupation with increasing the skill level of the population: both endowing our economies with university educated workers and reduce the ranks of low skilled workers in Europe, which are still of substantial size. Promoting lifelong learning is seen as important in a setting where information flows and constant change are so prevalent. At the same time, there is an aspiration for an increase in private investments in human capital, by firms and families, and for a better use of public resources. All of these are very valid goals, and they need to be tackled in a consistent and cohesive way. A message of this paper and of the work of Carneiro and Heckman (2003) is that human capital policy involves many different areas of policy (from health policy to education policy, from tax policy to crime prevention) and an integrated view of an individual over the life-cycle.

For example, it will not be possible to promote tertiary education or learning on the job if individuals do not get adequate earlier preparation in childhood and adolescence. Young adult education and training builds on top of earlier investments. Firms, families and schools are equal partners in the process of skill formation. To achieve a better use of resources we need better information and common sense suggests that such information is very localized, especially in a world where heterogeneity is so important. Therefore, more school and family autonomy in the allocation of education resources is called for. Skill is in high demand in the modern world. Firm investments are important and account for more than a third of the lifetime human capital acquired by an individual. Investments in skill should be seen as investments in capital, and policies that paralell investment policies through the use of tax credits and other instruments can be (and have been) used by governments to promote investment. These are just a few examples. This paper is
very incomplete and what has been achieved is far behind what the title suggests: a human capital strategy for Europe. But it serves as a springboard for future learning.

Above all, there is a fundamental difficulty with writing such a paper, and with thinking of global education strategies for Europe. Europe is a composed of very different countries. The data in this paper provides a clear illustration of this heterogeneity, and is only a part of the overall picture. Heterogeneity means that different people react differently to the same policies. Policies need to be designed and implemented at the local level, making use of local information. An integrated vision of Europe is useful is important, and the principles developed in this paper are quite general, but the implementation and design of policies needs to take into account the specificity of each country's problems and opportunities.

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Figure 1


Figure 1 : Ratio of the $50^{\text {th }}$ to the $10^{\text {th }}$ percentile of countries' earnings distribution. Source: OECD.


Figure 2 : Ratio of the $90^{\text {th }}$ to the $10^{\text {th }}$ percentile of countries' earnings distribution. Source: OECD.


Figure 8 : Vertical axis: unemployment rate (as in Figure 6) after removing country and year effects; horizontal axis: earnings dispersion in the low portion of their distribution (as in Figure 6) after removing country and year effects. Data points are plotted along with OLS unweighted regression line.


Figure 9 : Vertical axis: unemployment rate, OECD Economic Outlook definitions; horizontal axis: earnings dispersion in the low portion of their distribution, from OECD "Trends in earnings dispersion" file. Data points are plotted along with OLS unweighted regression line.

## Table 1-Male Unemployment Rates

ay Education (Percentages)

| Country and education | 1971-1982 | 1983-1990 | 1991-1993 |
| :---: | :---: | :---: | :---: |
| Germany |  |  |  |
| Total | 3.12 | 5.6 | $4.1{ }^{\text {b }}$ |
| High ed. | 1.7 | 3.1 | 2.2 |
| Law ed. | 6.4 | 13.0 | 10.7 |
| Ratio | 3.8 | 4.2 | 4.9 |
| Difference | 4.7 | 9.9 | 8.5 |
| Italy |  |  |  |
| Total ${ }^{\text { }}$ | 7.7 | 11.2 | $11.2{ }^{\text {b }}$ |
| High ed. | 12.2 | 13.1 | 12.5 |
| Low ed. | 4.6 | 7:3 | 7.5 |
| Ratio | 0.38 | 0.55 | 0.6 |
| Difference | -4.7 | -5.8 | -5.0 |
| Netherlands |  |  |  |
| Total ${ }^{+}$ | $6.3{ }^{\text {c }}$ | $10.0{ }^{5}$ | 6.8 |
| High ed. | 3.2 | 5.7 | 5.0 |
| Low ed. | 7.0 | 14.0 | 9.9 |
| Ratio | 2.2 | 2.5 | 2.0 |
| Difference | 3.8 | 8.3 | 4.9 |
| Spain |  |  |  |
| Total | $8.9{ }^{2}$ | 16.9 | 15.1 |
| High ed. | 6.2 | 9.9 | 9.0 |
| Law ed. | 10.6 | 19.6 | 20.0 |
| Ratio | 1.7 | 2.0 | 2.2 |
| Difference | 4.4 | 9.7 | 11.0 |
| Sweden |  |  |  |
| Total | 2.4 | 2.5 | 5.8 |
| High ed. | 1.0 | 1.1 | 2.8 |
| Low ed. | 2.9 | 3.3 | 6.9 |
| Ratio | 2.9 | 3.0 | 2.5 |
| Difference | 1.9 | 2.2 | 4.1 |
| United Kingdom |  |  |  |
| Total | $5.0{ }^{\text {c }}$ | 9.0 | $10.8{ }^{\text {n }}$ |
| High ed. | 2.4 | 4.4 | 6.2 |
| Low ed. | 7.5 | 15.9 | 17.1 |
| Ratio | 3.1 | 3.6 | 2.6 |
| Difference | 5.1 | 11.5 | 10.9 |
| Cartada |  |  |  |
| Tatal | $6.8{ }^{\text {r }}$ | 9.15 | 11.5 |
| High ed. | 2.5 | 3.9 | 5.1 |
| Low ed. | 8.3 | 11.9 | 16.1 |
| Ratio | 3.3 | 3.1 | 3.2 |
| Difference | 5.8 | 8.0 | 11.0 |
| United States |  |  |  |
| Tatal | 4.9 | 6.2 | 6.0 |
| High ed. | 2.0 | 2.4 | 3.0 |
| Low ed. | 7.8 | 11.3 | 11.0 |
| Ratio | 3.9 | 4.7 | 3.7 |
| Difference | 5.8 | 8.9 | 8.0 |

Notes: Ratio refers to the ratio of the low-education unemplayment rate to the high-education unemplayment rate; difference refers to the law-education rate minus the high-education rate. Detailed sources may be found in Nickell and Betl ( 1995 table 2), with the exception of the data for Germany, which come from Friedrich Auttler and Manfred Tessaring ( 1993 table 3), adjusted to he campatible with OECD standardized rates.
${ }^{\dagger}$ Includes females.

* 1975-1982.
${ }^{\mathrm{h}}$ 1991-1992.
- 1975, 1977, 1979, 1981 .
${ }^{4} 1983,1985,1990$.
c 1973-1982.
「1975-1979.
*1984-1990.


## Table 2-Earnings Differentials by Education (Males)

Ratio of high- to low-education groups

| Country | Early 1970's | Early 1980's | Late 1980's |
| :--- | :---: | :---: | :---: |
| Germany |  | 1.36 | 1.42 |
| Italy | 1.96 | 1.60 | 1.61 |
| Netherlands |  | 1.50 | 1.22 |
| Sweden | 1.40 | 1.16 | 1.19 |
| United Kingdom | 1.64 | 1.53 | 1.65 |
| Canada | 1.65 | 1.40 | 1.42 |
| United States | 1.49 | 1.37 | 1.51 |

Sources: OECD Employment Outlook (1993), Steven J. Davis (1992 table 5.6).

Figure 3

Figure 2.2. Percentage of younger (25-34 year olds) and older adults (45-54) with upper secondary education or higher, 1995


Countries are ranked by percentage of 45-54 year olds
with upper secondary attainment or higher.
Data for Figure 2.2, p. 99.
Source: Labour Force Survey data (see OECD, 1997b).
Younger adults are more qualified,
but the generation gap varies greatly across countries.

Figure 4
Schooling participation rates by year of birth


## Figure 1: Changes in Education Participation



Notes:

1. Staying on rates from DfES series. We thank Damon Clark for providing these numbers.
2. The higher education age participation index is the number of young (under 21) home initial entrants expressed as a proportion of the averaged 18 to 19 year old population. Source: DfES.

Source: Blanden and Machin (2004)
Source: International Adult Literacy Survey, 1994-1998.


 Comparative distribution of literacy levels


C. Mean quantitative score on a scale with range 0-500 points, by level of educational attainment, population aged 16-65, 1994-1998

- Completed tertiary education
$\diamond$ Completed upper secondary education
- With less than upper secondary education


Countries are ranked by the mean score of those who have completed tertiary education.
Source: International Adult Literacy Survey, 1994-1998.
C. Mean quantitative score on a scale with range 0-500 points, by level of educational attainment, population aged 20-25, 1992-1998


- Completed tertiary education
$\diamond$ Completed upper secondary education
- With less than upper secondary education

Countries are ranked by the mean scores of those who have completed upper secondary education.
Sources: International Adult Literacy Survey, 1994-1998; and US National Adult Literacy Survey, 1992.

## Table 3

## Is Literacy Getting Better in the Adult Population?

|  | Prose Literacy |  |  |  | Quantitative Literacy |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\%$ in Level 1 |  |  | in Level 1 |  |  |  |
| Age | $16-25$ | $26-35$ | $36-45$ | $16-25$ | $26-35$ | $36-45$ |  |
| US | 23 | 20 | 19 | 26 | 20 | 18 |  |
| Germany | 9 | 12 | 14 | 4 | 5 | 6 |  |
| UK | 17 | 18 | 17 | 22 | 20 | 19 |  |
| Netherlands | 8 | 6 | 9 | 8 | 7 | 10 |  |
| Sweden | 4 | 5 | 7 | 5 | 4 | 7 |  |

## Table 4

## Skills and Earnings Distributions

|  | Earnings |  | Skills (Literacy Test Score Ratios) ${ }^{\text {c }}$ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | 90/10 ${ }^{\text {a }}$ ratio | Gini ${ }^{\text {b }}$ coefficient | 90/10 |  | 95/5 |
|  |  |  | Prose | Prose | Quantitative |
| UK | 3.35 | 32.4 | 1.75 | 2.34 | 2.56 |
| Australia | 2.90 | 30.5 | 1.69 | 2.47 | 2.41 |
| Belgium | 2.25 | 27.2 | 1.68 | 2.20 | 2.33 |
| Canada | 4.19 | 28.5 | 1.78 | 2.51 | 2.42 |
| Denmark | 2.17 | 21.7 | 1.39 | 1.57 | 1.67 |
| Finland | 2.38 | 22.8 | 1.54 | 1.82 | 1.81 |
| Germany | 2.32 | 28.2 | 1.51 | 1.75 | 1.68 |
| Ireland | (3.35) | 32.4 | 1.71 | 2.21 | 2.47 |
| Netherlands | 2.59 | 25.5 | 1.48 | 1.72 | 1.79 |
| Norway | 1.98 | 25.6 | 1.44 | 1.68 | 1.76 |
| NZ | 3.04 | - | - | 2.20 | 2.34 |
| Portugal | 4.05 | - | - | 3.48 | 3.17 |
| Sweden | 2.13 | 23.0 | 1.51 | 1.78 | 1.81 |
| Switzerland | 2.69 | 26.9 | 1.72 | 2.25 | 2.45 |
| US | 4.37 | 34.4 | 1.90 | 2.69 | 2.72 |
| Correlation with $1^{\text {st }}, 2^{\text {nd }}$ column respectively |  |  | 0.850 .82 | 0.830 .81 | 0.810 .83 |

[^7]
## FIGURE 3.12

## Literacy and adult education participation

Per cent of population aged 16-65 participating in adult education and training during the year preceding the interview at each literacy level and in total, document scale, 1994-1998


Countries are ranked by the total participation rate.
Source: International Adult Literacy Survey, 1994-1998.

Appendix B

## SOME TRENDS IN THE SOCIAL AND ECONOMIC ENVIRONMENTS

Figure B.1. Real gross domestic product per capita, in constant prices, average based on selected OECD countries, 1966-99


Selected countries include: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.
Source: OECD. Real GDP deflated using 1998 US dollar. Based on Purchasing Power Parity.

Figure B.3. Percentage of children living in relative poverty, selected OECD countries, 1990s \% living in household below $50 \%$ of median income


Note: Percentage of children living in relative poverty is defined as the percentage living in households below 50 per cent medium income threshold. The poverty rates refer to the following years: 1990 (Spain), 1992 (Belgium, Denmark and Japan), 1994 (Canada, France, Germany, Greece, Hungary, Luxembourg, Mexico, Netherlands, Turkey), 1995 (Finland, Italy, Norway, Poland, Sweden, United Kingdom), 1996 (Czech Republic), 1996-97 (Australia) and 1997 (Ireland, United States).
Source: UNICEF (2000), "A league table of child poverty in rich nations", Innocenti Report Card No. 1, UNICEF Innocenti Research Centre, Florence.

Figure 12
Figure B.7. Incidence of lone-parenting, selected OECD countries, comparison between the 1980s and 1990s
$\%$ of households with children and one adult



Note: Survey years in brackets.
Source: OECD based on Eurostats Demographics, 1996. Lone-parenting is defined as the percentage of households with children with one adult. The incidence is defined as the number of lone-parent families as a percentage of all families with dependent children.

## Figure 13

Figure B.11. Number of acute drug-related deaths recorded in the European Union per million people, 1986-97


Includes: Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.
Source: European Minister Conference for Drugs and Drug Addiction; UNDCP Redbook (2000), Global Illicit Drug Trends; UN demographic projections (1998 revisions).

Figure 14
Figure B.12. Criminal victimisation rates, 1980s and 1990s


Note: Percentage of the population victimised in one year. Survey year in bracket.
Source: 1996 International Crime Victims Survey.

Rates of Return to Human Capital Investment Initially Setting Investment to be Equal Across all Ages


Rates of Return to Human Capital Investment Initially Setting Investment to be Equal Across all Ages

Figure 16
Optimal Investment Levels


## Figure 17 <br> Children of NLSY

Average Percentile Rank on Anti-Social Score, by Income Quartile*

*The income measure we use is average family income between the ages of 6 and 10. Income quartiles are then computed from this measure of income
The higher the anti-social score the w orse is the behaviorof the child.
$\rightarrow$ Lowest Income Quartile $\rightarrow$ Second Income Quartile - Third Income Quartile $*$ Highest Income Quartile

Table 5:
How Do Labor Markets Treat the GED Recipients?
A First Glance at the Data
High School Dropouts, GED Recipients and High School Graduates

| Variable | OLS |  |  |
| :---: | :---: | :---: | :---: |
|  | (i) | (ii) | (iii) |
| High school dropout | $\begin{array}{r} -0.273 \\ (0.024) \end{array}$ | $\begin{array}{r} -0.193 \\ (0.026) \end{array}$ | $\begin{array}{r} -0.022 \\ (0.033) \end{array}$ |
| GED degree | $\begin{array}{r} -0.181 \\ (0.039) \end{array}$ | $\begin{array}{r} -0.187 \\ (0.038) \end{array}$ | $\begin{array}{r} -0.107 \\ (0.038) \end{array}$ |
| Armed Forces Qualifying Test* |  | $\begin{array}{r} 0.106 \\ (0.013) \end{array}$ | $\begin{array}{r} 0.074 \\ (0.014) \end{array}$ |
| Years of schooling |  |  | $\begin{array}{r} 0.070 \\ (0.011) \end{array}$ |
| Training |  |  | $\begin{array}{r} 0.029 \\ (0.005) \end{array}$ |
| GED-HSD <br> F-test: probability>F: GED=HSD | $\begin{array}{r} 0.092 \\ \{0.029\} \end{array}$ | $\begin{array}{r} 0.006 \\ \{0.876\} \end{array}$ | $\begin{array}{r} -0.085 \\ \{0.039\} \end{array}$ |
| Observations | 12824 | 12824 | 12824 |
| Individuals | 1288 | 1288 | 1288 |
| R-square | 0.140 | 0.161 | 0.183 |

Notes:
The table reports results for a sub-sample of white males aged 20-36 from the NLSY The sub-sample excludes GED recipients who got their degree at age 16 or 17. All specifications include control for: (1) experience, (2) county level unemployment rate, (3) region of residence, (4) and cohort of birth.

* Age-adjusted to 0 mean in the population sample

High school dropouts are those who dropped out of school and did not get a GED diploma GED recipients are those who dropped out of school and get a GED diploma.
High school graduates who graduated high school and did not take further schooling.
( ) Standard errors in parenthesis.

Table 6:
Tllicit and $D$ elinquent Activity by $W$ hites,
Shown Separately for $H$ igh S choolD ropouts, G ED Recipients, and H igh S choolG raduates.

|  | Males^ |  |  | Fem ales ${ }^{\wedge}$ ^ |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | HS <br> Dropouts | GED <br> Recipients | HS <br> G raduates | HS Dropouts | GED <br> Recipients | HS <br> G raduates |
| Index of illicitactivity (LA) ~ | $\begin{gathered} 0.11 \\ (0.012) \end{gathered}$ | $\begin{gathered} 0.18 * \\ (0.017) \end{gathered}$ | $\begin{gathered} 0.05 \\ (0.006) \end{gathered}$ | $\begin{gathered} -0.01 \\ (0.013) \end{gathered}$ | $\begin{gathered} 0.05 * \\ (0.015) \end{gathered}$ | $\begin{gathered} -0.04 \\ (0.004) \end{gathered}$ |
| Particularquestions: |  |  |  |  |  |  |
| Skipped school in last year | $\begin{gathered} 0.13 \\ (0.023) \end{gathered}$ | $\begin{gathered} 0.10 \\ (0.030) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.011) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.030) \end{gathered}$ | $\begin{gathered} 0.13 * \\ (0.035) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.011) \end{gathered}$ |
| Shoplifted last year | $\begin{gathered} 0.05 \\ (0.027) \end{gathered}$ | $\begin{gathered} 0.15 * \\ (0.039) \end{gathered}$ | $\begin{gathered} 0.01 \\ (0.014) \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.038) \end{gathered}$ | $\begin{gathered} 0.17 * \\ (0.045) \end{gathered}$ | $\begin{gathered} -0.03 \\ (0.014) \end{gathered}$ |
| Smoked pot last year | $\begin{gathered} 0.14 \\ (0.029) \end{gathered}$ | $\begin{gathered} 0.26 * \\ (0.037) \end{gathered}$ | $\begin{gathered} 0.03 \\ (0.016) \end{gathered}$ | $\begin{gathered} 0.05 \\ (0.044) \end{gathered}$ | $\begin{gathered} 0.27 * \\ (0.043) \end{gathered}$ | $\begin{gathered} 0.03 \\ (0.017) \end{gathered}$ |
| Used drugs last year | $\begin{gathered} 0.10 \\ (0.026) \end{gathered}$ | $\begin{gathered} 0.26 * \\ (0.039) \end{gathered}$ | $\begin{gathered} 0.03 \\ (0.013) \end{gathered}$ | $\begin{gathered} 0.09 \\ (0.038) \end{gathered}$ | $\begin{gathered} 0.24 * \\ (0.045) \end{gathered}$ | $\begin{gathered} 0.03 \\ (0.013) \end{gathered}$ |
| Ever stopped by police | $\begin{gathered} 0.16 \\ (0.028) \end{gathered}$ | $\begin{gathered} 0.25 * \\ (0.039) \\ \hline \end{gathered}$ | $\begin{gathered} 0.09 \\ (0.014) \end{gathered}$ | $\begin{gathered} -0.03 \\ (0.030) \\ \hline \end{gathered}$ | $\begin{gathered} 0.00 \\ (0.035) \\ \hline \end{gathered}$ | $\begin{gathered} -0.09 \\ (0.009) \\ \hline \end{gathered}$ |

[^8]

B lack M ales


Hispanic M ales


W hite Fem ales


B lack Fem ales


Hispanic Fem ales


Source: Heckman, Hsee and Rubinstein (2001)

Table 7
Outcomes of Early Intervention Programs

|  | Program (Years of Operation) | Outcome | Followed Up to Age | $\begin{gathered} \hline \hline \text { Age of } \\ \text { Treatment } \\ \text { Effect** } \end{gathered}$ | Control Group | Change in Treated Group |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Cognitive Measures |  |  |  |  |  |  |
|  | Early Training Project (1962-1965) | IQ | 16-20 | 6 | 82.8 | +12.2 |
|  | Perry Preschool Project (1962-1967) | IQ | 27 | 7 | 87.1 | +4.0 |
|  | Houston PCDC (1970-1980) | IQ | 8-11 | 2 | 90.8 | +8.0 |
|  | Syracuse FDRP (1969-1970) | IQ | 15 | 3 | 90.6 | +19.7 |
|  | Carolina Abecedarian (1972-1985) | IQ | 21 | 12 | 88.4 | +5.3 |
|  | Project CARE (1978-1984) | IQ | 4.5 | 3 | 92.6 | +11.6 |
|  | IHDP (1985-1988) | IQ (HLBW sample) | 8 | 8 | 92.1 | +4.4 |
| Educational Outcomes |  |  |  |  |  |  |
|  | Early Training Project | Special Education | 16-20 | 18 | 29\% | -26\% |
|  | Perry Preschool Project | Special Education | 27 | 19 | 28\% | -12\% |
|  |  | High School Graduation |  | 27 | 45\% | +21\% |
|  | Chicago CPC (1967-present) | Special Education | 20 | 18 | 25\% | -10\% |
|  |  | Grade Retention |  | 15 | 38\% | -15\% |
|  |  | High School Graduation |  | 20 | 39\% | +11\% |
|  | Carolina Abecedarian | College Enrollment | 21 | 21 | 14\% | +22\% |
| Economic Outcomes |  |  |  |  |  |  |
|  | Perry Preschool Project | Arrest Rate | 27 | 27 | 69\% | -12\% |
|  |  | Employment Rate |  | 27 | $32 \%$ | +18\% |
|  |  | Monthly Earnings |  | 27 | \$766 | +\$453 |
|  |  | Welfare Use |  | 27 | 32\% | -17\% |
|  | Chicago CPC (preschool vs. no preschool) | Juvenile Arrests | 20 | 18 | 25\% | -8\% |
|  | Syracuse FDRP | Probation Referral | 15 | 15 | 22\% | -16\% |
|  | Elmira PEIP (1978-1982) | Arrests (HR sample) | 15 | 15 | 0.53 | -. 029 |

[^9]Figure 19 - Effect of Schooling on AFQT for Different Demographic Groups, NLSY79 Coefficients from a Regression of AFQT on Schooling at Test Date and Completed Schooling


This graph shows the effect of schooling at test date on AFQT scores for different demographic groups in the NLSY. It plots the coefficients on schooling at test date of a regression of AFQT scores on schooling at test date and complete schooling (see Hansen, Heckman and Mullen). The baseline category is 8 years of schooling. For example, white males with 9 years of schooling at test date score 12 points higher on the AFQT than white males with 8 years of schooling. White males with 15 years of schooling score 25 points higher on the AFQT than white males with 8 years of schooling.

# Figure 20 <br> Density of Percentile PIAT Math Scores at Ages 5-6 <br> CNLSY 79 Males 


_ White $\quad-\quad-$ - Black $\ldots$........... Hispanic
This test measures the child's attainment in mathematics as taught in mainstream education. It consists of 84 multiple-choice questions of increasing difficulty, beginning with recognizing numerals and progressing to geometry and trigonometry. The percentile score was calculated separately for each sex at each age.

Figure 21: Percentage Increase in Investment in Period 1 Relative to Unconstrained Amount of Investment in Period 1 Needed to Remedy Low Investment at Period 0


Let $K_{1}(\xi)$ and $K_{1}^{*}(\xi)$ denote the optimal and remediation investments in period 1. In this figure we plot $\frac{K_{1}^{*}(\xi)-K_{1}(\xi)}{K_{1}(\xi)}$. For each value of the elasticity of substitution $\xi$, we compute the steady state stock of human capital $H(\xi)$. We take this as the target. We then set the parental human capital $H_{p}(\xi) 2.5 \%$ below $H(\xi)$. We then compute $K_{0}$, the investment in period 0 , by approximating the policy function $g\left(H_{p}(\xi)\right)$ linearly around the steady state. We then use the production function to determine the remediation investment in period 1 that is needed to obtain $H(\xi)$ given initial conditions $H_{p}(\xi)$ and $K_{0}=g\left(H_{p}(\xi)\right)$.

## Table 8

Return to one year of college for individuals at different percentiles of the math test score distribution

White males from High School and Beyond

|  | $5 \%$ | $25 \%$ | $50 \%$ | $75 \%$ | $95 \%$ |
| :--- | :--- | :--- | :--- | :--- | :--- |
| Average return in the population | 0.1121 | 0.1374 | 0.1606 | 0.1831 | 0.2101 |
|  | $(0.0400)$ | $(0.0328)$ | $(0.0357)$ | $(0.0458)$ | $(0.0622)$ |
| Return for those who attend college | 0.1640 | 0.1893 | 0.2125 | 0.2350 | 0.2621 |
|  | $(0.0503)$ | $(0.0582)$ | $(0.0676)$ | $(0.0801)$ | $(0.0962)$ |
| Return for those who do not attend college | 0.0702 | 0.0954 | 0.1187 | 0.1411 | 0.1682 |
|  | $(0.0536)$ | $(0.0385)$ | $(0.0298)$ | $(0.0305)$ | $(0.0425)$ |
| Return for those at the margin | 0.1203 | 0.1456 | 0.1689 | 0.1913 | 0.2184 |
|  | $(0.0364)$ | $(0.0300)$ | $(0.0345)$ | $(0.0453)$ | $(0.0631)$ |

Wages are measured in 1991 by dividing annual earnings by hours worked per week
multiplied by 52 . The math test score is and average of two 10 th grade math test scores.
There are no dropouts in the sample and the schooling variable is binary (high school - college).
The gross returns to college are divided by 3.5 (average difference in years of schooling between high school graduates that go to college and high school graduates that do not in a sample of white males in the NLSY). To construct the numbers in the table we proceed in two steps. First we compute the marginal treatment effect using the method of local instrumental variables as in Carneiro, Heckman and Vytlacil (2001). The parameters in the table are different weighted averages of the marginal treatment effect. Therefore, in the second step we compute the appropriate weight for each parameter and use it to construct a weighted average of the marginal treatment effect (see also Carneiro, 2002). Individuals at the margin are indifferent between attending college or not.

Table 9
Average marginal effect of AFQT, family income, grade completed and father's education on participation in company training

| Variables | Average marginal effect |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | White males |  | Black males |  | Hispanic males |  |
|  | (1) | (2) | (1) | (2) | (1) | (2) |
| Age-adjusted AFQT | 0.0149 | - | 0.0182 | - | 0.0066 | - |
|  | (0.0024) | - | (0.0033) | - | (0.0037) | - |
| Family income in 1979 (in $\$ 10,000$ ) | -0.0021 | -0.0005 | -0.0047 | -0.0019 | 0.0011 | 0.0015 |
|  | (0.0012) | (0.0011) | (0.0024) | (0.0023) | (0.0024) | (0.0023) |
| Grade completed | 0.0382 | - | 0.0060 | - | 0.0036 | - |
|  | (0.001) | - | (0.0014) | - | (0.0014) | - |
| Father's education | -0.0014 | 0.0007 | 0.0003 | 0.0010 | 0.0002 | 0.0008 |
|  | (0.0006) | (0.0005) | (0.0008) | (0.0008) | (0.0007) | (0.0007) |
|  | White females |  | Black females |  | Hispanic females |  |
| Age-adjusted AFQT | (1) | (2) | (1) | (2) | (1) | (2) |
|  | 0.0076 | - | 0.0169 | - | 0.0159 | - |
|  | (0.0025) | - | (0.0038) | - | (0.0045) | - |
| Family income in 1979 (in $\$ 10,000$ ) | -0.0007 | 0.0001 | -0.0006 | 0.0014 | -0.0065 | -0.0043 |
|  | (0.0011) | (0.0011) | (0.0024) | (0.0023) | (0.0031) | (0.0029) |
| Grade completed | 0.0027 | - | 0.0014 | - | 0.0013 | - |
|  | (0.0010) | - | (0.0016) | - | (0.0016) | - |
| Father's education | 0.0001 | 0.0009 | 0.0015 | 0.0021 | -0.00001 | 0.0007 |
|  | (0.0006) | (0.0006) | (0.0008) | (0.0008) | (0.0009) | (0.0008) |
| Note: The panel data set was constructed using NLSY79 data from 1979-1994. Data on training in 1987 is combined with 1988 in the original data set. Company training consists of formal training conducted by employer, and military training excluding basic training. |  |  |  |  |  |  |
| Specification (1) includes a constant, age, father's education, mother's education, number of siblings, southern residence at age 14 dummy, urban residence at age 14 dummy, and year dummies. |  |  |  |  |  |  |
| Specification (2) drops age-adjusted AFQT and grade completed. Average marginal effect is estimated using average derivatives from a probit regression. Standard errors are reported in parenth |  |  |  |  |  |  |

# Table 10 -Effect of Participation in Head Start and Preschool on PPVT Score and Absence of Grade Repetition 

| Variable | OLS-unadjusted |  |  | OLS-adjusted |  |  | Mother fixed effects |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | White (i) | AfricanAmerican (ii) | $\begin{gathered} \text { Difference } \\ \text { (iii) } \end{gathered}$ | White (iv) | AfricanAmerican (v) | Difference (vi) | White (vii) | AfricanAmerican (viii) | Difference (ix) |
| A. Dependent Variable: PPVT Score |  |  |  |  |  |  |  |  |  |
| Head Start ${ }^{2}$ | $-5.621$ | $1.037$ | -6.658 | -0.383 | 0.739 | $-1.122$ | 5.875 | 0.247 | 5.628 |
| Other preschool ${ }^{\text {b }}$ | (1.077 | ${ }^{(1.223)}$ | $(1.990)$ 7.070 | (1.453) 1.679 | $(1.135)$ -0.790 | (1.844) | (1.520) | (1.358) | (2.038) |
|  | (1.275) | (1.481) | (1.955) | (1.171) | (1.311) | (1.759) | (1.296) | (1.296) | $\begin{gathered} 0.557 \\ (1.833) \end{gathered}$ |
| Constant | $\begin{aligned} & 31.512 \\ & (0.783) \end{aligned}$ | $\begin{aligned} & 13.762 \\ & (0.823) \end{aligned}$ | $\begin{aligned} & 17.749 \\ & (1.136) \end{aligned}$ | $\begin{array}{r} -106.706 \\ (16.306) \end{array}$ | $\begin{array}{r} -49.201 \\ (15.846) \end{array}$ | $\begin{gathered} -57.505 \\ (22.737) \end{gathered}$ | (1.29) | (1.29) |  |
| $F$ (Head Start <br> $=$ preschool) <br> $F$ (all covariates) | 75.38 | 0.40 | 36.22 | 1.56 | 1.21 | 2.77 | 7.45 | 0.06 | 4.81 |
|  | [0.00] | [0.53] | [0.00] | [0.21] | [0.27] | [0.10] | [0.01] | [0.81] | [0.03] |
|  | 43.62 | 0.99 | 133.49 | 71.51 | 15.70 | 79.78 | 3.75 | 3.13 | 4.31 |
|  | [0.00] | [0.37] | [0.00] | [0.00] | (0.00] | [0.00] | [0.00] | [0.00] | [0.00] |
| $R^{2}$ | 0.03 | 0.01 | 0.14 | 0.27 | 0.19 | 0.34 | 0.73 . | 0.68 | 0.75 |
| Sample size | 2,319 | 1,158 | 3,477 | 2,319 | 1,158 | 3,477 | 2,319 | 1,158 | 3,477 |
| B. Dependent Variable: Probability Never Repeated Grade |  |  |  |  |  |  |  |  |  |
| Head Start ${ }^{2}$ | $\begin{gathered} -0.035 \\ (0.058) \end{gathered}$ | $\begin{gathered} -0.010 \\ (0.061) \end{gathered}$ | $\begin{gathered} -0.025 \\ (0.084) \end{gathered}$ | $\begin{gathered} 0.004 \\ (0.061) \end{gathered}$ | $0.000$ | $\begin{gathered} -0.004 \\ (0,088) \end{gathered}$ | $0.473$ $(0.122)$ | $0.008$ (0.098) | $0.465$ |
| Other preschool ${ }^{\text {b }}$ | 0.029 | -0.069 | 0.098 | -0.005 | 0.100 | 0.095 | 0.061 | (0.098) | -0.158) |
|  | (0.062) | (0.085) | (0.104) | (0.063) | (0.088) | (0.106) | (0.099) | (0.125) | (0.158) |
| Constant | $\begin{gathered} 0.654 \\ (0.031) \end{gathered}$ | $\begin{gathered} 0.537 \\ (0.043) \end{gathered}$ | $\begin{gathered} 0.118 \\ (0.052) \end{gathered}$ | $\begin{gathered} 0.487 \\ (0.810) \end{gathered}$ | $\begin{gathered} 0.049 \\ (0.882) \end{gathered}$ | $\begin{gathered} 0.572 \\ (1.191) \end{gathered}$ | ) | (0.125) | (0.158) |
| $F$ (Head Start = preschool) | 0.76 | 0.47 | 1.20 | 0.02 | 1.30 | 0.61 | 8.40 | 1.22 | 8.05 |
|  | [0.38] | [0.49] | [0.27] | [0.90] | [0.26] | [0.44] | [0.01] | [0.27] | [0.01] |
| $F$ (all covariates) | 0.39 | 0.34 | 2.82 | 2.50 | 1.15 | 2.21 | 3.57 | 1.26 | 2.35 |
|  | [0.68] | [0.72] | [0.02] | [0.00] | [0.32] | [0.00] | [0.00] | [0.28] | [0.01] |
| $R^{2}$ | 0.01 | 0.01 | 0.01 | 0.08 | 0.05 | 0.08 | 0.62 | 0.59 | 0.61 |
| Sample size | 414 | 314 | 728 | 414 | 314 | 728 | 414 | 314 | 728 |

Notes: Standard errors are reported in parentheses below the coefficients; $p$ values are given in brackets below the $F$ statistics. Variance-covariance matrices were estimated by the method of infinitesimal jackknife for PPVT scores. OLSadjusted regressions include controls for child age, gender, and whether first born, (log) household permanent income, mother's education, mother's AFQT score, mother's height, number of siblings when the mother was age 14, and grandmother's education. Fixed-effect models include controls for child age, gender, whether first born, and household income at age 3.
${ }^{2}$ Dumnly variable $=1$ if participated in Head Start.
${ }^{\text {D }}$ Dummy variable $=1$ if participated in ather preschool.

Table 11-Fixed-Effects Estimates of Impact of Head Start and Preschool on Child Well-Being,

| Variable | Dependent variable: PPVT score |  |  | Dependent variable: probability never repeated grade |  |  | Dependent variable: probability of measles immunization |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | White <br> (i) | AfricanAmerican (ii) | $\begin{gathered} \text { Difference } \\ \text { (iii) } \end{gathered}$ | White (iv) | African- <br> American (v) | Difference <br> (vi) | White (vii) | AfricanAmerican (viii) | Difference <br> (ix) |
| A. Include interactions with AFQT of mother: |  |  |  |  |  |  |  |  |  |
| Head Start ${ }^{\text {a }}$ | $\begin{gathered} 4.826 \\ (2.136) \end{gathered}$ | $\begin{gathered} -0.462 \\ (1.821) \end{gathered}$ | $\begin{gathered} 5.288 \\ (2.807) \end{gathered}$ | $\begin{gathered} 0.123 \\ (0.186) \end{gathered}$ | $\begin{gathered} -0.006 \\ (0.146) \end{gathered}$ | $\begin{gathered} 0.130 \\ (0.239) \end{gathered}$ | $\begin{gathered} 0.046 \\ (0.047) \end{gathered}$ | $\begin{gathered} 0.083 \\ (0.050) \end{gathered}$ | $\begin{array}{r} -0.036 \\ (0.069 \end{array}$ |
| Head Start $\times A F Q T$ of mother | $\begin{gathered} 2.032 \\ (3.352) \end{gathered}$ | $\begin{gathered} 2.103 \\ (4.810) \end{gathered}$ | $\begin{gathered} -0.072 \\ (5.863) \end{gathered}$ | $\begin{gathered} 0.831 \\ (0.323) \end{gathered}$ | $\begin{gathered} 0.040 \\ (0.316) \end{gathered}$ | $\begin{gathered} 0.791 \\ (0.452) \end{gathered}$ | $\begin{gathered} 0.060 \\ (0.062) \end{gathered}$ | $\begin{gathered} 0.030 \\ (0.099) \end{gathered}$ | $\begin{gathered} 0.029 \\ (0.119) \end{gathered}$ |
| Other presehool ${ }^{\text {b }}$ | $\begin{gathered} 2.278 \\ (2.170) \end{gathered}$ | $\begin{gathered} -1.300 \\ (1.483) \end{gathered}$ | $\begin{gathered} 3.578 \\ (2.628) \end{gathered}$ | $\begin{gathered} 0.217 \\ (0.204) \end{gathered}$ | $\begin{gathered} 0.210 \\ (0.192) \end{gathered}$ | $\begin{gathered} 0.007 \\ (0.28 \mathrm{~L}) \end{gathered}$ | $\begin{gathered} 0.086 \\ (0.044) \end{gathered}$ | $\begin{gathered} 0.048 \\ (0.049) \end{gathered}$ | $\begin{gathered} 0.038 \\ (0.067) \end{gathered}$ |
| Other preschool $\times \mathrm{AFOT}$ of mother | $\begin{array}{r} -1.396 \\ (2.724) \\ \hline \end{array}$ | $\begin{aligned} & 4.545 \\ & (3.764) \end{aligned}$ | $\begin{gathered} -5.941 \\ (4.647) \end{gathered}$ | $\begin{gathered} -0.203 \\ (0.246) \end{gathered}$ | $\begin{gathered} -0.135 \\ (0.419) \end{gathered}$ | $\begin{gathered} -0.068 \\ (0.473) \end{gathered}$ | $0.045$ (0.044) | $\begin{gathered} 0.007 \\ (0.082) \end{gathered}$ | $0.038$ $(0.095)$ |
| $F$ (Head Start and interaction) | $\begin{gathered} 7.72 \\ {[0.00]} \end{gathered}$ | $\begin{gathered} 0.10 \\ {[0.91]} \end{gathered}$ | $\begin{gathered} 3.39 \\ {[0.03]} \end{gathered}$ | $\begin{aligned} & 11.48 \\ & 0.001 \end{aligned}$ | $\begin{gathered} 0.01 \\ {[0.99]} \end{gathered}$ | $\begin{gathered} 5.39 \\ {[0.01]} \end{gathered}$ | $\begin{aligned} & 4.04 \\ & {[0.02]} \end{aligned}$ | $\begin{gathered} 4.00 \\ {[0.02]} \end{gathered}$ | $\begin{gathered} 0.16 \\ {[0.85]} \end{gathered}$ |
| $F$ (Preschool and interaction) | $\begin{gathered} 0.74 \\ {[0.48]} \end{gathered}$ | $\begin{aligned} & 0.74 \\ & {[0.48]} \end{aligned}$ | $\begin{gathered} 1.04 \\ {[0.35]} \end{gathered}$ | $\begin{gathered} 0.59 \\ {[0.56]} \end{gathered}$ | $\begin{gathered} 0.89 \\ {[0.41]} \end{gathered}$ | $\begin{gathered} 0.02 \\ {[0.98]} \end{gathered}$ | $\begin{aligned} & 14.14 \\ & {[0.00]} \end{aligned}$ | $\begin{gathered} 1.12 \\ {[0.33]} \end{gathered}$ | $\begin{gathered} 0.87 \\ 0.87 \\ {[0.42]} \end{gathered}$ |
| $F$ (all covariates) | $\begin{aligned} & 3.74 \\ & {[0.00]} \end{aligned}$ | $\begin{gathered} 3.12 \\ {[0.00]} \end{gathered}$ | $\begin{gathered} 4.29 \\ {[0.00]} \end{gathered}$ | 3.79 $[0.00]$ | $\begin{gathered} 0.95 \\ {[0.48]} \end{gathered}$ | 2.26 $[0.00]$ | 154.10 [0.00] | $\begin{aligned} & 80.26 \\ & {[0.00]} \end{aligned}$ | $\begin{gathered} 117.00 \\ {[0.00]} \end{gathered}$ |
| $R^{2}$ | 0.73 | 0.68 | 0.75 | 0.63 | 0.59 | 0.62 | 0.69 | 0.68 | 0.69 |
| B. Include Interactions with Age of Child: |  |  |  |  |  |  |  |  |  |
| Head Start ${ }^{\text {a }}$ | $\begin{gathered} 6.878 \\ (2.397) \end{gathered}$ | $\begin{gathered} 6.845 \\ (1.933) \end{gathered}$ | $\begin{gathered} 0.033 \\ (3.080) \end{gathered}$ | $\begin{gathered} 0.266 \\ (0.311) \end{gathered}$ | $\begin{gathered} 0.218 \\ (0.295) \end{gathered}$ | $\begin{gathered} 0.048 \\ (0.429) \end{gathered}$ | $\begin{gathered} 0.266 \\ (0.045) \end{gathered}$ | $\begin{gathered} 0.258 \\ (0.048) \end{gathered}$ | $\begin{gathered} 0.008 \\ (0.067) \end{gathered}$ |
| Head Start $\times$ age of child ${ }^{c}$ | $\begin{gathered} -0.192 \\ (0.410) \end{gathered}$ | $\begin{gathered} -1.278 \\ (0.309) \end{gathered}$ | $\begin{gathered} 1.086 \\ (0.513) \end{gathered}$ | $\begin{gathered} 0.025 \\ (0.036) \end{gathered}$ | $\begin{gathered} -0.025 \\ (0.033) \end{gathered}$ | $\begin{gathered} 0.050 \\ (0.049) \end{gathered}$ | $\begin{gathered} -0.043 \\ (0.008) \end{gathered}$ | $\begin{gathered} -0.035 \\ (0.007) \end{gathered}$ | $\begin{aligned} & -0.008 \\ & (0.011) \end{aligned}$ |
| Other preschool ${ }^{\text {b }}$ | $\begin{gathered} 0.165 \\ (1.832) \end{gathered}$ | $\begin{gathered} 2.970 \\ (1.863) \end{gathered}$ | $\begin{aligned} & -2.805 \\ & (2.613) \end{aligned}$ | $\begin{gathered} 0.173 \\ (0.350) \end{gathered}$ | $\begin{gathered} 0.726 \\ (0.461) \end{gathered}$ | $\begin{aligned} & -0.553 \\ & (0.572) \end{aligned}$ | $\begin{gathered} 0.128 \\ (0.031) \end{gathered}$ | $\begin{gathered} 0.045 \\ (0.046) \end{gathered}$ | $\begin{gathered} 0.083 \\ (0.057) \end{gathered}$ |
| Other preschool $\times$ age of child ${ }^{c}$ | $\begin{array}{r} 0.264 \\ (0.362) \\ \hline \end{array}$ | $\begin{gathered} -0.467 \\ (0.386) \\ \hline \end{gathered}$ | $\begin{array}{r} 0.731 \\ (0.529) \\ \hline \end{array}$ | $\begin{gathered} -0.014 \\ (0.041) \end{gathered}$ | $\begin{gathered} -0.074 \\ (0.059) \end{gathered}$ | $\begin{array}{r} 0.061 \\ (0.071) \end{array}$ | $\begin{array}{r} -0.002 \\ (0.006) \\ \hline \end{array}$ | $\begin{gathered} 0.002 \\ (0.009) \end{gathered}$ | $\begin{gathered} 0.0 .004 \\ (0.011) \\ \hline \end{gathered}$ |
| $F$ (Head Start and interaction) | $\begin{gathered} 7.89 \\ {[0.00]} \end{gathered}$ | $\begin{gathered} 8.86 \\ {[0.00]} \end{gathered}$ | $\begin{gathered} 5.26 \\ {[0.01]} \end{gathered}$ | $\begin{gathered} 7.68 \\ {[0.00]} \end{gathered}$ | $\begin{gathered} 0.29 \\ {[0.75]} \end{gathered}$ | $\begin{gathered} 4.78 \\ {[0.01]} \end{gathered}$ | $18.53$ [0.00] | $\begin{aligned} & 15.00 \\ & {[0.00]} \end{aligned}$ | $\begin{gathered} 0.48 \\ {[0.617]} \end{gathered}$ |
| $F$ (Preschool | 0.64 | 1.27 | 0.96 | 0.25 | 1.69 | 0.50 | 13.73 | 1.21 | 1.46 |
| and interaction) | [0.53] | [0.28] | [0.38] | [0.78] | [0.19] | [0.61] | [0.00] | [0.30] | [0.23] |
| $F$ (all covariates) | 3.74 | 3.19 | 4.31 | 2.76 | 1.17 | 1.92 | 160.23 | 85.57 | 122.61 |
|  | [0.00] | [0.00] | [0.00] | [0.01] | [0.32] | [0.02] | [0.00] | [0.00] | [0.00] |
| $R^{2}$ | 0.73 | 0.68 | 0.75 | 0.62 | 0.59 | 0.61 | 0.69 | 0.69 | 0.69 |

Nores: Standard errors are reported in parentheses below the coefficients; $p$ values are given in brackets below the $F$ statistics. The variance-covariance matrix for PPVT models was calculated by the method of infinitesimal jackknife. All models include controls for child age, gender, whether first born, and household income at age 3.
${ }^{4}$ Dummy variable $=1$ if participated in Head Start.
${ }^{6}$ Dummy variable $=1$ if participated in other preschool.
${ }^{\text {c Age of child is expressed as years since age } 5 .}$

Distribution of public and private expenditure on educational institutions, by level of education (2000)
■ Private expenditure on educational institutions, excluding public subsidies to households and other private entities

- Total public subsidies to households and other private entities, excluding public subsidies for student living costs
- Public expenditure on educational institutions

Pre-primary education


Primary, secondary and post-secondary non-tertiary education


Tertiary education


1. Post-secondary non-tertiary included in tertiary education.
2. Post-secondary non-tertiary included in both upper secondary and tertiary education.
3. Total public subsidies to households may be included in private payments.

Countries are ranked in ascending order of the proportion of direct public expenditure in primary, secondary and post-secondary non-tertiary education. Source: OECD. Table B3.2. See Annex 3 for notes (www.oecd.org/edu/eag2003).

Differences in expenditure on educational institutions per student relative to primary education (2000)
Ratio of expenditure on educational institutions per student at various levels of education to expenditure on educational institutions per student in primary education, multiplied by 100


Notes: A ratio of 500 for tertiary education means that expenditure on educational institutions per tertiary student in a particular country is 5 times the expenditure on educational institutions per primary student.
A ratio of 50 for pre-primary education means that expenditure on educational institutions per pre-primary student in a particular country is half the expenditure on educational institutions per primary student.

1. Public institutions only.
2. Public and independent private institutions only.

Countries are ranked in descending order of expenditure on educational institutions per student in tertiary education relative to expenditure on educational institutions per student in primary education.
Source: OECD. Table B1.1. See Annex 3 for notes (www.oecd.org/edu/eag2003).


[^0]:    *This paper was prepared for the workshop on Quality and Efficiency in Education and Training organized by the Directorate General for Economic and Financial Affairs, European Commission, Brussels, May 27th 2004. It draws heavily on my joint work with James Heckman and Flavio Cunha (see Carneiro and Heckman, 2003; Carneiro, Cunha and Heckman, 2003a,b). I thank Paulo Santiago, Hillary Steedman, Jason Tsarsh and David Young for providing me with very useful references.
    ${ }^{1}$ Ljunqvist and Sargent (2001) and Heckman (2001) use this term to characterize today's labor market.

[^1]:    ${ }^{2}$ Furthermore, such tests can be used as a measure of quality of the educational system, although one needs to make sure these tests are adequately designed to be comparable in every country. Hanushek written extensively on issues on school quality. For example, in Hanushek (2001) he illustrates how in the US there has been no aggregate growth in test scores at the same time that there has been a dramatic growth in school expenditure.

[^2]:    ${ }^{3}$ Heckman, Lochner and Taber (1998) develop a model in which ability determines schooling and both ability and schooling determine post school investment. While Ben-Porath (1967) emphasized the self-productivity of human capital, he assumed human capital was homogeneous and did not develop models of heterogeneous skills and abilities.

[^3]:    ${ }^{4}$ These estimates correct for the endogeneity of schooling and account for heterogeneity in the returns to schooling, both in terms of observable and unobservable variables.
    ${ }^{5}$ In other analysis of the Head Start data, Currie, Garces and Thomas (2003) show that Head Start has important effects on high school graduation, wages and criminal behavior of adults. The effect on criminal behavior is very strong for blacks. Although the program had a small effect on black test scores it had a large effect on black adult outcomes through its effect on behavioral skills.

[^4]:    ${ }^{6}$ In this model each parent only has one child, although this assumption can be relaxed.

[^5]:    ${ }^{7}$ One important exception has been the Literacy Hour in England, evaluated by Machin and McNally (2003).

[^6]:    ${ }^{8}$ See Council of the European Union (2004).

[^7]:    Sources: a) OECD (1996), Table 3.1, 1994 or 1995 except Denmark, 1990; Norway, 1991. b), c) OECD (2000), Tables 2.1, 4.13. Refers to 1994-8

[^8]:    Notes: The table shows means (with standard errors in parenthesis) from the NLSY
    $\sim$ ILA is the average score on the 22 yes/no questions regarding illicit and delinquent behavior.
    Responses are age-adjusted and standardized to 0 mean in the population sample
    ${ }^{\wedge}$ The male sample excludes males reporting being in prison, for any period of time, in the years 1979-1994
    $\wedge \wedge$ The female sample excludes teenage mothers
    HSD = high school dropouts who do not get a GED degree
    GED = GED recipients
    HSG = high school graduates who do not take further schooling (12 years of schooling)

    * Significantly different from HSD figures at the 5 percent level

[^9]:    Notes: HLBW = heavier, low birth weight sample; HR = high risk. ${ }^{*}$ Age when treatment effect was last statistically significant.
    Cognitive measures include Stanford-Binet and Weshler Intelligence Scales, California Achievement Tests, and other IQ
    and achievement tests measuring cognitive ability. All results significant at .05 level or higher.
    Source: Karoly (2001) For a discussion of the specific treatments offered under each program, see Heckman (2000) and Karoly (2001).

