EXCELLENCE FOR PRODUCTIVITY?

Bert Minne
Marieke Rensman
Björn Vroomen
Dinand Webbink

Centraal Planbureau

CPB Netherlands Bureau for Economic Policy Analysis
Van Stolkweg 14
P.O. Box 80510
2508 GM The Hague, the Netherlands

Telephone +31 70 338 33 80
Telefax +31 70 338 33 50
Internet www.cpb.nl

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Abstract in English

This report surveys the recent literature on human capital and productivity. Recent studies suggest that the right-hand side of the skill distribution is important for productivity, especially in countries that already have a high level of productivity. An empirical analysis of the Dutch skill distribution reveals that the Netherlands is not positioned among the best-performing countries at the right-hand side of the distribution. On average, the Dutch skill level is high, but this level is mainly based on the relatively high skill level at the left-hand side of the skill distribution. The Dutch position declines when moving to the right-hand side. At the very highest skill level, the Netherlands is not among the best of the world. This is true for both secondary education and higher education. The Dutch share of graduates from higher education is also not among the highest in the OECD. The findings on the skill distribution are robust for several skill surveys, age groups and over time. This robustness may be the result of the structure of the Dutch educational system. The findings indicate that there is scope for improvement of skills at the right-hand side of the distribution. Therefore, policies that raise the Dutch performance at high- and top skill levels in higher education or in earlier stages of education may improve Dutch productivity. Further research is needed to assess these policies.

Key words: skill levels, education, knowledge economy, productivity

Abstract in Dutch

Dit rapport geeft een overzicht van het onderzoek naar de bijdrage van menselijk kapitaal aan productiviteit. Recente studies wijzen erop dat vooral hoge niveaus van kennis en vaardigheden belangrijk zijn voor productiviteit, vooral in landen die een hoog productiviteitsniveau hebben. Een empirische analyse van de vaardigheidsverdeling laat zien dat Nederland niet tot de beste landen behoort aan de rechterkant van de verdeling. Het gemiddelde Nederlandse vaardigheidsniveau is hoog, maar dit is vooral te danken aan het relatief hoge niveau aan de linkerkant van de vaardigheidsverdeling. De Nederlandse positie daalt als we naar de rechterkant van de vaardigheidsverdeling gaan. Op het allerhoogste vaardigheidsniveau behoort Nederland niet tot de top van de wereld. Dit geldt zowel voor het voortgezet onderwijs als voor het hoger onderwijs. Ook behoort Nederland niet tot de top van OESO-landen met de hoogste aandelen van afgestudeerden in het hoger onderwijs. De bevindingen over de vaardigheidsverdeling zijn robuust voor verschillende vaardigheidstoetsen en leeftijdsgroepen, en over de tijd heen. Deze robuustheid kan het resultaat zijn van de structuur van het Nederlands onderwijs. De resultaten laten zien dat er ruimte is voor verbetering van vaardigheden aan de rechterkant van de verdeling. Daarom zou beleid dat de Nederlandse prestaties op hoge en top-vaardigheidsniveaus in het hoger onderwijs of in eerdere fasen van het onderwijs doet stijgen, de Nederlandse productiviteit kunnen verbeteren. Verder onderzoek is nodig om dit soort beleid vast te stellen.

Steekwoorden: vaardigheidsniveaus, onderwijs, kenniseconomie, productiviteit

Een uitgebreide Nederlandse samenvatting is beschikbaar via www.cpb.nl.

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Preface

Human capital is one of the main drivers of individual productivity and economic growth. Recently, there has been a renewed attention in the economic literature for the distribution of skills in individual countries. The right-hand side of this distribution is argued to be important for productivity, particularly in countries that already have a high productivity level. Furthermore, there is also an ongoing debate on ‘excellent’ skills among Dutch policy makers.

This report explores the Dutch skill distribution and the potential impact of high- and top skill levels on productivity. The report firstly investigates the economic literature in order to reveal the impact of different skill levels on productivity: average-, high- and top skill levels. The report then presents facts on the Dutch skill distribution and compares it with the skill distributions of other rich countries. It appears that the Netherlands is not among the best-performing countries at the right-hand side of the distribution, particularly not at the very highest skill level.

This report is the result of the integration of two original CPB projects on excellence in education and participation in higher education. Although the project benefited from the valuable suggestions and comments of various people and representatives of organisations, the analysis does not necessarily represent the views of these people or their organisations. CPB is completely responsible for the analysis and conclusions in this study.

We would like to thank the members of the advisory committee: André de Moor, Jackie Bax and Jan van Velsen (Ministry of Education, Culture and Science), Niels Achterberg, Selwyn Moons, Sander Baljé and Geertje Sonnen (Ministry of Economic Affairs), Paul Reuter (Ministry of Finance) and Johan van Geffen (Ministry of Agriculture, Nature and Food Quality). In addition, we interviewed Jeroen Bartelse (formerly of VSNU, the Association of Universities in the Netherlands), Hugo Levie (VSNU), Joke van den Bandt-Stel and Chiel Renique of VNO-NCW (Confederation of Netherlands Industry and Employers). Some discussion with Hessel Oosterbeek and Eric Bartelsman (Free University Amsterdam) helped us to structure the research. We would also like to thank Willem Houtkoop of the Max Goote Institute (Free University Amsterdam) for providing IALS data, Frans Kaiser of the Center for Higher Education Policy Studies (CHEPS) for his explanation on CHEPS data for higher education, and Vincent Fructuoso van der Veen of Statistics Netherlands for thinking along with us on data sources. Finally, we thank Daniël Waagmeester and Maarten Cornet (formerly of CPB, now of Ministry of Finance), and other CPB colleagues for their contributions and comments.

Coen Teulings
Director CPB

Summary

Overview

Most of the economic literature that investigates the effect of human capital on economic growth focuses on the impact of the average level of human capital. In addition, studies that compare educational systems and their performance between countries generally focus on average outcomes, such as average scores in international tests. It is not clear, however, whether the average level of human capital is the most important determinant of productivity or whether productivity is driven mainly by the levels of human capital around this average, for instance, the levels at the bottom or at the top. For instance, higher levels of skill might be important for productivity through innovation and R&D-activity. These activities might also increase the productivity of other workers (spillover effects) as it is typically difficult to appropriate all the benefits of new ideas.

This study addresses the following questions. First, what does economic research say about the impact of a country's high- and top skill levels on productivity? Several recent studies suggest that the right-hand side of the skill distribution is important for productivity, particularly in countries with a high level of productivity.

Second, how does the Dutch skill distribution compare to that in other countries? This study reveals that the average Dutch skill level is high, but also that this level is based mainly on the high skill level at the left-hand side of the skill distribution. At this side of the skill distribution the Netherlands is one of the best countries in the world, and scores at least in the top five. The Dutch position declines when moving to the right-hand side of the skill distribution. At the highest skill levels the Netherlands does not belong to the top ten of the world. In addition, the Netherlands does not belong to the top ten of OECD countries with the highest shares of graduates from tertiary education.

The findings regarding the skill distribution are robust for several skill tests and age groups and over time. This robustness may be the result of particular elements in the Dutch skill production. The organisation of the Dutch educational system may be an important factor for this finding. Therefore, policies that raise the Dutch performance at high- and top skill levels may improve Dutch productivity. Further research is needed to develop effective policies.

Evidence on the impact of average-, high- and top skill levels on productivity (Chapter 2)

A higher average education or skill level leads to a higher productivity at both the country and the individual level. The average quality of education (measured as test scores) seems to have a strong effect on productivity.

There are indications of external effects from higher educated workers. Recent research suggests that the social returns to higher education might exceed the private returns. Furthermore, the growth-enhancing effect of higher education seems to be larger in countries

close to the technology frontier. This is relevant for the Netherlands, which is close to that frontier. At the individual level, the financial returns to skills have increased in the last decades, especially for the higher educated, which suggests an increase in the demand for skills.

The literature on the impact of top performers (scoring in the right-tail of the skill distribution) is small. At the macroeconomic level, there are indications that the growth effect of the top level of the skill distribution is larger than that of lower levels of the skill distribution. In addition, some microeconomic evidence suggests that top performers are very important for the productivity of firms.

Dutch skill distribution in international perspective (Chapter 3)

We investigated the Dutch skill distribution as indicated by individual test scores of three international literacy surveys in order to determine the skill levels of the Netherlands relative to those of other rich countries. These surveys are PISA, TIMSS and IALS. Although differences exists in measurement objectives and participants, these surveys complement each other in their findings on the Dutch skill distribution.

On average, the Dutch skill level is high. At the left-hand side of the skill distribution the Netherlands is one of the best countries of the world, and is generally in the top five. Dutch immigrant students also outperform immigrant students of a selection of OECD countries at the left-hand part of the skill distribution. The Dutch position (considering all students) declines when moving to the right-hand side of the skill distribution. This decline is robust for several skill tests and age groups. From the 75^{th} percentile of the distribution of test scores (the best quarter of the population) the ranking of the Netherlands shows a stronger decline, and for several tests the Netherlands drop out of the top ten of the world. The Dutch position further declines when moving to the 95^{th} and 99^{th} percentiles. At these highest levels of the skill distribution the Netherlands ranks for nearly all tests below the top ten or lower. When we focus on the top one percent of individuals (99^{th} percentile) within the OECD, we see that the Netherlands ranks on average 13. The OECD top is formed by the Republic of Korea, Japan, Australia and New Zealand, which are followed closely by Switzerland and Finland. The Dutch position in international rankings seems quite stable.

Dutch performance in higher education (Chapter 4)

We took a closer look at the performance of Dutch higher educated individuals. We compared the Dutch share of the population with tertiary attainment and the skill distribution of the Dutch higher educated with their counterparts in other countries.

The analysis shows that the level and growth of the Dutch tertiary attainment in 2004 lies below several other rich countries, particularly the Scandinavian countries. A complication is that international comparisons of attainment are difficult because of differences between educational systems. Several countries have short programs of higher education (one-year programs), whereas Dutch higher education consists of programs with a duration of at least four years.

Compared to several other countries, Dutch higher educated individuals do not belong to the best at the right-hand side of the skill distribution of the higher educated in the IALS. The pattern is similar to those based on the PISA, TIMSS for thirteen- and fifteen-year-olds and the entire IALS population. The ranking of the Netherlands falls at higher percentiles. A second finding is that the contribution of Dutch higher education to the skill-level increase between secondary and higher education seems to be lower than in other comparable countries. This is based on the difference in average skill levels of graduates from secondary and higher education. For the Netherlands this difference is smaller than in other rich countries. Dutch graduates of secondary education have a relatively high average skill level. But this is also the case for Sweden. And the skill difference between graduates of secondary and higher education is larger in Sweden than it is in the Netherlands. Furthermore, other countries (such as Norway and Belgium) that lag behind in secondary education, surpass the Dutch skill level in higher education. It should be noted that the Dutch IALS data were collected in 1994 and that the data for the higher educated is limited (new comparable data are being collected in 2007). Furthermore, the analysis of the skill differences between secondary and higher education is based on average test scores. Finally, the findings are restricted to the skills that are measured.

Research agenda (Chapter 5)

The combination of recent indications of the high impact of high- and top skill levels on productivity improvement and the declining performance of the Netherlands compared to other countries from the lowest skill levels to the top skill level, calls for policies that will raise Dutch performance at high- and top skill levels.

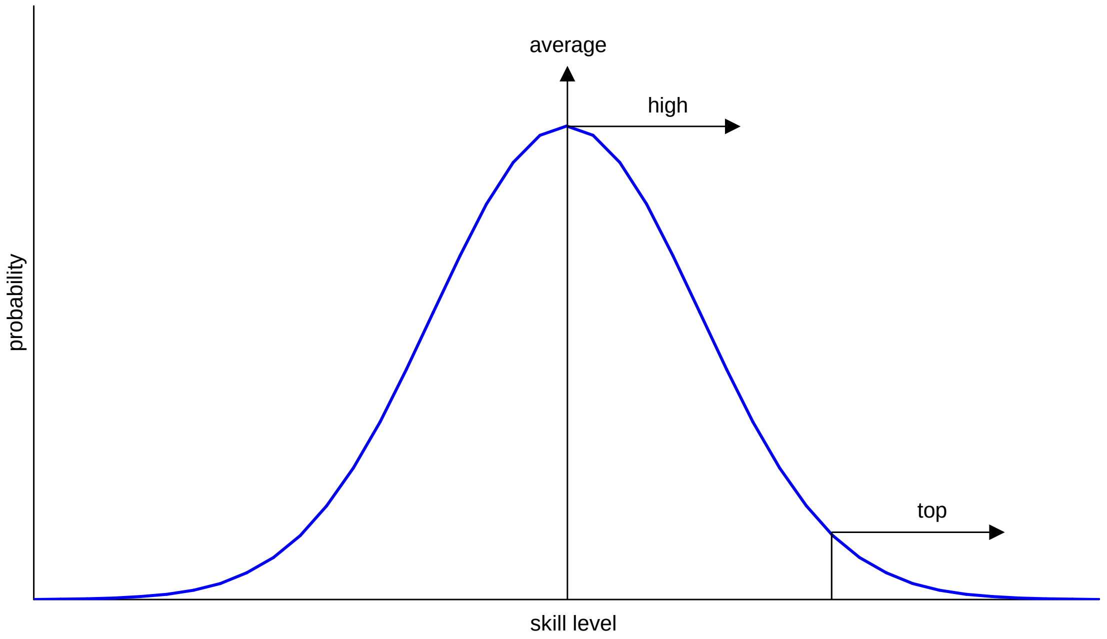
Further research is needed to develop effective policies. First, how can Dutch performance improve at higher skill levels? The question refers to Dutch higher education, but also to earlier stages of education. How effective are special programs for excellent students in secondary or higher education? In addition, can the introduction of selection of students, flexibility in college fees or the entry of private suppliers in higher education increase the quality of higher education? What is the role of the funding structure of higher education? Should public or private funding be increased? Second, how can the share of graduates from higher education in the Netherlands be increased? Which policy options in secondary or higher education are effective to increase the share of graduates?

1 Introduction

Human capital is one of the main drivers of individual productivity and economic growth. Most of the economic literature that investigates the effect of human capital on economic growth focuses on the impact of the average level of human capital. In addition, most studies that compare educational systems and their performance between countries focus on average outcomes, such as average scores in international tests. It is not clear, however, whether the average level of human capital is the most important determinant of productivity or whether productivity is driven mainly by the levels of human capital around this average, for instance, the levels at the bottom or at the top.

Recently, there has been a renewed attention in the economic literature for the difference between adoption and creation of technology, and the relation with a country’s distribution of human capital (skills). It has been argued that lower levels of human capital or skill are important for the absorption of new technology, and that higher levels of human capital are important for the creation of new technology and for innovation. For countries near the technology frontier (like the Netherlands) this could mean that the share of higher educated workers in the labour force is an important determinant of economic growth. As higher educated workers are usually found at the right-hand side of a the skill distribution of a country, this could mean that this side of the skill distributionm, in particular, is driving economic growth (Figure 1.1).

Figure 1.1 The skill distribution in an economy



It is also possible that a top skill level (the right-tail of the skill distribution in Figure 1.1) is the main determinant of productivity. The human capital of a group of top students, top researchers or top institutions could be the main driver of productivity. Individuals with excellent human capital such as students, scientists, researchers and entrepreneurs may create relatively many external effects in knowledge creation and utilization, compared to an 'average' individual. This may happen because these excellent individuals, for instance, create basic innovations in various areas (organisation, marketing, design, and so forth) or boost technological progress at the frontier. In this case, they determine the economic performance of an economy to a considerable extent.

'Excellence' is one of the main issues in current debates on knowledge creation and absorption, and is of particular importance for policy for higher education, scientific and private research institutions. In the framework of the Lisbon agenda, policy makers want to stimulate top performers in productivity, research, science and education, and also prevent 'brain drain' of talented people (see, for instance, European Commission, 2004; Ministry of Economic Affairs, 2004, or the project 'Leren excelleren' of the Dutch Innovation Platform[1]).

Both the renewed attention in the literature and the current policy debate on excellence raise questions on the importance of the distribution of skills in a country; more specifically, the importance of the right-hand side of this distribution. If the right-hand side of the skill distribution is important for economic growth, it then becomes relevant to take a close look at the Dutch composition of skills. This study addresses two questions:

- What is the importance of the right-hand side of a country's skill distribution for productivity?
- How does the Dutch skill distribution compare with that of other rich countries?

The main contribution of this report is that we focus on the entire distribution of skills, and pay particular attention to the right-hand side of the skill distribution. We compare the Dutch distribution of skills with that of other countries measured at different ages and with different instruments. The analysis is based on skills measured in international tests. This measure is more comparable between countries than are years of schooling, which is used more often. A second contribution of the report is that we explicitly highlight the potential economic importance of high- and top skill levels. We do so by surveying the theoretical and empirical economic literature on average-, high- and top skill levels and their impact on productivity at the country level and the individual level.

The structure of the report is as follows. We first survey the literature on the importance of skills for productivity, especially high- and top skill levels (Chapter 2). Next, we compare the Dutch skill distribution with that of other countries, using the results of international test surveys like PISA, TIMMS and IALS (Chapter 3). In addition, we take a special look at participation and skills in Dutch higher education (Chapter 4). Considering the fact that Dutch productivity ranks

[1] See *Het Financieele Dagblad*, June 6, 2007: 'Laat onderwijs excelleren', by A. Rinnooy Kan and D. Zijderveld.

among the highest in the world, we pay particular attention to the right-hand side and right-tail of the Dutch skill distribution. In Chapter 5, we identify some key questions arising from our analysis and propose a research agenda.

2 The impact of average-, high- and top skill levels on productivity

This chapter surveys the current human capital literature in order to describe the impact of high- and top skilled individuals on productivity. A small number of recent studies indicate that these individuals are relatively important for productivity. There are indications of external effects from higher educated workers. The growth-enhancing effect of higher education seems to be larger in countries close to the world technology frontier. This is relevant for the Netherlands, which is close to that frontier. At the individual level, the returns to skills have increased in the last decade – especially for the higher educated, which suggests an increase in the demand for skills. Finally, there are some scarce indications that top skilled individuals are relatively more productive.

2.1 Introduction

What is the importance of the right-hand side of a country's skill distribution for productivity? A substantial literature documents the importance of skills for productivity. The main measure of skills in this literature is educational attainment. Many studies investigate the effect of education on productivity. These studies typically focus on the average level of education, and sometimes on the effect of higher education. A few studies use direct measures of skills, such as scores on specific tests. These studies investigate whether a higher skill level leads to higher productivity. Few studies, however, focus on the effect of top percentiles of the skill distribution on productivity.

Our survey discusses three different, increasing, skill levels: average, high and top. We start with the evidence on the economic effect of the average skill or human capital level, as measured by educational attainment and test scores (section 2.2). Next, we proceed with the studies that focus on the higher skilled on the right-hand side of the skill distribution (section 2.3). These studies typically analyse the impact of higher education. Finally, we discuss the literature that explicitly focuses on the top percentiles of the skill distribution (section 2.4).

Our discussion of the literature thus moves from the mean of the skill distribution to the right-hand side and ultimately to the right-tail (see Figure 1.1). The number of skilled individuals becomes smaller when moving further to the right to the highest percentiles of the skill distribution. In the discussion of the evidence we distinguish between studies at the country level and those at the individual level.

2.2 The average skill level and productivity

This section discusses studies on the economic effect of the average skill or human capital level, or the mean of the skill distribution. A key idea in standard endogenous growth models and human capital models is that human capital is important for innovative activity and absorption of technology. Innovation and absorption, in turn, can affect productivity growth. Another issue is that a great deal of empirical evidence is based on measurement of the average skill level by years of schooling. Some recent studies use a more direct measure of the skill level: test scores in international student surveys. This seems to give a better measure to compare skill levels of countries, because differences in education systems do not hinder the comparison, as years of schooling do.

2.2.1 Impact of the average skill level on the productivity of countries

Innovation and absorption

In modern growth models, human capital can fulfil a role in innovation and in technology absorption. Innovations are the introduction of new and useful products or production processes on the market. These innovations are developed through research and development (R&D) carried out by skilled workers.[2] Endogenous growth theory states that innovations lead to increases in productivity (Romer, 1990; Aghion and Howitt, 1992). Modern human capital models, such as the model of Benhabib and Spiegel (1994), also see innovations as an engine of productivity growth.

Technology absorption is the assimilation and application of technologies or innovations generated by others.[3] According to many modern growth models, absorption requires capacity to understand the knowledge encompassed in the technology or innovation. This absorptive capacity is delivered by human capital (Nelson and Phelps, 1966), or skilled workers in R&D (Cohen and Levinthal, 1989).

Effects of education on the level and growth of production

Empirical applications of human capital models indicate that an increase in the human capital stock (i.e., the average human capital level) increases the production *level*. For instance, De la Fuente and Domenech (2006) show that an increase by one year of the average education level of the labour force increases the level of GDP by 8 percent.

There is also evidence on the impact of education on the *growth rate* of production. Barro (1997) finds that an additional year of education for men at the upper secondary education level leads to an increase of the growth rate of productivity by 1.2 percent points per year. Benhabib and Spiegel (1994) find in an empirical application of their model that there is a significant positive effect of the human capital stock on innovation and absorption (and thereby productivity

[2] It should be noted that R&D can contain both applied and basic research. Basic research by scientists is also important for productivity, though it may take more time before it contributes to the national knowledge stock.

[3] The literature uses various terms, such as adoption, diffusion and imitation, which encompass a similar basic concept of adoption, adaptation and utilization of innovations developed elsewhere.

growth).[4] However, the empirical foundation of the growth effect is weak compared to the level effect, as appears from the many debates on the estimates (see Sianesi and van Reenen, 2003; Krueger and Lindahl, 2001).

Externalities from human capital

At the macroeconomic level, human capital can lead to positive external effects through R&D activity. R&D creates new knowledge that is difficult to appropriate by the producer of the knowledge. This is because new knowledge is at least partially non-excludable and non-rival.[5] Once the new knowledge is produced, other individuals in society can obtain at least a part of it at no cost.[6] The social return to the new knowledge is thus larger than the private return of the producer of this new knowledge. In the standard endogenous growth model, knowledge spillovers from R&D may lead to underinvestment (from a social viewpoint) in R&D and innovation. The empirical literature provides substantial evidence for knowledge spillover effects of R&D (see Cornet et al., 2006, Table 5.1, p.55).

There is empirical evidence that the social and private returns to the average level of education are about equal for many rich countries (given the current education policy instruments). The estimated size of the effect of average level of human capital on the productivity level in various countries corresponds with the estimated size of the private returns to the average level of education in microeconomic research (see page 21). There are also indications in the literature that other types of external effects from human capital arise from education. Education might not only increase individual financial returns, but might also increase health, reduce criminality and increase transfer of knowledge to new generations (Minne et al., 2007).

Skill levels measured by test scores

Due to international differences in education systems, measurement in years of schooling may complicate comparison of the skill performance of countries (Hanushek, 2002, p.10). Some recent studies measure skills (the output of education) directly by using data from international student and adult literacy surveys. The survey data concern test scores of students or adults for mathematics, science, reading and problem solving. Empirical studies that use this approach tend to find a positive and significant effect of the average skill level on productivity.

[4] They also find that the result is robust for three subsamples of countries from poor to rich, where for poorest countries the adoption effect is significant, and for the richest countries the innovation effect dominates.

[5] Non-excludability implies that it is very difficult to prevent others from using the new knowledge. Non-rivalness means that the use of the new knowledge by one individual or firm does not prevent other individuals from using it simultaneously.

[6] Patenting is a tool to appropriate returns to new ideas, but it cannot fully prevent or delay the diffusion of the new knowledge into the society.

Hanushek and Kimko (2000) use student test scores in mathematics and science in four IEA and two NAEP surveys between 1965 and 1991.[7] The mean level of quality or skill of the labour force is calculated as the average (over time) of all available test scores of the country concerned.[8] They conduct cross-country regressions of growth in average real per capita GDP between 1960 and 1990 for 31 countries. They find that one standard deviation increase in test score[9] is related to around one percentage point increase in annual growth rates of per capita GDP. Quantity of schooling has a smaller effect (about a one-third percentage-point difference). Adding other determinants (international trade, private and public investment and political instability) reduces the size of the coefficient of QL1 and QL2 a little, but it is still positive.

Other empirical studies seem to confirm these positive effects of test scores.[10] For instance, Barro (2001) uses the IEA and NAEP surveys to estimate the effect of more test domains (mathematics, science, reading, and an overall measure). He finds that particularly science test scores have a positive and statistically significant effect, compared to mathematics. Reading scores have a positive effect only when science and mathematics scores are included; otherwise, they have a negative impact. The impact of the overall test score is positive and significant.

Jamison et al. (2006) and Hanushek and Woessmann (2007) extend the data of Hanushek and Kimko (2000). Jamison et al. (2006) find on the basis of 45 countries in the period 1960-2000 that one standard deviation higher test score[11] yields 0.87 percentage points higher growth. Adding other determinants of growth (such as openness) reduces the impact of the test scores to 0.45 percent annual growth – a more plausible value, according to Jamison et al. (2006). Additional estimations lead them to argue that skills (educational quality) very likely increase the rate of technological progress and thereby productivity. Skill does not work via country-specific characteristics or via additional years of schooling. Hanushek and Woessmann (2007) use data for 50 countries and find that one standard deviation higher test score[12] is associated with a two percentage points increase in growth of per capita GDP between 1960 and 2000 (controlling for initial GDP per capita and years of schooling in 1960). The coefficient of the test score is significant and positive – even when including regional dummies, or variables for openness and protection against expropriation, although the estimated size reduces to about 1.4 percent.

Most of the discussed empirical studies use mathematics and science test scores, such as

[7] IEA = International Association for the Evaluation of Educational Achievement, NAEP = National Assessment of Educational Progress.

[8] Hanushek and Kimko (2000) construct two different skill measures: QL1, which sets the world mean on each of the six underlying tests equal to 50, and QL2, which adjusts all scores based on US international performance modified for the national time pattern of scores on the NAEP survey. The correlation between QL1 and QL2 is high (above 0.90).

[9] Equivalent to an increase of 47 test-score points in PISA 2000 mathematics, which has a standardized OECD mean of 500.

[10] Hanushek and Woessmann (2007) renumerate a number of these studies. We focus on some of them in the text.

[11] Equivalent to an increase of 57 points in PISA.

[12] Equivalent to an increase of 100 points in PISA.

Hanushek and Woessmann (2007). This is mainly because there are more data available on mathematics and science tests. It is also often presupposed that mathematics and science literacy are the most important proxies for skill. But the empirical evidence that compares the economic importance of mathematics and science literacy with that of other types of literacy (such as reading) is rather small (for instance, Barro, 2001).

2.2.2 Impact of the average skill level on individual returns

Private returns to education

A huge literature studies the effect of education on individual wages. The main conclusion is that an additional year of education leads to a wage increase of 5 to 15 percent. The traditional approach in this literature is to estimate a so-called Mincer wage equation (which regresses (log) wages on education, experience and experience squared). The estimated coefficient of education can be interpreted as the private return to a year of education. The main concern with this approach is that the estimated coefficient does not reflect the causal effect of education because more able or more motivated individuals might select into higher levels of education (Card, 1999). In the last decade many studies have tried to estimate the causal effect of education by exploiting natural experiments or using a sample of identical twins (Ashenfelter et al., 1999). The general picture arising from this literature is that an additional year of education leads to a wage increase of 5 to 15 percent. As there are many excellent reviews of this literature (for instance, Harmon et al., 2003), we do not further discuss these findings.

Test scores and wages

At the microeconomic level there is evidence that higher test scores lead to higher individual income on the labour market. For instance, Mulligan (1999), Murnane et al. (2000) and Lazear (2003) estimate Mincer wage equations for the US including a measure of individual cognitive skill. These studies use different but nationally representative databases of students who have been monitored after leaving high school. The data comprise test scores and earnings (and other variables such as years of schooling and experience). When the test scores from the different databases in the three studies are standardized, one standard deviation increase[13] in the mathematics test score at the end of high school leads to 12 percent higher annual earnings in a later stage (Hanushek, 2006). There is also some evidence for substantial returns to test scores in developed countries outside the US (Hanushek and Woessmann, 2007).

[13] That is, an increase from the 50th to the 84th percentile of the test score distribution in the US surveys.

2.3 High skill levels and productivity

This section focuses on the right-hand side of the skill distribution. The analysis of the economic impact of this right-hand side typically focuses on higher education. Here, the literature implicitly assumes that higher education implies a relatively high skill level.[14]

A number of recent growth models distinguish higher education and lower education. The essence of these models is that higher education can lead to externalities and that the distance to the technology frontier determines the relative growth-enhancing effect of the higher educated. At the microeconomic level there are indications that higher educated individuals receive relatively high economic returns, and that these are increasing relatively fast.

2.3.1 Impact of high skill levels on the productivity of countries

Productivity growth and externalities from higher education

Iranzo and Peri (2006) develop a total factor productivity (TFP) growth model with positive externalities from higher education. They suppose that advanced technology is complementary to higher educated workers, and traditional technology is complementary to less educated workers. The argument is that the entry of a new product variety makes the incumbent varieties more exclusive. The entrant captures the private returns of the new variety, but does not take account of the additional welfare for the incumbents. This external effect leads to TFP growth.[15]

In the empirical application of this model, Iranzo and Peri (2006) analyse the macroeconomic impact of increases in the average education level in the US states between 1960 and 1980.[16] They find small external effects (measured as an increase of TFP) of an increase in the share of 'high school graduates', but large external effects of an increase in the share of college education.

The distance to the technology frontier

The economic impact of the higher educated may depend on the distance to the technology frontier. For instance, Vandenbussche et al. (2006) and Aghion et al. (2005) argue that the

[14] One may indeed expect that higher educated individuals *on average* have a relatively high skill level, but the two concepts are not identical. The right-hand side of the skill distribution in the economy as displayed in Figure 1.1 may comprise highly skilled (even top skilled) individuals who did not graduate from higher education.

[15] A reasoning of why TFP growth encompasses external effects is as follows. Assume that two higher educated persons (Person A and Person B) produce two products which are equal. Higher education enables persons to grasp advanced technology. The next year, Person A makes a new variety instead of the original one, while Person B makes the original product again. The volume of products remains the same (namely two products) but there is product differentiation now. Person A earns the private returns of the new variety. However, the original product has become more exclusive. It enables Person B to earn extra profits. These profits have not been taken into account by Person A. There is no externality to lower educated workers, who produce homogeneous products with traditional technology.

[16] Because of potential endogeneity and omitted variable bias, they apply instrumental variables. Changes in compulsory school laws, the location of Land Grant colleges and preferences of skilled immigrants are considered as shifters of schooling on different parts of the labour force's schooling distribution, and used as instruments.

innovative activities of skilled human capital (the higher educated) have relatively larger economic effects (compared to unskilled human capital) in countries that are closer to the technology frontier. The underlying idea in the models is that unskilled workers are important for imitation or absorption of new technology, and skilled workers for innovation. The models assume that countries far from the world technology frontier follow an imitation strategy, and countries close to the frontier are relatively active in innovation.

Some sidelines on the skills of higher educated workers

There are some sidelines in the study of the economic impact of high skills. We briefly describe two of them: an empirical study on the impact of heterogeneity in the type of skill, and a theoretical paper on sectoral allocation of skills.

- *General or specific education.* Within a group of highly skilled individuals with similar skill levels there can exist heterogeneity in the type of skill. Such a refinement is found in the model of Krueger and Kumar (2004a). They distinguish between vocational and general education among skilled workers. They assume that general education is costly, but enables workers to become entrepreneurs and operate new production technologies. Vocational, skill-specific education does not offer this opportunity (see also Lazear, 2004). Economies that favor general education will grow faster than those that favor vocational education. Moreover, if the rate of technological progress increases, the gap between these economies will increase. Krueger and Kumar (2004b) calibrate their model and argue that in the 1980s and 1990s (when ICT technologies emerged at a rapid pace) the US was growing faster than the more vocationally oriented European countries. The latter countries experienced skill shortages in the rapidly advancing technology areas. Historical evidence on the USA and UK seems to confirm that general academic education matters relatively much for innovation and growth (Goldin and Katz, 2001). The standard economic literature is still not conclusive, however, on the differences in economic impact between general and specific skills.
- *Sectoral allocation of skills and radical innovations.* In a model developed by Galor and Tsiddon (1997), the allocation of talents across occupations is related to the frequency of technological breakthroughs. In periods of major technological progress (inventions), the return to skill or ability rises. This enhances mobility and leads to a higher concentration of high-ability, better-educated individuals in technologically advanced sectors, so that wage inequality rises. This concentration stimulates further technological progress and growth. However, once the existing technologies become more accessible through innovations, the importance of ability declines and mobility decreases. Galor and Tsiddon (1997) conclude that impediments to intersectoral mobility may be bad for technological progress and growth. Their model assumptions rest upon empirical observations, but they do not test the model further.

The contribution of human capital to growth is separated into a level effect and a composition effect (Vandenbussche et al., 2006). Holding the composition of human capital constant, an increase in its aggregate level is always good for growth. However, holding the human capital level constant, the growth-enhancing effect of human capital depends on both the composition of the stock (that is, the share of the higher educated) and the distance to the frontier. Aghion et al. (2005) extend this with migration to account for endogeneity in the size and composition of the human capital stock. Migration reinforces the positive interaction between higher education and proximity to the frontier. This is due to higher wages (hence less emigration) for the higher educated close to the frontier.

Vandenbussche et al. (2006) use data for 22 OECD countries every five years between 1960 and 2000. They find that extending the share of higher educated individuals particularly increases the productivity in countries nearer the technology frontier. Extending education at lower levels benefits countries farther from the frontier. Using data for US states and 26 birth cohorts between 1947 and 1972, Aghion et al. (2005) find a qualitatively similar result, and migration further increases the effects of higher education close to the frontier.[17]

2.3.2 Impact of high skill levels on individual returns

Wage inequality

A substantial literature investigates changes in the returns to education in the course of time. Since the middle of the eighties the private returns to education in the US and the UK have been increasing (Katz and Autor, 1999).

Meanwhile, the inequality of wages between lower educated individuals and higher educated individuals has increased strongly. Decompositions of this inequality show that the higher returns to observed skills (education and experience) are an important factor. In addition, the returns to unobserved skills seem to move in line with the changes in returns between levels of education (Lemieux, 2006). In the Netherlands, the returns to education began to increase in the 1990s, and especially the returns for higher educated individuals have increased (Leuven and Oosterbeek, 2000; Jacobs and Webbink, 2006). Table 2.1 shows changes for the Netherlands since 1979.

Table 2.1 Wage differences between secondary/higher educated workers and workers with no or only primary education, 1979-2002

	1979	1985	1989	1996	1997	2002
Secondary education[a]						
VBO	9.2	10.6	8.4	8.0	8.9	12.8
MAVO	10.9	17.3	15.4	15.6	15.4	16.0
MBO	31.4	26.0	22.8	25.5	28.4	33.7
HAVO+VWO	26.9	30.4	29.7	25.4	26.4	34.0
Tertiary education[a]						
HBO	56.8	41.9	40.8	44.2	47.5	57.0
WO	86.8	70.3	59.1	62.7	67.9	80.5

Source: Jacobs and Webbink (2006), who use the Wage Structure Surveys (LSO) of Statistics Netherlands as data source.
[a] Currently, VBO and MAVO are combined into VMBO as preparatory middle-level vocational education. MBO is middle-level vocational secondary education. HAVO and VWO are generally oriented secondary education. HBO is vocational higher education and WO academic higher education. See also Appendix E for ISCED classifications.

[17] Aghion et al. (2005) argue that the instrument used by Vandenbussche et al. (2006) is imperfect (ten-year lagged education spending). They construct instruments based on the number of legislators on federal appropriations committees (for research or frontier tertiary education), chairmen of legislatures' education committees (vocational post secondary education and undergraduates), and progressiveness of supreme courts (primary and secondary education).

The increase of returns to education and skills suggests that the demand for skills has increased in the last decade. The literature is not conclusive on the factors that lie behind the growing demand for skills. Skill-biased technological change might be important, but changes in patterns of specialization and a growing internationalisation of economic relations might also play an important role.[18]

2.4 Top skill levels and productivity

Following the line in the previous sections, this section moves to the top percentiles of the skill distribution. If human capital is important for innovation, it follows logically that individuals at the top are important for innovation. But do these top performers have an additional impact on productivity? And is the impact linear or not? Are there external effects from top skill levels? As Hanushek and Woessmann (2007, p.38) phrase it, "is it a few 'rocket scientists' at the very top of the distribution who are needed to spur economic growth, or is it 'education for all' that is needed to lay a broad base at the lower parts of the educational distribution?"

The literature on the impact of top performers is relatively scarce. This is because the analysis of top performers is a relatively new topic in the literature (compared to the literature on the impact of higher education), and measurement of skills was relatively difficult until recently (compared to years of schooling or the education level). The economic literature does not offer a growth model in which the role of top performers is explicitly distinguished from that of the 'average' individual. The literature is empirically oriented, and typically measures top performance with test scores or economic success.

There are indications that top performers are relatively important for productivity compared to individuals with lower levels. Moreover, according to microeconomic evidence, top perfomers seem to be more productive than other highly skilled individuals. But there is still no evidence of a non-linear economic effect from the top.

2.4.1 Impact of top skill levels on the productivity of countries

High test scores

The macroeconomic literature that uses direct measures of skills has begun to distinguish top skill levels. This literature is still in its infancy, however, and there are many methodological problems. We discuss two empirical studies: Coulombe and Tremblay (2004) and Hanushek and Woessmann (2007).

[18] CPB (2007, p.93) discusses wage inequality between lower and higher paid workers in the same period, without distinction in education levels. It concludes that this inquality increased up to 1996, and leveled off thereafter.

Coulombe and Tremblay (2004) construct time series for 1960-1995 for individuals aged 17-25 years in 14 countries participating in the International Adult Literacy Survey (IALS) 1994. The IALS tests individuals aged 16 to 65 years for prose, document and quantitative skills and categorizes them according to five, increasing, skill levels. In order to estimate the effect of the highest skilled individuals on per capita GDP growth, the authors use the share of the population aged 17-25 years that achieved at least skill level 4.[19] They find only a positive significant economic effect of prose skills beyond level 4. More importantly, the average skill level (measured as average scores) has a stronger effect on growth than the top skill level (scores beyond level 4) for all domains (prose, document and quantitative skill).

However, these relatively negative results on the economic effect of top performers must be interpreted with care. There are methodological problems with the estimations. For instance, the 'top' group consists of very few observations. Furthermore, the results are based on a strong assumption. The time series used are namely constructed from cross-section data using the age distribution of test scores, without a correction for adjustment in the quality of human capital that occurs during an individual's lifetime through learning and human capital depreciation.

Using the same data source as for their estimates on average test scores for mathematics and science, Hanushek and Woessmann (2007) put the shares of students above 400 and 600 points[20] jointly into one growth regression[21] over the period 1960-2000. The threshold of 400 points captures basic literacy ('education for all'), and 600 points the top performers. For both skill levels they find a significant positive effect on economic growth. But the effect of the highest level is about six times larger than the effect of the lower level. They state that adding control variables such as openness and regional dummies leave the estimates qualitatively similar (hence positive and significant).[22]

The conclusions by Hanushek and Woessmann (2007) on a positive impact of top skill levels contradict the results of Coulombe and Tremblay (2004). Comparing the econometric problems in the two studies, the results of Hanushek and Woessmann (2007) seem to be more robust. But Hanushek and Woessmann (2007) emphasize that multicollinearity between the average and top skill level (400 and 600 points) may give less efficient estimators, and that further research is needed. They trust the pattern of the estimates based on various alternative regressions rather than the specific point estimates themselves. Their findings thus suggest that an increase in skills at the top of the skill distribution is more important for productivity growth than an increase at other parts of the skill distribution – but also mention that the point estimates should be

[19] These population shares for prose, quantitative and document literacy are on average about 1 percent, and at most 3 percent.

[20] The standardized average test score is 500 points.

[21] Including the initial level of GDP per capita and years of schooling in 1960.

[22] These estimates were not presented by Hanushek and Woessmann (2007).

intepreted with care.

2.4.2 Impact of top skill levels on individual returns

'Stars' and their economic success

Few microeconomic studies analyse top performers in the market. These studies analyse the economic impact of activities of so-called 'star scientists' and firm dynamics.

First, Zucker et al. (2002) find that 'star scientists' in biotechnology add more economic value to the firms with which they collaborate, than the 'average scientist' in the same area. This is based on data for biotechnology scientists employed at one of 112 US top research universities. Star scientists are defined as researchers that report more than 40 genetic-sequence discovery articles or published (up to early 1990s) more than 20 articles on such discoveries. Firm-academics links are measured by co-publications of at least one firm scientist and one academic scientist. Statistical analysis and Poisson regression analyses with these data show that the mean economic success of star scientists is much higher than the success of the entire group (or the average) of scientists employed at the 112 universities.[23]

Furthermore, there seem to be localized knowledge spillovers from the activities of star scientists who collaborate with firms.[24] Research done by a star scientist who has no links to any firm does not lead to spillovers to the market, even if he or she is a 'star'. This suggests that the external effects are 'associated with market transactions rather than uncompensated spillovers from the ivory tower' (Zucker et al., 2002, p.163). Darby and Zucker (2003) argue that the scientific knowledge needed for development of new technologies is embodied in star scientists as tacit knowledge, which leads to natural excludability. Working jointly at the lab bench is necessary to transfer this knowledge.

Does the winner take all market returns?

The literature on so-called 'super stars' states that talented individuals tend to search for a job where they are rewarded highly for their efforts (Rosen, 1981). Firms that employ these talents catch a part of the market return of these efforts. Sometimes there arises a winner-takes-all market, where the number one individual takes all returns, notwithstanding the possibility that the difference in skill with the number two is very small (Frank and Cook, 1995). Although the biggest examples can be found in entertainment and sport, also in the education sector so-called top universities (such as Harvard) attract the bulk of talented students.

Other indications of the importance of top performers are found by Bartelsman and his co-authors, who use data on productivity of firms in the US and Europe. It appears that the productivity dispersion of entrants and sectors as a whole (entrants and incumbents) in the US is

[23] The analyses are extended to Japan and the semi-conductors sector, with similar results.

[24] Measured as the number of patents.

larger than in Europe. A large dispersion in productivity indicates that the firms are relatively more often innovative. Entering the market, innovative firms face uncertainty and many are not successful. But successful innovative entrants will have high productivity and gain resources rapidly. Such firm dynamics and competition appear to correlate with higher aggregate productivity growth.[25]

Regression of the coefficient of variation (dispersion) of the labour productivity distribution of *entrants* on country, industry and time dummies reveals that the US has the highest coefficient of variation and the Netherlands an average value for the coefficient of variation in a group of five countries with Finland, France and the UK (Bartelsman, 2004). Furthermore, the difference in the coefficient of variation between high-tech industries and other industries is larger in the US than in the four EU countries (Bartelsman and Scarpetta, 2004). Finally, entrants in the US are smaller than those in the four EU countries, but the growth of survivors is much larger in the US. Hence, US entrants are more often of the innovative type, and EU entrants of the adopter type.

The productivity distribution of *all* firms (entrants and incumbents) in the US is wider than in the EU (Bartelsman, 2004). In the US, the average firm in the top quartile is 2.2 times as productive as the industry average; in the Netherlands this is only 1.6. Moreover, the productivity level of the top quartile in manufacturing industries in the US is higher than in any industry in EU countries (Bartelsman and de Groot, 2004). This US top quartile may represent the global frontier. The productivity gap between the average firm in a country and the global frontier in the US represents the distance to the frontier for that country. In the US, the gap is 53%, and in the Netherlands 61%.

In sum, the scarce evidence above on the productivity effects of top performers provides some indication that a top performer is even more productive than the ordinary highly skilled individual and highly productive firm. There is no evidence, however, on non-linear effects from top performers. Furthermore, the studies only analyse the effect of top performers on innovation and productivity growth, and not the education level of top performers. Still, it is conceivable that top performers acquire skills at higher levels of education.

2.5 Conclusions

The previous discussion of empirical findings yields the following conclusions:

- A higher average education or skill level leads to more productivity both at the country and at the individual level. The average quality of education (measured as test scores) seems to have a strong effect on growth.

[25] Aggregate productivity growth can be decomposed into within-firm productivity changes, between-firm allocation of resources for incumbents, and the contribution from entry and exit.

- There are indications of external effects from higher educated workers (usually scoring on the right-hand side of the skill distribution) (Iranzo and Peri, 2006). Furthermore, the growth-enhancing effect of higher education seems to be larger in countries close to the technology frontier (Vandenbussche et al., 2006). This is relevant for the Netherlands, which is close to the technology frontier. At the individual level, the returns to skills have increased in the last decade, especially for the higher educated, which suggests an increase in the demand for skills.
- The literature on the impact of top performers (scoring in the right-tail of the skill distribution) is small. At the macroeconomic level, there are indications that the growth effect of the top level of the skill distribution is larger than that of lower levels of the skill distribution (Hanushek and Woessmann, 2007). In addition, some microeconomic evidence suggests that top performers are more productive than highly skilled individuals or firms.

In sum, some recent studies suggest that skills at the right-hand side of the skill distribution are relatively important for productivity, and that the effects of these skills on productivity seem to be increasing.

3 The Dutch skill distribution

This chapter explores the Dutch skill distribution. We approximate this distribution with test scores from three international literacy surveys. The findings indicate that the Netherlands does not belong to the best-performing countries at the right-hand side of the skill distribution. There is a declining pattern in the ranking of the Netherlands over the skill distribution. At the left-tail (below the 5th percentile) of the distribution the Netherlands is among the best. In the middle part (between the 25th and 75th percentile) the Dutch performance is relatively stable. Above the middle part of the skill distribution the Netherlands drops out of the top ten.

3.1 Introduction

The findings of the previous chapter on the importance of high- and top skill levels for productivity raise questions with regard to the shape of the skill distribution of the Netherlands. Furthermore, how does the Dutch skill distribution differ from the distributions of other rich countries?

We approximate the skill distribution by test scores from international literacy surveys, in line with recent developments in the literature. Test scores are better than the number of years of schooling at indicating skills (quality of human capital) of individuals. Test scores thus provide better indications of the economic effect of high- and top skill levels on productivity (Hanushek and Woessmann, 2007).

We examine the achievements of Dutch students and adults on three international literacy surveys: PISA, TIMSS and IALS. Although these surveys complement each other in their findings on the Dutch skill distribution, several differences should be noted. The IALS is conducted among adults aged 16-65 years. PISA assesses how well 15-year-olds are equipped with the skills required for tackling future challenges. TIMSS assesses the achievements of 13-year-old students based on their school curriculum. We elaborate on the three surveys in section 3.2.1.

In our empirical analysis below we focus on the high and top skill levels. We thus focus on the right-hand part of the skill distribution. This focus is an extension of common analyses of the average skill levels (see, for example, Antenbrink et al., 2005). Those analyses reveal a relatively stable and high average Dutch skill level for the period 1965-2003 (see Appendix A).

3.2 Data and measurement

3.2.1 International literacy surveys: PISA, TIMSS and IALS

We asses the achievements of the Netherlands by using data of the three literacy surveys PISA, TIMSS and IALS, which are discussed below. This is followed by a discussion on the skill distribution and an interpretation of results.

PISA

The ‘Programme for International Student Assessment’ (PISA) of the OECD is a comprehensive program to assess the knowledge and skills of 15-year-old students on three literacy domains: mathematical literacy, reading literacy and scientific literacy (OECD, 2005a).

PISA aims to assess the capabilities of students in applying acquired knowledge and skills: how well equipped are students to tackle challenges in the future (OECD, 2005a). An example is preparedness to participate on the labour market. Consequently, PISA does not focus on how well a student has mastered a certain school curriculum.

Data are available for the first and second PISA rounds in 2000 and 2003.[26] The selection of students is an important issue, and is therefore carefully monitored by PISA. The Dutch student sample in PISA 2003 is a representative sample of all types of secondary education.[27] Because of sample issues, the PISA consortium recommended excluding the data for the Netherlands in the analyses concerning PISA 2000 (see OECD, 2000b, pp.187–188). Consequently, we refrain from an analysis using the PISA 2000 data.

The design and development of the PISA 2003 survey involved an international multi-step process. After the assessment frameworks were developed, participating countries could submit survey items. Subsequently, items were selected and refined at several development centers. Items that were selected by an international panel were pre-tested in Austria, Australia, Japan and the Netherlands. This was followed by national and international reviews and the subsequent selection of items for field trials. A study of the field trials and the national review reports (together with other information) resulted in the final list of survey items (see also OECD, 2005b, chapter 2).

We refer to Appendix B for a more extensive overview of PISA, including an overview of participating countries and the number of observations per country.

TIMSS

The ‘Third International Mathematics and Science Study’ (TIMSS) collects data on students’ achievements, curricula and school environment. The TIMSS is conducted under auspices of the International Association for the Evaluation of Educational Achievement (IEA).

TIMSS focuses on mathematical literacy and science literacy and assesses the achievements of students in attaining a certain knowledge level. This is slightly different from PISA, which focuses on application of acquired knowledge.

[26] The results of PISA 2006 were not available yet at the moment of the writing of this report.

[27] Types of secondary education included in the Dutch sample: ‘PRO’, ‘VMBO’, ‘HAVO’ and ‘VWO’ (CITO, 2004). See also Appendix E for their ISCED classification.

We use two rounds of TIMSS conducted in 1999 and 2003. The Netherlands did not satisfy guidelines for sample participation rates in the TIMSS 1995 survey (see Harmon et al., 1997, p.A-21). We therefore exclude this 1995 survey from our analysis.

TIMSS collects data for several groups of students.[28] In each country a representative sample of students aged nine and thirteen is selected in a similar way as PISA. However, we have chosen to focus on the thirteen-year-olds, in order to stay in line with the population of PISA.[29] Appendix B provides an overview of participating countries and the number of observations in TIMSS 1999 and 2003.

IALS

The 'International Adult Literacy Survey' (IALS) is a program initiated to assess the performance of adults on three literacy domains: prose, document and quantitative literacy. The IALS is an initiative of several governments, national statistical agencies, research institutions and the OECD. It was co-ordinated by Statistics Canada and the Educational Testing Service of Princeton, New Jersey. Next to the assessment of skills, the IALS also collects information on labour characteristics (for example, wages) of the participant.[30]

The focus of IALS on adults is a clear distinction from PISA and TIMSS. Participating countries constructed a sample of inhabitants aged 16-65 at different educational levels. Subsequently, IALS can provide information on entrants to the labour market and on the effect that higher levels of education may have on, for example, income.

During the period 1994-1998 the IALS was conducted in three cycles. The first survey was conducted in 1994 among nine countries, including the Netherlands. This was followed by surveys among five countries in 1996 and among nine countries in 1998, both without the Netherlands. Appendix B shows which countries participated in a certain year.

3.2.2 Interpreting the skill distribution

The skill levels (proxied by the test score values) of the participants of a literacy survey form a distribution. A distribution indicates the probability that a certain skill level is observed, given the population of participants in the survey. Such a distribution is shown in the left-hand graph of Figure 3.1, which is similar to Figure 1.1. The horizontal axis indicates the skill levels. The vertical axis indicates the probability of occurence. The higher along the vertical axis, the higher

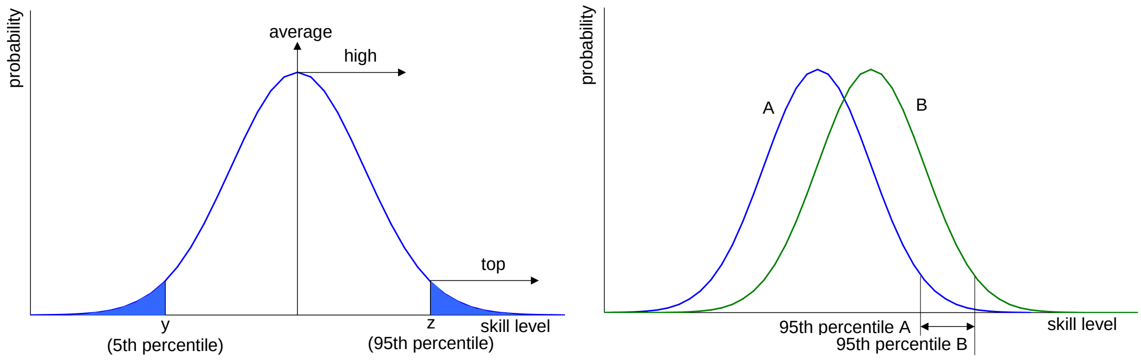
[28] Types of education included in TIMSS 2003: 'VMBO', 'HAVO', 'VWO' (Martin et al., 2004); TIMSS 1999: 'VBO', 'MAVO', 'HAVO', 'VWO' (Martin et al., 2000a). See also Appendix E for their ISCED classification.

[29] The IEA also assesses reading literacy via the 'Progress in International Reading Literacy Study' (PIRLS). The PIRLS focuses on fourth graders (nine- and ten-year-old students). This population is not of primary interest to our study and PIRLS is therefore not considered here.

[30] For the Netherlands a two-stage systematic sampling was used. The first stage was based on the selection of postal codes. The second stage involved selection of one address in each postal code. Finally, based on date of birth the person to be interviewed was selected (Statistics Canada, 1998).

is the probability that a skill level is observed. The left and right tail correspond to the lowest and highest skill levels. The occurrence of these levels is less frequent, which is translated into a lower probability. Note that the considered distribution is symmetrical around the mean. In an empirical application this might not be the case. The tails at the left- and right-hand sides may differ (the one tail being longer than the other tail), and the distribution might subsequently be skewed.

Figure 3.1 Characteristics of a skill distribution



Our measure of skill performance is the difference in the skill distribution of, for example, two countries. Differences occur when the skill distribution of the one country is positioned more to the left or to the right than the distribution of the other country.[31] A more common measure for comparison between countries is the mean or average of the skill distribution. We extend the comparison to the entire distribution.

More precisely, our empirical analysis considers differences between countries in their skill levels at various percentiles. A percentile value indicates which share (percentage) of the population has a skill level less than or equal to the percentile value. For example, the value x of the pth percentile indicates that p-percent of the population has a skill level of *at most* level x. Hence, the 50th percentile splits the population in half, and is equal to the median.

In the left-hand graph of Figure 3.1 we have indicated the 5th percentile, which corresponds to a certain skill level y. This indicates that 5 percent of the participants have *at most* a skill level of y. These 5 percent are shown by the blue area in the left-hand part of the graph. We also indicated the 95th percentile, which corresponds to a value z. That is, 95 percent of the population have a skill level of *at most* level z. Subsequently, this also implies that 5 percent of the population have a level of *at least* level z. The blue area in the right-hand part of the graph indicates this group of 5 percent with the highest scores.

We derive the differences in skill levels of several countries at these percentiles. The right-hand graph of Figure 3.1 demonstrates this principle. Country *B* outperforms country *A*, as

[31] It is obvious that a shift of a country's skill distribution to the right indicates an improvement in its skill levels.

its distribution is positioned more to the right. The difference in skill distribution at the 95th percentile is indicated by the two-sided arrow. The difference in the value of the 95th percentile, and other percentiles, can be used directly as an indicator of deviation in skill performance or used to determine a ranking at that percentile.

We use three types of graphs to demonstrate the differences in skill levels between the Netherlands and other rich countries. First, we display their skill distributions (see for example Figure 3.2). Such a picture immediately shows the differences in shape and location of the skill distributions. Second, we determine the ranking of the Netherlands among a group of rich countries at each percentile (see for example Figure 3.3). This visualizes the relative position of the Netherlands. Third, we plot the deviations in percentile values for country-by-country comparisons (see for example Figure 3.4). These deviations in percentile values show how far the Netherlands lie behind or ahead other countries.

3.3 The Dutch skill distribution

Asking how well the Netherlands performs at different skill levels leads us to an analysis of the entire skill distribution. We approximate the skill distribution with test scores from the three literacy surveys PISA, TIMSS and IALS. Although differing in measurement objective and survey populations, the three surveys complement each other with regard to the relative position of the Dutch skill distribution.

3.3.1 Skill distribution based on PISA 2003

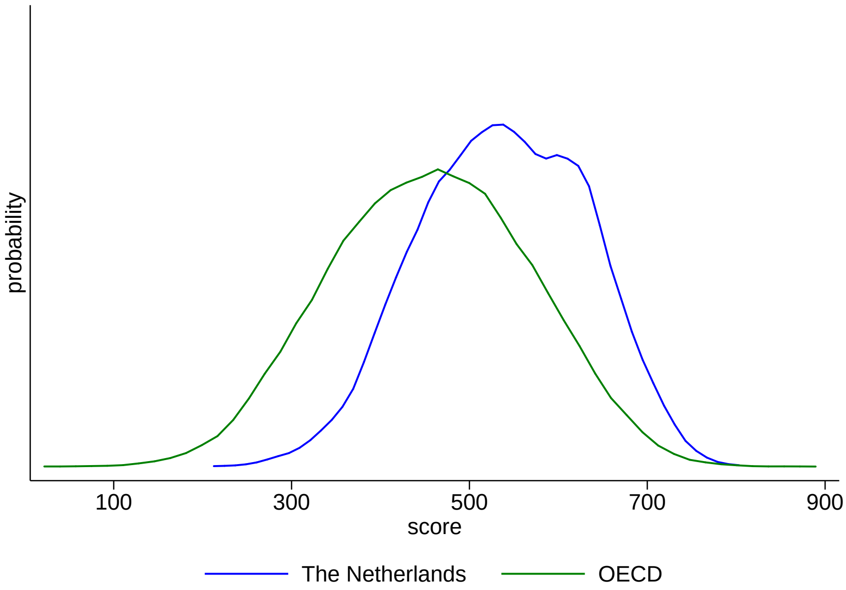
PISA 2003 is the most recent and extensive survey available to us for an international comparison. We use the data of the thirty OECD members that participated in PISA 2003.[32] The data of these 30 countries, including the Netherlands, are weighted to obtain the 'OECD average'. This OECD average serves as the benchmark for the Netherlands. Weighting by the sample weights is required, due to the procedure used for selecting students, and to ensure that results are representative for the total population.

Comparing the skill distributions of the Netherlands and the OECD

Figure 3.2 shows the skill distributions for the Netherlands and the OECD for the mathematical literacy domain. The distributions of the other three domains assessed in PISA 2003 (reading literacy, scientific literacy and problem solving) are quite similar (see Appendix C). The horizontal axis indicates the value of the test score. PISA 2003 is constructed in such a manner that the average score of a student in all OECD countries is 500 points. Consequently, the distribution of the OECD is centered around 500 points.

[32] Next to the OECD members, eleven so-called 'OECD partners' participated in PISA 2003.

Figure 3.2 Skill distribution of the Netherlands and the OECD in mathematical literacy (PISA 2003) [a]



Source: Own calculations based on PISA 2003

[a] See Section 3.2.2 for more details on the skill distribution, and Appendix C for the skill distribution in the other three domains of PISA 2003.

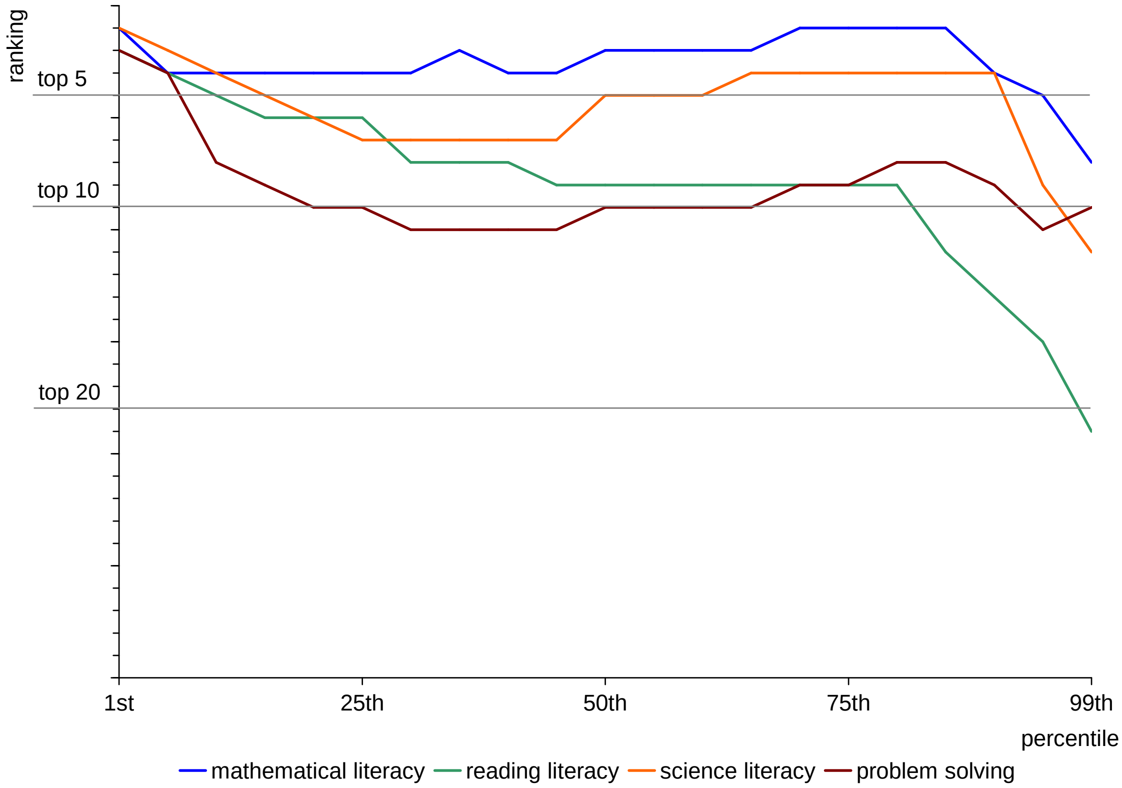
The differences between the Dutch skill distribution and that of the OECD turn up through three characteristics of the distribution: its relative position, dispersion of the population around the mean, and the skewness. Concerning the position of the Dutch skill distribution, Figure 3.2 shows that, on average, the performance of the Netherlands is better than that of the OECD. The distribution of the Netherlands is positioned more to the right. This indicates that its average value and percentile values are higher than those of the OECD.

Figure 3.2 also reveals that the left-hand side of the distribution is shifted more to the right than the right-hand side. That is, the dispersion of the population around the mean is smaller in the Netherlands than in the OECD as a whole. The performance of the Dutch students at the lower percentiles compared to that of OECD students is better than the performance of the Dutch students at the higher percentiles compared to that of the OECD students.

Finally, Figure 3.2 shows that the skill distribution of the Netherlands is skewed to the left. In other words, the left tail is longer than the right tail. Hence, the distribution is not symmetrical. The skewness indicates that more than 50 percent of the population has a test score above the average value. In addition, an analysis of the distributions of all the 30 OECD members (not shown in this report) reveals that, in general, these distributions are skewed to the left.

The resulting deviations of the Dutch percentile values from the OECD percentile values are presented in Table C.1 and Figure C.2 in Appendix C. The Netherlands has a significant lead at

Figure 3.3 Dutch ranking on four literacy domains among 30 OECD members, PISA 2003



Source: Own calculations based on PISA 2003

the left-hand side of the distribution. This lead is however lost at the right-hand side, except for mathematical literacy. In reading literacy the Netherlands has a significant lag at the 99th percentile.

The ranking of the Netherlands at various percentiles

We have determined the ranking of the Netherlands among the 30 OECD members at several percentiles of the distribution. This ranking is based on the test score values at these percentiles for all OECD members. Figure 3.3 shows the Dutch ranking for the four PISA literacy domains. The higher along the vertical axis, the better the Dutch ranking is. This graph also includes three additional lines that indicate whether the Netherlands is in the top five, top ten, or top twenty of the 30 OECD members.

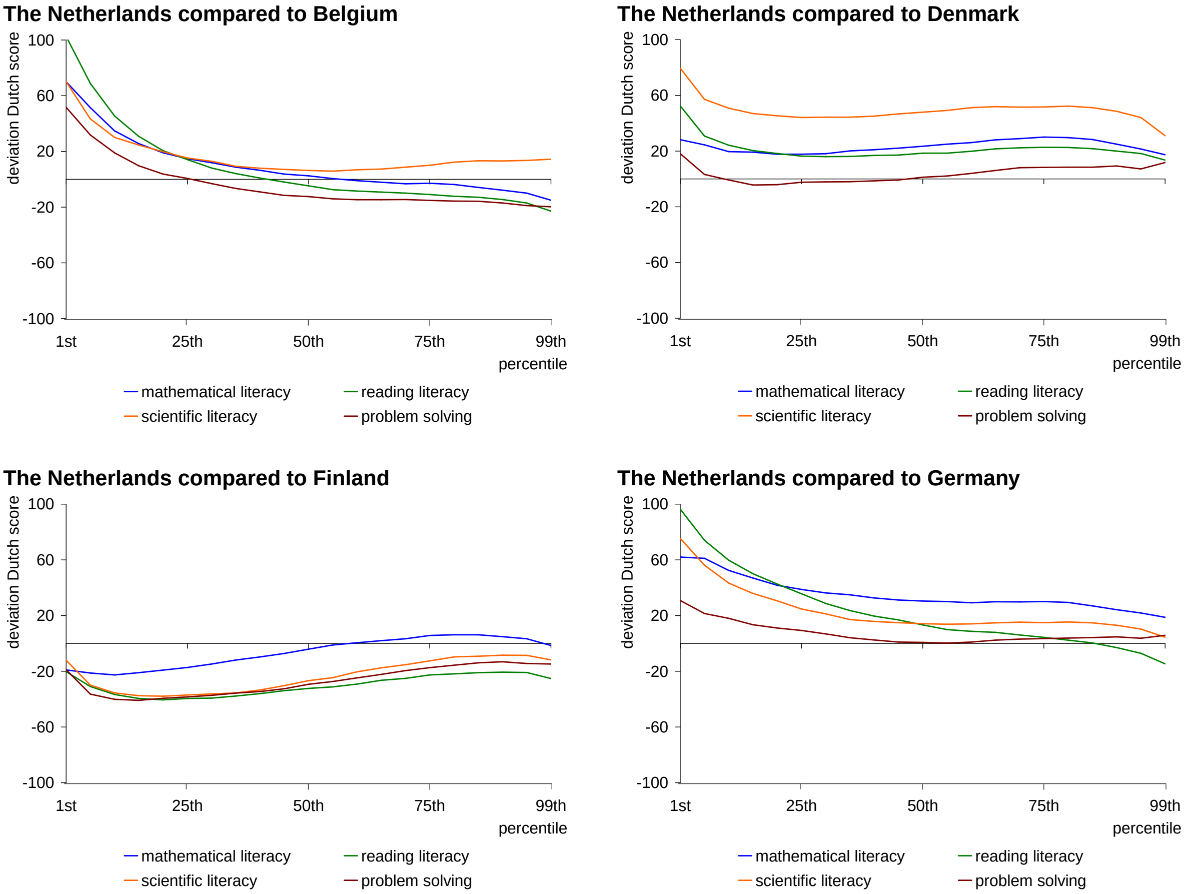
The performance of the Dutch ‘middle class’ students is relatively stable. The ranking of the 50 percent of the Dutch population between the 25th and 75th percentile in Figure 3.3 is relatively constant, and in the top ten. Deviations in ranking occur mainly at the left- and right tails of the skill distribution.

The top skilled Dutch students are not top of the OECD class, in contrast to the Dutch students at the left-hand side of the distribution. The values of the 1st, 5th and 10th percentiles of the Netherlands are, in general, in the top five. This indicates that the students in the left tail perform well. From the 75th percentile the Dutch ranking starts to decline. For the 95th and 99th percentile values, the Netherlands ranks just barely in the top ten or in the top twenty. The best students of the Netherlands are therefore not the best of the OECD. This confirms our earlier finding on the difference with the OECD between the left- and right-hand sides of the skill distribution in Figure 3.2.

Country-by-country comparison at various percentiles

In addition to the comparison with the OECD, we compare the Netherlands with nine European OECD members and the United States. These comparisons are shown in Figures 3.4 and 3.5.

Figure 3.4 Deviation of Dutch scores on four literacy domains from four European countries, PISA 2003[a]

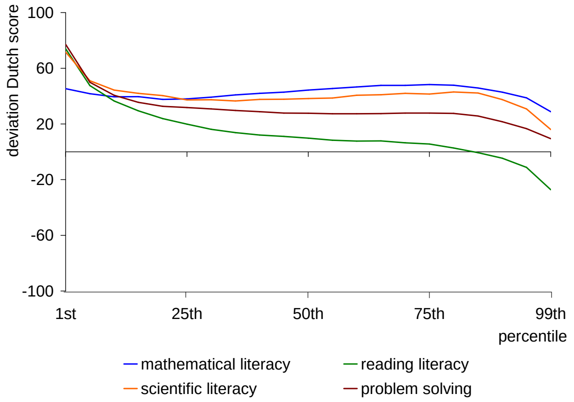


Source: Own calculations based on PISA 2003

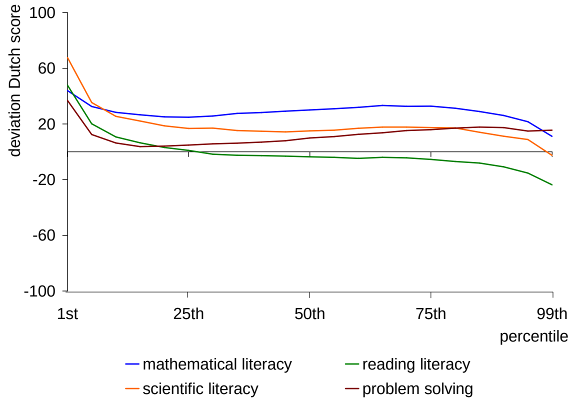
[a] The Netherlands has a higher skill level at a certain percentile when the graph line is above the horizontal line at deviation value zero.

Figure 3.5 Deviation of Dutch scores on four literacy domains from three European countries and the United States, PISA 2003[a]

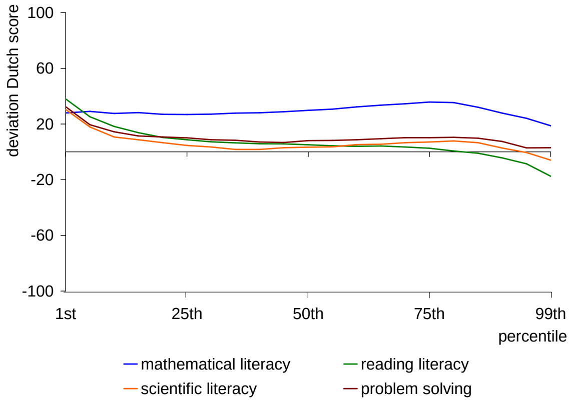
The Netherlands compared to Norway



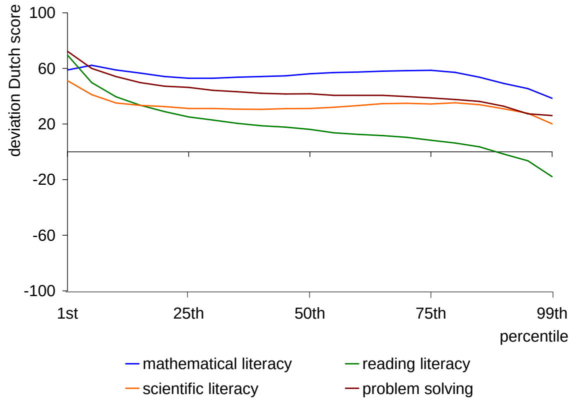
The Netherlands compared to Sweden



The Netherlands compared to United Kingdom[b]



The Netherlands compared to United States



Source: Own calculations based on PISA 2003

[a] The Netherlands has a higher skill level at a certain percentile when the graph line is above the horizontal line at deviation value zero.

[b] Findings for the United Kingdom should be interpreted with care due to data limitations (see also Appendix B).

The graphs depict the deviation of the Dutch test scores from the scores of another country (vertical axis) at several percentiles (the horizontal axis below the graphs). The Netherlands performs better than the reference country when the value on the vertical axis (the deviation) is positive. To see this at a glance, the graphs include a horizontal line at deviation value zero. Table C.2 shows whether the deviations are statistically significant.

The graphs in Figures 3.4 and 3.5 reveal that the Dutch skill levels are generally higher than those of the reference countries. Most graphs have lines above the horizontal line at value zero. The Scandinavian countries, except Finland, do not outperform the Netherlands. Belgium exceeds the Netherlands at the higher percentiles (the deviations being statistically significant), except for scientific literacy. The performance of the group between the 25th and 75th percentiles is relatively stable, similar to our earlier comparison with the OECD as a whole.

Dutch students on the left-hand side of the distribution perform relatively better than the highly skilled students on the right-hand side. Deviations in percentile value at the lower percentiles are especially large and significant for Belgium, Germany, Luxemburg, Sweden and the United States. Deviations at the higher percentiles are relative small, expect for Norway and the United States.

The performance of Finland and the United States is intriguing. Finland does better, in general, than the Netherlands (with the deviations being statistically significant). Only in mathematical literacy, the performance of both countries is similar at the higher percentiles. We elaborate more on the Finnish performance in the box on page 46. The United States is lagging significantly behind the Netherlands at all percentiles. We will further investigate the skill performance of the United States in the next chapter on higher education.

Conclusions

The Netherlands does not belong to the best performing countries at the right-hand side of the skill distribution. In addition, the top skilled Dutch students at the right tail (above the 95thpercentile) of the distribution do not perform as well as the Dutch students at the left tail (below the 5th percentile) when compared to other OECD students. That is, there is a declining pattern in the ranking of the Netherlands when moving to higher percentiles in the skill distribution. However, the middle class students (between the 25th and 75th percentile) continue to have a relatively stable position among the top ten of the 30 OECD members.

The Netherlands performs well compared to neighbouring countries such as Belgium, Germany and Denmark. Although the Scandinavian countries are often used as a benchmark by policy makers, these countries do not have higher skill levels. An exception is Finland, which is in general better than the Netherlands. These findings are robust for differences in the populations of participating countries (see Appendix D).

3.3.2 Skill distribution based on TIMSS 1999 and 2003, and IALS 1994-1998

This section uses the test scores of TIMSS and IALS to approximate the Dutch skill distribution. The TIMSS is similar to PISA in terms of design and student population, but differs in measurements objectives. The two TIMSS rounds in 1999 and 2003 may reveal changes in skill levels over time. The IALS differs from PISA, as the IALS participants are aged between 16 and 65 years. Consequently, IALS is the only survey that directly approximates the skill distribution of the total Dutch population.

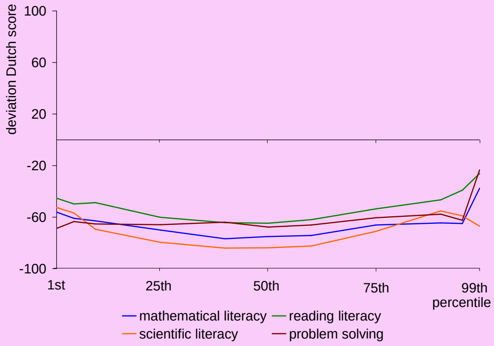
Skill distribution based on TIMSS 1999 and 2003

Since the countries that participated in TIMSS differ from those of PISA, the TIMSS benchmark for the Netherlands differs from that of PISA. We compare the Netherlands with all participants

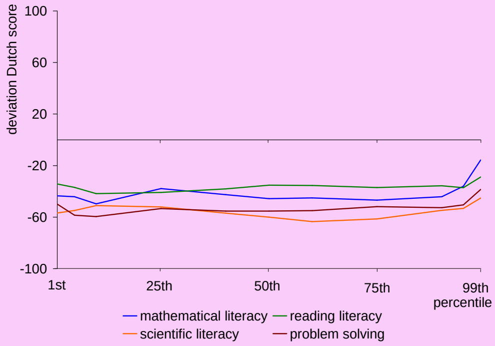
Achievements of Dutch immigrant students in PISA 2003

There is an ongoing debate on the performance of Dutch immigrant students compared to native students.[a] An immigrant student is identified according to his or her place of birth and that of his or her parents. We define a first-generation immigrant [FGI] student as born abroad, as are his/her parents. A second-generation immigrant [SGI] student is defined as born in the country of assessment with both his/her parents born abroad. A native student is born in the country of assessment and has at most one parent born abroad.[b] A direct comparison of Dutch native students and Dutch immigrant students indicates a relatively stable deviation of test scores at the various percentile values (see the two graphs below). The difference between native and first-generation students is approximately 60 points. The second-generation students perform slightly better. The difference with native students for this group is around 50 points. At the 99th percentile we see a sharp decrease in the lag of second-generation students.

Dutch FGI-students compared to Dutch native students, taking student characteristics into account



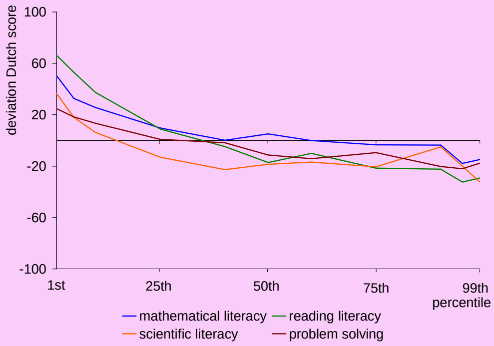
Dutch SGI-students compared to Dutch native students, taking student characteristics into account



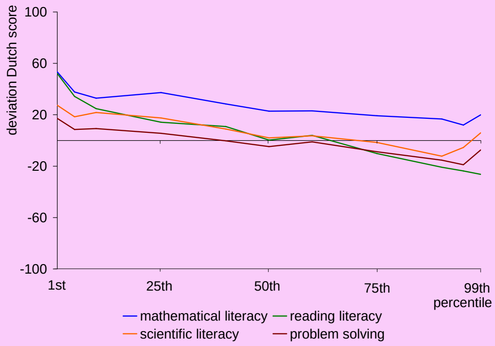
Another perspective on the performance of Dutch immigrant students is to compare them with their foreign counterparts. PISA allows us to compare first- and second-generation Dutch immigrant students with the immigrant students in 14 OECD members. These 14 countries have also a significant immigrant population, similar to the Netherlands.[c] We take into account the characteristics of participants as these may differ for the several countries (see also Appendix D).

Comparison of the first- and second-generation immigrants with their foreign counterparts in the 14 OECD members reveals a pattern similar to that of the whole Dutch student population (see graphs below). At the lower percentiles we see a lead over the OECD-14, which turns into a lag at the higher percentiles. These findings indicate that the Dutch immigrant students outperform the OECD immigrant students at the left-hand side of the skills distribution. However, this lead is lost at the right-hand side of the distribution.

Dutch FGI-students compared to OECD FGI-students



Dutch SGI-students compared to OECD SGI-students



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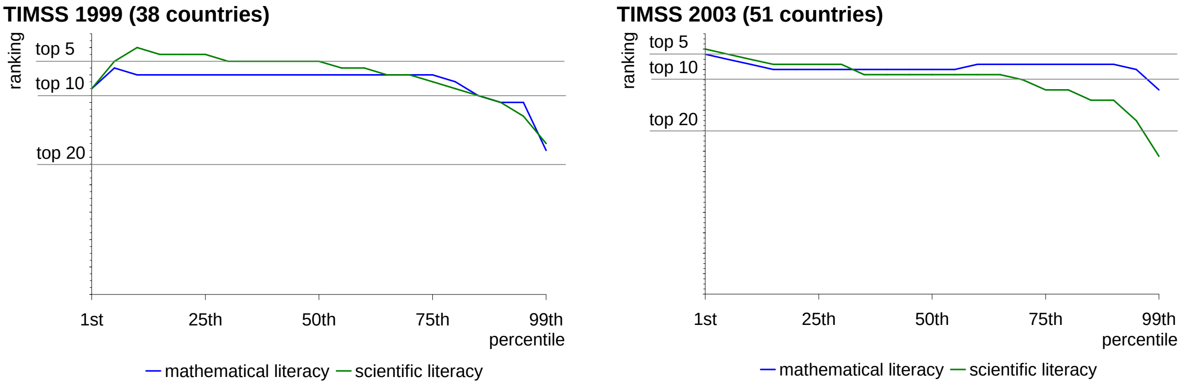
Source: Own calculations based on PISA 2003.

[a] See, for example, J.-D. Bouma, "De kloof", *NRC Handelsblad*, September 9, 2006 (in Dutch).

[b] These definitions differ from those used by OECD (2006b).

[c] Included countries are Australia, Austria, Belgium, Canada, Denmark, France, Germany, Luxembourg, New Zealand, Norway, Sweden, Switzerland and the United States. See also OECD (2006b).

Figure 3.6 Dutch ranking on two literacy domains among participants of TIMSS 1999 and 2003



Source: Own calculations based on TIMSS 1999 and 2003

of the different TIMSS rounds.[33]

Figure 3.6 indicates the ranking of the Netherlands on the two TIMSS rounds (1999 and 2003) in the same way that Figure 3.3 does for PISA 2003. Note that the number of participating countries is different for the two rounds, which may influence the ranking of the Netherlands. We focus on the pattern in skill levels in the two rounds rather than the exact ranking itself.

The two TIMSS rounds reveal a similar declining pattern for the Netherlands, as was shown by the PISA 2003 data. The ranking decreases over the percentiles. At the top of the distribution, which corresponds to the top skilled students, the Netherlands is not in the top ten. One exception is TIMSS 2003 mathematics, which shows a relatively stable, although slightly declining, pattern.

In addition, the TIMSS rounds provide some indication of an improvement at the left-tail of the distribution over the last decade – particularly at the first and fifth percentiles. The Dutch ranking at these percentiles increases over the two rounds and is the highest for TIMSS 2003. The latter is in line with PISA 2003, which also shows the best performance of the Netherlands at these percentiles.

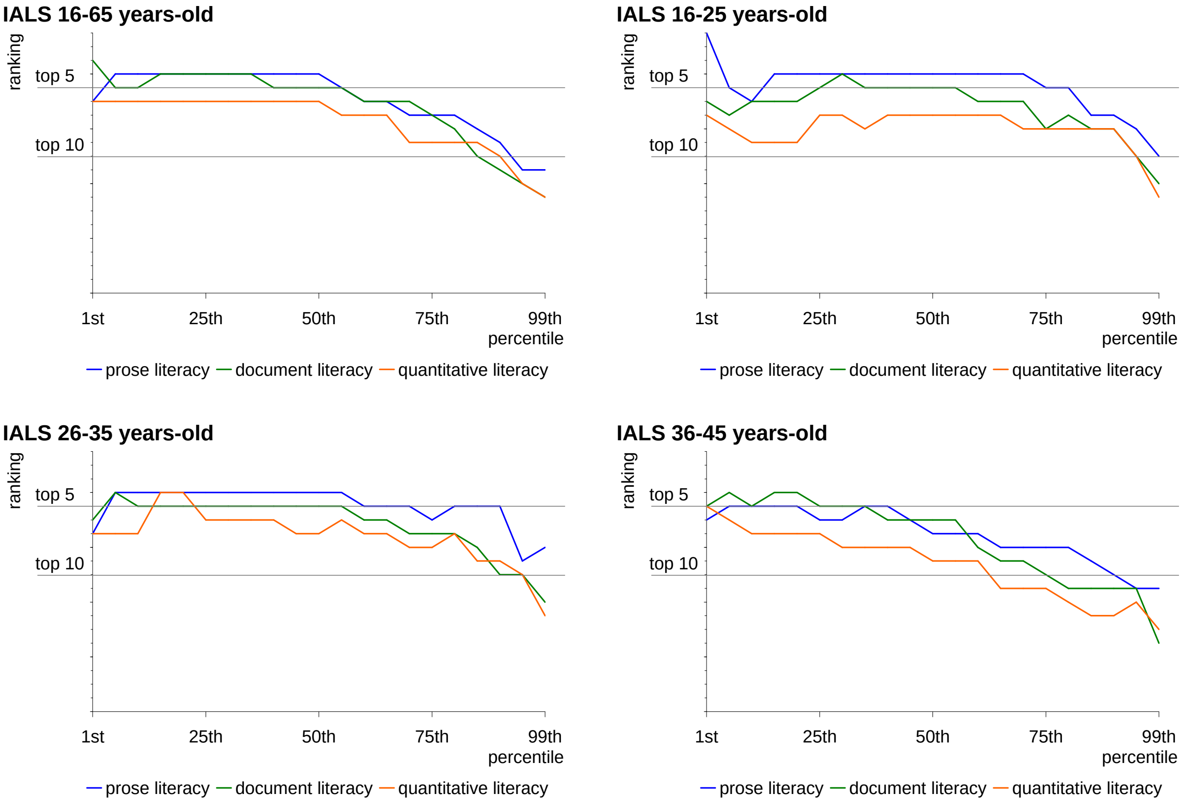
Skill distribution based on IALS 1994-1998

We compare the Dutch IALS 1994 scores with those of all 17 countries that participated in the IALS surveys between 1994 and 1998 (see also Table B.4). As IALS participants are aged between 16 and 65 years, the IALS allows us to consider several cohorts. We distinguish four age groups: 16-65 year-olds, 16-25 year-olds, 26-35 year-olds and 36-45 year-olds.[34] The Dutch position among the 17 IALS countries is shown in Figure 3.7.

[33] Note that certain countries are represented only by specific communities (in contrast to PISA). For example, the United Kingdom is represented by England and Scotland.

[34] Defining several cohorts reduces the number of observations. Findings should therefore be interpreted with care.

Figure 3.7 Dutch ranking on two literacy domains among 19 participants of IALS 1994-1998, by age cohort



Source: own calculations IALS 1994-1998

The IALS data confirm the declining pattern of Dutch skill levels over the percentiles as demonstrated by the PISA and TIMSS. The top-left graph in Figure 3.7 shows a declining lead of the Netherlands over the total IALS population aged 16-65 years. The Netherlands is not in the top-ten for the top skilled adults at the right-hand side of the distribution.

The measured skills are relatively stable for the several age cohorts, as the rankings differ slightly. The group aged 26-35 years performs in general better than the other two groups. The perfomance of the group aged 36-45 is lagging behind at the higher percentiles.

Conclusions

The findings based on TIMSS and IALS support the findings of PISA 2003. Neither survey has the Netherlands in the top at the right-hand side of the skill distribution. Similar to PISA, both TIMSS and IALS reveal a relatively stable and high skill level for the middle class students between the 25th and 75th percentile. In addition, the TIMSS reveals that the declining pattern in ranking over the percentiles is persistent over time. The IALS indicates that this pattern is persistent for several cohorts within the population.

3.4 The ‘top’ OECD countries at the 99th percentile

The Netherlands is thus not the best at the highest percentiles of the skill distribution – but which OECD members are? To answer this question we focus on the ranking at the 99th percentile for the four domains of PISA 2003. This ranking is based on deviations in test scores while taking into account participant characteristics.[35] In addition, we determine the average deviation in the 99th percentile value over the four literacy domains and derive a ranking from this average.[36] The ranking of the top-ten OECD members, based on this average deviation of percentile value, is shown in the second column of Table 3.1.

Table 3.1 Top-ten OECD members at the 99th percentile, PISA 2003

Ranking	Total[a]	Mathematical literacy	Reading literacy	Scientific literacy	Problem solving
1	New Zealand	New Zealand	New Zealand	Japan	Japan
2	Republic of Korea	Republic of Korea	Australia	Republic of Korea	Republic of Korea
3	Japan	Switzerland	Canada	New Zealand	New Zealand
4	Australia	Belgium	Norway	Switzerland	Finland
5	Switzerland	Australia	Republic of Korea	France	Belgium
6	Finland	Finland	Sweden	Australia	Switzerland
7	Belgium	Japan	Belgium	Finland	Australia
8	Canada	Netherlands	Finland	Czech Republic	Canada
9	United Kingdom	Czech Republic	United Kingdom	United Kingdom	France
10	Sweden	Canada	Switzerland	Sweden	United Kingdom
Netherlands	13	8	22	13	13

Source: Own calculations based on PISA 2003, taking into account participant characteristics.
[a] Ranking derived from the average deviation at each percentile value over the four literacy domains.

Australia, Finland, Japan, South Korea, New Zealand and Switzerland may be considered as the best at the top percentile of the OECD skill distribution. These countries have consistently high rankings, and are the top six at the 99th percentile. In contrast, the Netherlands takes place 13 in this ranking.

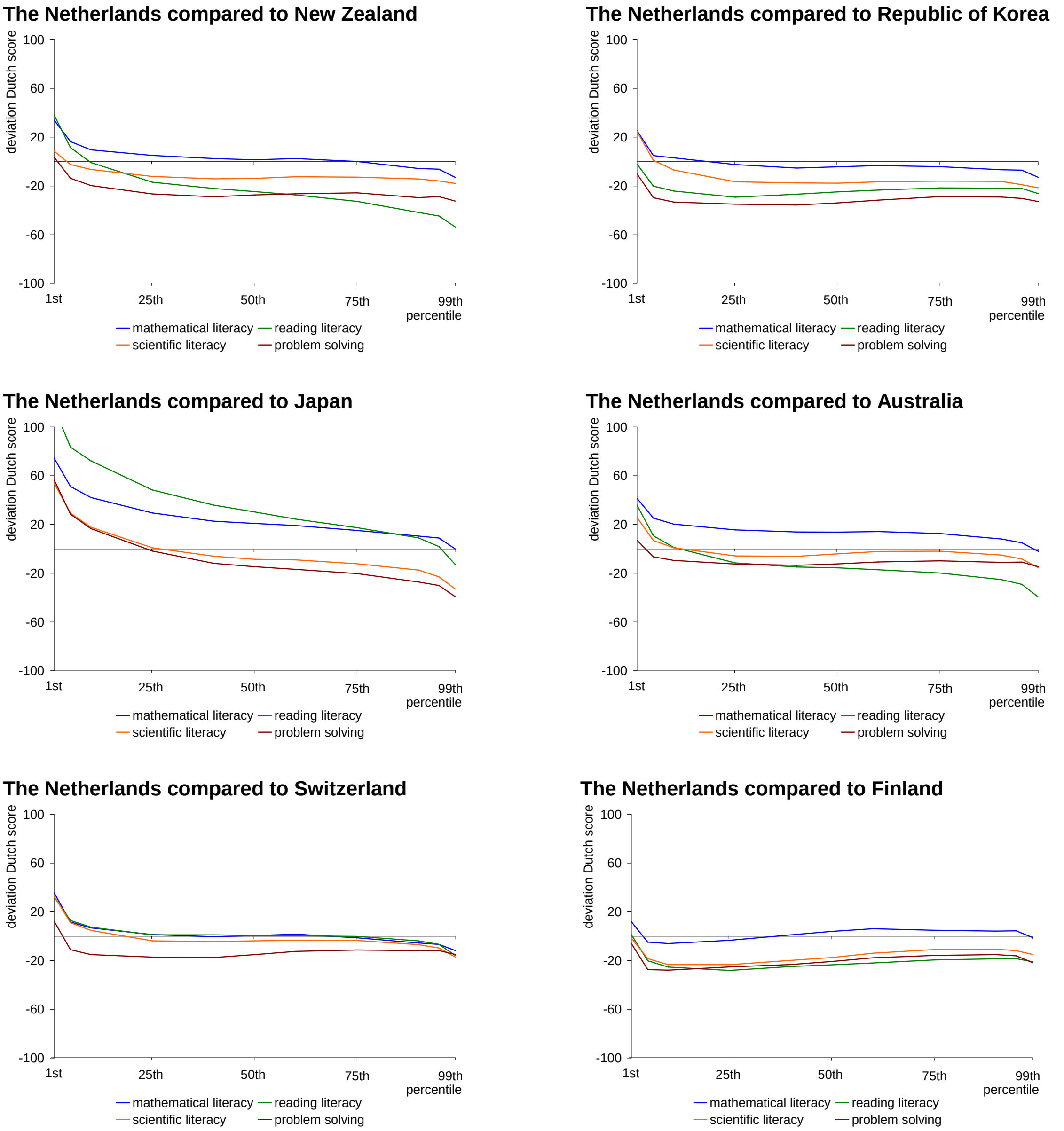
We plotted the deviations of the Dutch test scores from the test scores of the mentioned six ‘top’ countries in Figure 3.8. These deviations were obtained using quantile regressions including participant characteristics (see Appendix D). Table D.2 provides the deviations and the corresponding significance levels. The vertical axis indicates the deviation in test score similar to Figure 3.4).

The Netherlands is not that far behind the six ‘top’ countries – and even has a lead at several percentiles. The performance of Finland, the Republic of Korea and New Zealand is in general

[35] See Appendix A. This ranking may differ from the ranking presented in Figure 3.3.

[36] Determining an average of the four rankings yields similar results.

Figure 3.8 Deviation of Dutch scores on four literacy domains from six 'top' OECD countries performing the best at the 99th percentile, controlling for participant characteristics, PISA 2003



Source: Own calculations PISA 2003

significantly better at all percentiles. Still, the Netherlands continues to perform well at the first percentiles – especially compared to Australia and Japan. These two countries, however, outperform the Netherlands at the highest percentiles for several domains (the deviations being statistically significant). We take Finland as an example of a country with a better performance, and we discuss explanations for this success in the box on page 46.

Finland in more detail

The relative success of Finland on the literacy surveys has led to several studies on what might be behind this strong performance (see, for example, Välijärvi et al., 2002). We list below the most-often mentioned explanations.

- *Fit between PISA and curriculum.* The Finnish curriculum in mathematics and science emphasizes application of knowledge, problem solving and experimental thinking (Välijärvi et al., 2002, p.22). This fits very well with the PISA, which focuses on application of knowledge.
- *Special program to develop skills.* Välijärvi et al. (2002) believe that the national LUMA program has contributed to the high Finnish performance in mathematics and science. This program started in 1996, and aims to stimulate the mathematics and science skills of pupils.
- *Comprehensive school system.* Since the 1970s, Finland has a comprehensive school system, the so-called 'gymnasium'. Pupils have to choose a track only by age 16. The between-school variance in student performance in Finland (3,9%) is lowest of all OECD countries (on average 33.6%; OECD (2006b, Table A5.1)). The pattern is reversed with respect to within-school variance.
- *Quality of teachers.* In Finland, the societal status of the teacher is high (Välijärvi et al. (2002, p.42)). Teachers for secondary education are required to have an academic degree. The Finnish teachers also continue their training through further education.
- *Curricular and pedagogical autonomy.* Related to teacher quality is the relatively large autonomy of teachers and schools in setting the curriculum and in addressing pedagogical issues. Since the 1990s, the Finnish national core curriculum is flexible, decentralised and relatively less detailed (Välijärvi et al., 2002, p.43). [a]
- *Individual student support.* Students in Finland have the right (by school law) to receive support in special education and counselling (guidance in study skills, choice of subjects or programs and planning post-compulsory education). Furthermore, the highly qualified teachers are expected sto offer each individual student in his or her class optimal learning opportunities.
- *Cultural homogeneity.* The Finnish society is relatively homogenous, with only 1% of the population belonging to a minority. A heterogeneous population might give problems in education, leading to larger inequality in scores[b], a lower mean skill level, and possibly also a smaller top group.

[a] However, there are no national (exit) exams in Finnish secondary education. Teacher-based assessment is used instead.This contradicts the general observation by among others Woessman (2005) that autonomy in combination with central exit exams seem to lead to better educational performance.
[b] See e.g., Ammemueller (2004) on differences between Germany and Finland.

3.5 Conclusions

We have investigated the Dutch skill distribution by individual test scores of three international literacy surveys in order to ascertain what the skill levels of the Netherlands are compared to other rich countries. These surveys are PISA, TIMSS and IALS. Although differences exist in measurement objectives and participants, these surveys complement each other in their findings on the Dutch skill distribution.

The findings reveal that the Netherlands does not belong to the best-performing countries at the right-hand side of the skill distribution. In addition, the performance of the Netherlands at the left-hand side of the skill distribution is better than at the right-hand side when compared to other OECD countries. That is, there is a declining pattern in the ranking of the Netherlands along the percentiles. The Netherlands is among the best below the 5th percentile of the skill distribution. Between the 25th and 75th percentile the ranking is relatively stable in the top ten. After the 75th percentile the ranking declines more strongly. Above the 95th percentile the Netherlands drops out of the top ten.

Our findings on the Dutch skill distribution are robust for differences in populations of participating countries, tests and age groups. Moreover, indications are obtained that the Dutch performance is relatively stable over time. Our findings also hold for the subsample of Dutch first- and second-generation immigrant students.

The Netherlands performs well compared to neighbouring countries like Belgium, Germany and Denmark. The Scandinavian countries generally have lower skill levels than the Netherlands. An exception is Finland, which generally does better than the Netherlands.

When we focus on the top one percent individuals (99th percentile) within the OECD we see that the Netherlands is not among the ten best countries. The Netherlands has a moderate ranking of place 13 at the right-hand side of the skill distribution. The OECD top is formed by the Republic of Korea, Japan, Australia and New Zealand, which are closely followed by Switzerland and Finland.

4 A closer look at higher education

This chapter focuses on the higher educated individuals who occupy a large part of the right-hand side of the skill distribution. The level and growth of the Dutch tertiary attainment lies below several other rich countries, especially the Scandinavian countries. It should be noted, however, that international comparisons of attainment are difficult because of differences between national education systems. Furthermore, in the IALS 1994-1998 the highest scoring Dutch higher educated individuals performed less well than the highest scoring higher educated individuals in several other countries. In addition, the difference in skill level between graduates from secondary and higher education is lower in the Netherlands than its is in several other countries.

4.1 Introduction

The studies discussed in Chapter 2 indicate the possibility of external effects arising from higher education, and suggest that higher educated workers may be relatively important in countries close to the frontier. Chapter 3 showed that the Netherlands is not the best at the right-hand side of the skill distribution, compared to other countries. This chapter focuses on the right-hand side of the skill distribution of Figure 1.1. This consists mainly of higher educated individuals.

First, we present figures on the share of higher educated individuals in the population. We compare tertiary attainment in the Netherlands with attainment in other rich countries (Section 4.2). In addition, we compare the skill distribution of the Dutch higher educated compared to that of other countries (Section 4.3). Closely linked to this is the question to what extent the higher education system contributes to the growth of skills of its students. We therefore present also some tentative indications based on the difference in the average skill level between secondary and higher education.

4.2 Higher education attainment

How does the share of higher educated individuals in the Netherlands compare to that of other countries? This section examines tertiary attainment data.

Dutch tertiary attainment level relatively low

Table 4.1 shows the share of the population that has graduated from higher education for a sample of rich countries. Figures are shown for both the level and the change of higher education attainment for two age groups (25-34 years and 25-64 years). In 2004, 34 percent of the age group of 25-34 years in the Netherlands graduated from higher education, while this was 29 percent for the larger age group of 25-64 years. These Dutch shares are lower than those of most other countries in Table 4.1.

Table 4.1 Share of the population with tertiary education (ISCED 5 and 6) by age cohort, 1991-2004

	25-34 years		25-64 years	
	Change 1991-2004 (%-points)	Level 2004 (%)	Change 1991-2004 (%-points)	Level 2004 (%)
Europe and the United States				
United States	9	39	9	39
Sweden	15	42	9	35
Norway	12	39	7	32
Denmark	16	35	14	32
Belgium	14	41	10	30
The Netherlands	12	34	10	29
United Kingdom	13	31	9	26
Germany	2	23	3	25
France	18	38	9	24
'Top six' countries[a]				
Japan	.	52	.	37
Finland	5	38	9	34
Australia	13	36	9	31
South Korea	28	49	16	30
Switzerland	9	30	8	28
New Zealand	5	28	2	25

Source: OECD (2006a), Table A1.3a and OECD (2004a), Tables A3.4a and A3.4b. Countries are ranked according to the 2004 level of tertiary attainment for the population aged 25-64 years.

[a] These are the countries which score relatively high in the 99th percentile of the skill distribution; see section 3.4.

Differences in program structure complicate international comparison

However, differences in the program structure of the education system between countries complicate the interpretation of the relatively low performance of the Netherlands. An example of differences in educational systems is the distinction between parallel and sequential program structures. The Netherlands, Finland and Germany have a predominantly parallel system, with a formal distinction between two types of higher education at a comparable level: vocational (HBO, AMK and Fachhochschule) and academic (universities). In contrast, the United States and the United Kingdom have a sequential system in which students stack higher education degrees of rising levels. Countries with a sequential system tend to have more 'short' education programs, and more often count these programs as 'higher education' (at ISCED level 5 within the ISCED-1997 scheme as used by OECD; see Appendix E). Countries with parallel systems classify comparable programs in their own country as upper secondary or post-secondary non-tertiary education (ISCED 3 or 4). This is probably because the dividing line between the levels of higher education and lower education is more ambiguous in sequential systems. An illustration is the American vocational Associate Degree (AD), classified as ISCED 5 by the United States. It has been argued that this level of the AD is comparable to that of the Dutch MBO-4, which is classified as ISCED 4 by Statistics Netherlands (Bernelot Moens, 2005). Had the Dutch MBO-4 level been classified as higher education, this would have had a substantial impact on the Dutch participation rate: attainment in 2003 might have increased with 22 percentage points if MBO-4 had been included.[37]

Recent strong increase in share of higher educated in the Netherlands

The growth of the share of higher educated graduates is relatively low in the Netherlands. Between 1991 and 2004 the share of higher educated in the youngest age group in the Netherlands increased by 12 percentage points (Table 4.1).

Although the OECD figures suggest a relatively low tertiary attainment in 2004, the Dutch position seems to have improved substantially since 2002. In 2002, the share of Dutch tertiary attainment of the youngest age group was 28%, implying a growth of 6 percentage points between 1991 and 2002 (see also Antenbrink et al., 2005). The recent improvement can be attributed to an upward jump of the Dutch tertiary attainment level between 2003 and 2004.

As this remarkable increase might be caused by measurement errors, we compare the OECD figures with figures from the Dutch labour force survey (EBB). Figure 4.1 shows the development between 1996 and 2005 according to the EBB (compared with the OECD). The figures from the EBB show a more gradual increase, which corroborates the figures in Table 4.1 for 2004.[38]

Another explanation of the recent sharp increase in the share of higher educated might be enrolment. Figure 4.2 shows male and female enrolment (as a percentage of the male and female population of 18-24 years) in higher education since 1950. Both male and female enrolment have gradually increased since 1950. Male enrolment increased strongly between 1950 and 1979, from 9.5 to 34.7 percent. Since 1979, male enrolment grew somewhat, to 40 percent in 2004. For women, enrolment has grown more or less linearly since 1950. Men increased their advantage in enrolment during 1950 -1971. From 1971 on, women's enrolment rapidly caught up with that of the males, and in 1999 the women surpassed the males.[39] The overall picture of the change in male and female enrolment seems in line with the figures from the labour force survey, and further corroborates the findings in Table 4.1.

Conclusions

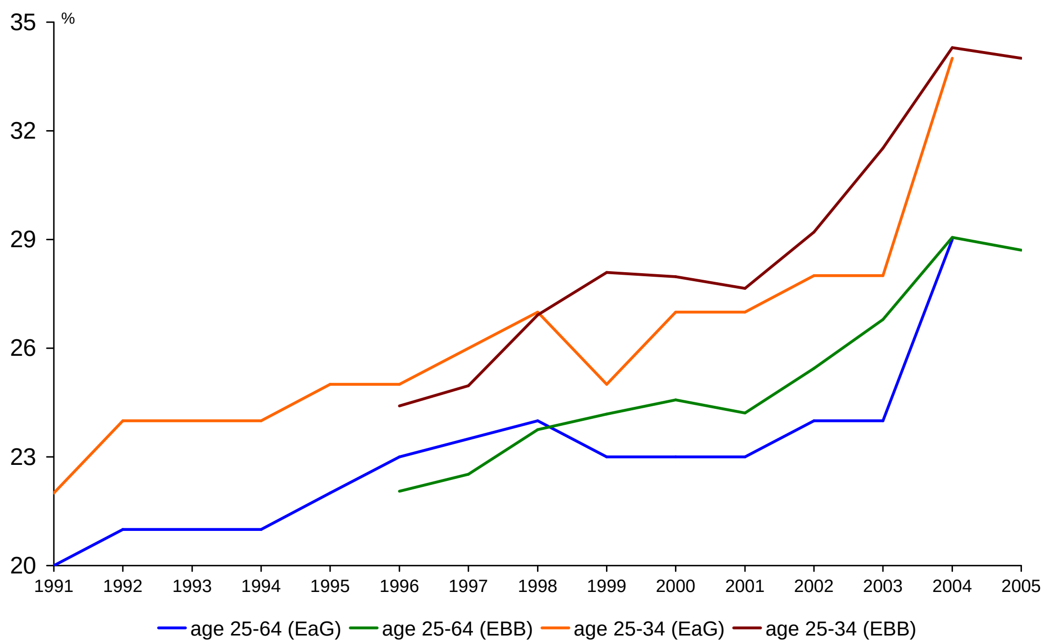
The share of the population that has attained higher education seems to indicate that the Netherlands does not belong to the best. In 2004, both the level and the growth of the share for

[37] Bernelot Moens (2005) shows that the percentage of the Dutch population in the age group 25-29 years that attained tertiary education equaled 33% in 2003. If people with a MBO-4 certificate are added, the share equals 55%. The difference is 22%.

[38] Takkenberg (2006) argues that the recent increase of the share of tertiary attainment for the 25-34 year-olds is probably related to the increase in the first-year student ratio during the period 1995-1999.

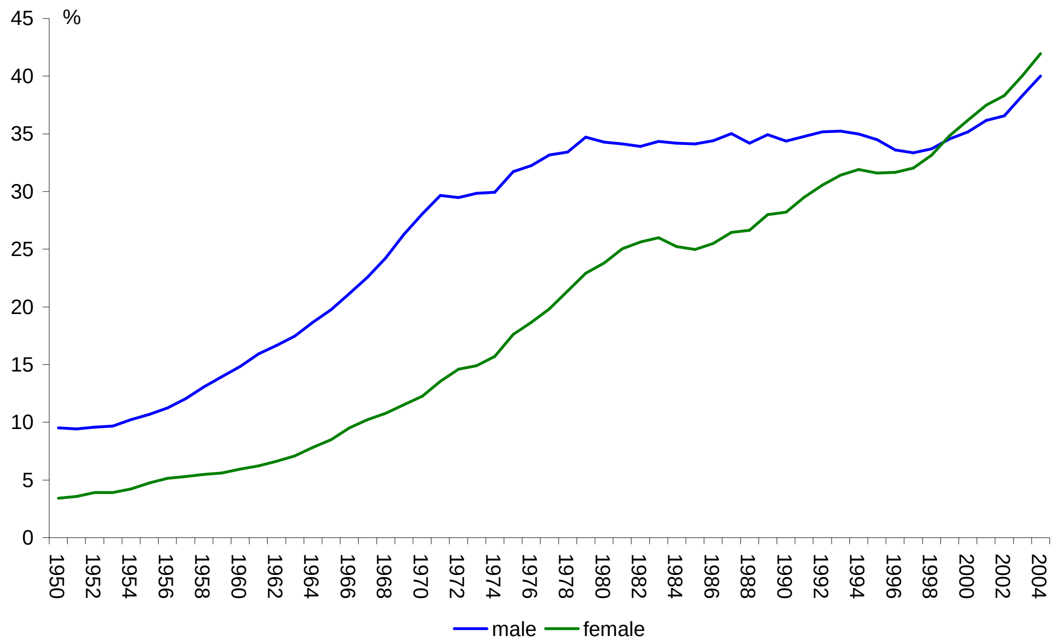
[39] This development is in line with the change in enrolment in the United States.

Figure 4.1 Dutch tertiary attainment level 1991-2005, OECD and EBB



Source: OECD, Education at a Glance (1995-2006), and Statistics Netherlands, Labour Force Survey (EBB) (from Statline 25-01-2007).

Figure 4.2 Dutch enrolment in higher education, males and females aged 18-24 years



Source: Statistics Netherlands, Historische Reeksen, download from www.cbs.nl, Thema's, Dossiers, Historische Reeksen, Onderwijs. Data: University students and HBO students, full time plus part time. Non-available data of university enrolment 1972 and 1973 are interpolated. Population 18-24 years: estimated as 2/20 * population 0-20 years + 4/25 * population 20-45 years. It is assumed that the share of men equals the share of women (50 percent).

the 25-34 year olds were lower than in several other rich countries. The Dutch position is above the OECD average, but lags behind some other countries.[40]

It should be noted that international comparisons are difficult because of differences between education systems. Several countries have short programs of higher education (one-year programs), whereas Dutch higher education consists of programs with a duration of at least four years.

4.3 Level and growth of skills of the higher educated

The previous section showed that the Dutch higher educated lag behind in quantity. But what is their skill performance compared to the higher educated in other countries? This section discusses two topics. The first is the Dutch skill distribution of the higher educated compared with the distributions of other countries. We present test scores in a similar way as in chapter 3. The second topic is the difference in skills between secondary and higher education. How does this Dutch skill difference compare to that of other countries?

The topics are analyzed with IALS data of 1994-1998, as more recent data are not available. Only IALS provides information on the level of education of surveyed participants, such as whether they completed schooling at some form of tertiary education (that is, ISCED levels 5 and higher). In the Netherlands, this relates to the system of higher education (HBO and university level).

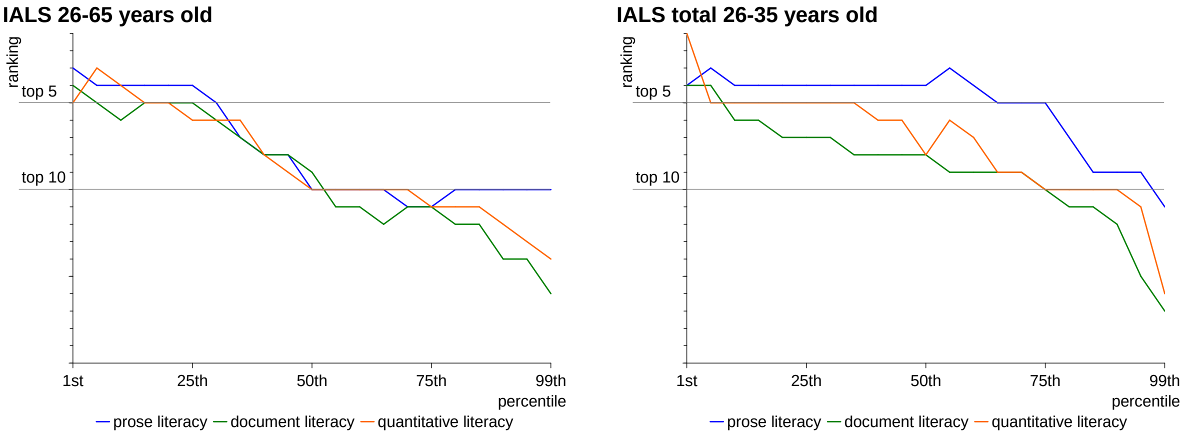
The skill distribution of the higher educated

The ranking among the 21 IALS countries of the Dutch higher educated aged 26-65 years is derived in a similar way as in chapter 3, and presented in the left-hand graph of Figure 4.3.[41] The right-hand graph shows the ranking for the youngest subgroup of the Dutch higher educated aged 26-35 years. The higher the Netherlands is on the vertical axis, the better its position (see also section 3.2.2). The selection of only the higher educated reduces the number of observations (see Table B.5 in Appendix B). Findings should therefore be interpreted with care.
The left-hand graph of Figure 4.3 indicates that the Netherlands does not belong to the best at the right-hand part of the skill distribution of the higher educated. In addition, the overall pattern

[40] The Netherlands scores better in another indicator, namely the 'Human Resources in Science and Technology Core'. This is the ratio of all people with a higher education certificate with a job that requires that level of education, and the labour force. The Netherlands ranks 5th in 2004 – after Denmark, Finland, Sweden and Belgium among 15 countries, and is far above the EU-15 average (Statistics Netherlands, 2006a, section 3.3). We do not elaborate on this measure, as it is distorted by international differences in the functioning of the labour markets, which is outside the scope of this paper.

[41] We determine the skill distribution of those participants in IALS that were either born in the country of survey, or immigrated to it. We selected only those immigrants with at most a completed schooling at ISCED level 3 in the country of origin. That is, these immigrants did not follow schooling at higher levels in the country of origin. This ensures that the skill distribution of the higher educated of a country is based on participants that have completed a tertiary education program in that specific country.

Figure 4.3 Dutch ranking of the higher educated among 21 participants of IALS 1994-1998 in three literacy domains, by age cohort



Source: Own calculations based on IALS 1994-1998

is similar to the findings based on PISA, TIMSS and IALS for the entire population. We see that the ranking of the Netherlands falls along the percentiles. The Dutch performances in Figure 4.3 could be an overestimation. The graphs exclude people with a MBO-4 certificate, who probably have in general lower test scores. Inclusion of MBO-4 could lower the Dutch performance.[42]

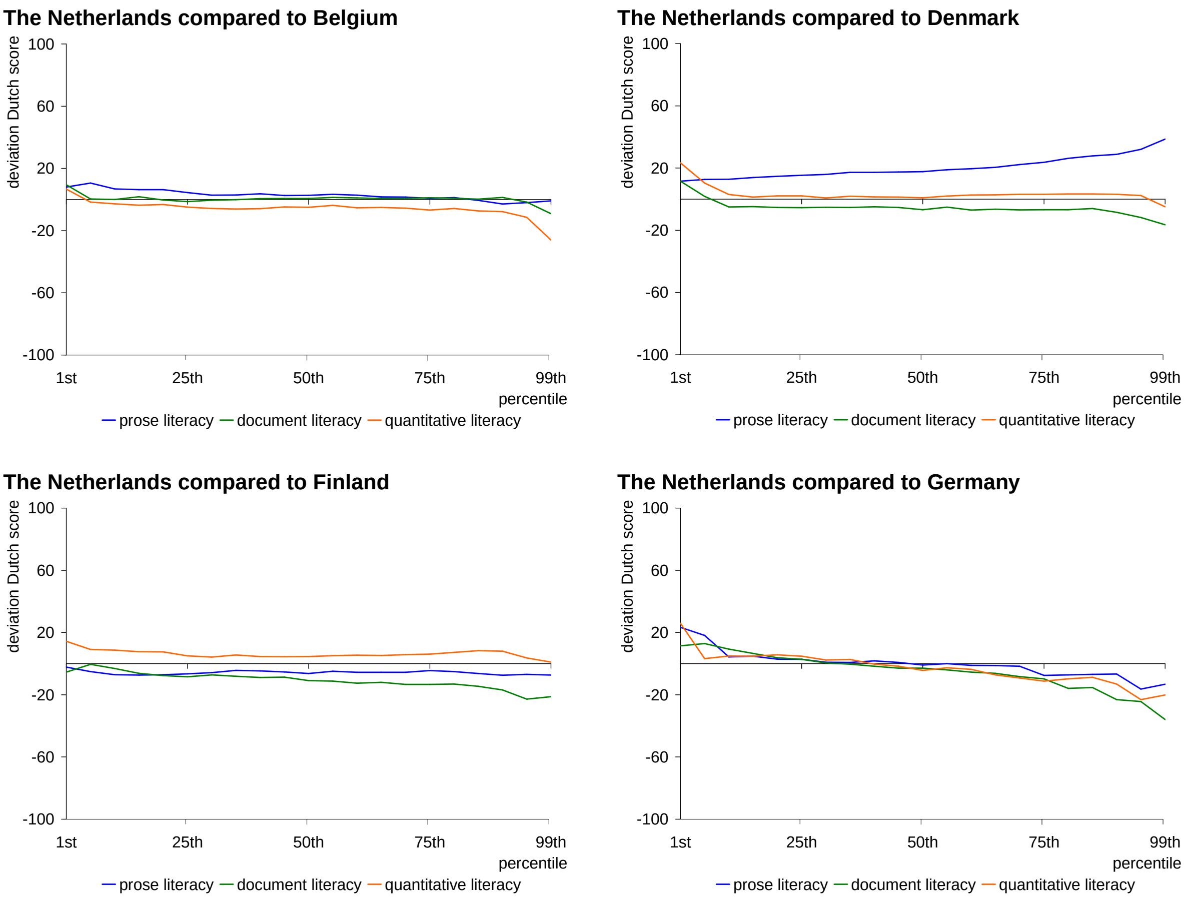
Comparison of the two graphs in Figure 4.3 reveals that the ranking differs in the middle part of the distribution for the two cohorts considered. The ranking of the youngest age group (26-35 years) is higher between the 25th and 75th percentile, which is positive for the Netherlands. At the lower and higher precentiles we see that in both graphs the ranking is similar.

A country-by-country comparison in Figures 4.4 and 4.5 for the youngest age group of 26-35 years shows that several countries clearly outperform the Netherlands at the top of the skill distribution. Especially Sweden performs significantly better at the top-ten percent of the skill distribution. The United States have a lead over the Netherlands at the higher percentiles as well, which is however not significant (see Table F.2). Compared to Belgium and Finland the deviation in test scores is smaller, but still demonstrates a declining pattern.

The skill levels of the higher educated of the United States and Sweden are intriguing when compared to the skill levels of these countries in Chapter 3. The Dutch skill levels in Chapter 3 are higher than those of Sweden and the United States. This difference in skill level may relate to the difference in population of the several literacy surveys. PISA is conducted among teenagers that have not completed any form of higher education. Subsequently, this may indicate that the contribution of the higher education system of Sweden and the United States is greater than that of the Netherlands. We investigate the contribution of the higher education system in

[42] MBO-4 students cannot be identified based on the IALS data. We were thus not able to derive the skill distribution of the higher educated including these MBO-4 students.

Figure 4.4 Deviation of Dutch scores of the higher educated from four European countries in three literacy domains, IALS 1994-1998, age group 26-35 years



Source: Own calculations based on IALS

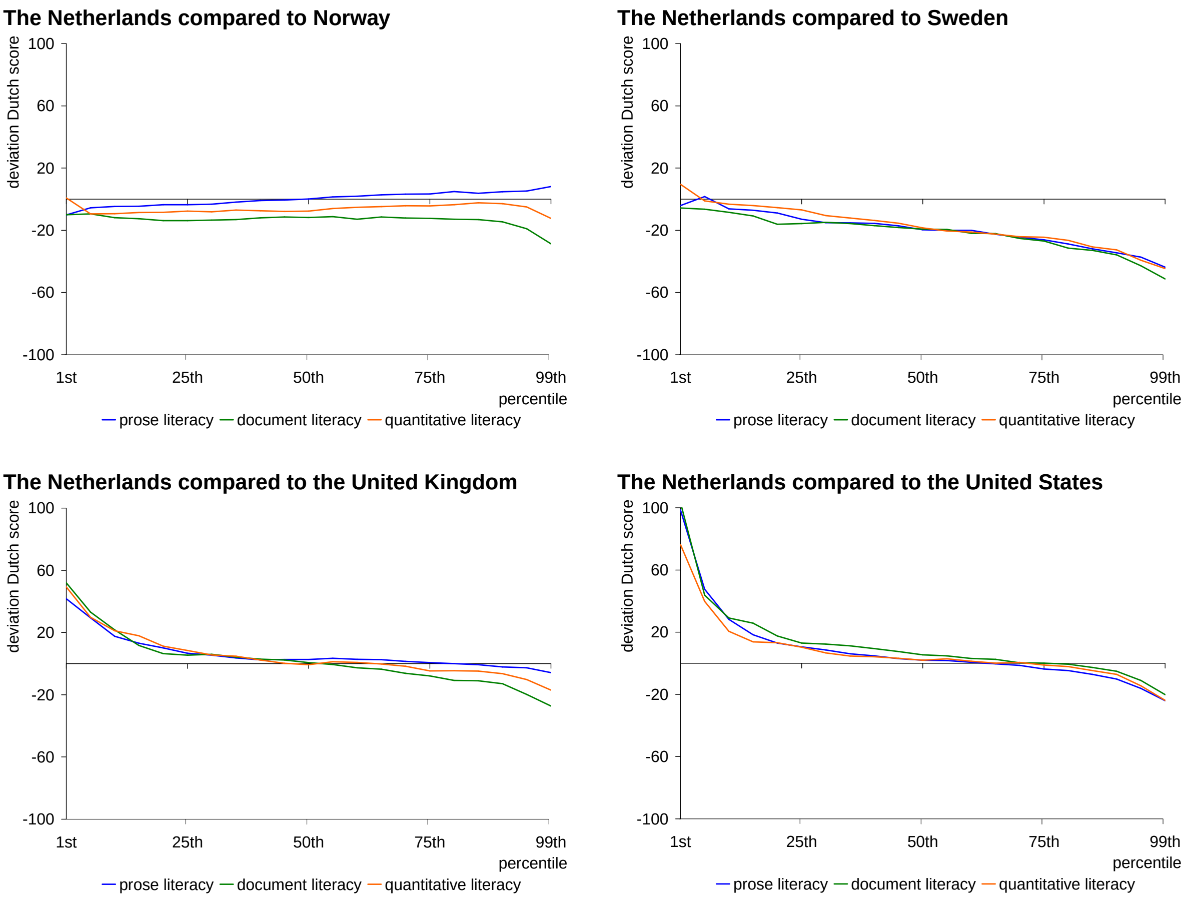
the following section.

Differences in average skill levels between secondary and tertiary education

The IALS data enable us to derive an approximation of the skill increase during higher education. The findings on the skill distribution of the higher educated, presented above, indicate that the contribution of the Dutch tertiary education program may differ from that of other countries. This skill increase is defined as the difference in average skill levels of people with a secondary education certificate and those with a higher education certificate. It should be noted that this definition excludes the increase of skills of people with a secondary education certificate, who drop out higher education.

Several limitations apply for our comparison. First, the comparison of the skill levels of graduates from secondary and higher education may be biased, as the comparison is not based

Figure 4.5 Deviation of Dutch scores of the higher educated from three European countries and the United States in three literacy domains, IALS 1994-1998, age group 26-35 years



Source: Own calculations based on IALS 1994-1998

on data of the same individuals at different points in time.[43] In addition, the IALS data are collected in the mid 1990s. Finally, we can only compare the differences in average values and not the differences, for example, at the top of the distribution. The comparison can thus only be seen as an approximation of the contribution of higher education to the average skill levels.

Table 4.2 shows the difference in skill levels between graduates from secondary and higher education for several countries for the 'quantitative' literacy domain.[44] This skill difference (in the 4th column) is based on the difference in average test scores for secundary and higher education, which are presented in the 2th and 3th columns. The 5th column shows the deviation

[43] To measure the value added of higher education, we would need information on the skill level of graduates of higher education at the time they graduated from secondary education. Even with this information available, however, there might also be other factors influencing the growth of skills of individuals. Our data contain information for those who graduated from secondary education and did not attain a higher level of education. It may be expected that the skill level of the latter group will differ from the skill level of graduates of higher education at the time they graduated from secondary education.

[44] This literacy domain of IALS is similar to the mathematical and problem-solving literacy domain of PISA.

of the Netherlands with the other countries with regard to the skill difference between secondary and higher education. We derived this deviation from a difference-in-difference estimation, which is presented in Appendix G. This is a formal method to statistically test the difference of the Netherlands with other countries based on the values of the 4th column.[45] In addition, Appendix G presents the findings for the document and prose literacy domains of IALS in Tables G.1 and G.2.

Table 4.2 Difference in Dutch average scores secondary and tertiary education, compared to other countries for the quantitative literacy domain (persons $\leq$ 35 years old), IALS 1994-1998

Country	Average education level[a] Secondary education (1)	Higher education (2)	Difference (2)− (1)	Difference-in-difference[b] comparison with the Netherlands
The Netherlands	306	323	17	
Belgium	298	331	33	− 18***
Denmark	311	323	12	6***
Germany	309	329	21	− 4
Finland	303	319	17	0
Norway	296	331	35	− 20***
New Zealand	287	303	16	1
Sweden	310	340	29	− 13***
United Kingdom	284	314	30	− 14***
United States	267	311	44	− 30***
'IALS' [c]	281	311	30	− 17***

Source: Own calculations based on IALS.
[a] Secondary education equals ISCED level 3, higher education equals ISCED levels 5 and 6.
[b] Difference-in-difference estimate obtained with the following control measures: gender, age, age squared, born in a foreign country (see Appendix G).
[c] Reference group including: Belgium, Switzerland, Chile, Czech Republic, Germany, Denmark, Finland, Hungary, Ireland, Italy, Norway, New Zealand, Poland, Slovenia, Sweden, United Kingdom, United States.

The difference in average skill levels in the three domains between graduates from secondary and higher education in the Netherlands is in general smaller than the differences in the other countries. The estimates in Table 4.2, Tables G.1 and G.2, show this remarkable result. Nearly all deviations of the Netherlands from the other countries are negative and statistically significant. Thus it seems that the Netherlands starts at a high skill level for secondary education (column 'secondary education'), and converges to an average skill level for higher education (column 'higher education').

The high average skill level of Dutch graduates of secondary education may explain the moderate increase in skill level in higher education. Dutch graduates from secondary education

[45] Small differences may occur between the direct calculation based on the 4th column and the difference-in-difference method. For example, based on column 4, the difference with Belgium is $33 - 17 = 16$, which differs slightly from the value of 18 obtained with the difference-in-difference method.

have on average higher skill levels than comparable graduates in other countries. However, we observe that although graduates from secondary education in Sweden score higher, the difference in skill levels with graduates from higher education in Sweden is higher. In addition, we observe that Norway and Belgium, while lagging behind with skill levels of graduates from secondary education, have higher skill levels for graduates of higher education than the Netherlands does. They surpass the Dutch skill level of higher education.

Conclusions

Compared to the situation in several other countries, higher educated individuals in the Netherlands do not belong to the best at the right-hand side of the skill distribution of the higher educated. The pattern is similar to the skill distributions based on the PISA, TIMSS and IALS for the entire population. The ranking of the Netherlands falls along the percentiles.

The contribution of Dutch higher education to the growth of skill between secondary and higher education seems to be lower than that in other comparable countries. This is derived from a comparison of average skill levels of graduates from secondary and higher education. It should be noted that these findings are based on average test scores, and that the tests were taken in the 1990s. In addition, the comparisons between education types and age levels do not take place at the individual level.

4.4 Conclusions

The findings on higher education suggest that several countries achieve a higher rate of tertiary attainment and have higher skills at the right-hand side of the skill distribution of the higher educated. In addition, the difference in skill level between graduates from secondary and higher education is larger in several countries than in the Netherlands.

The analysis shows that the level and growth of the Dutch tertiary attainment in 2004 lies below several other rich countries, especially the Scandinavian countries. A complication is that international comparisons of attainment are difficult because of differences between education systems. Several countries have short programs of higher education (one-year programs), whereas Dutch higher education consists of programs with a duration of at least four years.

Compared to several other countries, Dutch higher educated individuals do not belong to the best at the right-hand side of the skill distribution of the higher educated in the IALS. The pattern is similar to those based on the PISA, TIMSS for the 13- and 15-year-olds, and IALS for the age group of 16-65 years. The ranking of the Netherlands falls along the percentiles. A second finding is that the contribution of Dutch higher education to the skill increase between secondary and higher education seems to be lower than in other comparable countries. This is derived from the difference in average skill levels of graduates from secondary and higher education.

It should be noted that the IALS data are collected in 1994-1998 and observations are limited for the higher educated (new comparable data are being collected in 2007). Furthermore, the analysis of skill development in higher education is based on average test scores. In addition, the comparisons between education types and age levels do not take place at the individual level. Finally, the findings are restricted to the skills that are measured.

5 Research agenda

5.1 Summary of findings

This study focuses on the importance of the distribution of skills for productivity, and compares the Dutch skill distribution with the skill distributions of other countries. Most previous studies have focused on the *average* skill level. But there are indications in the recent literature that higher levels of skill might be important for productivity through innovation and R&D-activity. These activities might also increase the productivity of other workers (spillover effects) as it is typically difficult to appropriate all the benefits of new ideas. The main findings of this study are as follows:

- The right-hand side of the skill distribution is important for productivity, particularly in countries with a high level of productivity. Several recent studies indicate that the social returns of higher education exceed the private returns.
- On average, the Dutch skill level, indicated by international test scores, is high.
- At the left-hand side of the skill distribution, the Netherlands ranks as one of the best countries of the world and belongs generally to the top five. Dutch immigrant students outperform immigrant students of a selection of OECD countries at this part of the skill distribution.
- The Dutch position (considering all students) declines when moving to the right-hand side of the skill distribution. This decline is robust for several skill tests and age groups.
- From the 75^{th} percentile of the distribution of test scores (the best quarter of the population) the ranking of the Netherlands shows a stronger decline, and for several tests the Netherlands drops out of the top ten of the world.
- The Dutch position further declines when moving to the 95^{th} and 99^{th} percentiles. At these highest levels of the skill distribution, the Netherlands ranks for nearly all tests below the top ten, or lower.
- The Dutch score in secondary education (of students aged 13-15 years) is very good at the lowest levels, good on average and reasonable at a high level. At the highest level (the top one percent students) the Netherlands ranks 13 of 30 OECD countries.
- The Netherlands does not belong to the top ten of OECD countries with the highest shares of graduates from higher education. In Europe, the Scandinavian countries and Belgium have a higher share of graduates from higher education.
- The skills of the Dutch higher educated individuals (measured in 1994) show the same pattern as the skills measured during secondary education.
- The difference in skills between graduates from secondary and graduates from higher education is smaller in the Netherlands than in other countries. This is also true for several countries with a higher average skill level in secondary education. This might indicate that the contribution of

higher education to the skill increase between secondary and higher education is lower in the Netherlands.

- The Dutch position in international rankings is quite stable over time. The performance of Finland seems to be improving.

These findings suggest that especially on the right-hand side of the Dutch skill distribution there is scope for improvement. Several recent economic studies suggest that such an improvement might be important for the growth of productivity.

5.2 Questions for a research agenda

The findings from this study suggest that an improvement of Dutch skills at the high and top levels is important for the growth of productivity. Hence, policies that succeed in lifting the right-hand side of the skill distribution might generate significant benefits. However, these benefits should be weighted against the costs of these policies. In addition, several questions remain regarding the robustness of the evidence and the effectiveness of various policy options. Answers to these questions are important when it comes down to introducing effective policies.

Robustness of the evidence

An obvious question is to what extent the indications of a strong impact of high and top skills on productivity are robust. The evidence rests on several papers based on data in the USA. The evidence on top skills, moreover, is scarce. A second question is whether the results are robust for new data. This is particularly the case for the results for graduates from higher education, as we used data from 1994. It certainly is promising to test the facts on the Netherlands on new data, such as PISA 2006, TIMMS 2007 and Adult Literacy and Lifeskills 2007 (ALL, the successor of IALS).

How can Dutch performance improve at higher skill levels?

We can start by questioning why the Dutch relative performance declines if the skill level rises, and how Dutch performance can be improved at higher skill levels. The decline is observed in several tests taken during secondary education. Is this decline related to the organisation and incentive structure of Dutch primary and secondary education? For instance, what is the impact of the sorting of students when they leave primary education? Which instruments can be effective to generate top level skills? Recently, several special programs for excellent students have been introduced at different levels of Dutch education. How effective are these programs for generating excellent skills?

The relative decline of Dutch skills is also observed for 26-35 year-olds with a higher education certificate. In addition, the contribution of Dutch higher education to the increase in skills seems lower than in other countries. Which instruments can be effective to generate top level skills in higher education? For instance, what is the impact of selection of students, flexibility in college fees or the entry of private suppliers in higher education. What is the role of the current structure of funding of higher education? Can an increase of public or private funding generate more top level skills?

How to increase the Dutch share of graduates from higher education?

The second avenue of inquiry is why the Netherlands does not belong to the top in participation in higher education. The two main channels for increasing the share of graduates from higher education in the population are increasing enrolment in higher education and reducing drop out from higher education. Given the goal of increasing the share of graduates from higher education in the population, which channel would be the most promising for targeting policy instruments: reducing dropout or increasing enrolment? The option to reduce dropout in higher education seems to be the most promising. First, there is a large potential of students, since 18 percent of each cohort drops out after enrolling in higher education (see Appendix H). Second, dropouts are expected to have the ability to graduate from higher education because they succeeded for the exams of types of education that gives access to higher education. The second option (increasing enrolment) is less straightforward. First, increasing enrolment in higher education means attracting pupils who currently do not enrol in higher education. We may expect that, on average, their ability will be lower than the ability of those who currently enrol. Hence, we may expect higher costs of teaching this group to raise them to the level of higher education. In addition, increasing enrolment is less direct because the targeted group can still drop out on their way to or during higher education. The next question is which policy instruments would be the most effective to increase participation in higher education. It should be noted that policy options that increase the skill produced in secondary education could have an impact on both enrolment in higher education and reducing drop out in higher education.

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Appendix A Dutch ranking on average scores, 1964-2003

No evidence of deterioration in Dutch ranking on average scores since 1964

Chapter 3 asserts that there are no indications of a significant deterioration in the long-run trends of Dutch average performance. This appendix clarifies this proposition. The proposition is based on test scores in mathematics and science. Pupils in a large number of countries have been surveyed since 1964 through various international tests on their skills. The back of this appendix provides more information on these tests and background data. Below, we summarize some of these data.

Table A.1 is derived from Table A.2. Column (1) in Table A.1 shows the year in which tests were carried out. Column (2) lists the number of participating countries in a selected group of 20 countries that participated at least once in the surveys before 1995: Australia, Belgium, Canada, Finland, France, Germany, Hong Kong, Hungary, Israel, Italy, Japan, Republic of Korea, Netherlands, New Zealand, Norway, Poland, Singapore, Sweden, UK and US. The number of countries varies across the surveys, as not every country participated in each survey. Column (3) presents the rank number of the Netherlands, where countries are ranked from high to low average test scores. A low rank number indicates thus a strong Dutch average performance. Column (4) gives the ratio of columns (3) to (2) in order to adjust for the variation in number of selected countries. There are two observations in 2003:TIMSS and PISA. PISA is added because it is the backbone of Chapter 3.

The table indicates that the average test scores of Dutch pupils rank in the upper half within the group of 20 countries, as most ratios are lower than 50 (column 4). Moreover, there is no clear trend in column (4) for either mathematics or science. The mathematics ranking of the thirteen-year-old Dutch pupils in 1964 and the science ranking of the fourteen-year-olds in 1970 are exceptions. However, these latter two surveys are probably unreliable. The seventeen-year-olds namely performed much better in the same years – and their ratios fit better with the subsequent surveys.

Table A.1 is derived from Table A.2. Table A.3 provides similar information regarding the ranking of the Netherlands in the total number of countries that participated. The table reveals that the number of countries which participated rose to more than 40 – among them emerging and developing countries. Comparison between the rank numbers of the Netherlands in column (6) of both Table A.2 and A.3 shows that the rank number of the Netherlands is hardly affected. These observations lead to the conclusion that there is no evidence of a significant deterioration in the long-run trends of Dutch average performance.

Background data on all tests

Table A.2 provides full information on the rank numbers of the Netherlands in all literacy tests carried out for 20 selected countries. Table A.3 provides similar information for all countries

Table A.1 Dutch ranking on average scores among twenty selected countries, 1964-2003

	Number of countries (2)	Rank number Netherlands (3)	Ratio rank number to number of countries (%) (4) =(3)/(2)×100
Mathematics			
1964 (age 13)	11	7	65
1964 (age 17)	10	5	50
1981	14	2	15
1995	17	6	35
1999	15	6	40
2003 (TIMSS)	15	6	40
2003 (PISA)	18	4	20
Science			
1970 (age 14)	12	12	100
1970 (age 17)	12	4	35
1983	15	3	20
1995	17	4	25
1999	15	5	35
2003 (TIMSS)	15	7	45
2003 (PISA)	18	6	35

Source: Table A.2.

that participated in a test. The first column presents the years in which a literacy test was held. Column (2) shows the name of the survey. The surveys before 1995 are forerunners of TIMSS, so the tests are more or less comparable with the TIMSS. Column (3) mentions the subject. It shows that beside tests in mathematics and science, surveys were also carried out in reading, prose, documentation and problem solving. Column (4) gives the age of the pupils in the tests. Column (5) shows the number of participating countries. Table A.2 provides the number of selected countries, and Table A.3 the number of all countries that participated. The number of countries varies across the surveys, as not every country participated in each survey. Columns (6-10) give the rank numbers of the Netherlands at the average score and at four percentiles. Countries are ranked from high- to low test scores.

Table A.2 Dutch ranking on average scores and percentiles values among twenty selected countries, 1964-2003[a]

Year	Survey	Subject	Age	No. of countries	Ranking at mean	Ranking at percentile 5th	25th	75th	95th
1964	FIMS	Math	13	11	7	.	.	.	.
1964	FIMS	Math	17 (math students)	11	5	.	.	.	.
1964	FIMS	Math	17 (non-math stud)	9	4	.	.	.	.
1980-82	SIMS	Math	13	14	2	.	.	.	.
1995	TIMSS	Math	13	17	6	7	7	6	8
1999	TIMSS	Math	13	15	6	6	6	6	7
2000	PISA	Math	15	19	1	1	1	1	2
2003	TIMSS	Math	13	15	6	5	6	6	6
2003	PISA	Math	15	18	4	4	5	3	5
1994-98	IALS	Quantitative	16-65	13	4	4	4	7	10
1970-71	FISS	Science	14	12	12	.	.	.	.
1970-71	FISS	Science	17	12	4	.	.	.	.
1983-84	SISS	Science	14	15	3	.	.	.	.
1995	TIMSS	Science	13	17	4	3	3	5	8
1999	TIMSS	Science	13	15	5	3	3	7	8
2000	PISA	Science	15	19	6	8	7	4	4
2003	TIMSS	Science	13	15	7	3	5	9	11
2003	PISA	Science	15	18	6	4	7	5	7
2000	PISA	Reading	15	19	3	3	4	5	7
2003	PISA	Reading	15	18	7	4	6	8	13
1994-98	IALS	Prose	16-65	13	4	3	4	8	11
1994-98	IALS	Document	16-65	13	4	4	3	5	10
2003	PISA	Probl.Solv.	15	18	9	5	9	9	9

Sources:
- FIMS, SIMS, FISS, SISS: Medrich and Griffith (1992).
- TIMSS: Harmon et al. (1997), Mullis et al. (2000), Martin et al. (2000b), Mullis et al. (2004a), Mullis et al. (2004b).
- PISA: OECD/UNESCO (2003), OECD (2004b), OECD (2005c).
- IALS: OECD (2000a).

[a] These twenty countries are Australia, Belgium, Canada, Finland, France, Germany, Hong Kong, Hungary, Israel, Italy, Japan, Republic of Korea, Netherlands, New Zealand, Norway, Poland, Singapore, Sweden, UK and US.

Table A.3 Dutch ranking on average scores and percentiles values, 1964-2003

Year	Survey	Subject	Age	No. of countries	Ranking at mean	Ranking at percentile 5th	25th	75th	95th
1964	FIMS	Math	13	11	7	.	.	.	.
1964	FIMS	Math	17 (math students)	11	5	.	.	.	.
1964	FIMS	Math	17 (non-math stud)	9	4	.	.	.	.
1980-82	SIMS	Math	13	17	2	.	.	.	.
1995	TIMSS	Math	13	39	9	11	10	11	13
1999	TIMSS	Math	13	38	7	6	7	7	11
2000	PISA	Math	15	42	1	1	1	1	2
2003	TIMSS	Math	13	45	7	5	7	7	8
2003	PISA	Math	15	41	4	4	5	4	7
1994-98	IALS	Quantitative	16-65	20	6	5	6	9	13
1970-71	FISS	Science	14	12	12	.	.	.	.
1970-71	FISS	Science	17	12	4	.	.	.	.
1983-84	SISS	Science	14	17	3	.	.	.	.
1995	TIMSS	Science	13	39	6	5	4	9	12
1999	TIMSS	Science	13	38	6	4	4	8	13
2000	PISA	Science	15	42	6	9	7	4	4
2003	TIMSS	Science	13	45	9	5	7	11	16
2003	PISA	Science	15	41	8	5	9	5	10
2000	PISA	Reading	15	42	3	3	4	5	8
2003	PISA	Reading	15	41	9	5	9	10	16
1994-98	IALS	Prose	16-65	20	4	4	4	8	12
1994-98	IALS	Document	16-65	20	5	5	4	6	12
2003	PISA	Probl.Solv.	15	41	12	6	13	11	12

Sources:
- FIMS, SIMS, FISS, SISS: Medrich and Griffith (1992).
- TIMSS: Harmon et al. (1997), Mullis et al. (2000), Martin et al. (2000b), Mullis et al. (2004a), Mullis et al. (2004b).
- PISA: OECD/UNESCO (2003), OECD (2004b), OECD (2005c).
- IALS: OECD (2000a).

Appendix B International literacy surveys: PISA, TIMSS and IALS

In our analysis, we use the data from three literacy surveys. In Section 3.2.1 we briefly introduced the PISA, TIMSS and IALS. We eleborate on each survey below.

PISA

The ‘Programme for International Student Assessment’ (PISA) of the OECD is a comprehensive program to assess the knowledge and skills of 15-year-old students on three literacy domains: mathematical literacy, reading literacy and scientific literacy (OECD, 2005a).

PISA aims to assess the capabilities of students in applying acquired knowledge and skills: how well equipped are students to tackle challenges in the future (OECD, 2005a). An example is preparedness to participate on the labour market. Consequently, PISA does not focus on how well a student has mastered a certain school curriculum.

Data are available for the first and second PISA rounds in 2000 and 2003.[46] The selection of students is an important issue, and is therefore carefully monitored by PISA. The Dutch student sample in PISA 2003 is a representative sample of all types of secondary education.[47] Because of sample issues, the PISA consortium recommended excluding the data for the Netherlands in the analyses concerning PISA 2000 (see OECD, 2000b, pp.187–188). Consequently, we refrain from an analysis using the PISA 2000 data.

PISA consists mainly of three literacy domains: mathematical literacy, reading literacy and scientific literacy. Each round of PISA has one major domain that covers 70 percent of the testing time and two minor domains. For example, in 2003 this major domain was mathematical literacy. Other domains are occasionally included as well. For example, problem solving was included as an assessment domain in PISA 2003.

The design and development of the PISA 2003 survey involved an international multi-step process. After the assessment frameworks were developed, participating countries could submit survey items. Subsequently, items were selected and refined at several development centers. Items that were selected by an international panel were pre-tested in Austria, Australia, Japan and the Netherlands. This was followed by national and international reviews and the subsequent selection of items for field trials. A study of the field trials and the national review reports (together with other information) resulted in the final list of survey items (see also OECD, 2005b, chapter 2).

The Dutch student sample in PISA is a representative sample of all types of secundairy

[46] The results of PISA 2006 were not available yet at the moment of the writing of this report.

[47] Types of secondary education included in the Dutch sample: ‘PRO’, ‘VMBO’, ‘HAVO’ and ‘VWO’ (CITO, 2004). See also Appendix E for their ISCED classification.

education.[48] The selection of students is an important issue and therefore carefully monitored by PISA. The PISA consortium recommended concerning PISA 2000, to exclude the data for the Netherlands in analyses (see OECD, 2000b, pages 187-188). Consequently, we refrain from an analysis using the PISA 2000 data. Table B.1 summarizes the assessment of the PISA 2003 data. We refer to OECD (2001) and OECD (2004b) for an extensive discussion on PISA 2000 and PISA 2003 respectively.

Table B.1 Charecteristics PISA 2003[a]

Participants	
OECD members	Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Republic of Korea, Slovak Republic, Spain, Sweden, Switzerland, Turkey, United Kingdom[b], United States.
OECD partners	Albania, Argentina, Brazil, Bulgaria, Chile, Hong Kong-China, Indonesia, Israel, Latvia, Liechtenstein, Macao-China, Macedonia, Peru, Romania, Russian Federation, Thailand, Tunisia, Uruguay, Serbia
Definition of literacy domains	
Mathematical	“An individual’s capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual’s life as a constructive, concerned and reflective citizen.”
Reading	“An individual’s capacity to understand, use and reflect on written texts, in order to achieve one’s goals, to develop one’s knowledge and potential and to participate in society.”
Scientific	“The capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity.”
Problem-solving	“An individual’s capacity to use cognitive processes to confront and resolve real, cross-disciplinary situations where the solution path is not immediately obvious and where the literacy domains or curricular areas that might be applicable are not within a single domain of mathematics, science or reading.”

[a] See also OECD (2005a).
[b] Data limitations hinder an analysis for this country.

[48] Types of secundary education included in Dutch sample: ‘PRO’, ‘VMBO’, ‘HAVO’, and ‘VWO’ (CITO, 2004).

Table B.2 Number of observations PISA 2003 of OECD members

Australia	12551	Republic of Korea	5444
Austria	4597	Luxembourg	3923
Belgium	8796	Mexico	29983
Canada	27953	Netherlands	3992
Czech Republic	6320	New Zealand	4511
Denmark	4218	Norway	4064
Finland	5796	Poland	4383
France	4300	Portugal	4608
Germany	4660	Slovak Republic	7346
Greece	4627	Spain	10791
Hungary	4765	Sweden	4624
Iceland	3350	Switzerland	8420
Ireland	3880	Turkey	4855
Italy	11639	United Kingdom	9535
Japan	4707	United States	5456

Source: own calculations PISA 2003.

TIMSS

The ‘Third International Mathematics and Science Study’ (TIMSS) collects data on students’ achievements, curricula and school environment. The TIMSS is conducted under auspices of the International Association for the Evaluation of Educational Achievement (IEA).

TIMSS focuses on mathematical literacy and science literacy and assesses the achievements of students in attaining a certain knowledge level.[49] In addition, TIMSS focuses on the achievements of students in attaining a certain knowledge level. This is slightly different from PISA, which focuses on application of acquired knowledge.

TIMSS was conducted in 1995, 1999 and 2003. However, the Netherlands did not satisfy guidelines for sample participation rates (Harmon et al., 1997, p. A-21). We therefore exclude the TIMSS 1995 survey from our analysis. Participating countries differ for the 1999 and 2003 rounds; countries that participated in both rounds are presented in Table B.3. We refer to Harmon et al. (1997), Mullis et al. (2000); Martin et al. (2000b), and Mullis et al. (2004a,b) for a more elaborate discussion on TIMSS 1995, 1999 and 2003.

TIMSS collects data for several groups of students. In each country a representative sample of students aged nine and thirteen is selected in a similar way as PISA. However, we have chosen to focus on the thirteen-year-olds, in order to stay in line with the population of PISA.[50] In each country a representative sample of students aged nine and thirteen is selected in a similar way as PISA. However, we have chosen to focus on the 13-year-olds, in order to stay in line with the population of PISA.[51] Appendix B provides an overview of participating countries and the number of observations in TIMSS 1999 and 2003.

[49] The IEA assesses reading literacy via the ‘Progress in International Reading Literacy Study’ (PIRLS). The PIRLS focuses on fourth graders (nine and ten year old students). This population is not of interest to us for this study and PIRLS is therefore not considered.

[50] Types of education included in TIMSS 2003: ‘VMBO’, ‘HAVO’, ‘VWO’ (Martin et al., 2004); TIMSS 1999: ‘VBO’, ‘MAVO’, ‘HAVO’, ‘VWO’ (Martin et al., 2000a).

[51] The IEA also assesses reading literacy via the ‘Progress in International Reading Literacy Study’ (PIRLS). The PIRLS focuses on fourth graders (nine- and ten-year-old students). This population is not of primary interest to our study and PIRLS is therefore not considered here.

Table B.3 Number of observations TIMSS 1999 and 2003

	TIMSS 2003		TIMSS 2003
Armenia	5726	Sweden	4256
Australia	4791	Syrian Arab Republic	4895
Bahrain	4199	Tunisia	4931
Basque Country (Spain)	2514	United States	8912
Belgium (Flemish)	4970		
Botswana	5150		
Bulgaria	4117		
Chile	6377		TIMSS 1999
Chinese Taipei	5379		
Cyprus	4002	Australia	4032
Egypt	7095	Belgium (Flemish)	5259
England	2830	Bulgaria	3272
Estonia	4040	Canada	8770
Ghana	5100	Chile	5907
Hong Kong (SAR)	4972	Chinese Taipei	5772
Hungary	3302	Cyprus	3116
Indiana State (United States)	2188	Czech Republic	3453
Indonesia	5762	England	2960
Islamic Republic of Iran	4942	Finland	2920
Israel	4318	Hong Kong (SAR)	5179
Italy	4278	Hungary	3183
Japan	4489	Indonesia	5848
Jordan	4856	Islamic Republic of Iran	5301
Latvia	3630	Israel	4195
Lebanon	3814	Italy	3328
Lithuania	4964	Japan	4745
Malaysia	5314	Jordan	5052
Moldova	4033	Latvia	2873
Morocco	2943	Lithuania	2361
Netherlands	3065	Malaysia	5577
New Zealand	3801	Moldova	3711
Norway	4133	Morocco	5402
Ontario Province (Canada)	4217	Netherlands	2962
Palestinian National Authority	5357	New Zealand	3613
Philippines	6917	Philippines	6601
Quebec Province (Canada)	4411	Republic of Korea	6114
Republic of Korea	5309	Republic of Macedonia	4023
Republic of Macedonia	3893	Romania	3425
Romania	4104	Russian Federation	4332
Russian Federation	4667	Singapore	4966
Saudi Arabia	4295	Slovak Republic	3497
Scotland	3516	Slovenia	3109
Serbia	4296	South Africa	8146
Singapore	6018	Thailand	5732
Slovak Republic	4215	Tunisia	5051
Slovenia	3578	Turkey	7841
South Africa	8952	United States	9072

Source: own calculations TIMSS 1999 and 2003.

IALS

The 'International Adult Literacy Survey' (IALS) is a program initiated to assess the performance of adults on three literacy domains: prose, document and quantitative literacy. The IALS is an initiative of several governments, national statistical agencies, research institutions and the OECD. It was co-ordinated by Statistics Canada and the Educational Testing Service of Princeton, New Jersey. Next to the assessment of skills, the IALS also collects information on labour characteristics (for example, wages) of the participant.[52]

The focus of IALS on adults is a clear distinction from PISA and TIMSS. Participating countries constructed a sample of inhabitants aged 16-65 at different educational levels. Subsequently, IALS can provide information on entrants to the labour market and on the effect that higher levels of education may have on, for example, income.

During the period 1994-1998 the IALS was conducted in three cycles. The first survey was conducted among nine countries, including the Netherlands in 1994 . This was followed by surveys among five countries in 1996, and among nine countries in 1998, both without the Netherlands. Findings for Hungary, Norway and the Italian-speaking region of Switzerland should be interpreted with care. Data limitations apply for these three countries, which are of importance for our analysis. (see OECD, 2000a, p. 121).

[52] For the Netherlands a two-stage systematic sampling was used. The first stage was based on the selection of postal codes. The second stage involved selection of one address in each postal code. Finally, based on date of birth the person to be interviewed was selected (Statistics Canada, 1998).

Table B.4 Characteristics IALS 1994-1998

Participants	
1994	Canada (English and French-speaking populations)[a], France[b], Germany, Ireland, Netherlands, Poland, Sweden, Switzerland (German and French speaking regions)[a], United States
1996	Australia, Belgium (Flanders), Great Britain, New Zealand, Northern Ireland[c]
1998	Chile, Czech Republic, Denmark, Finland, Hungary, Italy, Norway, Slovenia, Switzerland (Italian-speaking region)[a]
Definitions literacy domains[d]	
Prose	“The knowledge and skills needed to understand and use information from texts including editorials, news stories, poems, and fiction.”
Document	“The knowledge and skills required to locate and use information contained in various formats, including job applications, payroll forms, transportation schedules, maps, tables, and graphics.”
Quantitative	“The knowledge and skills required to apply arithmetic operations, either alone or sequentially, to numbers embedded in printed materials, such as balancing a checkbook, calculating a tip, completing an order form, or determining the amount of interest on a loan from an advertisement.”

[a] We make no a distinction between the different language regions in a country for IALS
[b] France withdrew from the IALS in 1995
[c] Grouped with Great Britain
[d] See OECD (2000a).

Table B.5 Number of observations IALS 1994-1998 for several age cohorts[a]

	Cohort					
	Total	16-25	25-36	36-45	HE[b] 26-65	HE 26-35
Belgium (Flanders)	2261	750	440	451	610	216
Canada	4500	1259	1010	997	1022	382
Switzerland	4127	545	1152	992	692	276
Chile	3502	798	932	805	383	181
Czech Republic	3132	504	622	709	455	121
Germany	2062	339	565	425	268	87
Denmark	3026	592	708	660	741	210
Finland	2928	608	613	679	550	163
United Kingdom	6718	1044	1794	1552	1327	436
Hungary	2593	569	462	564	345	69
Ireland	2423	563	533	544	275	105
Italy	2974	523	723	748	377	110
Netherlands	2837	401	791	725	634	229
Norway	3307	721	762	721	1044	339
New Zealand	4223	757	1113	1017	681	210
Poland	3000	674	600	773	360	106
Slovenia	2972	709	633	671	324	120
Sweden	2644	575	562	563	543	148
United States	3035	561	673	711	813	240

Source: own calculations IALS.
[a] Data on Australia not available to us.
[b] Higher Educated

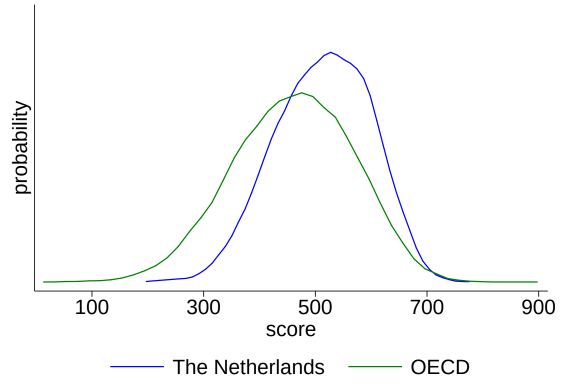
Appendix C Background statistics Dutch skill distribution, PISA 2003

This appendix provides additional information for the analysis in Section 3.3.

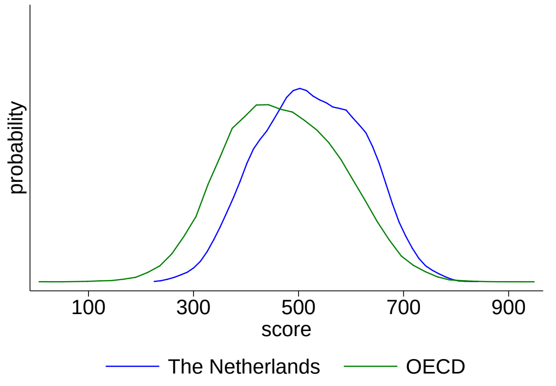
Skill distribution PISA 2003, three literacy domains

Figure C.1 Skill distribution of the Netherlands and the OECD in reading literacy, science literacy and problem solving (in addition to Figure 3.2), PISA 2003[a]

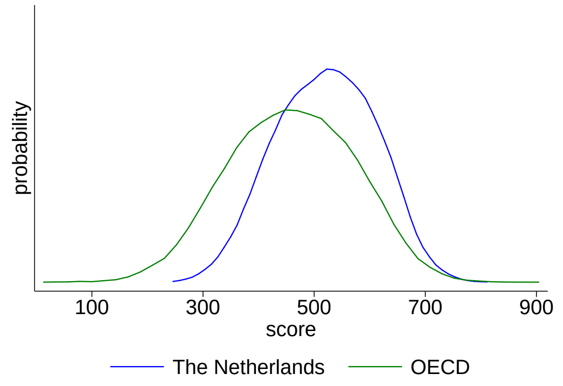
Reading literacy



Scientific literacy



Problem solving



Source: Own calculations based on PISA 2003

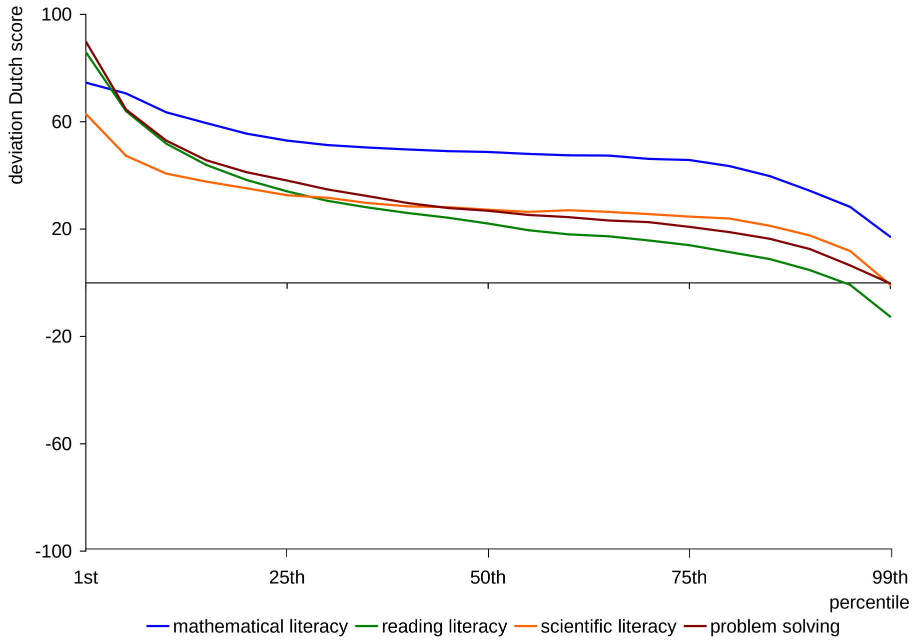
[a] See Section 3.2.2 for an explanation of the skill distribution.

Dutch performance compared to OECD

We determine the deviation of the Dutch scores from the OECD scores at several percentiles of the skill distribution. Table C.1 shows these deviations for the four literacy domains in PISA at nine percentiles. These deviations are also shown in Figure C.2.

The Netherlands has a significant lead at the lower percentiles. This lead is, however, lost at the right-hand side, and turns into a significant lag for reading literacy at the 99th percentile (the left-hand side).

Figure C.2 Deviation of Dutch scores on four literacy domains from the OECD, PISA 2003



Source: Own calculations based on PISA 2003

Table C.1 Deviation of Dutch scores on four literacy domains from the OECD, PISA 2003

	Percentile								
	1st	5th	10th	25th	50th	75th	90th	95th	99th
Literacy									
Mathematical	75***	71***	63***	53***	49***	46***	34***	28***	17***
Reading	86***	64***	52***	34***	22***	14***	5	− 1	-13***
Scientific	63***	47***	41***	33***	27***	25***	18***	12**	− 1
Problem solving	90***	65***	53***	38***	27***	21***	13***	6	0

Source: own calculations PISA 2003
Significance levels: *** = 1%, ** = 5%, * = 10%

Country-by-country comparison

Table C.2 shows the deviation of the Dutch score from the scores of eight OECD members at nine percentiles (see also Figures 3.4 and 3.5).

Table C.2 Deviation of Dutch scores on four literacy domains from the eight OECD members presented in Figure 3.4, PISA 2003

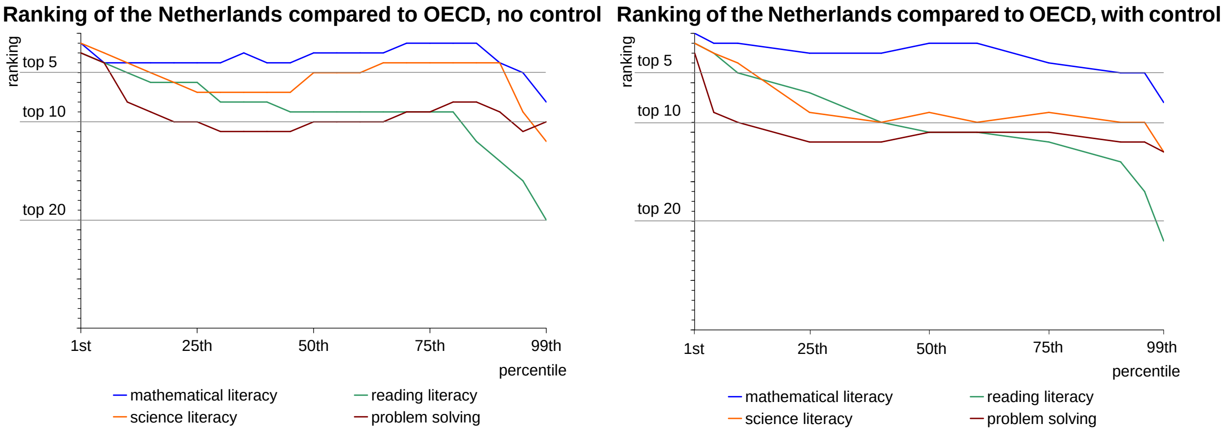
	Percentile								
	1st	5th	10th	25th	50th	75th	90th	95th	99th
Belgium									
Mathematical literacy	70***	51***	35***	15**	2	− 3	− 8**	− 10**	− 15**
Reading literacy	103***	69***	45***	14**	− 5	− 11**	− 15***	− 17***	− 23***
Scientific literacy	70***	43***	30***	15**	6	10**	13**	14**	14**
Problem solving	52***	32***	19**	1	− 12**	− 15***	− 17***	− 19***	− 20**
Denmark									
Mathematical literacy	28	24***	20**	18**	24***	30***	25***	21***	17**
Reading literacy	52***	31***	24***	16**	18***	23***	20***	18***	14*
Scientific literacy	80***	57***	51***	44***	48***	52***	49***	44***	31***
Problem solving	18	3	− 1	− 2	1	8*	9*	7	12
Finland									
Mathematical literacy	− 19	− 21**	− 23***	− 17***	− 4	6	5	3	− 2
Reading literacy	− 20	− 31***	− 37***	− 40***	− 32***	− 23***	− 21***	− 21***	− 25***
Scientific literacy	− 12	− 30***	− 35***	− 37***	− 27***	− 13**	− 8*	− 9	− 12
Problem solving	− 19*	− 36***	− 40***	− 38***	− 29***	− 17***	− 13***	− 14**	− 15*
Germany									
Mathematical literacy	62***	61***	52***	39***	30***	30***	24***	22***	19**
Reading literacy	96***	74***	60***	36***	13**	4	− 3	− 7	− 15**
Scientific literacy	75***	56***	43***	25***	14**	15**	13**	10*	4
Problem solving	31**	21**	18**	9	1	4	5	4	6
Norway									
Mathematical literacy	45**	42***	39***	38***	44***	48***	43***	39***	29***
Reading literacy	74***	48***	37***	20***	10*	6	− 5	− 11*	− 27***
Scientific literacy	72***	51***	44***	37***	38***	41***	38***	31***	16
Problem solving	77***	50***	41***	32***	28***	28***	22***	17**	9
Sweden									
Mathematical literacy	44**	32***	28***	25***	30***	33***	26***	22***	11
Reading literacy	48***	20**	11	1	− 4	− 5	− 11**	− 15**	− 24**
Scientific literacy	68***	35***	25***	17**	15**	17***	11*	9	− 3
Problem solving	37**	12	6	5	10**	16***	17***	15**	15*
United Kingdom									
Mathematical literacy	28*	29***	28***	27***	30***	36***	28***	24***	19**
Reading literacy	38**	25***	18***	9*	5	3	− 4	− 9	− 17**
Scientific literacy	30**	18**	11	5	3	7	3	0	− 6
Problem solving	32**	19**	14**	10*	8*	10**	7	3	3
United States									
Mathematical literacy	59***	62***	59***	53***	56***	59***	49***	46***	38***
Reading literacy	70***	50***	40***	25***	16***	8*	− 2	− 6	− 18**
Scientific literacy	51***	41***	35***	31***	31***	34***	31***	28***	20**
Problem solving	72***	60***	54***	46***	42***	39***	33***	27***	26***

Source: own calculations PISA 2003
Significance levels: *** = 1%, ** = 5%, * = 10%

Appendix D Dutch ranking controlling for participant characteristics, PISA 2003

Controlling for differences in participant characteristics may provide insights into the performance of the educational system. Differences in participant characteristics may influence the findings presented in Figure 3.4. For example, Finland and Japan have a more homogeneous population than the Netherlands. We include a set of five characteristics that may influence the test scores of a student: gender, age, family status, highest level of education of parents, and immigrant status.

Figure D.1 Dutch ranking among thirty OECD members, PISA 2003; with and without controlling for participant characteristics[a]



[a] The graph without controlling for participant characteristics is based on 22 percentile values. The other graph is based 11 on percentile values.

To obtain estimates of deviations in percentile values with the set of five control variables, we apply quantile regressions, which is an extension of the classical linear regression analysis. The ordinary least square estimator determines the mean value of the endogenous variable, conditional on the exogenous variables. With quantile regression, the linear model is estimated conditional on the quantile or percentile instead of the mean.

We use the quantile regressions to determine a new ranking for the Netherlands among the thirty OECD members for the four domains of PISA 2003. We visualised this ranking in the right graph of Figure D.1. The left graph indicates the ranking without taking characteristics into account, equal to Figure 3.3. In addition, the deviations of the Dutch scores from the OECD scores can be determined as well (see Table D.1).

The overall pattern of the new ranking of the Netherlands is similar to the ranking in the left graph without taking participant characteristics into account. The students at the left part of the distribution perform better in an international perspective than the students at the right. The plateau between the 25th and 75th percentile is visible as well – although at a lower ranking. Although taking into account participant characteristics affects our findings, this analysis yields in general similar findings to an analysis without taking these characteristics into account.

Table D.1 Deviation of Dutch scores on four literacy domains from the OECD, controlling for participant characteristics, PISA 2003[a]

	Percentile								
	1st	5th	10th	25th	50th	75th	90th	95th	99th
Literacy									
Mathematical	79***	62***	56***	49***	46***	40***	35***	31***	24***
Reading	76***	54***	43***	28***	18***	11***	4	− 2	− 10
Scientific	51***	39***	32***	26***	23***	20***	14***	9**	2
Problem solving	62***	46***	40***	31***	24***	17***	12***	7*	− 1

Source: own calculations PISA 2003.
Significance levels: *** = 1%, ** = 5%, * = 10%.
[a] Estimates obtained with quantile regressions, see also Appendix D.

‘Top’ six OECD members at the 99th percentile

Table C.2 shows the deviation of the Dutch scores from the 6 top OECD members at the 99th, taking into account participant characteristics (see also Figure 3.8).

Table D.2 Deviation of Dutch scores on four literacy domains from the top six OECD members at the 99th percentile presented in Figure 3.8, controlling for participant characteristics, PISA 2003[a]

	Percentile								
	1st	5th	10th	25th	50th	75th	90th	95th	99th
New Zealand									
Mathematical literacy	34***	16**	10*	5	1	0	− 6	− 6	− 13
Reading literacy	38**	11	− 1	-17***	-25***	-33***	-42***	-45***	-54***
Scientific literacy	9	− 3	− 6	-12**	-14***	-13**	-14**	-16***	− 18
Problem solving	4	-14**	-20***	-27***	-27***	-26***	-30***	-29***	-32***
Republic of Korea									
Mathematical literacy	25**	5	3	− 3	− 4	− 4	− 7	− 7	− 13
Reading literacy	− 2	-20**	-24***	-29***	-25***	-22***	-22***	-22***	-26***
Scientific literacy	25	1	− 7	-17**	-18***	-16***	-16**	-19***	-22**
Problem solving	− 10	-30***	-33***	-35***	-34***	-29***	-29***	-30***	-33***
Japan									
Mathematical literacy	74***	51***	42***	29***	21***	15**	10**	9	0
Reading literacy	116***	83***	72***	48***	30***	17***	9*	2	− 13
Scientific literacy	54***	29***	18**	1	− 9	-12**	-17***	-23***	-33***
Problem solving	57***	28***	17**	− 2	-15**	-20***	-27***	-30***	-39***
Australia									
Mathematical literacy	42***	25***	20***	16***	14***	13***	8**	5	− 2
Reading literacy	36***	11*	1	-12**	-16***	-20***	-25***	-29***	-39***
Scientific literacy	26*	7	1	− 6	− 4	− 2	− 5	− 8	− 15
Problem solving	7	− 6	-9*	-12**	-12***	-10**	-11**	-11**	− 15
Switzerland									
Mathematical literacy	36***	12	7	1	1	− 1	− 6	− 7	− 12
Reading literacy	32**	13**	7	1	1	0	− 4	− 7	-16**
Scientific literacy	33**	11	5	− 4	− 4	− 4	− 7	− 10	-17*
Problem solving	12	− 11	-15**	-17***	-15***	-11**	-12**	-12**	− 15
Finland									
Mathematical literacy	12	− 5	− 6	− 3	4	5	4	4	− 1
Reading literacy	1	-20**	-25***	-28***	-23***	-19***	-19***	-18***	-21**
Scientific literacy	− 2	-18***	-23***	-23***	-18***	-11**	-11*	-12**	− 15
Problem solving	− 6	-27***	-28***	-25***	-21***	-16***	-15***	-16***	-22**

Source: own calculations PISA 2003.
Significance levels: *** = 1%, ** = 5%, * = 10%.
[a] Estimates obtained with quantile regressions.

Appendix E ISCED-1997 classification as used by the OECD

Table E.1 ISCED-1997 classification as used by the OECD[a]

Code		Education for	Label and characteristics	Dutch programs
0			pre-primary education	bo 1/2
1			primary education	bo 3-8
2			lower secondary education	
	C	Direct entry into labour market		mbo-1 assistent, praktijkonderwijs
	B	Going to 3C		vmbo
	A	Going to 3A or 3B		havo/vwo 1-3
3			upper secondary education	
	C	Direct entry into labour market or going to other ISCED 3 or 4 programs		mbo-2, mbo-3
	B	Going to 5B		-
	A	Going to 5A		havo/vwo 4-6, mbo-4 middenkader
4			post-secondary non-tertiary education	
	C	Entry into labour market		mbo-4 specialist
	B	Going to 5B		-
	A	Preparation for 5A		modules Open University
5			first stage of tertiary education	
	B	Vocationally oriented, no access to 6		hbo 2-3 years (not hbo-bachelor);hbo-2 AD
	A	Access to 6		wo- and hbo-bachelor, wo-master
6			second stage of tertiary education (advanced research qualification)	wo-doctor

Source: Bernelot Moens (2005), Appendix 1.

[a] Notes: Completed 3C program has duration of at least two years; ISCED 4 does not necessarily have a higher level than ISCED 3; 5B has duration of at least two years after twelve years of education (from ISCED 1 onwards); 5A has duration of at least three, but usually four years.

Appendix F Background statistics skill distribution higher educated, IALS 1994-1998

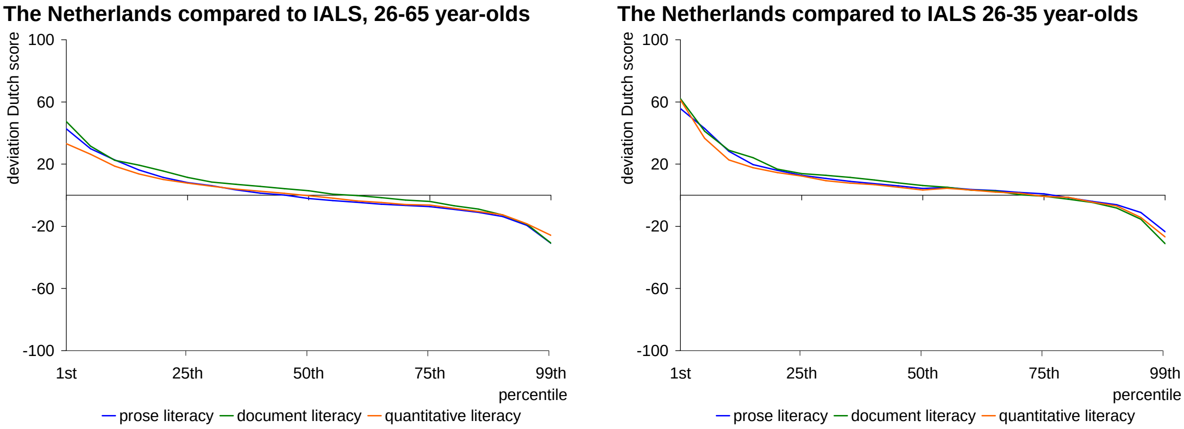
This appendix provides additional data for the analysis of Section 4.3.

Dutch scores compared to IALS scores

We determine the deviation of the Dutch scores from the IALS scores for two cohorts at several percentiles of the skill distribution. Table F.1 shows these deviations for the three literacy domains in IALS at nine percentiles. These deviations are also shown in Figure F.1.

The Netherlands has a significant lead at the lower percentiles. The lead is lost, however, at the right side, and turns into a significant lag for reading literacy at the 99^{th} percentile.

Figure F.1 Deviation of Dutch scores on three literacy domains from IALS total 1994-1998, by age cohort



Source: Own calculations based on IALS 1994-1998

Country-by-country comparison

Table F.2 shows the deviation of the Dutch scores from the scores of eight IALS participants at nine percentiles (see also Figures 4.4 and 4.5).

Table F.1 Deviation of Dutch scores on three literacy domains of higher educated from IALS total 1994-1998, by age cohort

	Percentile								
	1st	5th	10th	25th	50th	75th	90th	95th	99th
Higher educated 26-65 years old									
Prose literacy	43***	30***	23***	8**	− 2	-7**	-14***	-19***	-31**
Document literacy	47***	32***	22***	11***	3	− 4	-13***	-19**	-31**
Quantitative literacy	33**	26***	19***	8**	0	-6**	-13***	-18**	− 26
Higher educated 26-35 years old									
Prose literacy	56	43***	28***	13***	4	1	− 6	− 11	− 23
Document literacy	62**	41***	29***	14**	6	− 1	− 8	-15**	-31*
Quantitative literacy	61**	37***	23**	12**	3	− 1	− 7	− 14	− 27

Source: own calculations IALS 1994-1998.
Significance levels: *** = 1%, ** = 5%, * = 10%.

Table F.2 Deviation of Dutch scores on three literacy domains of higher educated from the eight IALS participants presented in Figures 4.4 and 4.5

	Percentile								
	1st	5th	10th	25th	50th	75th	90th	95th	99th
Belgium									
Prose literacy	8	11	7	4	3	1	− 3	− 2	− 1
Document literacy	9	0	0	− 1	1	1	1	− 2	− 9
Quantitative literacy	7	− 2	− 3	− 5	− 5	− 7	− 8	− 11	− 26
Denmark									
Prose literacy	12	13	13	15**	18**	24***	29***	32***	39**
Document literacy	12	2	− 5	− 5	− 7	− 7	− 8	− 12	− 16
Quantitative literacy	23*	10	3	2	1	3	3	2	− 5
Finland									
Prose literacy	− 2	− 5	− 7	− 7	− 6	− 4	− 7	− 7	− 7
Document literacy	− 5	0	− 3	− 8	− 11	-13*	-17*	-23*	− 21
Quantitative literacy	14	9	9	5	5	6	8	4	1
Germany									
Prose literacy	23	18	4	3	− 1	− 8	− 7	− 16	− 13
Document literacy	11	13	9	3	− 3	− 10	− 23	− 24	-36*
Quantitative literacy	26	3	5	5	− 4	− 11	− 13	− 23	− 20
Norway									
Prose literacy	− 10	− 6	− 5	− 4	0	3	5	5	8
Document literacy	− 10	− 10	− 12	-14**	-12**	-12*	-15**	-19**	− 29
Quantitative literacy	1	− 10	− 9	− 8	− 8	− 4	− 3	− 5	− 12
Sweden									
Prose literacy	− 4	2	− 6	− 13	-20**	-26**	-34**	-37**	-44*
Document literacy	− 6	− 6	− 8	-16**	-19**	-27**	-36***	-43**	-51**
Quantitative literacy	10	− 1	− 3	− 7	-18**	-25**	-33***	-39*	-45*
United Kingdom									
Prose literacy	42	29**	18*	7	3	1	− 2	− 3	− 6
Document literacy	52	33**	22**	6	1	− 8	-13*	-20*	− 27
Quantitative literacy	49***	30**	21**	8	− 1	− 5	− 6	− 10	− 17
United States									
Prose literacy	99	48***	28**	11	2	− 4	− 10	− 16	− 24
Document literacy	103	44***	29**	13**	5	0	− 5	− 11	− 20
Quantitative literacy	76	40**	21*	10	2	− 1	− 7	− 14	− 24

Source: own calculations IALS 1994-1998.
Significance levels: *** = 1%, ** = 5%, * = 10%.

Appendix G Difference in average skill levels: difference-in-difference estimation

For the comparison of the difference in skill levels in the Netherlands (of graduates from secondary education and graduates from higher education) with the differences in other countries, we estimate a difference-in-difference model, which has the following form:

$$T = \alpha + \beta HO + \delta NL + \gamma HO \times NL + \lambda X + \varepsilon, \quad \text{(G.1)}$$

with T as a score on a specific skill domain of IALS, HO is a dummy that has value of 1 when the individual graduated from higher education (ISCED levels 5, 6, 7) and a value of 0 when the individual attained secondary education (ISCED 3 level); NL is a dummy that has a value of 1 when the individual lives in the Netherlands and a value of 0 when the individual lives in another country; X is a vector of control variables including age, age squared, gender and being born in the country. The parameter of primary interest is γ, which is the difference-in-difference estimator:

$$\gamma = (T_{NL}^{HO} - T_{NL}^{VO}) - (T_{country}^{HO} - T_{country}^{VO}). \quad \text{(G.2)}$$

We estimate equation G.1 for the three domains (quantitative, prose, document) and for the comparison of the Netherlands with all IALS participants and eight separate countries. The results for the separate domains are shown in Tables 4.2, G.1 and G.2. The second and third columns show the average testscores for graduates of secondary and higher education. The fourth column shows the difference between higher and secondary education. The last column shows the difference-in-difference estimations obtained with age, age squared, gender and being born in the country, as control measures.

Table G.1 Difference in Dutch average scores between secondary and tertiary education, compared to other countries for the prose literacy domain (persons ≤ 35 years old), IALS 1994-1998

Country	Average education level[a] Secondary education (1)	Higher education (2)	Difference (2)− (1)	Difference-in-difference[b] comparison with the Netherlands
The Netherlands	305	320	15	
Belgium	288	317	29	− 14***
Denmark	288	303	15	0
Germany	295	322	27	− 11***
Finland	313	328	15	0
Norway	294	322	28	− 13***
New Zealand	290	308	18	− 4
Sweden	311	340	30	− 13***
United Kingdom	285	312	27	− 12***
United States	268	308	41	− 28***
'IALS' [c]	278	308	30	− 17***

Source: Own calculations based on IALS.
[a] Secondary education equals ISCED level 3; higher education equals ISCED levels 5 and 6.
[b] Difference-in-difference estimate obtained with the following control measures: gender, age, age squared, born in a foreign country.
[c] Refererence group including Belgium, Zwitzerland, Chile, Czech Republic, Germany, Denmark, Finland, Hungary, Ireland, Italy, Norway, New Zealand, Poland, Slovenia, Sweden, United Kingdom, United States.

Table G.2 Difference in Dutch average scores between secondary and tertiary education, compared to other countries for the document literacy domain (persons ≤ 35 years old), IALS 1994-1998

Country	Average education level[a] Secondary education (1)	Higher education (2)	Difference (2)− (1)	Difference-in-difference[b] comparison with the Netherlands
The Netherlands	311	320	10	
Belgium	297	321	24	− 15***
Denmark	313	328	15	− 6**
Germany	306	328	22	− 13***
Finland	316	333	17	− 8***
Norway	304	336	32	− 24***
New Zealand	289	306	17	− 8***
Sweden	315	342	27	− 17***
United Kingdom	289	315	25	− 17***
United States	268	304	36	− 29***
'IALS' [c]	280	306	26	− 19***

Source: Own calculations based on IALS.
[a] Secondary education equals ISCED level 3; higher education equals ISCED levels 5 and 6.
[b] Difference-in-difference estimate obtained with the following control measures: gender, age, age squared, born in a foreign country.
[c] Refererence group including Belgium, Zwitzerland, Chile, Czech Republic, Germany, Denmark, Finland, Hungary, Ireland, Italy, Norway, New Zealand, Poland, Slovenia, Sweden, United Kingdom, United States.

Appendix H Dutch education system and drop-out rates

Education flows

The first column of Table H.1 lists the levels of the Dutch education system. The lower levels of secondary education are VO 1,2, VMBO and MBO 1,2. Higher levels of secondary education are HAVO, VWO and MBO 3,4. Higher education consists of higher vocational education (HBO) and university education.

Table H.1 Transition probability Dutch pupils by level of education, 2004[a b]

	Going to higher level of education:								Or exit system:		Total
	Lower secondary education			Upper secondary education			Higher education		Leaving with	Leaving as	
	VO1,2	VMBO	MBO1,2	HAVO	VWO	MBO3,4	HBO	Univ.	certificate	dropout	
From:											
Primary [c]	95								0	5	100
VO1,2		58		18	19				0	5	100
VMBO			78	9					6	7	100
MBO1,2						67			21	12	100
HAVO [d e]					4	4	81		7	4	100
VWO [d e]						3	14	71	8	4	100
MBO3,4 [f]							42		26	32	100
HBO [g]								6	61	33	100
University [h]									33	45	100

[a] Source: Derived from Ministry of Education, Culture and Science (2006b), mainly Figure 2.1 (p.8). This Figure 2.1 has been adjusted; see the notes below.
[b] The figures on higher education differ from those in Section 4.2, due to differences in data sources.
[c] Row 'Primary education': distribution HAVO and VWO (total 37%) based on the number of pupils HAVO:VWO = 98:109 (Ministry of Education, Culture and Science, 2006b, p.77).
[d] Rows 'HAVO' and 'VWO': All pupils flowing from HAVO and VWO into MBO are assumed to flow into MBO 3,4. Figure 2.1 from Ministry of Education, Culture and Science (2006b) is not consistent as regards the outflow of HAVO and VWO. The distribution of the destination of HAVO and VWO graduates is computed from figures on p.79 of Ministry of Education, Culture and Science (2006b).
[e] Rows 'HAVO' and 'VWO': Assumption dropout HAVO = dropout VWO = 4% (= dropout of HAVO and VWO together).
[f] Row 'MBO 3,4'. The inflow into HBO from MBO 3,4 is half of the inflow from HAVO/VWO in 2004, according to the Ministry of Education, Culture and Science (2006b, p.103). Given the probabilities of the inflow into HBO from HAVO and VWO (together 20%), the probability of the flow from MBO 4 to HBO should be about 10%. This figure coincides with a probability of 36%, given the pupil has enrolled at MBO 4. All pupils with an MBO 4 certificate are supposed to flow to HBO, not to the university. The distribution across HBO and the two types of exit follow from Ministry of Education, Culture and Science (2006b, Figure 2.1, p.8)
[g] Row 'HBO': Dropout = 33%. Source: Statistics Netherlands (2006b, Table 5.2.11). 10% of the HBO certificate holders flow to universities. Given dropout, this is estimated at about 6% of the original HBO entrants. Source: Ministry of Education, Culture and Science (2006a, Figure 39).
[h] Row 'university': Source: Statistics Netherlands (2006b, Table 5.4.12).

Pupils at a certain level leave that level sooner or later. They can leave that level in two ways – either moving on to the nearest higher level after acquiring their certificate or exiting the education system. In the latter case, they exit with a certificate or as dropout. The table shows for each level (row) the distribution of the destinations of the pupils. As all pupils at a certain level exit that level once, the figures on each row add up to 100%. The table shows that the cells filled with figures are on or just above the diagonal cells, which reflects the fact that the system is structured in such a way that pupils can only go upward and step by step.

The figures on each row can be interpreted as a probability distribution of the destinations of a pupil of whom we know only that he or she follows education at that level.

Drop out

Table H.1 can be transformed into table Table H.2, which shows the probabilities of a random pupil who enters primary education to leave the education system at each level as a certificate holder or as drop out. In total 53% leave the system with a certificate and 47% as drop out. The sum equals 100%, reflecting that each pupil who enters primary education once leaves the education system as a certificate holder or as a drop out. Drop outs often have acquired a certificate at lower levels. For instance, a university drop out has acquired in general a VWO certificate.

Table H.2 shows that a random pupil has a 46% probability of entering higher education and a 18% probability of leaving as a drop out. This is the 18% mentioned in Chapter 5. Table H.2 also shows that this 18% is comprised of a 11% probability dropping out of HBO and a 7% probability dropping out of university.

Table H.2 Probability of exiting the Dutch education system with and without certificate, by level of education, 2004

Education level	Total exit %	Leaving with certificate %	Leaving as dropout %
Primary education	5	0	5
Lower secondary education	26	12	14
VO-1,2	5	0	5
VMBO	7	3	4
MBO-1,2	14	9	5
Upper secondary education	23	12	11
HAVO	3	2	1
VWO	3	2	1
MBO-3,4	17	8	9
Higher education	46	28	18
HBO	31	20	11
University	15	8	7
Total	100	53	47