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Immigrant Pupils' Scientific Performance: The Influence of Educational System Features of Origin and Destination Countries

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and Analysis
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The Influence of Educational System
Features of Origin and Destination
Countries

J. Dronkers, M. de Heus and M. Levels

Immigrant Pupils' Scientific Performance: The Influence of Educational System Features of Origin and Destination Countries

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Non-Technical Abstract

This paper explores the extent to which educational system features of destination and origin countries can explain differences in immigrant children's educational achievement. Using data from the 2006 PISA survey, we performed cross-classified multilevel analysis on the science performance of 9,279 15-year-old immigrant children, originating from 35 different countries, living in 16 Western countries of destination. We take into account a number of educational system characteristics of the countries of destination and origin, in order to measure the importance of differentiation, standardization, and the availability of resources. Our results show that differences in educational achievement between immigrants cannot be fully attributed to individual characteristics. Educational system characteristics of countries of destination and origin are also meaningful. At the origin level, the length of compulsory education positively influences educational performance. This is especially the case for immigrant pupils who attended education in their countries of origin. Results show that at the destination level, teacher shortage negatively affects immigrant pupil's scientific performance. Moreover, immigrant children perform less in highly stratified systems than they do in moderately differentiated or comprehensive ones. Especially immigrant children with highly educated parents perform worse in highly stratified systems.

Keywords: immigration, origin, destination, educational system, educational performance, PISA.

IMMIGRANT PUPILS' SCIENTIFIC PERFORMANCE: THE INFLUENCE OF EDUCATIONAL SYSTEM FEATURES OF ORIGIN AND DESTINATION COUNTRIES

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IMMIGRANT PUPILS' SCIENTIFIC PERFORMANCE: THE INFLUENCE OF EDUCATIONAL SYSTEM FEATURES OF ORIGIN AND DESTINATION COUNTRIES

Abstract

This paper explores the extent to which educational system features of destination and origin countries can explain differences in immigrant children's educational achievement. Using data from the 2006 PISA survey, we performed cross-classified multilevel analysis on the science performance of 9,279 15-year-old immigrant children, originating from 35 different countries, living in 16 Western countries of destination. We take into account a number of educational system characteristics of the countries of destination and origin, in order to measure the importance of differentiation, standardization, and the availability of resources. Our results show that differences in educational achievement between immigrants cannot be fully attributed to individual characteristics. Educational system characteristics of countries of destination and origin are also meaningful. At the origin level, the length of compulsory education positively influences educational performance. This is especially the case for immigrant pupils who attended education in their countries of origin. Results show that at the destination level, teacher shortage negatively affects immigrant pupil's scientific performance. Moreover, immigrant children perform less in highly stratified systems than they do in moderately differentiated or comprehensive ones. Especially immigrant children with highly educated parents perform worse in highly stratified systems.

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Introduction

A large body of research has shown that the educational success of immigrant children varies between different origin groups. Substantive variation exists in educational outcomes of different immigrant groups in the United States: Mexican Americans obtain lower average grades than Asians and whites (Bankston and Zhou, 2002; Kao, Tienda, and Schneider, 1996; Miller, 1995), they are more likely to drop out of high school (White and Kaufman, 1997), and less likely to earn a college degree (Camburn, 1990; Mare, 1995). Similar gaps in educational success between different immigrant groups and the native population have been observed in most other Western countries such as the Netherlands (van Tubergen and van de Werfhorst, 2007), Belgium (Phalet, Deboosere, and Bastiaenssen, 2007), Germany (Worbs, 2003), and France (Brinbaum and Cebolla-Boado, 2007). In order to explain these differences, research has often relied on classic individual-level determinants. These individual-level explanations have focused on differences in the cultural position (e.g. their motivation to perform) and the structural characteristics (e.g. parental capital and the time of arrival) of different immigrant groups (Kao and Thompson, 2003).

Although individual-level characteristics explain an important part of the variance in educational performance across immigrant groups, they do not tell the whole story. After controlling for a wide range of individual background characteristics (e.g. the educational attainment and occupational status of both parents, educational resources available at home, the immigrant generation, and the language spoken at home), differences in educational performance continue to exist across immigrants from different regions of origin and across immigrants living in different destination countries (Schnepf 2006; Marks 2005; Levels and Dronkers, 2008). In order to explain the remaining cross-group and cross-national variation, Levels, Dronkers, and Kraaykamp (2008) have examined the relevance of a range of contextual features of both countries of origin and destination. Their results indicate that

several macro-characteristics of both destination and origin countries affect the educational performance of immigrant children. For example, immigrant children from politically stable origin countries perform better at school than their counterparts from less stable countries. Also, origin countries' level of economic development negatively affects educational performance. At the destination level, immigrant children living in traditional immigration countries (Australia and New Zealand) have higher levels of educational performance. Levels et al. (2008) conclude that an exclusive focus on individual qualities cannot sufficiently explain the educational performance of immigrant children. Contextual features of both origin and destination countries do affect the educational performance of immigrant children, and must be part of any explanation of immigrant children's school success.

The study of contextual effects on immigrant pupils' scholastic performance is relatively recent. This study examines the influence of three important aspects of educational systems on the educational performance of immigrant children. National education systems differ for instance in the number of distinct educational programs at secondary education, the age at which children are selected into different educational programs, and the existence of nationally standardized examinations at the end of primary and secondary education (Shavit and Blossfeld, 1993; Shavit and Müller, 1998). Although these different educational structures have been suggested to explain differences in the educational success of immigrants across countries, there is little systematic evidence this claim (Buchmann and Parrado, 2006; Heath and Birnbaum, 2007). Moreover, no study so far has taken into account educational system features of immigrant children's countries of origin. Since first generation immigrant children might have attended school in their origin countries (Rumbaut, 2004), their educational performance is partly determined by the structure and organization of education in those countries. Therefore, in order to establish the effects of educational systems on the scholastic performance of immigrant children, characteristics of educational systems of origin countries must be studied. Levels et al. (2008) analyzed only general macro-characteristics of the origin and destination countries and found significant effects of economic development and political stability of the origin countries. However, these results might explained by features of the educational systems of the countries of origin and destination, because the level of economic development and political stability will be related to some characteristics of educational systems. Therefore we try to answer is the following research question: *To what extent is the educational performance of 15-year-old immigrant children determined by the degree of differentiation and standardization and the level of resources of educational systems of both their countries of origin and destination, also after controlling for the economic and political macro-characteristics of the countries of origin?*

Countries' educational systems

Important aspects of national education systems are the number of distinct educational tracks at secondary education, the age at which children are selected into different educational programs, the existence of nationally standardized examinations at the end of primary and secondary education and the availability of resources for teaching and learning (Shavit and Müller, 1998; Buchmann & Hannun, 2001). But in many other, often less tangible ways, national educational systems differ also: pedagogical practices, the nature of the curriculum, the status of teachers, the balance of power between various actors with the system (parents, teachers, school-boards, local authorities, national government). In this article we concentrate on three aspects of educational systems: the degree of differentiation, the degree of standardization, and the availability of resources. We have theoretical as well as practical arguments for this limitation. These three characteristics (differentiation, standardization, resources) are the most commonly mentioned in the literature (Buchmann and Hannun, 2001; Dunne, 2010; Shavit and Müller, 1998; Wössmann, 2003) as the most important educational

system features, which influence the strength of the relation between socio-economic parental backgrounds and educational outcomes. We assume that the immigration background of pupils is another aspect of parental background and thus that the relation between educational outcomes and immigration background is also strongest influenced by these three aspects of educational systems. Our more practical argument to focus only on differentiation, standardization, and resources is that the small number of destination countries (16) in the best available cross-national data-set (PISA data) makes it impossible to include all possible features of educational systems in the analysis. An additional argument for our focus is that many possible characteristics of educational systems lack reliable cross-national indicators for the origin and destination countries at hand.

We will assume that origin countries' educational systems affect immigrant children's educational outcome in their destination country only if they have received part of their education in their origin country. So, we do not expect direct effects of origin countries' education systems for the scholastic performance of second-generation immigrant children, who are born in a country to which their parents migrated. Moreover, the more time first generation immigrant children have received education in their origin country, the more relevant the education system of the origin country will be. Rumbaut (2004) has shown that educational performance of first generation immigrant children differs extensively between children who have migrated at an early age and children who have migrated later in life. Following Rumbaut's (ibid.) terminology, we distinguish between first generation children who have migrated before the age of 5 ('1.75 generation'), children who have migrated between the age of 5 and 12 ('1.5 generation'), and pupils who migrated after the age of 12 ('1.25 generation').

Differentiation

Differentiation of the education system refers to the extent to which pupils of the same age are divided into separate types of education. Whereas highly stratified systems select and allocate pupils into different types of secondary education at a relatively young age, systems that are less stratified postpone that decision until a later age. In moderate stratified systems, pupils are streamed early inside schools according to ability or different school-types are offered within the same school. Although the American high school system offers the same type of education to all high school pupils, it is characterized by a high degree of internal ability grouping. High achievers are generally assigned to 'honors' sections of a certain course; low achievers attend 'remedial' sections (Slavin, 1990; Gamoran, Nystrand, Berends and LePore, 2004). In comprehensive educational systems (like in Scandinavia) all pupils attend the same school-type and there exists hardly any tracking or streaming within these schools.

The early differentiation influences the educational choices of children of lower class parents (natives and immigrants) negatively. The rationale behind this is that educational choices made at a relatively early age are more heavily influenced by parental background than by children's actual achievements (Mare, 1981; Shavit and Blossfeld, 1993). Pfeffer (2008) has recently underscored the importance of parents' strategic knowledge of the education system as a crucial resource that translates into different educational choices. Parents' strategic knowledge is especially important in highly stratified systems. Immigrants are on average less knowledgeable of the different educational options in their destination countries and will therefore be less able to navigate their children successfully through the more differentiated educational systems. More general, as a result of a lower level of resources of immigrants (educational, occupational, knowledge of the educational system, a lower command of the host country's language) their children are more likely to be selected and allocated into lower educational streams and school-types (van de Werfhorst and van Tubergen, 2007).

The early institutional differentiation, either by different school-types or by streams within undifferentiated secondary schools, is related to curricular differentiation between the students. The curriculum is varying by school-type or the level of the stream. One of the most important differences in curriculum is that between vocational and general education. The curriculum offered in vocational education tends to be more restricted to practical skills instead of more abstract knowledge. This might lead to differences in educational performance between comparable students from general and vocational education. Also the more a school-type or a stream prepares students for college or university entrance, the more demanding the curriculum, the higher the criteria for academic success but also the opportunities for the students to learn more and perform better. This curriculum differentiation at an early age gives comparable 15-year old immigrant students in school-types and streams unequal opportunities to learn certain knowledge and skills (Baker & LeTendre, 2005).

One of the aims of this early institutional differentiation is the creation of homogeneous learning environments. The central argument behind different school-types, tracking or ability grouping is that homogeneous learning environments permit a focused curriculum and paced instruction, which increases the average performance of all students (Hanushek and Wössmann, 2005). This homogenization influences the ability composition of the school-type and the stream. The more demanding school-types or streams will have on average more students with higher scholastic skills, while the less demanding school-types or streams will have on average more students with lower demanding skills. This differentiation of ability composition of the student body between school-types and streams creates different opportunities for teaching and learning, both by the available time-on-task, the various criteria of teachers and students and the peer-group pressure for academic and non-academic success (Coleman et al, 1966; Scheerens and Bosker, 1997; Dronkers, 2010a).

Given the lower resources of many immigrant parents, their larger difficulties to gain early access for their children to those streams or school-types, which offer a more demanding curriculum and better teaching and learning environment, we hypothesize that *the educational achievement of 15-year-old immigrant children will be lowest in destination countries with highly stratified educational systems and highest in destination countries with a comprehensive educational system* (hypothesis 1).

Standardization

Standardization refers to the degree to which external standards exist in an educational system to maintain the quality level of the education. External standards give a set of standard rules and guidelines to schools, with which they have to comply (Wössmann, 2003). The best cross-national indicator for an external standard is a nationally standardized exam at the end of secondary education.¹ Since all students in a country attending the same school-type will face the same test at the end of secondary education, schools have an incentive to keep the quality of their education sufficiently high. After all, failing to warrant high quality education in a standardized system would most likely lead to lower average scores on the exams and might consequently damage an educational system's reputation (Bishop, 1997). We therefore hypothesize that *the existence of national exam in destination countries has a positive influence on the educational achievement of immigrant children living in this country* (hypothesis 2A).

Moreover, the degree of standardization of the educational system of immigrant children's countries of origin is expected to affect the educational achievement of immigrant children who attended part of their education in their origin country. In our case out best indicator of standardization in the countries of origin is the length of compulsory education, and a national standardized exam, because for that indicator is for many origin countries not

valid. Whereas second and 1.75 generation immigrants did not attend education in their origin country, 1.25 and 1.5 generation immigrants have been shaped by their origin countries' educational systems. Therefore we hypothesize that *the length of compulsory education of immigrant children's countries of origin positively affects the educational achievement of immigrants originating from these countries, and this is especially the case for the 1.25 generation, less for the 1.5 generation, and not for the 1.75 and second generation (hypothesis 2B).*

Resources to teach and learn

Educational achievement can be expected to be determined by the amount of time spent on teaching ('teaching time') and learning ('learning time'). Overall, the more teaching hours students receive and the more time they spend processing this information, the better their educational performance is likely to be (Ammermüller, 2005; Scheerens & Bosker, 1997). The learning and teaching time an educational system can provide for depends on the allocation of its human and material resources. National governments invest money in educating teachers, reducing teacher shortages, and equipping schools with modern information technologies in order to keep the quality of education high. However, research into the influence of school quality on educational achievement has suggested that school resources only have a very limited influence on pupils' performances. Coleman et al. (1966). revealed that, relative to students' individual background characteristics, measured differences in school resources (e.g. per pupil spending) matter little in determining educational outcomes of pupils in the US. Later studies focusing in the US or other Western countries have revealed a similar weak influence of material school resources (Dronkers, 2010a). Studies focusing on educational achievement in less developed countries have suggested that this might be related to the relatively low variance in educational resources within and across developed industrial nations. In developing nations, material and human resources such as the availability of textbooks and teacher training have shown to strongly determine achievement (see e.g. Heyneman and Loxley, 1983, and an elaborate review by Buchmann and Hannum, 2001).

Despite the limited support for a positive influence of educational systems' resources on educational achievement across developed countries, the picture might look differently for immigrant children. Next to having a socioeconomic disadvantage to natives, immigrant children's educational performance is also hindered by specific immigrant characteristics, like the mastery of the language of the destination country. Immigrant parents' limited knowledge of the education system and their restricted language skills hinder their possibilities to help their children with their homework or prepare them for tests. Therefore the educational achievement of immigrant children must depend more on the resources provided by their educational systems. We test the following hypothesis: *the quality of resources of a destination country's educational system positively affects the educational performance of immigrant children living in this country (hypothesis 3A).*

The same reasoning applies to the resources educational systems in origin countries possess. The educational achievement of immigrant children who attended part of their education in their origin country (the 1.25 and 1.5 generation), is likely to be affected by the quality of the resources of their origin country's educational system. It is expected that *the quality of resources of an origin country's educational system positively affects the educational performance of immigrant children originating from this country, and this is especially the case for the 1.25 generation, less for the 1.5 generation, and not for the 1.75 and second generation (hypothesis 3B).*

We will control our results for two macro-characteristics of the countries of origin shown to affects educational performance of immigrant children: i.e. economic prosperity and political

stability (Levels et al. 2008). Both indicators refer to two important push factors for immigration: lack of economic prosperity and political unrest. In this way we want to ascertain that the effects of the educational systems are not spurious and explainable by economic prosperity and political stability of the origin countries.

Data

The 2006 data from the Program for International Student Assessment [PISA], initiated by the Organization for Economic Co-operation and Development [OECD], were used to test the hypotheses of this study. Since 2000, the OECD has conducted large scale tests among 15-year-olds living in its member states and partner states every three years. Pupils' mathematical, reading, and scientific literacy were assessed. In doing so, the OECD aimed to find out to what degree pupils near the end of compulsory education have acquired knowledge and skills essential for full participation in society. The main focus of the 2006 study was on scientific literacy (OECD, 2007). Therefore we use this scientific literacy score as dependent variable.² PISA also provides information on individual and school characteristics by respectively administering a student and a principal questionnaire. Each school's principal is asked to provide information on numerous school characteristics, such as the teacher-student ratio, the number of vacant science positions, and the school's location. The student questionnaire asks students to provide detailed information on parental education and occupations, resources available at home, the language spoken at home and the birth countries of both the parents and the student. Since specific information on the birth country of both the parents and the student is essential to our analysis, we could only use countries that measured with enough specificity birth countries. Therefore, although not less than 57 countries participated in the 2006 PISA wave, only data from the following 16 developed countries are suited to test our hypotheses: Australia, Austria, Belgium, Denmark, Finland, Germany, Greece, Latvia, Liechtenstein, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Switzerland and Scotland.³ We excluded all pupils from those countries of origin were unknown or which had in total less than 30 cases.⁴ Therefore we analyze 9.279 immigrant pupils from 35 different countries of origin in 16 countries of destination.⁵

This selection of pupils who gave valid information on the countries of birth of themselves and their parents reduced sharply the number of pupils with missing values on one of the variables. In order not to lose pupils with missing values, we imputed each missing value with the average score on that variable of the pupils with the same combination of origin and destination. Only for the variables immigrant generation (age at arrival) and language spoken at home the numbers of pupils with missing values were substantial (see table 1). We made two dummies to indicate whether a pupil had a missing value on these variables and added them to the equations.

Variables

Dependent variable

The dependent variable of this study is scientific literacy. In order to be able to cover as many facets from the scientific field as possible (in general, the scientific field should be regarded as a combination of the disciplines Biology, Physics, Chemistry and Geography, covering topics such as health, natural resources and environment), a test with a total assessment time of 390 minutes was developed. However, since it would not be sensible to administer a test of more than 6 hours to an individual pupil, 13 largely comparable item clusters, with a duration of 2 hours each, were derived from the core test. These booklets were allocated to individual students according to a random selection process. Since two booklets can never have exactly the same average difficulty, Item Response Modeling was used by PISA to establish

comparable science results across students. We averaged the five plausible scores on scientific literacy. Estimating the same models five times with another plausible value and averaging the parameters, gives the same outcomes as using the average of the five plausible values (see Levels et al (2008b) for a comparable approach).

Educational system features of countries of destination

Information on destination countries' educational systems has been derived from PISA 2006, by aggregating these school characteristics to the destination country level, also using schools with only native pupils. The principal provided these school characteristics.

Quality of educational resources is an index composed by PISA (IRT scaling) that indicates to what extent instruction at school is hindered by the following factors: shortage or inadequacy of science laboratory equipment, shortage or inadequacy of instructional materials (e.g. textbooks), shortage or inadequacy of computers for instruction, lack or inadequacy of internet connectivity, shortage or inadequacy of computer software for instruction, shortage or inadequacy of library materials, shortage or inadequacy of audio-visual resources. Positive values refer to higher quality resources in a country of destination.

The *degree of teacher shortage* is an index provided by PISA (IRT scaling) that indicates the extent to which instruction is hindered by the following factors: a lack of qualified science teachers, a lack of qualified mathematics teachers, a lack of qualified language teachers, and a lack of qualified teachers of other subjects. Positive values refer to countries with higher teacher shortages.

Nationally standardized exam is a dummy variable that indicates whether a destination country has nationally standardized examinations in science at the end of secondary education. This is the case in Australia, Germany, Denmark, Finland, Liechtenstein, Luxembourg, Latvia, the Netherlands, Norway, New Zealand, and Scotland (1) and not in Austria, Belgium, Switzerland, Greece, and Portugal (0, reference category). This information has been derived from additional information provided by PISA (OECD, 2007, table 5.2).

To measure the level of *differentiation* of the educational system, we classified countries according to their stratification level. This was based on the first age at which pupils have to choose between different educational types, the number of types pupils can choose between, and the presence of more types of internal ability grouping or tracking. Although PISA provides this information for all countries in the sample, we have consulted additional descriptions of national experts (Schneider, 2008; Shavit and Müller, 1998; UNESCO, 2007). Overall, the different sources have revealed a similar pattern. In the highly stratified countries, children can choose between at least 3 different educational types at age 10 (Germany, Austria), 11 (Liechtenstein), or 12 (Switzerland, the Netherlands). In comprehensive systems, children are not selected into different educational types before age 15 and they are not tracked within their common schools. We define Austria, Switzerland, Germany, Liechtenstein, and the Netherlands as highly stratified systems; Belgium, Greece, Portugal, and Luxembourg as moderately stratified systems; and Finland, Norway, Denmark, New Zealand, Australia, Scotland, and Latvia as systems that are hardly stratified. We use dummy variables indicating whether countries have highly stratified, moderately differentiated or comprehensive education systems. The latter are reference.

Educational system features of countries of origin

Information on educational systems of origin countries' educational systems has been derived from *World Data on Education* 2006/2007.

The *Education for All Development Index (EDI)* is a composite expressing to what degree a origin country succeeds in providing education for all. It consists of a country's total primary net enrolment ratio (the percentage of primary-school-age children who are enrolled

in either primary or secondary school), the survival rate up to grade 5, adult literacy, and gender parity in primary and secondary education. It ranges from 0,75 (Morocco) to 0,99 (e.g. Germany, France, and Sweden). The EDI-scores reflect the situation in 2004.

The *student-teacher ratio in primary education* was taken into account at both the origin and destination level. At the origin level, it ranges from 10 to 40 students per teacher, with an overall average of slightly less than 20 students per teacher for all origin countries. At the destination level, it ranges from 10 to 18. Data have been gathered in 2006.

Years of compulsory education refers to the duration of compulsory schooling in countries of origin. On average for all origin countries in our data, pupils are obliged to attend school for slightly less than 10 years. The mandatory length of schooling varies considerably between origin countries, from 5 to 13 years. Again, data reflect the situation in 2006.

Macro-economic characteristics of countries of origin

A country's level of economic development was approached by its *Human Development Index (HDI)* (2007). It provides a broad picture of a country's human development level. Ranging from 0 to 1, the Human Development Index (2007/2008) combines information on countries' life expectancies, adult literacy rates, gross enrolment ratios in primary, secondary, and tertiary education, and GDPs in order to measure countries' levels of human development. The countries political stability is measured with the World Bank Government Indicator for political stability (Kaufmann, Kraay and Mastruzzi 2005). The measurement represents the perceived likelihood of revolutionary regime-change by violent or otherwise unconstitutional means. A higher score refers to a more stable political situation.

Individual level variables

In line with Rumbaut (2004), we have constructed immigrant generation variables that combine information on the birth countries of both the parents and the pupil and his/her age of migration. *Second generation* immigrant children are those pupils of whom at least one parent was born abroad, but who have been born in the current destination country themselves. *First generation* immigrant pupils have been born abroad themselves as well. If the age of migration of first generation immigrant pupils was before age 5, those pupils have been labeled *1.75 generation* immigrant pupils. The *1.5 generation* refers to first generation pupils who have migrated between the age of 5 and 12, and the *1.25 generation* refers to those pupils who migrated after the age of 12. First generation immigrant pupils without an age of arrival got the average age of their combination of origin and destination country. We also created an *immigrant generation missing dummy variable*. Second generation immigrants are used as the reference category.

One native parent. A dummy variable was used to identify pupils who had one immigrant and one native-born parent (1); pupils with two non-native parents represent the reference group (0).

Official language of destination country spoken at home. We included a dummy variable to differentiate immigrant children who speak one of their destination country's official languages at home (1) from children who speak a foreign language (0). Immigrant pupils without a valide answer on this question got the average answer of their combination of origin and destination country. We also created a *language missing dummy variable*.

Parental occupational status is measured according to the ISEI scale (Ganzeboom, de Graaf, Treiman, and de Leeuw, 1992), which ranges from 16 to 90. We use the ISEI score of the parent with the highest occupational status.

Parental educational level is measured according to the ISCED scale (UNESCO, 2006) and ranges from 0 to 6. We use the ISCED level of the highest educated parent.

Home possessions is a summary index of the amount of material and cultural goods that are available at home. It is a combined measure of the availability of a study desk, a private room, a quiet place to study, a computer, educational software, access to the internet, classic literature or poetry books, works of art, books to help with school work, a dictionary, a dishwasher, and more than 100 books. A higher score indicates a higher level of home possessions.

Vocational education. A dummy variable indicates whether a pupil is currently enrolled in a vocational (1) or general (0) type of education. This division has been adopted from the ISCED classification.

Grade. Since not all pupils attend the same grade, we have included a variable to account for this. As a result of between-country variance in the counting of grades, we have standardized grade around the modal grade in a country.

Female. We control for gender-effects by using a dummy variable indicating whether a pupil is female (1) or male (0).

Table 1 provides an overview of minimum and maximum scores, the mean and the standard deviation of all variables in our analysis.

Table 1 here

Analyses and results

Methods

To analyze non-hierarchically structured data, cross-classified multilevel regression analyses are appropriate (Snijders and Bosker, 1999). We used Iterative Generalized Least Squares (IGLS) estimation techniques from the statistical analysis program MLwiN to estimate models (Browne, 2003). Although originally designed to fit hierarchical models, IGLS can also be adapted to non-hierarchical data structures. IGLS is based on an iterative procedure which provides point estimates for all parameters, including their standard deviations. We make use of a double comparative design (*cf.* Van Tubergen, 2006; Levels et al., 2008), that models variance between origin countries and variance between destination countries simultaneously. This is necessary in order to disentangle the various macro-level effects. An additional advantage of this double comparative multilevel approach is that the variation of (unmeasured) factors, unique to each destination or origin country, are captured by the random intercept at the origin and destination levels and thus does not cause much bias in the parameters of the measured variables.

As a consequence of the double comparative design, native pupils cannot be included in our analysis, since for native pupils the origin country equals the destination country. However, in order to account for the fact that in some destination countries the average performance of all pupils is higher than in others (as an indicator of the general quality of schooling), the average science performance of natives per destination country is added as a variable to the analysis. This approach has been suggested by van Tubergen (2006) and was adopted by Levels et al. (2008). We apply this approach because in this analysis we do not want to explain differences in average performances of pupils (both natives and immigrant) in different countries, but we focus on the differences in the performance of immigrant pupils in these countries.⁶

Descriptive results

Table 2 presents the average scientific performance of immigrant pupils per destination and origin country. On average, the 9.279 immigrant pupils living in our 16 destination countries

have a scientific literacy score of 468, which is 32 points below the OECD mean. However, the overall immigrant mean of 468 conceals the considerable variation by origin and destination country. The difference between the lowest and highest performing origin group is almost 200; immigrant pupils from Cap Verde have an average science score of 380, immigrant pupils from the United States have an average score of 571. Other high performers are the Chinese and Australian immigrants (552 and 548 respectively). Those variable scores of immigrants originating from different countries might indicate the existence of origin effects. Next to those apparent origin effects, destination effects seem to exist as well. Whereas immigrant pupils living in Australia have an average science score of 536, immigrant pupils in Denmark have a score of no higher than 388. So, science performance of immigrants also differs across different countries of destination.

Table 2 here

Variance components

A cross-classified multilevel model, which does not include any explanatory variables, gives the distribution of unexplained variance across three levels. By far the most variance occurs at the individual level (74%). Since our data set contains 16 relatively homogeneous (developed) destination countries, the small variance at the destination level (7%) is not surprising. A larger amount of variance can be attributed to variance across origin groups: 19% of all variance in the educational achievement of immigrant pupils can be attributed to the countries immigrant children migrated from. So, although variance at the individual level accounts for the largest share of differences in educational achievement, a quarter of those differences exists at contextual levels.⁷

Individual effects

In model 1 of table 3, a range of individual-level characteristics is added to the initial empty model. Taking into account individual-level variables is not only important because the majority of variance in scientific literacy is caused by individual-level predictors, but also because they allow the detection of composition effects (Hox, 2002). Immigrants in one destination country might outperform immigrants in another, not because of contextual effects, but because destination countries host immigrant pupils with different individual background characteristics. The same reasoning applies to immigrants originating from different origins. In order to rule out individual background differences across different origin groups, individual-level variables have to be taken into account.

Most results are in line with earlier research. Parental education and occupation, and home possessions have a large positive influence on scientific literacy. This strong influence of parental class position on educational achievement or attainment has been widely documented for natives in many Western countries (see e.g. Shavit and Blossfeld, 1993, and more recently, Breen, Luijkx, Müller, and Pollak, 2009). Moreover, immigrant children who speak their host country's language at home perform better at school than their counterparts who do not. Interesting is the large negative effect of attending vocational types of education. Comparable immigrant pupils who attend vocational education perform 57 points less on the science scale than immigrant pupils who attend general types of education. This finding might reflect the differences in the offered curriculum: whereas vocational education types pay more attention to practical skills needed at the labor market, general types of education more heavily focus on more abstract knowledge, also related to later entrance of college or university. The grade of the 15-year old pupil has a strong effect on educational outcomes, reflecting both differences in scholastic ability and in curriculum offered to the pupils. By

controlling for grades, cross-national differences in grading cannot explain the found effects of characteristics of educational systems.

The results furthermore underscore the importance of taking into account immigrant children's age of migration. Second generation immigrants and 1.75 generation immigrants have the highest educational performance, 1.5 generation immigrants score 7 points lower, and 1.25 generation immigrants score 31 points lower. These results indicate that the more time immigrant children have spent in their host country's educational system, the better they perform.

As can be seen from comparing the variance components of model 1 (table 3) to the mentioned components of the empty model, composition effects indeed explain an important share of the initial variance in scientific performance. After inclusion of individual-level characteristics and the average performance of the natives of the destination countries, the initial variance at the destination level is reduced by 33% and the variance at the origin level by 62%. Apparently, a substantial share of the differences in educational achievement across different origin groups and across immigrants living in different destination countries can be attributed to differences in individual background characteristics of these groups. This finding underscores the importance of individual features for explaining macro-level differences. The average educational performance of natives in the destination countries affects the performance of the immigrant children positively, which reflects a general effect of the general quality of educational systems on outcomes.

Tables 3 and 4 here

The effect of educational systems

Due to the relatively large number of educational system characteristics in comparison to the rather limited degrees of freedom at the destination and partly at the origin level, we have added all characteristics at the destination and origin levels single one by one to model 1 of table 3. The parameters of this single addition are shown in table 4. Subsequently, educational system characteristics have been added simultaneously to model 1 of table 3, starting with the characteristics that resulted in the largest improvement in model fit in table 4. In model 2 of table 3, only the significant educational system features of origin and destination countries are presented. In model 3, the hypothesized cross-level interactions are added.⁸

At the destination level, the degree of differentiation of an educational system significantly affects immigrant children's educational performance. The educational performance of immigrant children in highly stratified educational systems is on average 40 points lower than the performance of their counterparts in comprehensive systems. This finding supports partly hypothesis 1. But the effect van moderately differentiated education system on education performance is more positive than that of a comprehensive education system, and that runs partly against the first hypothesis that any differentiation in educational systems is detrimental for the educational performance of immigrant children. The inclusion of cross-level interactions between the degree of differentiation and parental background (model 3) reveals some interesting additional information. Whereas former research has repeatedly shown that the effect of social class origin on the educational performance of native pupils is larger in countries with differentiated educational systems (see e.g. Dupriez et al., 2008; Duru-Bellat and Suchaut, 2005; Pfeffer, 2008; and Schütz, Ursprung, and Wössmann, 2005), we find the opposite pattern for immigrant pupils. Figure 1 illustrates this interaction: the influence of parental education on the educational performance of immigrants is weaker in highly and moderately differentiated education systems than in comprehensive systems. Stated differently, no matter how well immigrants' parents are educated, their

performance is lowest in highly stratified systems, and the highest in moderately differentiated systems.

Figure 1 here

No support has been lent to hypothesis 2A on the importance of external standards. The existence of nationally standardized examinations in science has no significant influence on immigrant pupils' performance. Hypothesis 3A on the resources of a destination country's educational system receives some support from our findings. As can be seen in model 2, the educational performance of immigrants is lower in countries with high levels of teacher shortage ($b=-33.95$). In additional analysis we added the GDP of the destination countries to model 3. This inclusion of GDP at the destination level had hardly an effect on the coefficients.⁹

At the origin level, the duration of compulsory education has a substantial positive influence on scientific performance ($b=8.45$; model 2). In line with hypothesis 2B, this positive influence is strongest for immigrant children who attended part of their education in their origin country (the 1.25 generation, and to a lesser extent, the 1.5 generation). Figure 2 graphically displays this interaction. Whereas the difference in educational performance between second generation immigrants who originate from countries with 5 or 13 years of compulsory education is 54 score points, the difference for the 1.75 generation is 76 points, for the 1.5 generation 81 points, and for the 1.25 generation no less than 156 points.

In order to rule out the possibility that years of compulsory education are a mere reflection of origin countries' level of economic and political prosperity, we add both origin countries' scores on political stability and economic prosperity (HDI). Model 4 of table 3 shows that those indicators did not significantly influence immigrants' educational performance and their inclusion affected the other coefficients hardly. The significant effect of the EDI-score at the origin level (in table 4) turned insignificant in combination with other variables, like compulsory years, as shown in model 5 of table 3. Hypothesis 3B has to be rejected. However, if we run analyses without years of compulsory education but with the two indicators of political stability and economic prosperity, the effect of HDI is positive and becomes significant while the effect of political stability remains negative but still insignificant.¹⁰

The variance in scientific performance at the destination level has declined by 72% after addition of the educational system characteristics and the cross-level interactions in model 3. The variance at the origin level has been reduced by 73%.

Figure 2 here

Conclusion and discussion

The focus of this study was on educational system features of origin and destination countries and their relation with the educational performance of 15-years old immigrant children. Relying on the literature on educational systems, we assumed that educational systems broadly differ in their degree of differentiation, their level of standardization, and the availability of resources and that these system features are significant for the educational performance of immigrant children. Using PISA 2006 data, this research has examined the scientific performance of 9.279 immigrant pupils from 35 different countries of origin living in 16 different Western countries of destination. Although former and also our research underscore the importance of individual in explaining immigrant children's educational performance (Levels et al., 2008) we show that the features of the educational systems of both origin and destination countries also affect the educational performance of immigrant

children, independently of the economic and political prosperity of the origin countries, the average educational performance of the natives in the destination countries or the GDP of destination countries. As said earlier, the results with reading or math scores as dependent variables instead of scientific literacy are substantially the same, which is additional evidence that characteristics of educational systems are relevant for educational outcomes.

Our analysis reveals also that differences in average scientific performance across immigrants living in different destination countries cannot be solely attributed to compositional differences of the immigrants or the average educational performance of the natives in the countries of destination. The degree to which an educational system is highly stratified has an important influence on immigrant children's educational performance. In line with expectations, the average science performance of immigrants is lowest in highly stratified educational systems than in educational systems with a moderate level of differentiation. In highly stratified systems, pupils have to choose between different educational tracks at a relatively young age. As a result of their lower linguistic resources and the lower parental knowledge of the educational options immigrant pupils in highly stratified systems are more likely to be selected into lower school-types, in which they have a less demanding curriculum and a less favorable school composition, than comparable immigrant pupils in less differentiated systems. Interestingly, our results indicate that the science score of lower class immigrant children is highest in moderately differentiated systems, and not in comprehensive systems. But immigrant pupils from higher social classes perform lowest in highly stratified educational systems compared with immigrant pupils from the same social class in moderately differentiated or comprehensive systems. So, the highly stratified educational system seems even not to function as a good sorting system for well performing migrant children from the higher social classes. The combination of these findings suggest that the educational performance of the average immigrant pupils is only hampered in highly stratified systems, but not in moderately differentiated systems. The latter conclusion deviates from results found by Pfeffer (2008) and Dunne (2010) for native pupils from lower classes, who perform also less in moderately differentiated educational systems.

In addition to the negative effect of differentiation, our results show that immigrant pupils perform less in destination countries that have a high degree of teacher shortage, also with control for the average score of the native pupils (which is also influenced negatively by a teacher shortage). This shortage might lower the quality of teaching in those societies, because more lessons are skipped or given by unqualified teachers. Immigrant pupils might be more vulnerable for a lower quality of teaching due to their lack of linguistic resources and their lower knowledge of their country of destination. The strong effect of attending vocational track on educational performance of comparable immigrant pupils is another indication of the importance of early curriculum differentiation. Vocational schools pay more attention to practical skills needed at the labor market, while general education focus on more abstract knowledge, related to later entrance of college or university. This different curriculum offered in vocational and general education leads to different educational performance of the pupils. The negative effect of stratified educational systems on the educational performance of immigrant children cannot be explained by the existence of a vocational stream within these systems. Our results show that both features have independent negative effects on educational performance of comparable immigrant children.

Also the grade of the pupil has a strong effect on performance. This effect might both reflect differences in scholastic performance in primary and early secondary education and differences in offered curriculum. The negative effect of stratified educational systems on the educational performance of immigrant children cannot be explained by the existence of differences in grading in these educational systems.

We did not find the hypothesized effect of the national examination in destination countries on immigrants' children outcome. It might be that a national exam also compels schools to be cautious with the placement of pupils, who might have a higher propensity to fail the national exam. Immigrant's children might be considered by school authorities to be such a risk and therefore placed in a lower track.

As was the case at the destination level, differences in scientific literacy across immigrants originating from different countries of origin cannot be solely attributed to compositional differences or to the average educational performances in their countries of destination. The years of compulsory education in the origin country caused a substantial reduction in variance at the origin level: the longer the length of compulsory education, the better especially first generation immigrant children who have attended education in that particular origin country perform in science. Our models show that compulsory years of education are not a mere reflection of origin countries' level of economic or political prosperity (more developed and stable nations attach a higher value to education, and therefore make standardized education compulsory for a longer length of time). The length of compulsory education might be an independent indicator of quality of education offered to all pupils in immigrants' origin countries. The positive effect of duration of compulsory education for immigrant children who never attended education in their origin country (the second and 1.75 generation), can most likely be attributed to unmeasured parental educational resources. This unmeasured variance is likely to be related to the length of standardized compulsory education in the countries of origin, which might be an indicator of the quality of education for all pupils in their origin country.

Overall, this study has underscored the importance of taking into account educational system features as an explanation of differences in educational achievement across different origin groups and across immigrants living in different destination countries. Although individual level characteristics account for the largest educational achievement differences between immigrant pupils, educational system characteristics have an effect on top of these individual level characteristics and the average educational performance in their countries of origin. We also showed that differences in educational systems contribute to explaining the effects of economic and political macro-characteristics of the countries of origin (HDI, Political stability) on the educational performance of immigrant children in destination countries. This means that the effects of educational system features partly interpret the effects of economic development. Our results improve those of Levels et al (2008) by showing that both features of the educational systems and the level of economic and political prosperity of origin countries should be included while analyzing educational performance of immigrant children. Our results suggest that the level of economic and political prosperity of the origin countries influences the features of the educational system of origin, but that this prosperity has only an indirect effect on outcomes via the standardized quality of the educational system, measured by length of compulsory education. Levels et al (2008) have overestimated the effect of economic and political development, because they did not include educational system features in their analysis.¹¹ Our results might imply that origin-related variation in the educational performance of immigrant children might be reduced if origin countries invest in their educational system. More research is needed to test this claim.

The finding that the educational performance of immigrant pupils is partly determined by characteristics of educational structure of their countries of origin and destination, calls for more direct measures of various aspects countries' educational systems and the inclusion of other aspects of educational systems in further analyses. We consider this article only as a start of such an endeavor. Moreover, in order to provide more robust tests of hypotheses concerning effects of educational systems, information from a larger number of destination countries would be necessary. Given the importance of immigrant children success in

education, it is incomprehensible that OECD destination countries like Canada, France, United Kingdom, United States or Sweden do not collect and make available this information.¹²

Another important improvement will be the inclusion of a school-level between the levels of counties of origin and destination and the individual pupil. Dunne (2010) and Dronkers (2010b) showed independently that school characteristics like school composition and ethnic and social-cultural diversity in schools have different effects and implications in different educational systems for educational achievement, although these school-level variables seem not explain away the independent effects of origin and destination macro-characteristics.

Notes

¹ Other forms of external standards like national assessment or a national inspectorate are less reliable indicators for a cross-national analysis.

² However, if we use the more limited measurement of reading and mathematics in PISA 2006 as dependent variables, our results are substantially the same: webpage SoE/Sage table A5

³ Information on the construction of the origin of the pupils and the number of immigrants in each combination is available on the webpage of the SoE/Sage (tables A1 & A2).

⁴ Bangladesh (5), Czech republic (6), Denmark (15), Estonia (8), Greece (15), Hungary (12), Liechtenstein (4), Rumania (28), Slovakia (6), Slovenia (5), Macedonia (22).

⁵ Since the OECD allows participating countries to propose their own birth country categories, some countries have measured more origin countries than others. As a result, the number origin countries in the different countries of destination are partly dependent on the quality of the national survey. Therefore we have compared the origin countries in PISA with national statistics. In the case of Australia, Austria, Finland, Switzerland, Luxembourg, and New Zealand the three largest immigrant groups as identified by the statistical offices are also represented in PISA data. In the case of Belgium, Germany, Liechtenstein, the Netherlands, and Scotland, the two largest groups are represented. In Greece, the largest immigrant group (Albanians, Eurostat, 2008) is that also in PISA data. Russians are the largest immigrant group in Latvia (Eurostat, 2008), which is also the case in PISA data.

⁶ We have computed the models of table 3 also without the average science performance of the natives (see table A3 webpage SoE/Sage). The deletion of this macro-variable had hardly any effect on the coefficients in table 3.

⁷ The inclusion of an additional school-level does not eliminate the variance of origin or destination country (Dronkers, 2010b).

⁸ We have conducted a sensitivity analysis for the results of the parameters of the countries of destination by deleting one by one each of the countries of destination (see table 4A webpage SoE/Sage). The parameters happen to remain very stable and hardly affected by the deletion of one of the countries of destination. Another sensitivity analysis used the difference on the Hofstede (1986) collectivism-individualism dimension between origin and destination country as an indicator of the cultural distance between immigrants' origin and destination. The addition of this difference show that immigrants' children, who origin from countries with a higher collectivism score relative to their destination country, have lower educational outcomes, but the addition of this cultural distance does alter the effects of the characteristics of the educational systems (see Table A4 webpage SoE/Sage).

⁹ See table A6 webpage SoE/Sage.

¹⁰ See table A6 webpage SoE/Sage.

¹¹ We have made analysis with more macro-characteristics of the countries of origin. Although we had fewer degrees of freedom due to the higher number of included macro-variables, the reported effects of the educational systems remain more or less equal and also significant.

¹² Also in PISA wave 2009 these countries have not measured the countries of birth.

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Figure 1 The average science score of immigrant children by parental education and the degree of differentiation of the destination countries' educational systems (based on model 3, table 4)

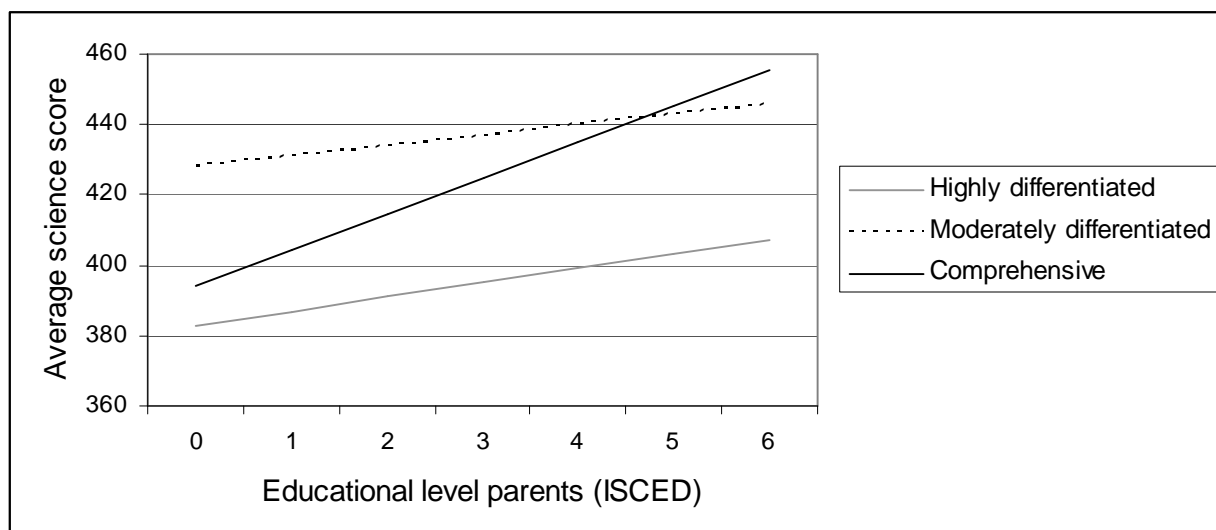


Figure 2 The average science score of immigrant children by immigrant generation and the compulsory years of education in the countries of origin (based on model 3, table 4)

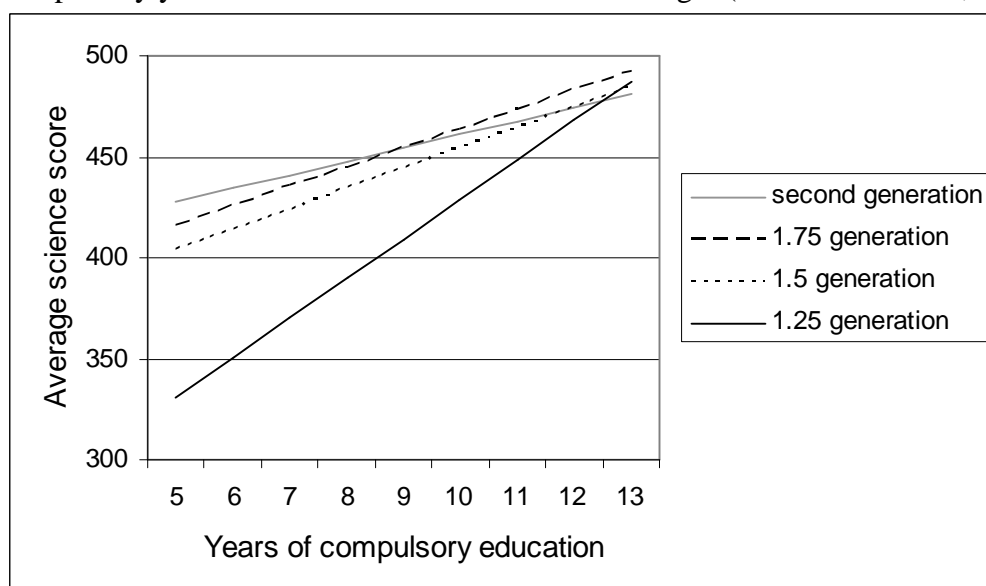


Table 1 Descriptive statistics of all variables in analysis (N=9.279)

	Min.	Max.	Mean	S.d.
<i>Dependent variable</i>				
Scientific literacy	130.30	841.04	468.63	103.20
<i>Destination variables</i>				
Average science performance natives	479.77	565.41	523.08	12.68
<i>Resources</i>				
Quality educational resources	-0.55	0.88	0.29	0.29
Degree of teacher shortage	-0.83	1.05	0.24	0.43
Student-teacher ratio in primary education	10	18	13.64	2.59
<i>Standardisation</i>				
Nationally standardized exams science	0	1	0.57	0.50
<i>Differentiation</i>				
Highly stratified system	0	1	0.31	0.46
Moderately differentiated system	0	1	0.25	0.47
Comprehensive system (ref.)	0	1	0.44	0.48
<i>Origin variables</i>				
<i>Resources</i>				
EDI-score	0.75	0.99	0.94	0.05
Student-teacher ratio in primary education	10	40	19.70	7.41
<i>Standardisation</i>				
Compulsory years of education	5	13	9.76	1.55
<i>Economic and Political Features</i>				
Human Development Index	0.41	0.96	.85	0.10
Political stability	-2.31	1.92	0.04	0.74
<i>Individual-level variables</i>				
Vocational type of education	0	1	0.16	0.37
Grade	-3	3	0.04	0.64
Girls	0	1	0.50	0.50
Parental education	0	6	3.92	1.85
Parental occupation	16	90	44.55	16.87
Home possessions	-5.12	4.02	-0.11	0.87
<i>Immigrant characteristics</i>				
Second generation (ref.)	0	1	0.51	0.50
1.75 generation	0	1	0.24	0.43
1.5 generation	0	1	0.16	0.36
1.25 generation	0	1	0.06	0.23
Immigrant generation unknown	0	1	0.04	0.19
One native parent	0	1	0.06	0.23
Language of test country spoken at home	0	1	0.50	0.50
Language spoken at home unknown	0	1	0.11	0.31

Source: PISA 2006, own calculations

Table 2 Average scientific literacy of immigrant pupils per country of destination and country of origin (N=9.279)

<i>Origin countries</i>	Destination countries																Mean
	AU	AT	BE	CH	DE	DK	EL	FI	LI	LU	LV	NL	NO	NZ	PT	SC	
Albania	0	412	0	359	0	0	434	0	358	0	0	0	0	0	0	0	404
Australia	0	0	0	0	0	0	0	0	0	0	0	0	0	548	0	0	548
Austria	0	0	0	495	0	0	0	0	554	0	0	0	0	0	0	0	519
Belarus	0	0	0	0	0	0	0	0	0	0	504	0	0	0	0	0	504
Belgium	0	0	0	0	0	0	0	0	0	528	0	0	0	0	0	0	528
Bosnia Herzegovina	0	445	0	0	451	421	0	0	0	0	0	0	0	0	0	0	440
Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	464	0	464
Cap Verde	0	0	0	0	0	0	0	0	0	380	0	0	0	0	0	0	380
China	562	518	0	0	0	0	0	0	0	0	0	0	0	547	458	483	552
Congo	0	0	427	0	0	0	0	0	0	0	0	0	0	0	0	0	427
Croatia	0	458	0	0	433	0	0	0	0	0	0	0	0	0	0	0	451
France	0	0	448	507	0	0	0	0	446	505	0	0	0	0	0	0	488
Germany	0	521	508	549	0	0	0	0	550	532	0	504	0	0	0	0	526
India	551	0	0	0	0	0	0	0	0	0	0	0	0	0	0	541	551
Italy	0	0	0	443	415	0	0	0	445	430	0	0	0	0	0	0	438
Rep. of Korea	514	0	0	0	0	0	0	0	0	0	0	0	0	528	0	0	521
Morocco	0	0	438	0	0	0	0	0	0	0	0	0	0	0	0	0	438
Netherlands	0	0	522	0	0	0	0	0	0	0	0	0	0	0	0	0	522
New Zealand	508	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	508
Pakistan	0	0	0	0	0	383	0	0	0	0	0	0	0	0	0	454	412
Philippines	512	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	512
Portugal	0	0	0	454	0	0	0	0	445	420	0	0	0	0	0	0	428
Russia	0	0	0	0	466	0	0	550	0	0	496	0	0	0	0	0	493
Samoa	0	0	0	0	0	0	0	0	0	0	0	0	0	425	0	0	425
Serbia Montenegro	0	426	0	427	414	0	0	0	417	0	0	0	0	0	0	0	420
South Africa	541	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	541
Spain	0	0	0	466	0	0	0	0	516	0	0	0	0	0	0	0	467
Sweden	0	0	0	0	0	0	0	522	0	0	0	0	465	0	0	0	477
Switzerland	0	0	0	0	0	0	0	0	521	0	0	0	0	0	0	0	521
Turkey	0	380	414	425	411	374	0	0	389	0	0	466	0	0	0	0	429
Ukraine	0	0	0	0	0	0	0	0	0	0	472	0	0	0	0	0	472
United Kingdom	542	0	0	0	0	0	0	0	0	0	0	0	0	569	0	0	550
United States	571	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	571
Vietnam	518	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	518
Mean immigrants	536	437	453	444	438	388	434	522	498	455	492	472	444	525	464	474	468
Mean natives	524	525	527	527	531	501	480	565	540	512	495	540	492	537	482	516	518
Difference (I-N)	12	-88	-74	-83	-93	-113	-46	-43	-42	-67	-3	-68	-48	-12	-18	-42	-50

Notes: Destination countries: AU=Australia; AT=Austria; BE=Belgium; CH=Switzerland; DE=Germany; DK=Denmark; EL=Greece; FI=Finland; LI=Liechtenstein; LU=Luxembourg; LV=Latvia; NL=Netherlands; NO=Norway; NZ=New Zealand; PT=Portugal; SC=Scotland.

Source: PISA 2006.

Table 3 Cross-classified regression of educational system characteristics of countries of origin and destination, controlled for individual characteristics, on the scientific literacy of immigrant pupils; Nd=16, No=35, Ni=9.279

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	462.62** (7.62)	483.79** (9.13)	393.99** (20.78)	382.90** (29.58)	315.55** (61.17)
<i>Destination effects of education</i>					
Average science performance natives		0.77** (0.31)	0.70** (0.31)	0.70** (0.31)	0.73** (0.31)
Degree of teacher shortage		-33.95** (12.39)	-36.16** (12.57)	-35.67** (11.52)	-35.85** (12.63)
Highly stratified education system		-39.13** (13.12)	-11.22 (14.68)	-12.65 (14.82)	-12.51 (14.80)
Highly stratified education system * parental education			-6.15** (1.36)	-6.14** (1.36)	-6.15** (1.36)
Moderately differentiated education system		0.41 (13.60)	33.93** (15.25)	33.01** (15.22)	35.16** (15.32)
Moderately differentiated education system * parental education			-7.23** (1.48)	-7.21** (1.48)	-7.23** (1.48)
<i>Origin effects of education</i>					
Compulsory years of education		8.45** (1.84)	6.71** (1.91)	6.01** (2.43)	5.35** (2.13)
Compulsory years of education * 1.75 generation			2.81** (1.41)	2.84** (1.42)	2.84** (1.41)
Compulsory years of education * 1.5 generation			3.42** (1.50)	3.44** (1.51)	3.42** (1.50)
Compulsory years of education * 1.25 generation			12.84** (2.18)	12.86** (2.18)	12.83** (2.18)
EDI					96.85 (71.20)
<i>Origin effects of economy & politics</i>					
HDI				22.41 (42.89)	
Political stability				-0.02 (0.05)	
<i>Individual effects</i>					
Grade	47.54** (1.41)	47.53** (1.41)	47.59** (1.41)	47.60** (1.41)	47.61** (1.41)
Vocational type of education	-56.50** (2.73)	-56.58** (2.72)	-57.36** (2.72)	-57.36** (2.72)	-57.38** (2.72)
Girls	-7.92** (1.62)	-7.90** (1.62)	-7.86** (1.62)	-7.85** (1.62)	-7.86** (1.62)
Parental education	4.94** (0.56)	4.92** (0.56)	10.25** (1.18)	10.24** (1.18)	10.24** (1.18)
Parental occupation	0.89** (0.06)	0.88** (0.06)	0.86** (0.06)	0.86** (0.06)	0.86** (0.06)
Home possessions	9.47** (1.06)	9.40** (1.06)	9.00** (1.06)	8.99** (1.06)	8.98** (1.06)
<i>Immigrant characteristics</i>					
Second generation	Ref.	Ref.	Ref.	Ref.	Ref.
1.75 generation	2.19 (2.28)	2.12 (2.28)	-25.38* (13.77)	-25.71* (13.80)	-25.78* (13.77)
1.5 generation	-7.05** (2.58)	-7.22** (2.58)	-40.85** (15.09)	-41.04** (15.11)	-41.06** (15.09)
1.25 generation	-30.93** (3.83)	-30.94** (3.83)	-160.71** (22.40)	-160.80** (22.41)	-160.73** (22.40)
Immigrant generation unknown	-19.96** (4.36)	-20.19** (4.36)	-18.46** (4.36)	-18.44** (4.36)	-18.46** (4.36)
One native parent	5.69 (3.84)	4.96 (3.84)	5.35 (3.89)	5.35 (3.90)	5.30 (3.89)
Language of test country spoken at home	16.66** (2.29)	15.83** (2.30)	15.34** (2.30)	15.34** (2.30)	15.34** (2.30)
Language spoken at home unknown	-22.95** (2.87)	-23.20** (2.87)	-23.55** (2.86)	-23.54** (2.86)	-23.51** (2.86)
<i>Variance components^a</i>					
Destination	511 (33)	201 (74)	214 (72)	208 (135)	225 (139)

Origin	771 (62)	549 (73)	543 (73)	542 (119)	517 (115)
Individual	5996 (32)	5996 (37)	5956 (37)	5956 (37)	5956 (37)
Deviance (IGLS; -2*LL)	107244	107216	107155	107155	107153

Source: PISA 2006, own calculations. Notes: standard deviations in parentheses; ** = significant at the 0.05 level, * = significant at the 0.1 level. ^a Between parentheses, the explained variance (in %) at respectively destination, origin, and individual level, as compared to model 0 (table 3). As recommended by Snijders and Bosker (1999), the explained variance at the individual level is computed by calculating the change in total variance.

Table 4 The coefficients, standard errors and improvement in model fit in a single addition of the origin and destination educational characteristics to model 1 of table 4, relative to the performance of the natives in the countries of destination

		Co.	SE	IMF
Destination effects				
<i>Resources</i>	Quality educational resources	4.518	18.31	0.1
	Degree of teacher shortage	-21.73*	12.25	2
	Student-teacher ratio in primary education	-3.92	3.30	0.9
<i>Standardization</i>	Nationally standardized exams science	-21.07	14.37	0.6
<i>Differentiation</i>	Highly stratified system	-24.47*	13.72	5.9
	Moderately differentiated system	-2.88	15.53	5.9
	Comprehensive system	Ref.	Ref.	Ref.
Origin effects				
<i>Resources</i>	EDI-score	224.10**	70.09	9
	EDI-score * 1.25 generation	116.42	77.13	13
	EDI-score * 1.5 generation	58.71	51.19	13
	EDI-score * 1.75 generation	-25.55	51.08	13
	Student-teacher ratio in primary education	-1.65**	0.47	11.1
	Student-teacher ratio in primary education * 1.25 generation	-0.30	0.52	12.5
	Student-teacher ratio in primary education * 1.5 generation	-0.12	0.34	12.5
	Student-teacher ratio in primary education * 1.75 generation	0.24	0.31	12.5
<i>Standardization</i>	Compulsory years of education	8.85**	1.91	18.6
	Compulsory years of education * 1.25 generation	12.77**	2.18	53.7
	Compulsory years of education * 1.5 generation	3.43**	1.51	53.7
	Compulsory years of education * 1.75 generation	2.78**	1.42	53.7

Source: PISA 2006, own calculations

Note: ** = significant at the 0.05 level, * = significant at the 0.1 level

APPENDIX: webpage second author

Table A1 schematic overview of the decision rules used to determine a pupil's country of origin and immigrant status

	Country of birth student	Country of birth mother	Country of birth father	Country of origin	Immigrant status
1	A	A	A	A ¹	I, first generation
	T	T	T	T ²	N
2	B	A	A	A	I, first generation
	T	A	A	A	I, second generation
	A	T	T	T	N
	A	B	A	A	I, first generation
	A	T	A	A	I, first generation
	T	A	T	A	I, second generation
	A	A	B	A	I, first generation
	A	A	T	A	I, first generation
3	T	T	A	A	I, second generation
	A	B	C	B	I, first generation
	T	A	B	A	I, second generation
	A	T	B	B	I, first generation
4	A	B	T	B	I, first generation
	Miss.	A	A	A	I, generation unknown
	Miss.	T	T	T	N, country of birth
	A	Miss.	A	A	I, first generation
	T	Miss.	T	T	N
	A	A	Miss.	A	I, first generation
5	T	T	Miss.	T	N
	Miss.	Miss.	A	A	I, generation unknown
	Miss.	Miss.	T	T	N, country of birth
	Miss.	A	Miss.	A	I, generation unknown
	Miss.	T	Miss.	T	N, country of birth
	A	Miss.	Miss.	A	I, first generation
6	T	Miss.	Miss.	T	N
	B	Miss.	A	A	I, first generation
	T	Miss.	A	A	I, second generation
	A	Miss.	T	T	N
	B	A	Miss.	A	I, first generation
	T	A	Miss.	A	I, second generation
	A	T	Miss.	T	N
	Miss.	B	A	B	I, generation unknown
	Miss.	T	A	A	I, generation unknown
7	Miss.	A	T	A	I, generation unknown
	Miss.	Miss.	Miss.	Miss.	Miss.

¹ Country of origin *not* equal to current destination country

² Country of origin equal to current destination country

Table A2 Overview of the number of immigrant pupils by country of origin and country of destination

<i>Origin countries</i>	<i>Destination countries</i>																Total
	AU	AT	BE	CH	DE	DK	EL	FI	LI	LU	LV	NL	NO	NZ	PT	SC	
Albania	-	13	-	125	-	-	187	-	1	-	-	-	-	-	-	-	326
Australia	-	-	-	-	-	-	-	-	-	-	-	-	-	54	-	-	54
Austria	-	-	-	31	-	-	-	-	21	-	-	-	-	-	-	-	52
Belarus	-	-	-	-	-	-	-	-	-	-	107	-	-	-	-	-	107
Belgium	-	-	-	-	-	-	-	-	-	89	-	-	-	-	-	-	89
Bosnia Herzegovina	-	136	-	-	13	40	-	-	-	-	-	-	-	-	-	-	189
Brazil	-	-	-	-	-	-	-	-	-	-	-	-	-	-	45	-	45
Cap Verde	-	-	-	-	-	-	-	-	-	80	-	-	-	-	-	-	80
China	252	8	-	-	-	-	-	-	-	-	-	-	-	117	4	16	397
The Congo	-	-	137	-	-	-	-	-	-	-	-	-	-	-	-	-	137
Croatia	-	36	-	-	14	-	-	-	-	-	-	-	-	-	-	-	50
France	-	-	125	119	-	-	-	-	2	184	-	-	-	-	-	-	430
Germany	-	44	147	173	-	-	-	-	16	100	-	90	-	-	-	-	570
India	104	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	107
Italy	-	-	-	300	30	-	-	-	13	98	-	-	-	-	-	-	441
Rep. of Korea	69	-	-	-	-	-	-	-	-	-	-	-	-	76	-	-	145
Morocco	-	-	225	-	-	-	-	-	-	-	-	-	-	-	-	-	225
The Netherlands	-	-	95	-	-	-	-	-	-	-	-	-	-	-	-	-	95
New Zealand	263	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	263
Pakistan	-	-	-	-	-	25	-	-	-	-	-	-	-	-	-	17	42
The Philippines	134	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	134
Poland	-	25	94	-	77	-	-	-	-	-	-	-	-	-	-	-	196
Portugal	-	-	-	241	-	-	-	-	6	799	-	-	-	-	-	-	1046
Russia	-	-	-	-	79	-	-	25	-	-	186	-	-	-	-	-	290
Samoa	-	-	-	-	-	-	-	-	-	-	-	-	-	130	-	-	130
Serbia Montenegro	-	78	-	952	21	-	-	-	14	-	-	-	-	-	-	-	1065
South Africa	112	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	112
Spain	-	-	-	119	-	-	-	-	3	-	-	-	-	-	-	-	122
Sweden	-	-	-	-	-	-	-	11	-	-	-	-	39	-	-	-	50
Switzerland	-	-	-	-	-	-	-	-	63	-	-	-	-	-	-	-	63
Turkey	-	161	156	244	198	81	-	-	11	-	-	505	-	-	-	-	1356
Ukraine	-	-	-	-	-	-	-	-	-	-	101	-	-	-	-	-	101
United Kingdom	490	-	-	-	-	-	-	-	-	-	-	-	-	200	-	-	690
United States	47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47
Vietnam	33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33
Total	1504	501	979	2304	432	146	187	36	150	1350	394	595	39	577	49	36	9279

Notes: AU=Australia; AT=Austria; BE=Belgium; CH=Switzerland; DE=Germany; DK=Denmark; EL=Greece; FI=Finland; LI=Liechtenstein; LU=Luxembourg; LV=Latvia; NL=the Netherlands; NO=Norway; NZ=New Zealand; PT=Portugal; SC=Scotland.
Source: PISA 2006.

Table A3 Cross-classified regression of educational system characteristics of countries of origin and destination on the scientific literacy of immigrant pupils, *not controlled for the average performance of natives in the countries of destination*; Nd=16, No=35, Ni=9.279

	Model 1	Model 2	Model 3
Intercept	462.62** (7.62)	392.35** (19.89)	385.87** (21.13)
<i>Destination effects</i>			
Degree of teacher shortage		-28.47** (13.79)	-31.10** (13.68)
Highly differentiated education system		-26.55* (14.15)	-3.67 (15.27)
Highly differentiated education system *			-6.19** (1.36)
Parental education			
Moderately differentiated education system		0.69 (15.06)	27.20** (16.30)
Moderately differentiated education system * parental education			-7.27** (1.48)
<i>Origin effects</i>			
Compulsory years of education		8.88** (1.87)	7.09** (1.94)
Compulsory years of education * 1.75 generation			2.86** (1.41)
Compulsory years of education * 1.5 generation			3.49** (1.50)
Compulsory years of education * 1.25 generation			12.95** (2.18)
<i>Individual effects</i>			
Grade	47.54** (1.41)	47.57** (1.41)	47.63** (1.41)
Vocational type of education	-56.50** (2.73)	-56.60** (2.73)	-57.38** (2.72)
Girls	-7.92** (1.62)	-7.90** (1.62)	-7.86** (1.62)
Parental capital			
Parental education	4.94** (0.56)	4.91** (0.56)	10.28** (1.18)
Parental occupation	0.89** (0.06)	0.88** (0.06)	0.86** (0.06)
Home possessions	9.47** (1.06)	9.40** (1.06)	9.00** (1.06)
Immigrant generation			
Second generation	Ref.	Ref.	Ref.
1.75 generation	2.19 (2.28)	2.13 (2.28)	-25.82* (13.77)
1.5 generation	-7.05** (2.58)	-7.19** (2.58)	-41.53** (15.10)
1.25 generation	-30.93** (3.83)	-31.05** (3.83)	-161.89** (22.40)
Immigrant generation unknown	-19.96** (4.36)	-20.17** (4.36)	-18.42** (4.36)
One native parent	5.69 (3.84)	5.14 (3.84)	5.51 (3.90)
Language of test country spoken at home	16.66** (2.29)	15.70** (2.30)	15.22** (2.30)
Language spoken at home unknown	-22.95** (2.87)	-23.16** (2.87)	-23.55** (2.86)
<i>Variance components^a</i>			
Destination	511 (33)	322 (58)	315 (59)
Origin	771 (62)	568 (72)	560 (72)

Individual	5996 (32)	5995 (35)	5956 (36)
Deviance (IGLS; -2*LL)	107244.3	107221.6	107159.5

Source: PISA 2006, own calculations

Notes: standard deviations in parentheses; ** = significant at the 0.05 level, * = significant at the 0.1 level

^a Between parentheses, the explained variance (in %) at respectively destination, origin, and individual level, as compared to model 0 (table 3). As recommended by Snijders and Bosker (1999), the explained variance at the individual level is computed by calculating the change in total variance.

Table A4 Sensitivity analysis of the macro-level effects, based on model 3 of table 3 (final model, individual level effects not presented). Destination countries one by one excluded, four destination countries with a unique combination their origin countries excluded (Greece, Lithuania, Norway, Portugal), without three smallest destination countries (Liechtenstein, Luxembourg, Lithuania) & effects controlled for difference of score on Hofstede's (1984) collectivism-individualism dimension of origin country and destination country.

	<i>All 16</i>	<i>-AU</i>	<i>-AT</i>	<i>-BE</i>	<i>-CH</i>	<i>-DE</i>	<i>-DK</i>	<i>-EL</i>	<i>-FI</i>
N	9279	7775	8778	8300	6975	8847	9133	9092	9243
<i>Destination effects</i>									
Average science performance natives	0.70** (0.31)	0.55* (0.30)	0.73** (0.31)	0.95** (0.32)	0.69** (0.32)	0.71** (0.32)	0.42* (0.25)	0.73** (0.33)	0.86** (0.42)
Degree of teacher shortage	-36.16** (12.57)	-35.76** (12.05)	-34.47** (12.59)	-34.14** (11.68)	-35.47** (13.04)	-38.96** (14.07)	-32.20** (9.31)	-34.97** (13.15)	-40.08** (14.40)
Highly differentiated education system	-11.22 (14.68)	-25.62 (15.71)	-15.73 (15.17)	-15.50 (13.81)	-7.19 (16.48)	-13.94 (16.80)	-18.65* (11.49)	-11.26 (14.76)	-17.60 (17.60)
Highly differentiated education system * parental education	-6.15** (1.36)	-3.98** (1.84)	-5.97** (1.38)	-6.06** (1.38)	-6.48** (1.56)	-6.07** (1.39)	-6.49** (1.41)	-6.12** (1.36)	-5.93** (1.36)
Moderately differentiated education system	33.93** (15.25)	44.35** (16.21)	33.92** (15.15)	40.85** (17.35)	34.63** (15.71)	34.79** (15.68)	25.31** (12.19)	32.39** (15.92)	33.42** (15.40)
Moderately differentiated education system * parental education	-7.23** (1.48)	-4.09** (1.92)	-7.18** (1.48)	-5.48** (1.67)	-7.21** (1.48)	-7.13** (1.48)	-7.58** (1.52)	-7.18** (1.50)	-7.01** (1.48)
<i>Origin effects</i>									
Compulsory years of education	6.71** (1.91)	9.02** (2.08)	6.74** (1.97)	5.85** (2.09)	5.89** (2.04)	7.55** (1.86)	5.54** (1.96)	6.65** (1.93)	6.67** (1.91)
Compulsory years of education * 1.75 generation	2.81** (1.41)	3.58** (1.57)	2.66* (1.45)	3.36** (1.56)	2.37 (1.55)	1.86 (1.34)	3.14** (1.43)	2.90** (1.43)	2.79** (1.41)
Compulsory years of education * 1.5 generation	3.42** (1.50)	4.26** (1.69)	3.23** (1.53)	3.32** (1.68)	2.92* (1.64)	2.95* (1.58)	3.74** (1.51)	3.66** (1.53)	3.39** (1.50)
Compulsory years of education * 1.25 generation	12.84** (2.18)	13.39** (2.47)	12.40** (2.25)	13.67** (2.45)	11.84** (2.37)	11.73** (2.13)	13.08** (2.19)	12.69** (2.20)	12.83** (2.18)

Continued

	-NO	-NZ	-PT	-SC	-EL & -LV & -NO & -PT	-LI & -LU & -LV	Value distan origin destinat
N	9240	8702	9230	9243	8610	8829	9279
<i>Destination effects</i>							
Average science performance natives	0.61* (0.33)	0.60* (0.32)	0.86** (0.29)	0.71** (0.32)	1.11** (0.41)	0.82** (0.33)	0.60* (0.32)
Degree of teacher shortage	-34.52** (12.62)	-38.30** (12.52)	-22.32* (13.00)	-36.81** (12.85)	-0.68 (15.24)	-44.38** (14.58)	-44.11* (13.20)
Highly differentiated education system	-12.50 (14.62)	0.87 (15.83)	-7.53 (13.12)	-9.20 (15.19)	-3.70 (13.16)	-9.25 (14.82)	-8.03 (15.10)
Highly differentiated education system *	-5.98** (1.36)	-7.62** (1.48)	-6.18** (1.36)	-6.15** (1.37)	-6.32** (1.40)	-6.43** (1.37)	-6.18** (1.36)
parental education							
Moderately differentiated education system	29.54* (15.59)	45.68** (15.76)	28.65** (14.40)	36.68** (15.88)	4.08 (15.66)	37.55** (15.60)	42.71* (15.88)
Moderately differentiated education system *	-7.01** (1.48)	-8.70** (1.59)	-7.25** (1.48)	-7.22** (1.49)	-7.42** (1.54)	-7.66** (1.51)	-7.29** (1.48)
parental education							
<i>Origin effects</i>							
Compulsory years of education	6.80** (1.93)	7.04** (1.77)	6.86** (1.90)	6.82** (1.99)	7.21** (1.98)	6.85** (2.16)	10.10**
Compulsory years of education * 1.75 generation	2.85** (1.41)	2.62* (1.42)	2.66* (1.42)	2.80** (1.42)	3.09** (1.45)	2.35 (1.51)	2.78* (1.41)
Compulsory years of education * 1.5 generation	3.43** (1.50)	3.91** (1.52)	3.23** (1.51)	3.15** (1.52)	3.16** (1.54)	2.92* (1.61)	3.45** (1.50)
Compulsory years of education * 1.25 generation	12.86** (2.18)	12.13** (2.26)	13.76** (2.22)	12.96** (2.21)	13.74** (2.25)	13.14** (2.32)	12.92* (2.18)
Distance between origin and destination country on Hofstede's collectivism-individualism dimension							-0.41* (0.18)

Note: ** = significant at the 0.05 level, * = significant at the 0.1 level; Indicator value distance Collectivism-individualism Hofstede (1984).

Table A5 Cross-classified regressions of educational system characteristics of countries of origin and destination, controlled for individual characteristics (model 3), on the science, reading and math score of immigrant pupils.

	Reading	Math	Science
Intercept	386.68** (20.12)	434.96** (18.96)	393.99** (20.78)
<i>Destination effects of education</i>			
Average science performance natives	0.67** (0.31)	0.50* (0.26)	0.70** (0.31)
Degree of teacher shortage	-42.49** (12.61)	-29.60* (10.40)	-36.16** (12.57)
Highly stratified education system	-9.91 (14.82)	-8.42 (12.34)	-11.22 (14.68)
Highly stratified education system * parental education	-6.45** (1.38)	-5.67** (1.26)	-6.15** (1.36)
Moderately differentiated education system	31.43** (15.34)	24.59** (12.74)	33.93** (15.25)
Moderately differentiated education system * parental education	-6.37** (1.50)	-7.55** (1.37)	-7.23** (1.48)
<i>Origin effects of education</i>			
Compulsory years of education	5.67** (1.83)	5.30** (1.78)	6.71** (1.91)
Compulsory years of education * 1.75 generation	2.19 (1.43)	2.42 (1.31)	2.81** (1.41)
Compulsory years of education * 1.5 generation	1.49 (1.52)	3.35** (1.40)	3.42** (1.50)
Compulsory years of education * 1.25 generation	11.09** (2.21)	8.67** (2.03)	12.84** (2.18)
<i>Individual effects</i>			
Grade	50.18** (2.76)	48.34** (1.31)	47.59** (1.41)
Vocational type of education	-58.04** (2.76)	-55.54** (2.52)	-57.36** (2.72)
Girls	29.95** (1.64)	-18.10** (1.50)	-7.86** (1.62)
Parental education	8.90** (1.20)	8.11** (1.10)	10.25** (1.18)
Parental occupation	0.88** (0.06)	0.82** (0.06)	0.86** (0.06)
Home possessions	10.13** (1.08)	10.46** (0.99)	9.00** (1.06)
<i>Immigrant characteristics</i>			
Second generation	Ref.	Ref.	Ref.
1.75 generation	-24.73 (13.95)	-23.65* (12.79)	-25.38* (13.77)
1.5 generation	-22.97 (15.29)	-44.62** (14.02)	-40.85** (15.09)
1.25 generation	-144.48** (22.70)	-115.08** (20.81)	-160.71** (22.40)
Immigrant generation unknown	-22.57** (4.42)	-22.25** (4.05)	-18.46** (4.36)
One native parent	1.84 (3.95)	3.59 (3.61)	5.35 (3.89)
Language of test country spoken at home	16.91** (2.32)	7.59** (2.14)	15.34** (2.30)
Language spoken at home unknown	-24.81** (2.90)	-28.01** (2.66)	-23.55** (2.86)
<i>Variance components^a</i>			
Destination	236 (140)	107 (88)	214 (72)
Origin	471 (106)	479 (105)	543 (73)
Individual	6125 (90)	5144 (76)	5956 (37)
Deviance (IGLS; -2*LL)	107406	105792	107155

Source: PISA 2006, own calculations. Notes: standard deviations in parentheses; ** = significant at the 0.05 level, * = significant at the 0.1 level.

Table A6 Cross-classified regressions of educational system characteristics of countries of origin and destination, controlled for not shown individual characteristics (model 3) with GDP of destination country or with compulsory education but with HDI and Kaufman political stability.

	plus GDP destination country	Plus HDI & political stability minus compulsory education
<i>Destination effects of education</i>		
Average science performance natives	0.69** (0.32)	0.80** (0.30)
Degree of teacher shortage	-32.68** (16.57)	-29.84** (11.96)
Highly stratified education system	-9.42 (15.89)	-17.15 (14.15)
Highly stratified education system * parental education	-6.15** (1.36)	-6.15** (1.36)
Moderately differentiated education system	36.00** (16.57)	26.84* (14.60)
Moderately differentiated education system * parental education	-7.23** (1.48)	-7.23** (1.48)
GDP	-0.001 (0.010)	
<i>Origin effects of education</i>		
Compulsory years of education	6.69** (1.91)	X
Compulsory years of education * 1.75 generation	2.82** (1.41)	X
Compulsory years of education * 1.5 generation	3.42** (1.50)	X
Compulsory years of education * 1.25 generation	12.84** (2.18)	X
HDI		107.13** (36.90)
Political stability		-0.02 (0.05)

Source: PISA 2006, own calculations. Notes: standard deviations in parentheses; ** = significant at the 0.05 level, * = significant at the 0.1 level.