16

PISA and Policy Relevance – Three Examples of Analyses

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INTRODUCTION

This chapter will provide three examples of possible analyses with PISA data. The examples will begin with a concrete policy question which will be followed by a step-by-step analysis:

1. how to translate a policy question into a working hypothesis;
2. how to choose the most appropriate approach to answer the hypothesis;
3. how to compute, referring to the relevant chapters in this manual on technical matters;
4. how to interpret the results;
5. how to draw policy recommendations.

The first example will investigate how to determine which student population should be targeted by an educational reform designed to reduce the gender gap in reading. As it will be demonstrated, the male student distribution differs from the female student distribution, not only by their mean but also by their standard deviation.

The second example will scrutinise the school composition effect in a particular country, *i.e.* Belgium. In addition to the potential efficiency of promoting socio-economic diversity within schools, this example also illustrates the usefulness of the PISA data for answering a policy question in a specific national context.

The last example will explore the influence of some characteristics at the educational system level on the students' expected occupational status at age 30. It will be extended to the issue of segregation in academic performance.

EXAMPLE 1: GENDER DIFFERENCES IN PERFORMANCE

It is current practice to build efficiency and equity indicators of educational systems based on national or international surveys. International agencies, including the OECD, regularly release updated sets of indicators (*e.g.* OECD's *Education at a Glance*). Among equity indicators, differences of achievement in various domains (mainly reading, mathematics and science) between males and females are often presented. Computing these indicators does not raise technical problems and there is relative consensus among modern democratic societies that the gender gap in performance should be reduced. Until recently, the major concern was to improve females' achievement in scientific domains; but, currently, there is a growing concern about males' underachievement in reading literacy.

Lietz (2006) conducted a meta-analysis of gender differences in reading at the secondary education level. Results indicated that: *(i)* gender differences existed across the 139 studies under review that were not due to chance; and *(ii)* slightly over half of these differences could be explained by differences in the design of some of the large-scale assessment programmes included in the meta-analysis and the basis of calculating effect size. Further, the reason for greater gender differences in more recent assessment programmes which could, for example, be related to item selection procedures, contextual changes surrounding reading in society and at school, or the scaling of reading scores, warrant further scrutiny (Lietz, 2006, pp. 336-337).

Lafontaine and Monseur (forthcoming) has explored the impact of some of the test characteristics – especially the question format, the reading process and the type of texts – on gender equity indicators in reading literacy. They concluded that:

the variance analysis clearly shows that the reading aspect has a larger impact (24% of variance explained) than item format on the difference in reading achievement between males and females. But item format also makes a striking difference (16% of variance explained). The type of text appears to be one of the major

factors contributing to gender differences. This result is not surprising and can be related to the differences in written material regularly read by males and females respectively.

In summary, PISA and other large-scale assessments have shown the evidence of females outperforming males in reading and recent methodological investigations have pointed out the influence of item format, type of texts and reading aspects on the size of the gender gap.

However, few recommendations are provided to policy makers to reduce these gender differences. Should remediation programmes designed to reduce the gender gap in reading target all male students or primarily male low performers? In other words, is the gender difference constant or variable across the ability range? According to Wagemaker (1996, p. 42) based on the IEA Reading Literacy Study, "in some countries, it is evident that disparity between boys and girls is not uniformly systematic across the ability distribution." PISA offers a unique opportunity to test the hypothesis of a larger distribution for males. Indeed, data are collected every three years in three domains, *i.e.* reading literacy, mathematics literacy and science literacy.

As a starting point, the hypothesis can be translated as follows: there is no statistical difference between the standard deviation computed on the male population and the standard deviation computed on the female population. Mathematically, the null hypothesis can be written as:

$$H_0 :\ _{males} -\ _{females} = 0$$

The standard deviations for each domain and on the first three data collections have been computed for males and for females and then compared. However, as illustrated in Chapter 11, the two standard deviation estimates are not independent. Therefore, the significance test for the gender difference in standard deviation requires the use of the PROC_DIF_PV macro. Box 16.1 presents the syntax for testing the similarity of the standard deviations.

Box 16.1 **SAS® syntax for testing the gender difference in standard deviations of reading performance (*e.g.* PISA 2000)**

```
libname PISA2000  "c:\pisa\2000\data\";
libname PISA2006  "c:\pisa\2006\data\";
options nofmterr notes;
run;

data temp1;
         set pisa2000.intread;
         if (cnt in ('AUS','AUT','BEL','CAN','CZE','DNK','FIN','FRA','DEU','GRC',
                     'HUN','ISL','IRL','ITA','JPN','KOR','LUX','MEX','NLD','NZL',
                     'NOR','POL','PRT','SVK','ESP','SWE','CHE','TUR','GBR','USA'));
         w_fstr0=w_fstuwt;
         read1=pv1read;
         read2=pv2read;
         read3=pv3read;
         read4=pv4read;
         read5=pv5read;
         keep cnt schoolid stidstd read1-read5 w_fstr0-w_fstr80 st03Q01;
run;

%include "c:\pisa\macro\proc_dif_pv.sas";

%BRR_PROCMEAN_DIF_PV(INFILE=temp1,
                     REPLI_ROOT=w_fstr,
                     BYVAR=cnt ,
                     PV_ROOT=read,
                     COMPARE=st03Q01,
                     CATEGORY=2 1,
                     STAT=std,
                     OUTFILE=exercise1);
run;
```

Table 16.1 presents the differences in the standard deviations between males and females by domain and by country in PISA 2000. For instance, in Australia, the difference in the standard deviation between males and females is equal to 6.94 with a standard error of 2.48. As (6.94/2.48) is greater than 1.96, this difference is significant. The standard deviation of the male student performance in reading is higher by 6.94 than the standard deviation of the female student performance in reading. In other words, the performance of males varies more than the performance of females.

Table 16.1
Differences between males and females in the standard deviation of student performance (PISA 2000)

	Reading		Mathematics		Science	
	Difference (males – females)	S.E.	Difference (males – females)	S.E.	Difference (males – females)	S.E.
AUS	**6.94**	(2.48)	3.45	(3.31)	**6.58**	(2.98)
AUT	4.12	(2.74)	**6.75**	(3.23)	4.06	(2.99)
BEL	**8.16**	(3.44)	**7.24**	(3.25)	**10.66**	(4.81)
CAN	**5.22**	(1.10)	**5.16**	(1.33)	**4.65**	(1.44)
CHE	3.44	(2.26)	3.47	(3.68)	4.02	(3.07)
CZE	**11.92**	(4.14)	**8.01**	(3.38)	**7.9**	(3.87)
DEU	5.58	(5.23)	0.93	(3.76)	1.67	(3.74)
DNK	**6.68**	(3.16)	4.3	(3.56)	6.5	(3.73)
ESP	**9.33**	(2.32)	**7.01**	(2.70)	**8.83**	(2.74)
FIN	6.21	(3.19)	1.41	(2.79)	**8.52**	(2.65)
FRA	**8.19**	(2.35)	**5.82**	(2.42)	5.91	(3.27)
GBR	**5.71**	(2.43)	**7.06**	(3.12)	4.02	(3.55)
GRC	**10.09**	(3.28)	**9.55**	(4.78)	**8.11**	(3.98)
HUN	2.54	(2.81)	1.44	(3.85)	3.01	(3.22)
IRL	4.35	(2.87)	3.27	(3.65)	3.55	(3.28)
ISL	**8.72**	(2.32)	4.77	(3.44)	**6.03**	(3.07)
ITA	**9.75**	(4.19)	5.92	(4.16)	**9.81**	(4.56)
JPN	**11.19**	(3.34)	**11.64**	(5.24)	**12.74**	(4.07)
KOR	3.84	(2.79)	2.21	(4.09)	2.31	(3.45)
LUX	5.45	(3.28)	7.02	(4.08)	**9.81**	(4.19)
MEX	3.69	(2.49)	**6.32**	(3.03)	5.73	(3.10)
NOR	**12.42**	(2.62)	**9.58**	(3.20)	**11.27**	(3.74)
NZL	**9.04**	(3.06)	**9.82**	(3.54)	**7.77**	(3.50)
POL	**10.25**	(3.69)	**11.83**	(4.48)	6.59	(3.82)
PRT	**6.96**	(2.64)	1.41	(4.17)	4.7	(3.08)
SVK		(0.00)		(0.00)		(0.00)
SWE	**5.84**	(2.40)	2.7	(3.46)	6.43	(3.63)
TUR		(0.00)		(0.00)		(0.00)
USA	**12.89**	(3.24)	**9.15**	(2.64)	**12.27**	(4.40)

Note: Differences that statistically differ from 0 are in bold.

Table 16.2 provides a summary of gender differences in standard deviation for reading, mathematics and science performance in PISA 2000, PISA 2003 and PISA 2006. Of the 260 comparisons, only 6 are negative, meaning that the standard deviation for females is higher than the standard deviation for males. Further, 177 differences, *i.e.* 68%, are positive and differ significantly from 0, which means that the distribution of the male performance is more widespread than the distribution of the female performance.

Table 16.2
Distribution of the gender differences (males – females) in the standard deviation of the student performance

	Domain	Negative non-significant difference	Positive non-significant difference	Positive significant difference
PISA 2000	Reading	0	9	18
	Mathematics	0	13	14
	Science	0	13	14
PISA 2003	Reading	0	8	22
	Mathematics	2	7	21
	Science	0	12	18
PISA 2006	Reading	0	4	25
	Mathematics	2	6	22
	Science	2	5	23

To better understand why the standard deviation is higher for males than for females, 5^{th}, 10^{th}, 90^{th} and 95^{th} percentiles are computed by gender on the combined reading scale in PISA 2000. Table 16.3 presents the differences between males and females in these percentiles. Box 16.2 presents the SAS® syntax for computing the difference for the 5^{th} percentile.

Table 16.3

Gender difference on the PISA combined reading scale for the 5^{th}, 10^{th}, 90^{th} and 95^{th} percentiles (PISA 2000)

	Gender difference (males – females) in percentiles of the reading performance distribution							
	5^{th}		10^{th}		90^{th}		95^{th}	
	Difference	S.E.	Difference	S.E.	Difference	S.E.	Difference	S.E.
AUS	-44.5	(11.4)	-40.5	(8.5)	-21.6	(8.1)	-20.3	(8.6)
AUT	-38.5	(11.0)	-35.1	(8.5)	-19.1	(6.1)	-18.8	(8.8)
BEL	-38.8	(12.8)	-43.4	(12.7)	-16.4	(5.7)	-14.1	(5.6)
CAN	-42.8	(4.2)	-41.3	(3.6)	-25.3	(3.6)	-22.9	(3.5)
CHE	-24.5	(10.1)	-24.4	(8.4)	-20.6	(6.6)	-17.6	(5.7)
CZE	-68.2	(18.1)	-56.6	(11.8)	-21.5	(5.6)	-20.3	(6.6)
DEU	-56.1	(20.8)	-45.2	(12.2)	-25.4	(7.2)	-21.6	(5.9)
DNK	-41.0	(7.9)	-35.9	(7.2)	-16.4	(4.7)	-14.5	(7.3)
ESP	-37.3	(6.5)	-37.0	(6.7)	-11.1	(5.5)	-8.5	(6.0)
FIN	-65.4	(8.8)	-68.1	(5.5)	-40.0	(4.9)	-39.8	(5.9)
FRA	-46.5	(9.6)	-44.5	(6.7)	-20.1	(4.3)	-18.4	(6.1)
GBR	-38.6	(8.8)	-32.2	(7.5)	-17.9	(6.8)	-14.1	(8.7)
GRC	-52.3	(12.8)	-53.9	(8.5)	-23.4	(6.9)	-22.5	(7.8)
HUN	-34.0	(9.4)	-34.1	(8.6)	-26.1	(6.9)	-23.9	(6.5)
IRL	-30.6	(10.9)	-32.4	(9.9)	-20.0	(6.7)	-19.0	(8.6)
ISL	-54.8	(8.6)	-56.3	(7.2)	-26.1	(5.0)	-23.4	(7.9)
ITA	-54.2	(12.5)	-49.0	(12.0)	-23.4	(6.2)	-22.2	(6.6)
JPN	-56.7	(12.8)	-49.4	(12.4)	-18.5	(5.9)	-17.3	(7.4)
KOR	-28.0	(10.1)	-21.1	(9.1)	-13.3	(5.2)	-13.3	(5.2)
LUX	-34.7	(12.6)	-35.0	(9.0)	-19.6	(5.4)	-14.6	(8.6)
MEX	-21.6	(9.0)	-22.8	(6.2)	-13.2	(7.0)	-11.5	(9.1)
NOR	-61.0	(13.2)	-62.4	(8.1)	-28.7	(5.8)	-25.3	(6.9)
NZL	-68.0	(12.2)	-61.7	(9.3)	-34.0	(8.5)	-33.9	(14.0)
POL	-49.4	(12.3)	-53.3	(10.4)	-24.5	(7.3)	-22.5	(9.6)
PRT	-29.3	(10.0)	-33.4	(7.3)	-9.6	(4.9)	-6.7	(5.6)
SWE	-43.8	(7.6)	-49.5	(6.4)	-29.6	(6.3)	-27.7	(6.1)
USA	-52.4	(10.1)	-52.2	(9.1)	-11.1	(7.9)	-7.7	(11.4)
OECD average	**-44.9**	**(2.2)**	**-43.4**	**(1.7)**	**-21.4**	**(1.2)**	**-19.3**	**(1.5)**

Box 16.2 **SAS® syntax for testing the gender difference in the 5^{th} percentile of the reading performance (*e.g.* PISA 2000)**

```
%BRR_PROCMEAN_DIF_PV(INFILE=temp1,
                     REPLI_ROOT=w_fstr,
                     BYVAR=cnt ,
                     PV_ROOT=read,
                     COMPARE=st03Q01,
                     CATEGORY=2 1,
                     STAT=p5,
                     OUTFILE=exercise2);
run;
```

On average, across OECD countries, the gender differences are equal to -45, -43, -21 and -19 for the 5^{th}, 10^{th}, 90^{th} and 95^{th} percentiles respectively. It therefore appears that the gender gap varies according to the level of proficiency, the difference in performance between males and females being greater for low achievers than it is for high achievers.

Next, let's examine whether the gender difference is constant or not according to the different types of items. Two new reading scales are computed: the first scale is based on multiple-choice items and the second scale is based on open-ended items. Table 16.4 presents the difference between the standard deviation for males and the standard deviation for females. On average, the standard deviation for males is greater than females by 3.8 on the multiple-choice item scale, and by 8.2 on the open-ended item scale.

Table 16.4
Gender difference in the standard deviation for the two different item format scales in reading (PISA 2000)

	Scale of multiple-choice items		Scale of open-ended items	
	Difference (males – females) in the standard deviation	S.E.	Difference (males – females) in the standard deviation	S.E.
AUS	4.7	(3.1)	8.8	(3.1)
AUT	1.2	(2.5)	4.4	(3.0)
BEL	3.3	(3.0)	7.9	(3.2)
CAN	3.7	(1.4)	6.5	(1.5)
CHE	3.1	(2.7)	4.6	(3.1)
CZE	2.0	(2.6)	8.2	(3.1)
DEU	-1.2	(3.7)	4.7	(3.6)
DNK	2.5	(2.7)	6.8	(3.3)
ESP	4.3	(2.1)	10.8	(2.1)
FIN	6.1	(3.0)	9.2	(2.3)
FRA	4.2	(2.6)	8.6	(2.6)
GBR	2.5	(3.1)	5.4	(2.8)
GRC	4.7	(3.4)	13.6	(3.5)
HUN	-0.7	(3.3)	3.7	(3.2)
IRL	2.9	(3.0)	6.4	(2.8)
ISL	7.7	(3.6)	12.1	(3.0)
ITA	1.7	(2.9)	9.2	(3.6)
JPN	4.3	(3.1)	13.4	(3.6)
KOR	1.8	(3.0)	5.2	(2.1)
LUX	3.7	(3.4)	5.4	(3.6)
MEX	2.8	(2.6)	3.5	(3.5)
NOR	8.0	(3.1)	12.8	(3.7)
NZL	6.6	(3.6)	9.0	(4.3)
POL	6.0	(3.7)	12.5	(3.7)
PRT	4.6	(2.7)	8.1	(2.8)
SWE	5.4	(2.3)	6.2	(2.7)
USA	6.9	(3.2)	14.5	(3.4)
OECD average	**3.8**	**(0.6)**	**8.2**	**(0.6)**

The item format is therefore related to the gender difference in the performance distribution. Increasing the proportion of multiple-choice items will minimise the difference between males and females in performance dispersion. As the proportion of open-ended items increase, the difference between males and females in performance distribution will increase.

In conclusion, the results suggest that any strategies aimed at reducing the gender gap should target male low performers. The consistent findings of the wider gender gap for students at the lower end of performance, in conjunction with the impact of item format on the standard deviation, might also suggest a tendency of male low performers to invest less in schoolwork than female low performers. Even if some studies demonstrate that reading disabilities are more frequent in males than in females (Rutter *et al.*, 2004), remedial strategies will have to take into account student motivation and behaviour in school.

EXAMPLE 2: PROMOTING SOCIO-ECONOMIC DIVERSITY WITHIN SCHOOL?

A few decades ago, some OECD countries set up a school catchment area that obliges students to attend their local schools. Countries with such a school attendance policy usually present small between-school variance (i.e., intraclass correlation coefficients) in students' performance and students' socio-economic background indicator. Every school, in some sense, has students who represent the population in the area that the school is located in.

In other countries, parents are free to select the school their children attend. This freedom generally tends to be related to an increase between-school variance in students' performance and students' socio-economic background. The PISA initial reports have extensively discussed such equity issues and equity in educational opportunity is an important issue that policy makers can no longer ignore (OECD, 2004, 2007). Belgium is one of the countries which show large between-school variance in student performance in science and the majority of which are explained by the student and school socio-economic background, together with other OECD countries including Austria, Czech Republic, Germany, Hungary and the Netherlands (OECD, 2007, Table 4.1a). For these countries, what would be the best strategy to provide students with equal educational opportunity regardless of their socio-economic background? The following section will examine this issue, taking Belgium as an example.

As illustrated in Figure 1.1 in Chapter 1 of this manual, between-school variance in performance (i.e. academic segregation) and between-school variance in students' socio-economic background (i.e. social segregation) are closely intertwined. Unfortunately, it is not easy to know whether social segregation is an antecedent or a consequence of academic segregation. For example, in countries with a substantial proportion of students enrolled in private schools with admission fees, one might suspect that academic segregation is partly a consequence of social segregation. In some other countries where students are grouped at an early age according to their performance, social segregation may be a consequence of academic segregation.

Before adopting a specific educational reform, it is important to disentangle the relationship between social segregation and academic segregations and help policy makers know where to target a reform. For example, even if a reform is designed to decrease the difference in school socio-economic intake, the reform would fail when social segregation is simply the consequence of academic segregation.

In this example, the PISA index of economic, social and cultural status (ESCS) is used as an indicator of the student socio-economic background. As described in Chapter 15, estimating the importance of the school socio-economic composition effect on student performance requires the computation of the school average PISA index of economic, social and cultural status (ESCS) of student. The composition effect, then, can be estimated with the following multilevel model:

$$Y_{ij} = \beta_{0j} + \beta_{1j}\,(ESCS) + \varepsilon_{ij}$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\,(MU\_ESCS) + U_{0j}$$

$$\beta_{1j} = \gamma_{10}$$

In the educational system in Belgium, the school socio-economic composition has an important impact on student performance, as illustrated in Model 2 in Table 16.5. The SAS® macro PROC_MIXED_PV was used to obtain unbiased estimates of the standard errors.

Table 16.5

Random and fixed parameters in the multilevel model with student and school socio-economic background

	Model 1		Model 2	
	Estimate	S.E.	Estimate	S.E.
τ_0^2	5113.8	(142.5)	1456.7	(88.8)
2	4750.7	(126.7)	4568.4	(118.1)
Intercept	509.9	(0.3)	491.3	(0.5)
ESCS			17.3	(1.2)
MU_ESCS			102.6	(1.5)

An increase of 1 point on the school socio-economic intake variable (*i.e.* school average ESCS) is associated with an increase of 102.6 points in science. As the school socio-economic intake in Belgium ranges from -1.73 to 1.63, the difference in science performance between the most disadvantaged and the most advantaged schools in Belgium is more than 300 score points.

It should also be noted that the student socio-economic background and the school socio-economic background explain about 72% of the school variance, *i.e.* (5 113.8-1 456.7)/5 113.8.

In Belgium, the educational system consists of three types of secondary schools: *(i)* schools that provide general education only; *(ii)* schools that provide vocational education only; *(iii)* schools that provide both general and vocational education.

Before starting the multilevel analysis, a data file is prepared, as shown in Box 16.3. Two dummy variables are created to differentiate the three types of schools: GEN for the schools that provide only general education and VOC for the schools that provide only vocational education. The detailed description for the variable REPEAT and MU_REPEAT is provided later in this section.

Box 16.3 [1/2] **SAS® syntax for preparing a data file for the multilevel analysis**

```
data temp2;
      set pisa2006.stu;
      if (cnt=“BEL”);
      if (st01Q01 in (10,11,12)) then repeat=0;
      if (st01Q01=9) then repeat=1;
      if (st01Q01=8) then repeat=2;
      if (st01Q01=7) then repeat=3;
      if (repeat = .) then delete;
run;
proc sort data=temp2;
      by cnt schoolid stidstd;
run;
proc means data=temp2 vardef=wgt noprint;
      var escs repeat;
      by schoolid;
      weight w_fstuwt;
      output out=temp3 mean=mu_escs mu_repeat;
run;
data temp4;
      merge temp2 temp3;
      by schoolid;
run;
proc freq data=temp2 noprint;
      table schoolid * iscedo / out=temp5;
run;
proc transpose data=temp5 out=temp6;
      var count;
      by schoolid;
      id iscedo;
run;
data temp7;
      set temp6;
      if (_1 = .) then _1=0;
      if (_3 = .) then _3=0;
    gen=0;
      voc=0;
      if (_3=0) then gen=1;
      if (_1=0) then voc=1;
      keep schoolid gen voc;
run;
```

Box 16.3 [2/2] **SAS® syntax for preparing a data file for the multilevel analysis**

```
data temp8;
       merge temp4 temp7 ;
       by schoolid;
       nbmis=0;
       array mis (6) escs mu_escs repeat mu_repeat gen voc;
       do i=1 to 6;
             if (mis(i) in (.,.N,.M,.I)) then nbmis=nbmis+1;
       end;
       if (nbmis=0);
       w_fstr0=w_fstuwt;
run;
proc univariate data=temp8 noprint;
       var w_fstr0;
       by cnt;
       output out=temp9 sum=somme n=nombre;
run;
data temp10;
       merge temp8 temp9;
       by cnt;
       array aaa (81) w_fstr0-w_fstr80;
       do j=1 to 81;
             aaa(j)=(aaa(j)/somme)*nombre;
       end;
       pv1=pv1scie;
       pv2=pv2scie;
       pv3=pv3scie;
       pv4=pv4scie;
       pv5=pv5scie;
run;
```

As a first step, preliminary analysis is conducted, using only one plausible value without replicates, to examine if the school composition effect differs according to school type. Box 16.4 presents the SAS® syntax for this preliminary analysis and Box 16.5 presents the SAS® output of this model. As shown in Box 16.4, analysing the variability of the school composition effect according to school type can be modelled by Level 2 interactions (*i.e.* mu_escs*gen and mu_escs*voc). It is also necessary, as described in Chapter 15, to include them (*i.e.* gen and voc) as the main effects.

Box 16.4 **SAS® syntax for running a preliminary multilevel analysis with one PV**

```
proc mixed data= temp10 noclprint  noitprint noinfo method=ml;
           class schoolid;
           model pv1= escs mu_escs gen voc mu_escs*gen mu_escs*voc
            /solution;
           random intercept /subject=schoolid ;
                  weight w_fstr0;
run;
```

Box 16.5 **SAS® output for fixed parameters in the multilevel model**

Solution for Fixed Effects

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	485.19	3.2541	263	149.10	<.0001
ESCS	17.0069	0.9346	8506	18.20	<.0001
mu_escs	120.78	8.6052	8506	14.04	<.0001
gen	54.3207	8.9145	8506	6.09	<.0001
voc	1.2123	6.0937	8506	0.20	0.8423
mu_escs*gen	-77.8060	14.2017	8506	-5.48	<.0001
mu_escs*voc	-40.9547	13.9624	8506	-2.93	0.0034

The school composition effect shown in Box 16.4 is the effect compared with a reference group, *i.e.* schools providing both general and vocational education. The school composition effect for schools providing general education only is equal to 43, *i.e.* 120.78-77.80, and the school composition effect for schools providing vocational education only is equal to 80, *i.e.* 120.78-40.95. However, these results were obtained by using only one plausible value and the macro was not used so that standard errors are not unbiased.

According to *Les indicateurs de l'enseignement* (2007, p. 35), a student who has to repeat a grade in secondary education is two or three times more likely to move to another school than to repeat the grade in the same school in the French-speaking community in Belgium. Further, usually, the student will move to a school that has a lower socio-economic intake.

The grade repetition information was therefore added to the previous model both at the student and school levels. The proportion of grade repetition at the school level is a proxy of academic segregation. In Belgium, as compulsory education is dictated by the calendar year of birth and as the PISA target population is also defined in term of the calendar year, it is straightforward to determine if a student is in the expected grade or not. The difference in years between the expected grade and the actual grade is computed at the student level (*i.e.* REPEAT) and the school average of these differences is also computed at the school level (*i.e.* MU_REPEAT), as seen in Box 16.3. These variables are included as independent variables.

It is also possible to model cross-level interactions for analysing the differences between the three types of schools as shown in the model in Box 16.3. Here, however, in order to facilitate the readability of the results, a multilevel model is run separately for each of the three school types. The final model can be written as:

$$y_{ij} = \beta_{0j} + \beta_{1j}\,(ESCS) + \beta_{2j}\,(REPEAT)$$

$$\beta_{0j} = \gamma_{00} + \gamma_{10}\,(MU\_ESCS) + \gamma_{20}\,(MU\_REPEAT)$$

$$\beta_{10} = \gamma_{10}$$

$$\beta_{20} = \gamma_{20}$$

If the school socio-economic composition effect decreases substantially by introducing the grade repetition variables, this means that social segregation is mainly a result of academic segregation in Belgium.

Table 16.6 presents the fixed and random parameters estimates of the final model as well as two previous models, *i.e.* the empty model (Model 1) and the model with student and school socio-economic background (Model 2). Estimates and their respective standard errors were obtained with the PROC_MIXED_PV macro as shown in Box 16.6.

The intraclass correlation on the whole population is equal to 0.52. It is respectively equal to 0.42, 0.26 and 0.42 for schools providing both general and vocational education, for schools providing general education only, and for schools providing vocational education only. Therefore, in Belgium, differences between schools in performance are small for the schools providing general education only, but large for schools providing vocational education or schools providing both general and vocational education.

The results of Model 2 indicate that the school socio-economic composition effects are important for students in schools providing both general and vocational education and to a lesser extent for students in schools providing vocational education only. On the other hand, the school socio-economic composition effect is small for students in schools providing general education. The percentage of school variance explained by the student socio-economic background and the school socio-economic intake are respectively equal to 66%, 38% and 58% for population in schools providing both general and vocation education, in schools providing general education only and in schools providing vocational education only.

Table 16.6

Random and fixed parameters in the multilevel model with socio-economic background and grade retention at the student and school levels

Schools providing both general and vocational education

	Model 1		Model 2		Model 3	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
τ_0^2	4115.4	(149.8)	1400.4	(96.5)	666.9	(90.4)
2	5582.0	(335.5)	5271.2	(310.0)	4516.3	(256.9)
Intercept	486.9	(0.5)	485.3	(0.6)	539.9	(3.4)
ESCS			22.0	(1.6)	18.6	(1.6)
MU_ESCS			114.9	(2.5)	57.6	(4.7)
REPEAT					-49.0	(2.0)
MU_REPEAT					-55.8	(7.1)

Schools providing general education only

	Model 1		Model 2		Model 3	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
τ_0^2	1350.2	(105.7)	842.4	(91.3)	377.6	(50.0)
2	3740.9	(299.8)	3663.3	(290.3)	3326.4	(235.3)
Intercept	578.1	(0.6)	539.8	(1.6)	587.5	(2.3)
ESCS			12.1	(2.1)	9.6	(2.0)
MU_ESCS			48.3	(3.0)	15.1	(3.0)
REPEAT					-45.2	(3.7)
MU_REPEAT					-90.3	(6.9)

School providing vocational education only

	Model 1		Model 2		Model 3	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
τ_0^2	3185.9	(251.6)	1346.1	(144.4)	569.9	(127.4)
2	4363.0	(437.2)	4251.6	(438.2)	3924.5	(403.2)
Intercept	468.6	(1.0)	486.0	(0.8)	531.8	(1.9)
ESCS			13.1	(2.6)	11.1	(2.5)
MU_ESCS			86.0	(4.0)	12.7	(5.7)
REPEAT					-38.9	(5.6)
MU_REPEAT					-78.1	(7.9)

The results of Model 3 illustrate the importance of the academic segregation in Belgium, even within school types. Indeed, the introduction of the grade repetition information substantially reduces the school composition effect. For instance, in schools providing general education only, this effect changes from 48.3 to 15.1 and from 86.0 to 12.7 for schools providing vocational education only. This reduction also reflects the high correlation between the school socio-economic intake and the percentage of over-aged students.

In conclusion, these results indicate that social segregation in the Belgian educational system is mainly an outcome of academic segregation. Thus, promoting social diversity within each school, without taking into account academic segregation, will not substantially reduce educational inequities.

Box 16.6 **SAS® syntax for running multilevel models with the PROC_MIXED_PV macro**

```
%include "c:\pisa\macro\proc_mixed_pv.sas";

/*Model 1*/
%BRR_MIXED_PV(INFILE=temp10,
              REPLI_ROOT=w_fstr,
              PV_ROOT=pv,
              FIXEF=,
              RANEF=,
              BYVAR=cnt gen voc,
              LEVEL2=schoolid,
              OUTSCREEN="c:\ml.out",
              OUTFILE=exercise3);
run;

/*Model 2*/
%BRR_MIXED_PV(INFILE=temp10,
              REPLI_ROOT=w_fstr,
              PV_ROOT=pv,
              FIXEF=escs mu_escs,
              RANEF=,
              BYVAR=cnt gen voc,
              LEVEL2=schoolid,
              OUTSCREEN="c:\ml.out",
              OUTFILE=exercise4);
run;

/*Model 3*/
%BRR_MIXED_PV(INFILE=temp10,
              REPLI_ROOT=w_fstr,
              PV_ROOT=pv,
              FIXEF=escs mu_escs retard mu_retard,
              RANEF=,
              BYVAR=cnt gen voc,
              LEVEL2=schoolid,
              OUTSCREEN="c:\ml.out",
              OUTFILE=exercise5);
run;
```

EXAMPLE 3: THE INFLUENCE OF AN EDUCATIONAL SYSTEM ON THE EXPECTED OCCUPATIONAL STATUS OF STUDENTS AT AGE 30

This section examines the influence of an educational system on the expected occupational status of students at age 30. In PISA 2000 and PISA 2006 students were asked to report on their expected occupation at the age of 30. The open-ended responses for occupations were coded in accordance with the International Standard Classification of Occupations (ISCO 1988), to derive students' expected occupational status mapped to the International Socio-Economic Index of Occupational Status (ISEI) (Ganzebom *et al.*, 1992).

The structure of the educational system was assessed through the academic segregation and social segregation coefficients, as described in Chapter 1. By way of reminder, the two SAS® macros devoted to multilevel modelling return the intraclass correlation and its standard error. In Chapter 1, some of the consequences of social and/or academic segregations have been listed. Monseur and Crahay (forthcoming) demonstrated that as social and academic segregations increase, *(i)* the difference between low performers and high performers increases; *(ii)* the difference between disadvantaged and advantaged socio-economic backgrounds of students increases; and *(iii)* the correlation between the student socio-economic background and his/her performance in reading increases.

Three other indicators were computed for assessing the influence of the educational system on the index of expected occupational status of students:

1. the percentage of variance in students' expected occupational status that lies between schools;
2. the correlation between students' expected occupational status and student performance;
3. the correlation between students' expected occupational status and the international socio-economic index of occupational status (HISEI) for parents.

It is assumed that in highly tracked or segregated educational systems:

1. the intraclass correlation for students' expected occupational status will be higher,
2. the correlation between students' expected occupational status and student performance will be higher,
3. the correlation between students' expected occupational status and the international socio-economic index of occupational status (HISEI) for parents will be higher.

Table 16.7 and Table 16.8 present these five indicators respectively for PISA 2000 data and for PISA 2006. These five indicators include: the segregation indices (*i.e.* intraclass correlation coefficients) of student performance; international socio-economic index of occupational status (HISEI); and students' expected occupational status; as well as the correlation coefficients between student performance and students' expected occupational status; and between HISEI and students' expected occupational status.

Table 16.7
Segregation indices and correlation coefficients by country (PISA 2000)

	Segregation indices (intraclass correlation coefficient)						Correlation between:			
	Student performance in reading		International socio-economic index of occupational status (HISEI)		Students' expected occupational status		Student performance in reading and students' expected occupational status		International socio-economic index of occupational status (HISEI) and students' expected occupational status	
	rho	S.E.	rho	S.E.	rho	S.E.	Coefficient	S.E.	Coefficient	S.E.
AUS	0.18	(0.01)	0.17	(0.01)	0.09	(0.01)	0.41	(0.02)	0.24	(0.02)
AUT	0.60	(0.02)	0.23	(0.01)	0.42	(0.02)	0.42	(0.02)	0.34	(0.02)
BEL	0.60	(0.01)	0.24	(0.01)	0.38	(0.01)	0.51	(0.02)	0.37	(0.02)
CAN	0.18	(0.01)	0.12	(0.00)	0.07	(0.00)	0.30	(0.01)	0.17	(0.01)
CHE	0.43	(0.02)	0.18	(0.01)	0.26	(0.02)	0.45	(0.02)	0.37	(0.02)
CZE	0.53	(0.01)	0.20	(0.02)	0.38	(0.02)	0.52	(0.01)	0.35	(0.02)
DEU	0.59	(0.01)	0.21	(0.01)	0.31	(0.02)	0.46	(0.02)	0.30	(0.02)
DNK	0.19	(0.03)	0.13	(0.02)	0.10	(0.03)	0.42	(0.02)	0.31	(0.03)
ESP	0.20	(0.01)	0.26	(0.02)	0.08	(0.01)	0.41	(0.01)	0.26	(0.02)
FIN	0.12	(0.04)	0.13	(0.01)	0.05	(0.01)	0.38	(0.02)	0.26	(0.02)
FRA	0.50	(0.01)	0.20	(0.01)	0.28	(0.01)	0.46	(0.01)	0.31	(0.02)
GBR	0.22	(0.01)	0.16	(0.01)	0.08	(0.01)	0.41	(0.01)	0.27	(0.02)
GRC	0.51	(0.02)	0.22	(0.02)	0.22	(0.02)	0.40	(0.02)	0.28	(0.02)
HUN	0.67	(0.01)	0.30	(0.01)	0.40	(0.02)	0.51	(0.02)	0.36	(0.02)
IRL	0.18	(0.02)	0.13	(0.01)	0.05	(0.01)	0.42	(0.02)	0.24	(0.02)
ISL	0.08	(0.02)	0.15	(0.03)	0.04	(0.03)	0.34	(0.02)	0.22	(0.02)
ITA	0.55	(0.02)	0.22	(0.01)	0.38	(0.02)	0.31	(0.02)	0.31	(0.02)
JPN	0.46	(0.01)	0.06	(0.01)	0.09	(0.02)	0.18	(0.03)	0.13	(0.03)
KOR	0.37	(0.01)	0.19	(0.01)	0.18	(0.01)	0.29	(0.02)	0.21	(0.02)
LUX	0.31	(0.01)	0.20	(0.01)	0.20	(0.02)	0.29	(0.02)	0.23	(0.02)
MEX	0.53	(0.01)	0.33	(0.02)	0.13	(0.02)	0.20	(0.02)	0.18	(0.02)
NLD	0.50	(0.02)	0.13	(0.02)	0.19	(0.02)	0.45	(0.02)	0.25	(0.03)
NOR	0.10	(0.02)	0.09	(0.01)	0.07	(0.01)	0.42	(0.02)	0.31	(0.02)
NZL	0.16	(0.01)	0.12	(0.01)	0.06	(0.01)	0.38	(0.02)	0.25	(0.02)
POL	0.62	(0.01)	0.24	(0.01)	0.53	(0.02)	0.54	(0.02)	0.34	(0.02)
PRT	0.37	(0.02)	0.23	(0.01)	0.09	(0.01)	0.41	(0.02)	0.29	(0.02)
SWE	0.09	(0.01)	0.12	(0.01)	0.05	(0.01)	0.36	(0.02)	0.24	(0.02)
USA	0.29	(0.02)	0.15	(0.01)	0.05	(0.01)	0.27	(0.02)	0.14	(0.02)

Table 16.8
Segregation indices and correlation coefficients by country (PISA 2006)

	Segregation indices (intraclass correlation coefficient)						Correlation between:			
	Student performance in science		International socio-economic index of occupational status (HISEI)		Students' expected occupational status		Student performance in science and students' expected occupational status		International socio-economic index of occupational status (HISEI) and students' expected occupational status	
	rho	S.E.	rho	S.E.	rho	S.E.	Coefficient	S.E.	Coefficient	S.E.
AUS	0.18	(0.01)	0.16	(0.01)	0.08	(0.01)	0.39	(0.01)	0.22	(0.01)
AUT	0.55	(0.01)	0.26	(0.01)	0.46	(0.01)	0.39	(0.04)	0.36	(0.02)
BEL	0.52	(0.01)	0.22	(0.01)	0.36	(0.01)	0.48	(0.02)	0.33	(0.02)
CAN	0.19	(0.01)	0.12	(0.00)	0.08	(0.00)	0.28	(0.01)	0.20	(0.01)
CHE	0.36	(0.01)	0.15	(0.01)	0.17	(0.01)	0.30	(0.02)	0.25	(0.01)
CZE	0.53	(0.02)	0.26	(0.02)	0.34	(0.02)	0.50	(0.02)	0.35	(0.02)
DEU	0.57	(0.01)	0.21	(0.01)	0.29	(0.02)	0.43	(0.02)	0.34	(0.02)
DNK	0.16	(0.02)	0.10	(0.01)	0.07	(0.01)	0.41	(0.02)	0.27	(0.02)
ESP	0.15	(0.01)	0.21	(0.01)	0.06	(0.00)	0.42	(0.02)	0.25	(0.01)
FIN	0.06	(0.01)	0.10	(0.01)	0.05	(0.01)	0.39	(0.02)	0.28	(0.02)
FRA	0.54	(0.01)	0.28	(0.02)	0.31	(0.02)	0.43	(0.02)	0.33	(0.02)
GBR	0.20	(0.01)	0.13	(0.01)	0.08	(0.00)	0.42	(0.02)	0.26	(0.01)
GRC	0.47	(0.02)	0.29	(0.02)	0.30	(0.02)	0.45	(0.02)	0.26	(0.02)
HUN	0.61	(0.02)	0.28	(0.02)	0.41	(0.02)	0.45	(0.02)	0.30	(0.02)
IRL	0.17	(0.02)	0.17	(0.01)	0.07	(0.01)	0.42	(0.02)	0.26	(0.02)
ISL	0.09	(0.03)	0.13	(0.03)	0.07	(0.03)	0.34	(0.02)	0.22	(0.02)
ITA	0.50	(0.01)	0.20	(0.01)	0.36	(0.01)	0.31	(0.02)	0.28	(0.01)
JPN	0.47	(0.01)	0.10	(0.01)	0.16	(0.01)	0.26	(0.03)	0.17	(0.02)
KOR	0.35	(0.01)	0.13	(0.01)	0.11	(0.01)	0.35	(0.02)	0.13	(0.02)
LUX	0.30	(0.01)	0.24	(0.01)	0.26	(0.02)	0.42	(0.02)	0.30	(0.02)
MEX	0.40	(0.04)	0.25	(0.01)	0.08	(0.01)	0.13	(0.02)	0.12	(0.01)
NLD	0.60	(0.01)	0.18	(0.01)	0.32	(0.01)	0.49	(0.01)	0.29	(0.02)
NOR	0.11	(0.01)	0.12	(0.01)	0.05	(0.01)	0.37	(0.02)	0.25	(0.02)
NZL	0.17	(0.01)	0.12	(0.01)	0.07	(0.01)	0.35	(0.02)	0.23	(0.02)
POL	0.14	(0.01)	0.19	(0.01)	0.05	(0.01)	0.43	(0.01)	0.29	(0.01)
PRT	0.32	(0.01)	0.26	(0.01)	0.10	(0.01)	0.41	(0.02)	0.29	(0.02)
SVK	0.42	(0.02)	0.23	(0.02)	0.31	(0.02)	0.44	(0.02)	0.32	(0.02)
SWE	0.12	(0.02)	0.12	(0.01)	0.07	(0.01)	0.31	(0.02)	0.23	(0.01)
TUR	0.53	(0.02)	0.18	(0.01)	0.23	(0.02)	0.35	(0.02)	0.15	(0.02)
USA	0.24	(0.01)	0.15	(0.01)	0.04	(0.01)	0.22	(0.02)	0.13	(0.01)

Figure 16.1
Relationship between the segregation index of students' expected occupational status and the segregation index of student performance in reading (PISA 2000)

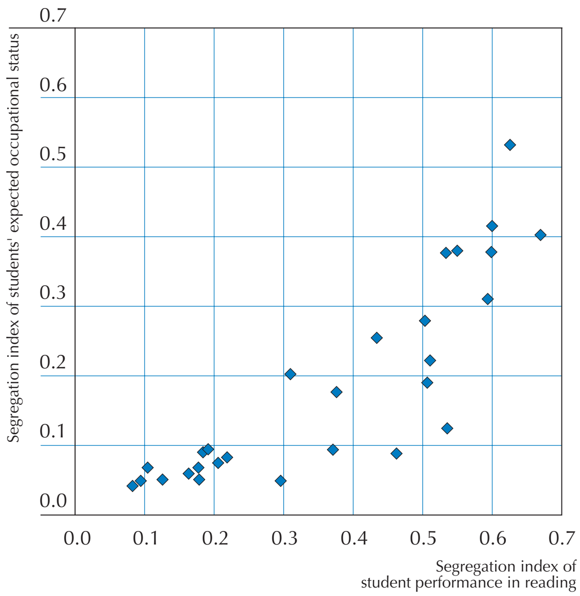

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Figure 16.1 presents the correlation at the country level between the segregation index of student performance in reading and the segregation index of students' expected occupational status. It can be observed in this figure that the segregation index of students' expected occupational status increases as the academic segregation increases. This result makes sense as in highly segregated educational systems, low performers are more likely to attend vocational schools that train students for specific types of occupations.

Figure 16.2 is quite appealing. As the intraclass correlation of the students' expected occupational status increases, the correlation between the parents occupation and the self-expected correlation tends to be higher than what is observed in non-segregated educational systems.

Figure 16.2

Relationship between the segregation index of students' expected occupational status and the correlation between HISEI and students' expected occulational status

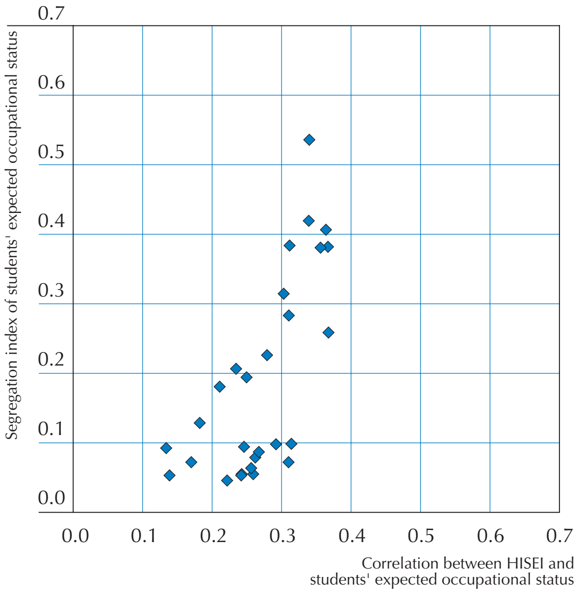

Table 16.9 and Table 16.10 present the correlation at the country level between the five indicators.

Table 16.9

Country correlations (PISA 2000)

	Segregation index of international socio-economic index of occupational status (HISEI)	Segregation index of students' expected occupational status	Correlation between student performance in reading and students' expected occupational status	Correlation between international socio-economic index of occupational status (HISEI) and students' expected occupational status
Segregation index of student performance in reading	0.63	0.86	0.28	0.43
Segregation index of international socio-economic index of occupational status (HISEI)		0.58	0.24	0.41
Segregation index of students' expected occupational status			0.54	0.69
Correlation between student performance in reading and students' expected occupational status				0.85

Table 16.10
Country correlations (PISA 2006)

	Segregation index of international socio-economic index of occupational status (HISEI)	Segregation index of students' expected occupational status	Correlation between student performance in science and students' expected occupational status	Correlation between international socio-economic index of occupational status (HISEI) and students' expected occupational status
Segregation index of student performance in science	0.65	0.88	0.23	0.29
Segregation index of international socio-economic index of occupational status (HISEI)		0.69	0.38	0.48
Segregation index of students' expected occupational status			0.45	0.60
Correlation between student performance in science and students' expected occupational status				0.78

As shown by Tables 16.9 and 16.10, academic segregation is highly associated with the segregation index of students' expected occupational status which seems to reinforce the correlation between: *(i)* performance and students' expected occupational status; and *(ii)* parents' occupational status and students' expected occupational status.

CONCLUSION

This chapter illustrated how policy relevant questions might be at least partially answered by PISA data. The first example addressed an important equity issue, *i.e.* the gender gap in reading. Results indicate that education reforms for reducing the gender gap in reading performance should be targeted at low male achievers. It also identified the methodological concern of the impact of item format on the respective standard deviation for boys and for girls. This is obviously an area where PISA offers extensive opportunities for methodological research.

The second example demystified the concept of school socio-economic composition in a particular context and revealed that in Belgium, social segregation mainly results from academic segregation.

Finally, the last example broadened the consequences on segregated education systems to students' expected occupational status at the age of 30. It concretised the long-term effects of educational policies.

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Preparation of data files

All data files (in text format) and the SAS® control files are available on the PISA website (*www.pisa.oecd.org*).

SAS® users

By running the SAS® control files, the PISA data files are created in the SAS® format. Before starting analysis, assigning the folder in which the data files are saved as a SAS® library.

For example, if the PISA 2000 data files are saved in the folder of “c:\pisa2000\data\”, the PISA 2003 data files are in “c:\pisa2003\data\”, and the PISA 2006 data files are in “c:\pisa2006\data\”, the following commands need to be run to create SAS® libraries:

```
libname PISA2000 “c:\pisa2000\data\”;
libname PISA2003 “c:\pisa2003\data\”;
libname PISA2006 “c:\pisa2006\data\”;
run;
```

SAS® syntax and macros

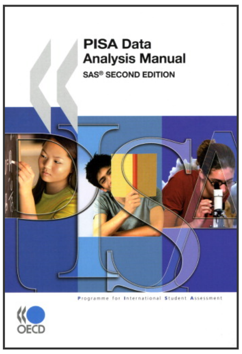
All syntaxes and macros in this manual can be copied from the PISA website (*www.pisa.oecd.org*). The 17 SAS® macros presented in Chapter 17 need to be saved under “c:\pisa\macro\”, before staring analysis. Each chapter of the manual contains a complete set of syntaxes, which must be done sequentially, for all of them to run correctly, within the chapter.

Rounding of figures

In the tables and formulas, figures were rounded to a convenient number of decimal places, although calculations were always made with the full number of decimal places.

Country abbreviations used in this manual

AUS	Australia	FRA	France	MEX	Mexico
AUT	Austria	GBR	United Kingdom	NLD	Netherlands
BEL	Belgium	GRC	Greece	NOR	Norway
CAN	Canada	HUN	Hungary	NZL	New Zealand
CHE	Switzerland	IRL	Ireland	POL	Poland
CZE	Czech Republic	ISL	Iceland	PRT	Portugal
DEU	Germany	ITA	Italy	SVK	Slovak Republic
DNK	Denmark	JPN	Japan	SWE	Sweden
ESP	Spain	KOR	Korea	TUR	Turkey
FIN	Finland	LUX	Luxembourg	USA	United States



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