Schooling, Labor Markets, and STEM Occupational Expectations:

A Comparative Perspective

By

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Abstract

Encouraging more students to pursue science, technology, engineering, and mathematics (STEM) education and occupations has been a prominent part of the national agenda in many countries. Policymakers and researchers believe that improving STEM literacy for all students is essential to promoting student engagement in STEM education and occupations. However, there has been little focus on fostering educational and occupational expectations in STEM fields even though prior research has shown that students' expectations of pursuing a science/engineering career in high school matter for their educational and occupational attainment. Further, several studies have shown that the gender gap in career expectations expressed before entry into college is strongly associated with gender segregation by fields of study in higher education.

Recently, policymakers and researchers in most developed countries have shifted the focus of cross-national comparisons from average student performance in math and science to career expectations in science-related fields. Several international studies have revealed cross-national differences in both science-related career expectations and gender gaps in these expectations. A small number of studies have attempted to investigate the sources of these cross-national differences, but this research has focused on only one dimension of national education systems—namely, stratification. Large-scale international comparative studies provide opportunities to examine cross-national differences in STEM occupational expectations and explore the macro-level factors associated with this variability. In this dissertation, I use large-scale international surveys and student achievement data from the Programme for International Student Assessment (PISA) 2000, 2003, and 2006 to investigate the degree to which features of national education systems and labor markets are associated with cross-national variation in students' STEM occupational expectations.

The analytical results show that cross-national differences in both education systems and labor markets are associated with students' STEM occupational expectations, but this association differs across STEM subfields (computing and engineering, and health services). For example, students' health services occupational expectations are negatively associated with both curricular standardization and stratification in secondary education, whereas computing and engineering occupational expectations are not associated with any of the characteristics of secondary education systems measured in the current study (the standardization of curriculum, the number of school types available to 15-year-old students, or early tracking). The association between curricular standardization and health services occupational expectations differs by gender and across performance levels. This study provides no evidence linking economic incentives (as measured by STEM wage premiums) to students' expectations for STEM occupations. Moreover, the study finds no evidence that an economic shift toward a postindustrial economy is positively associated with gender segregation in STEM occupational expectations, although both boys and girls are less likely to expect STEM occupations in postindustrial economies.

The results of this study may encourage policymakers and researchers to consider the unintended consequences of educational reforms. Several countries, including Germany and the United States, have attempted to implement national curricula and assessment standards, and although these reforms may improve students' test scores as intended, the results of this study suggest that they may also lower students' interest in pursuing STEM occupations. In addition, the results of this study highlight the importance of examining differences in the link between educational, social, and economic factors and STEM career expectations by gender and across academic performance levels. Finally, the results of this study demonstrate the importance of macro-level features of labor markets for the STEM career expectations of young adults.

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CHAPTER 1. Introduction

In recent decades, low participation in STEM (science, technology, engineering, and mathematics) disciplines in higher education has become a major concern for policymakers and researchers in the United States and most other developed countries. Many countries are facing a significant challenge as they attempt to prepare an adequate supply of qualified workers for employment in STEM fields (Cervantes, 1999; Roberts, 2002). For example, even in Japan, which is ranked near the top in international comparisons of mathematics and science achievement among students, the educational system is suffering from *rikei banare* (flight from science), a phenomenon in which students avoid the study of science, engineering, and mathematics, and prefer to study the arts, medicine, and finance (Fackler, 2009). In many countries, including Japan and Korea, policymakers and educational researchers have expressed that the low level of interest in STEM education and occupations among students is quite concerning because STEM graduates are increasingly central to national economic competitiveness and growth in a global economy (National Science Board, 2010).

In addition to these concerns about a lack of STEM students, researchers and policymakers in many countries are currently paying a great deal of attention to both the underrepresentation of women in STEM fields and sex segregation by field of study in higher education, as well as the effects of these trends on future occupational and wage inequality. While math and science gender differences in secondary school test scores, grades, and course-taking were once pronounced in the United States, they have virtually disappeared (Friedman, 1989; Hyde, Lindberg, Linn, Ellis, & Williams, 2008; Riegle-Crumb, Farkas, & Muller, 2006; Xie & Shauman, 2003). Over the past several decades, both the numbers and the proportion of women receiving bachelor’s degrees in almost all major STEM fields have increased dramatically (National Science Board, 2010). Despite this trend toward gender parity, however, men and women tend to study different fields within STEM. Gender gaps remain and are especially pronounced in certain STEM subfields (e.g., engineering, computer science, and physics) in the United States (National Science Board, 1998; 2012) as well as in other countries (Bradley, 2000; Bradley & Charles, 2004; Charles & Bradley, 2002; Else-Quest, Hyde, & Linn, 2010; Ramirez & Wotipka, 2001).

Prior research has shown that career expectations for STEM matter for students' educational and occupational attainment in STEM fields (Morgan, Gelbgiser, & Weeden, 2013; Tai, Liu, Maltese, & Fan, 2006). Researchers in the United States have conducted extensive research on how and why certain groups have more or less access to, opportunity in, and success in the educational trajectories leading to STEM occupations. Studies have focused on how differences in academic preparation and attitudes toward math and science in high school explained students' choices to choose a STEM major in postsecondary education (Correll, 2001; Riegle-Crumb & King, 2010). Recent studies have also shown that students who expect to have a STEM career are more likely to earn a STEM degree than students who do not, even after controlling for student demographics, parental background, achievement test scores, and academic characteristics such as enrollment in advanced mathematics and science classes (Maltese, 2008; Tai et al., 2006). In addition, prior research on gender inequality found that gender differences in science and engineering educational expectations before entry into college were some of the primary determinants of the gender disparity in science and engineering degree attainment (Xie & Shauman, 2003). These studies also found that the gender gap in STEM degree attainment was not explained by gender differences in high school math course-taking, grades, or attitudes.

Given the importance of career expectations for educational and occupational attainment in STEM fields, cross-national research in education has shifted from a focus on the vertical dimension of occupational expectations to a focus on the horizontal dimension. Recent studies have shown cross-national differences in adolescents' science-related career expectations (OECD, 2007b; 2009b; Sikora & Pokropek, 2011). Relative to students in other OECD (Organization for Economic Co-operation and Development) countries, Finnish, Japanese, and Korean students have low levels of interest in science-related careers, whereas students in Mexico, Portugal, and the United States have high levels of interest in science-related careers. These cross-national studies also found that girls have higher educational and occupational expectations than boys in a majority of OECD countries (McDaniel, 2010), but boys and girls expect careers in different fields (Sikora & Pokropek, 2011). Girls are underrepresented in career plans for computing and engineering, but they outnumber boys in career plans for health and medicine, even when nursing and midwifery are excluded. Comparative studies have focused primarily on creating a descriptive portrait of science-related career expectations (OECD, 2009b; OECD & UNESCO, 2003). In addition, a few studies have analyzed the role of individual- and school-level factors (e.g., gender, immigrant status, science performance, course-taking, and vocational program placement) in explaining cross-national variation in science-related career expectations among students (Sikora & Pokropek, 2011).

Despite these helpful initial findings, the literature on STEM career expectations remains incomplete. Researchers have not yet explored whether country-level factors such as the features of educational systems and labor markets help explain cross-national differences in students' science-related career expectations. Large-scale international comparative studies provide opportunities to examine this cross-national variation and its sources at the macro-level. Using large-scale international surveys and achievement data from the Programme for International Student Assessment (PISA), this study investigates cross-national variation in STEM-related occupational expectations, and whether this variation is associated with macro-level features of education systems and labor markets. In particular, the study focuses the following questions: (1) Are cross-national differences in students’ STEM occupational expectations related to features of national education systems and labor markets, and if so, how? (2) Is cross-national variation of gender gaps in STEM occupational expectations associated with features of national educations systems and gender stratification in the labor market? (3) What are the national trends in students’ STEM occupational expectations?

STEM OCCUPATIONAL EXPECTATIONS AND ENTRY INTO STEM EDUCATION AND OCCUPATIONS

A large number of researchers in many countries have attempted to understand the factors and processes that facilitate entry into STEM education and occupations (Correll, 2001; Morgan, et al., 2013; Schoon, Ross, & Martin, 2007; Tytler, Osborne, Williams, Tytler, & Clark, 2008; Xie & Shauman, 2003). Prior research has focused mainly on the transition from high school to postsecondary education in STEM educational and occupational trajectories. In particular, these studies analyzed whether differences in academic preparation and attitudes toward mathematics or science in pre-college years were determinants of entry into STEM educational trajectories and degree completion in STEM fields (Ethington & Wolfle, 1988; Federman, 2007; Maple & Stage, 1991).

Recent research on STEM career expectations found that expecting to obtain a STEM career was associated with a higher likelihood of earning a STEM degree. Using the National

Educational Longitudinal Survey of 1988 (NELS:88), Tai and his colleagues (2006) and Maltese (2008) examined the effect of early plans for STEM careers on degree completion in STEM fields. Maltese (2008) found that students who in eighth grade indicated that they desired a job in STEM fields at age 30 were significantly more likely to complete STEM degrees when accounting for attitudes toward mathematics and science, enrollment in certain mathematics and science courses, and test scores in high school. Tai et al. (2006) found that, among the students who graduated with baccalaureate degrees from 4-year colleges, the students who had reported (at age 14) that they expected to have STEM careers around age 30 were 3.4 times more likely to earn physical science and engineering degrees than students who did report this expectation, even when student demographics, parental background, achievement test scores, and academic characteristics such as enrollment in advanced mathematics and science courses were held constant. The authors also compared the estimated probabilities of earning science baccalaureate degrees for two pairs of prototypical students with all other predictors set to means. They found that students who had science-related career expectations but average math achievement had a 34 percent probability of earning a baccalaureate degree in engineering or the physical sciences, while students with non-science career aspirations and high levels of achievement had a 19% probability of earning such a degree.

Several studies in the United Kingdom (Schoon, 2001; Schoon, et al., 2007) and Australia (Anlezark, Lim, Semo, & Nguyen, 2008) examined the importance of science-related career aspirations for educational and occupational attainment in STEM fields. For example, Schoon and her colleagues (2007) found that occupational aspirations at age 16 were the key factor predicting occupational attainment in science, engineering, technology, and health professions at ages 30/33, after taking gender, family background, ability in math, and school type into account.

Researchers also found that the gender difference in expecting (in high school) to choose a science or engineering college major was the most single important factor in explaining horizontal gender segregation by fields of study in higher education (Xie & Shauman, 2003). A considerable body of research in the United States has provided extensive evidence of gender- and race/ethnicity-based disparities in STEM-related educational and career expectations among young adolescents (Bae, Smith, & Pratt, 1997; Catsambis, 1994, 1995; Riegle-Crumb, Moore, & Ramos-Wada, 2010; Wilson & Boldizar, 1990). Studies in other countries have also documented gender gaps in science-related career expectations (Adamuti-Trache & Sweet, 2009; Sikora & Pokropek, 2011). Further, there are gender-segregated horizontal expectations within science fields—girls are more likely to expect to major in biology and health science, whereas boys are more likely to expect to major in engineering and physics (Adamuti-Trache & Sweet, 2009; Benbow & Minor, 1986; Sikora & Pokropek, 2011).

Research on gender inequality in the United States suggests that differences in academic preparation play a minor role in explaining horizontal gender segregation in higher education. For example, Morgan and his colleagues (2013) found that differences in academic preparation accounted for only a small portion of the gender gap in college majors. Xie and Shauman (2003) also reported that the gender gap in science and engineering degree attainment was not explained by gender differences in high school math course participation and grades, attitudes, and college grades. The authors found that the gender disparity in students’ expectations (in high school) of pursuing a science or engineering career was the most important explanatory factor underlying gender differences in the likelihood of majoring in science or engineering in college. Xie and

Shauman (2003) also found that the gender gap in expectations concerning postsecondary science/engineering education was not explained by sex differences in math and science achievement.

A substantial amount of research in the United State has explored which factors influence science and engineering career expectations in early adolescence (Mau, 2003; Riegle-Crumb, et al., 2010; Wang & Staver, 2001). These studies have focused on the characteristics of students, families, and schools. In addition, a few U.S. studies have examined the influence of broader social environments, including occupational sex segregation in the labor market and sex differences in the proportions of highly successful and unsuccessful workers, on students' occupational expectations (Baird, 2008; Shu & Marini, 1998; Xie & Shauman, 1997).

Cross-national research on students' career expectations in science-related fields have focused largely on descriptive analyses. Although a few cross-national studies have examined the association between national education systems and gender gaps in science-related career plans (Sikora & Pokropek, 2011, 2012), these studies focused only on the influence of differentiated secondary education systems. Prior research has not examined whether macro-level features of education systems, economies, and labor markets help explain cross-national variation in students' STEM-related occupational expectations. To bridge this gap in the literature, I investigate how educational and economic contexts at the country level are linked to students' occupational preferences for STEM.

THE DIFFERENCE BETWEEN ASPIRATIONS AND EXPECTATIONS

Morgan (2007) explained that "expectations and aspirations, within sociological research on education and social inequality, are stable prefigurative orientations composed of specific beliefs about one’s future trajectory through the education system and one’s ultimate class or status position” (pp. 1528-1529). However, the terms *expectations* and *aspirations* are used differently in the theoretical literature; the term *aspirations* refers to the outcomes that individuals would ideally like to achieve or attain, while the term *expectations* refers to a more realistic appraisal of the outcomes an individual expects to achieve based on a recognition of their own abilities and structural constraints. Previous research has shown that measures of expectations are better predictors of future attainment than measures of aspirations (Goyette, 2008).

Researchers have typically used general measures of occupational aspirations and expectations that include questions regarding the type of jobs that young people plan or expect to have in the future. A few researchers have used more specific measures that capture unique elements of either students’ plans, aspirations, or expectations related to education and career (Marini & Greenberger, 1978; McLaughlin, Cohen, Lee, & National Center for Education Statistics, 1997). In these cases, occupational aspirations have been assessed by asking adolescents to state the occupation they wish or hope to have when they complete their education, while occupational expectations have been assessed by asking adolescents about the occupation that they expect to have as an adult. Cross-national surveys have included the following question about students’ occupational plans: “What kind of job do you *expect* to have when you are about 30 years old?” The PISA student questionnaire measured students’ occupational expectations via a single-question measure of 15-year-old students’ expected occupation around age 30.

ORGANIZATION OF THE DISSERTATION

In this dissertation, I investigate the degree to which features of national education systems and labor markets are associated with cross-national variation in students' STEM occupational expectations. The dissertation is organized as follows: In Chapter 2, I describe the data and methods used in the study. In Chapter 3, I investigate cross-national differences in students' STEM occupational expectations and the association between these differences and the features of national education systems. I pay particular attention to the features of secondary education systems, namely standardization and stratification. In Chapter 4, I examine cross-national variation of gender gaps in STEM-related occupational expectations and the extent to which the features of national education systems are associated with these gender gaps. I extend prior research by using a framework of stratification and standardization in the analysis. In Chapter 5, I investigate the degree to which labor market conditions and STEM wage expectations are associated with cross-national variation in students' occupational expectations. In Chapter 6, I examine the degree to which macro-level features of labor markets are associated with cross-national variation of gender gaps in STEM occupational expectations. In particular, I focus on gender inequality in the labor market and postindustrial economies. In Chapter 7, I use data from PISA 2000 through PISA 2006 to examine national trends in students' STEM occupational expectations over time. In particular, I investigate net country trends that persist after controlling for heterogeneity at the student and school levels. Finally, Chapter 8 includes a summary and overview of the sources of cross-national differences in STEM occupational expectations, a discussion of the implications of the findings for fostering students' career expectations for STEM fields, and suggestions for future comparative research on occupational expectations.

CHAPTER 2. Data and Methods

In this chapter, I describe the data sets, variables, and methods used in this study. Data from the Programme for International Student Assessment (PISA), which was administered in Organization for Economic Co-operation and Development (OECD) member and partner countries, are used as the primary data in an examination of cross-national variation in STEM occupational expectations. In addition, I use several external data sets to measure national characteristics. The study employs hierarchical generalized linear models (HGLM) in which the level 1 sampling model is a Bernoulli distribution (Raudenbush & Bryk, 2002) because the dependent variable is binary (whether a student expects to have a STEM-related occupation around the age of 30).

DATA

The Programme for International Student Assessment (PISA)

PISA is a triennial survey that measures the knowledge and skills of representative samples of 15-year-old students nearing the end of compulsory education who are attending either public or private schools in each participating country. PISA assessed performance in reading, mathematics, and science literacy in OECD member countries and a group of partner countries. Students schooled in the home or workplace, or outside the country were excluded from the target population. In each PISA survey wave, three subject domains were tested and one of three was assessed as the major domain. PISA 2000 focused on reading, PISA 2003 focused on mathematics, and PISA 2006 focused on science. PISA started the second cycle of data collection in 2009. The second cycle of PISA mirrored the first: PISA 2009 focused on reading, PISA 2012 focused on math, and PISA 2015 will focus on science. In addition to gathering data on students’ reading, math, and science literacy, PISA also used student and school questionnaires to collect information on various aspects of students’ home environments and family and school backgrounds. Unlike other international student achievement data, which include only information on educational expectations, PISA also collected information on students’ expected occupation around age 30. PISA employed a cross-sectional design; thus, occupational expectations and other student background variables were measured at the time of academic assessments. Because the sampling design was based on age rather than grade level, respondents’ grade levels differ across countries.

Most countries in the PISA data implemented a two-stage stratified sample design (Adams & Wu, 2002; OECD, 2005; 2009a).[1] The first-stage sampling units were individual schools that included 15-year-old students at the time of the assessment. Schools were systematically sampled from a comprehensive national list of all eligible schools, with probability proportional to their size. The second-stage sampling units were students within the sampled schools. Students were randomly sampled within schools with equal probability. In principle, PISA required a minimum of 150 schools to be selected in each country. The within-school sample size was usually 35 students. The goal was to obtain a minimum sample size of 4,500 students in each country. However, actual sample sizes varied widely across countries. In PISA 2006, for example, sample sizes ranged from 339 students in 12 schools in Liechtenstein to 22,646 students in 896 schools in Canada.

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[1] A few countries used a three-stage sampling design. When a three-stage design was implemented, geographical area-level sampling frames were used as an additional stage of frame creation and sampling. That is, geographical areas were sampled first (first-stage units), and then schools (second-stage units) were selected within sampled areas. Students were the third-stage sampling units in three-stage designs. In PISA 2000, Poland, the Russian Federation, and the United States used this three-stage sampling design. The Russian Federation and Turkey implemented a three-stage design in PISA 2003. The only country that employed a three-stage design was the Russian Federation in PISA 2006.

The current study focuses on PISA 2000, 2003, and 2006 to investigate cross-national variation in students' STEM occupational expectations. Data from PISA 2009 are excluded from the study because the 2009 survey did not include any items measuring students' occupational expectations in the student questionnaire. The unweighted sample sizes in 2000, 2003, and 2006 exceeded 200,000 students from 43 countries, 250,000 students from 41 countries, and 400,000 students from 57 countries, respectively.[2] In the PISA 2003 survey, a question about students' occupational expectations was included as an international option in an educational career questionnaire, and only 18 OECD and six partner countries (24 in total) administered the PISA educational career questionnaire that year.

Data Sources: National Characteristics

External data from several sources are used to measure the characteristics of national education systems, labor markets, and wage premiums for STEM occupations. Information on national education systems is gathered from the OECD reports (2005b; 2007b) and the *Education at a Glance, OECD Indicators* (OECD, 2005a), which uses figures from the OECD PISA database and the OECD education database . In addition, I use the TIMSS curriculum questionnaire and *World Data on Education* (Amadio, 2000) to capture features of national educations systems. Information on labor markets and wages for STEM occupations was derived from the International Labour Organization's (ILO) online LABORSTA database (http://laborsta.ilo.org/default.html). Gender-related indices including the Gender Empowerment Measure (GEM) were obtained from the *Human Development Report* by the United Nations Development Programme (UNDP, 2000; 2001; 2002; 2003; 2004; 2005; 2006). In addition,

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[2] The first PISA survey was conducted in 2000 in 32 countries, including 28 OECD member countries. Another 11 non-OECD countries administered the same PISA 2000 assessment in 2001/2002. These are Albania, Argentina, Bulgaria, Chile, Hong Kong-China, Indonesia, Israel, FYR Macedonia, Peru, Romania, and Thailand.

national economic development indicators are collected from the UNESCO Institute for Statistics and the World Bank.

VARIABLES

Dependent Variables

The outcome measure for the study is binary, indicating whether or not a student expected to have a STEM-related occupation around the age of 30. In PISA 2000, 2003, and 2006, the student questionnaire included the following single question measure of students' occupational expectations: What kind of job do you expect to have when you are about 30 years old? PISA classified students' responses to this open-ended question according to the International Standard Classification of Occupations 88 (ISCO-88); the ISCO occupation categories were then classified as either STEM-related occupations or non-STEM-related occupations.

This study examines six types of STEM occupational expectations (two skill levels in each of three STEM fields). First, because prior research has indicated that boys and girls expect to have science careers in different fields, the study explores in three fields: (a) general STEM-related fields including mathematics, natural science, engineering/computing, and health services; (b) computing and engineering (CE); and (c) health services (Sikora & Pokropek, 2011). Second, the analyses include two skill levels: (a) professional, technician, and associate professional occupations (ISCO-88, major group 2 and 3) and (b) only professional occupations (ISCO-88, major group 2). Professional occupations require at least a bachelor's degree at entry. Technicians and associate professionals must complete tertiary education that begins at age 17 or 18 and lasts 3-4 years, but awards degrees that are not equivalent to a bachelor's degree (Elias, 1997). For each STEM field, I create one measure for each skill level. Specific occupational titles for STEM-related occupations are listed in Appendix 2.1.

The outcome measures used in the current study differ from science-related career categories in the PISA 2006 report (OECD, 2007b). For example, in this study I include mathematics professionals in the science-related occupation category, but PISA 2006 did not classify math professionals as having a STEM-related occupation. In addition, PISA 2006 report included sociologists, anthropologists, and social work professionals (including welfare worker) in the science-related occupation category, whereas this study excludes these professions from STEM-related occupations. Students who indicated “don’t know” or “vague (e.g., a good job, a well-paid job)” were coded not expecting a STEM occupation.[3]

Individual-Level Control Variables

I include the following student-level controls:

Parents’ STEM-related occupations. Parent’s STEM-related occupation is a dummy variable, coded 1 when either of the respondents’ parents have a job in STEM-related field. The ISCO coding scheme is used to classify both students’ STEM occupational expectations and parents’ occupations in STEM fields.

Family socioeconomic status (SES). The PISA index of economic, social, and cultural status (ESCS) is used to measure family SES. Across survey waves, similar variables have been used to derive the ESCS index, including: 1) the highest occupational status of parents measured by the international socio-economic index of occupational status (ISEI) (Ganzeboom, De Graaf, & Treiman, 1992); 2) the highest educational level of parents; and 3) home possessions. The

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[3] The proportion of respondents who indicated either “don’t know” or “vague” ranged from 6 to 10 percent across PISA survey waves.

ESCS measure is standardized with a mean of 0 and a standard deviation of 1 across students in OECD countries (OECD, 2009a).

Students' academic ability. Because data on prior achievement is not available in cross-sectional data, previous cross-national studies on educational and occupational expectations have used students' achievement scores as a proxy for prior academic ability; however, ability should be measured prior to students being asked about their expectations (Buchmann & Dalton, 2002; McDaniel, 2010; Sikora & Pokropek, 2012). Because of this limitation, it remains unclear whether students who perform better in school are more likely to be interested in STEM occupations. In this study, I run two types of models: (a) models that control for student ability (reading, math, and science test scores) and (b) a model that does not control for student ability; I then assess whether the findings from these models are consistent.[4]

Other student-level controls. I also control for gender, age, grade level, immigration background (of both students and their parents), language spoken at home, parental occupational level (blue collar vs. white collar), mother's working status, and number of books in the home.

School-Level Control Variables

I include following school-level controls:

School SES. The socioeconomic status of each school is the mean of the family SES levels of all students in the school.

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[4] PISA adopted a balanced incomplete block design for assessment; this design pairs each block with every other block, but does not include all possible orderings of block pairs. Thus, five possible values were estimated for each PISA student achievement score. I used the first plausible value for each domain as a proxy for student ability. In addition, the PISA assessment focused on students' ability to use the knowledge and skills that are essential for full participation in society. The PISA assessment was not designed to assess the extent to which these students have mastered a specific curriculum; however, in the current study, I used the PISA assessment scales for reading, mathematics, and science literacy scores as a proxy for student ability.

School size. The index of school size is derived from the total enrollment for the school as reported by the school principal.

School community location. The measure of school community location is derived from data provided by the school principal. School communities are classified into five categories: (a) villages, hamlets, or rural areas (fewer than 3,000 people); (b) small towns (3,000 to about 15,000 people); (c) towns (15,000 to about 100,000 people); (d) cities (100,000 to about 1,000,000 people); and (e) large cities (more than 1,000,000 people).

Proportion of girls enrolled at school. The measure of the proportion of girls in the school is derived from enrollment data provided by the school principal. The variable is constructed by dividing the reported number of girls enrolled at the school by the total reported number of boys and girls attending each school.

School type. The PISA index of school type includes three categories: (a) public schools managed by a public education authority or agency, (b) government-dependent private schools (managed by a non-government organization but more than 50 percent of core funding is from government agencies), and (c) government-independent private schools (managed by a non-government organization and less than 50 percent of core funding is from government agencies).

School selectivity. School selectivity is based on principals’ reports of the extent to which student academic records and recommendations from feeder schools were considered in student admission decisions. Similar but slightly different response categories were used across the target PISA study cycles. To create comparable indices of school selectivity across cycles, schools are classified into three categories for each cycle. The PISA 2003 and PISA 2006 categories are: (a) schools in which neither factor was considered in student admissions; (b) schools in which at least one of these factors was considered in admission decisions; and (c) schools in which at least one of these factors was a high priority or pre-requisite for student admissions. The PISA 2000 categories are: (a) schools in which these factors were never considered in student admissions; (b) schools in which these factors were sometimes considered in admission decisions; and (c) schools in which these factors were always considered in student admissions.

Teacher shortage in math and science. The measure of teacher shortage in mathematics and science is derived from items asking how much school principals perceived that two factors—a lack of qualified mathematics teachers and a lack of qualified science teachers—hindered instruction at the school; response categories were "not at all," "very little," "to some extent," and "a lot." The index is calculated via IRT scaling, and is scaled to have a mean of 0 and a standard deviation of 1 across PISA participating countries. Positive values indicate above-average reports of a teacher shortage in math and science at a school.

Educational resources. The index of school educational resources is derived from several items measuring the school principal's perceptions of how much a lack of certain resources, including instructional materials, computers for instruction, library materials, audio-visual resources, and science lab equipment, hinder instruction at the school. The index is scaled to have a mean of 0 and a standard deviation of 1 across PISA participating countries; positive scores indicate a higher quality of educational resources.

Country-Level Control Variables

Each chapter uses different country-level indictors to measure national characteristics, including national education systems and labor markets. Thus, I include detailed information on these variables in each chapter. For country-level control variables, the PISA survey years are matched as closely as possible to the years in which national characteristics were measured. When there are gaps between the two, I assume the traits of the macro-level features of national education systems and labor markets are stable.

MODELS

Because the dependent variable (whether or not a student expects to have a STEM-related occupation around age 30) is binary, this study employs hierarchical generalized linear models (HGLMs) in which the level 1 sampling model is a Bernoulli distribution (Raudenbush & Bryk, 2002). To investigate cross-national variation in students' STEM occupational expectations and the association between this variation and macro-level features of education systems and labor markets (Chapter 3 through Chapter 6), this study uses three-level HGLMs in which students (level 1) are nested within schools (level 2) and within countries (level 3). The model is run separately for data from PISA 2000, 2003, and 2006. Additional models use a combined data set that pools the observations from countries that participated in every cycle of PISA 2000, 2003, and 2006; in these models, controls for the study year are included at the school level.[5] The final student weights are normalized at the country level to ensure that each country contributes equally to the analysis.

Model Specification for Three-Level HGLM

Level 1 (Student-level)

$$\eta_{ijk} = \log[\varphi_{ijk} / (1 - \varphi_{ijk})] = \pi_{0jk} + \pi_{1jk}(Female) + \pi_{2jk}(Parent.STEM - Occp) + \pi_{3jk}(FamilySES)$$
$$+ \pi_{4jk}(Grade) + \cdots + \pi_{Pjk}(Student.predictorP)$$

where

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[5] Poland and the United States implemented different sample designs across PISA survey waves. For the combined data set, I ran two types of models: (a) models excluding countries that implemented different sample designs across cycles and (b) models including countries that implemented different sample designs across cycles. I then assessed whether the findings from these models were consistent. When findings were consistent across the two models, I report the results from the model that includes Poland and the United States.

φ_{ijk} is the probability that a student *i* in school *j* in country *k* expects to have a STEM-related occupation around age 30;
η_{ijk} is the log odds that a student *i* in school *j* in country *k* expects to have a STEM-related occupation around age 30.

Level 2 (School-level)

$$\pi_{0jk} = \beta_{00k} + \beta_{01k}(Sch.SES) + \beta_{02k}(Location) + \beta_{03k}(\mathrm{Pr}ivate) + \cdots + \beta_{0Pk}(Sch.\ predictorP)_{jk} + r_{ojk}$$
$$\pi_{1jk} = \beta_{10k} + \beta_{11k}(Sch.SES) + \beta_{12k}(Location) + \beta_{13k}(\mathrm{Pr}ivate) + \cdots + \beta_{1Pk}(Sch.\ predictorP)_{jk} + r_{1jk}$$
$$\pi_{21jk} = \beta_{20k},\ \pi_{3jk} = \beta_{30k},\ \pi_{4jk} = \beta_{40k},\ \cdots,\ \pi_{Pjk} = \beta_{P0k}$$

Level 3 (Country-level)

$$\beta_{00k} = \gamma_{000} + \gamma_{001}(Country.\ predictor1)_k + \cdots + \gamma_{00P}(Country.\ predictorP)_k + u_{00k}$$
$$\beta_{10k} = \gamma_{100} + \gamma_{101}(Country.\ predictor1)_k + \cdots + \gamma_{10P}(Country.\ predictorP)_k + u_{10k}$$
$$\beta_{20k} = \gamma_{200},\ \beta_{30k} = \gamma_{300},\ \beta_{40k} = \gamma_{400},\ \cdots,\ \beta_{P0k} = \gamma_{P00}$$

Because the small N at the country level is problematic, I run the separate analyses for educational systems and labor market conditions.

Chapter 3 and Chapter 5 focus on the coefficient γ_{00P} estimated in the HLM, which reflect the association between country-level indicators and students' occupational expectations. Chapter 4 and Chapter 6 focus on γ_{10P}, the cross-level interaction between female and country-level indicators, in order to examine whether gender gaps in STEM occupational expectations are associated with features of national education systems and gender equality in the labor market.

In Chapter 7, I employ two-level HGLMs in which students (level 1) are nested within schools (level 2), in order to investigate trends in STEM occupational expectations across PISA survey waves since 2000. Dummy variables for the study year and country are included at the school-level to explore which countries are showing an increase or decrease in students' STEM occupational expectations over time. To examine whether the decrease in STEM occupational expectations over time is greater among high-achieving students than among-low-achieving students, I fit two-level HGLMs by science performance quartile. In addition, HGLMs are run separately by gender to compare boys' and girls' STEM-related occupational expectations. Trend analyses are restricted to countries that participated in each cycle of PISA (2000, 2003, and 2006).

DEPENDENT VARIABLES: DESCRIPTIVE STATISTICS

Because the PISA surveys are based on a two-stage stratified cluster-sample design in which schools are sampled with unequal probability, all descriptive analyses are weighted with sampling weights to obtain the correct point estimates. To achieve unbiased estimates of the population sampling variances, Balanced Repeated Replication (BRR) weights with Fay's adjustment are used (OECD, 2009a).

On average, across OECD countries and across all three PISA waves, approximately 28% of students reported that they expected to be in STEM-related occupations around age 30. Compared to respondents in other OECD member countries, respondents in Canada, Mexico, Portugal, and the United States were more likely to expect to be in STEM-related occupations (Table 2.1). About 43% of students in the United States expected to be in STEM occupations around age 30 in PISA 2000 and PISA 2003, and about 40% reported this expectation in PISA 2006. Relative to students in other OECD member countries, students in high-achieving countries such as Finland, Japan, and Korea reported low levels of interest in pursuing STEM occupations. For example, about 20% of Korean and Japanese students expected to be in STEM-related occupations at age 30 across PISA survey waves.

As shown in Table 2.1, gender differences in general STEM occupational expectations are small in many countries, although there is cross-national variation, with gender differences ranging from male-favorable to female-favorable. In many countries, including Belgium, Germany, Luxembourg, Switzerland, and the United Kingdom, gender differences in expectations are close to zero in PISA 2006. Girls' STEM occupational expectations are higher than boys' expectations in some countries, such as the United States, while boys' expectations are higher than girls' expectations in Korea and Mexico.

On average, across OECD countries and across all three PISA waves, about 11% of students expected to be in computing and engineering (CE)-related occupations around age 30. Across PISA survey waves, students' CE occupational expectation in Mexico and Poland are above the OECD average (Table 2.2). In PISA 2006, students' expectations for CE occupations in several countries such as Finland, Korea, Japan, the United Kingdom are below the OECD average. Unlike general STEM occupational expectations, CE occupational expectations are gender segregated. Across all countries and survey waves, CE occupational expectations are higher for boys than for girls, although the magnitude of this male-favorable gender gap varies across countries. For example, in PISA 2006, country-specific male-favorable gender gaps range from 5% in the Netherlands to 23% in Poland.

Across OECD countries, about 11% of students expected to be in a health service (including nursing) occupation around age 30. In contrast to the pattern of CE occupational expectations, health service-related occupational expectations are higher among girls than boys across all countries and survey waves (Table 2.3). This female-favorable gender gap remains even when nursing is excluded from the list of health service occupations (Table 2.4).

These descriptive statistics show that students' interest in STEM-related occupations differs across countries. Gender segregation in occupational expectations for STEM subfields, however, is consistent across countries and across PISA survey waves. In Chapter 4 and Chapter 6, I investigate whether gender gaps in STEM subfield occupational expectations remain when student, school, and country characteristics are taken into account.

Table 2.1 Percentage of Students Expecting STEM Occupations (ISCO-88 Major Groups 2 and 3) around Age 30, Total and by Gender

	PISA 2000						PISA 2003						PISA 2006					
	All students		Boys		Girls		All students		Boys		Girls		All students		Boys		Girls	
OECD	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)
Australia	31.70	2.55	35.89	1.42	29.58	1.30	31.07	0.55	32.34	0.88	29.83	0.77	31.85	0.61	32.59	0.77	31.13	0.86
Austria	22.05	5.66	27.70	1.85	22.35	1.32	24.36	0.98	23.83	1.28	24.87	1.44	24.05	1.39	22.99	1.99	25.02	1.39
Belgium	33.24	2.69	33.24	1.43	30.75	1.08	25.31	0.81	26.05	1.12	24.53	1.00	27.87	0.75	28.16	1.06	27.56	0.84
Canada	35.21	0.72	34.00	0.63	37.01	0.60							37.02	0.69	34.20	0.87	39.76	0.90
Czech Republic	18.82	1.49	19.15	1.36	19.00	2.06	18.75	1.01	21.36	1.19	16.12	1.17	21.72	1.02	22.81	1.32	20.46	1.49
Denmark	25.85	1.63	26.09	1.83	24.80	1.89							23.46	0.72	20.56	0.89	26.3	0.98
Finland	30.39	0.84	30.97	1.18	29.75	1.06							19.28	0.62	17.04	0.77	21.35	0.99
France	20.55	0.90	21.55	1.34	19.36	0.98	28.19	0.92	34.34	1.42	22.96	1.00	35.01	1.05	34.97	1.56	35.05	1.18
Germany	25.26	2.81	23.76	1.28	24.01	0.84	20.87	0.79	18.54	1.00	23.04	1.06	22.11	0.73	22.27	1.11	21.95	0.96
Greece	28.61	1.34	28.66	1.46	29.34	1.26	31.67	1.12	30.56	1.16	32.71	1.63	33.42	0.85	34.81	1.29	32.24	1.14
Hungary	15.47	1.15	18.48	1.48	13.11	1.08	19.15	1.03	20.54	1.21	17.58	1.24	20.54	1.15	22.44	1.50	18.68	1.23
Iceland	33.71	0.91	37.37	1.08	30.14	1.26	31.64	0.84	32.29	1.15	30.99	1.28	39.86	0.93	36.9	1.32	42.54	1.32
Ireland	25.74	1.02	28.66	1.43	23.34	1.10	24.84	0.86	25.8	1.13	23.90	1.19	31.12	0.86	32.33	1.36	30.01	0.91
Italy	25.99	1.50	27.32	1.97	25.07	1.47	29.88	1.00	32.26	1.21	27.70	1.37	33.08	0.97	35.87	1.24	30.38	1.01
Japan	21.39	1.59	15.95	1.40	25.84	2.03							19.57	1.33	18.38	1.10	20.74	2.2
Korea	22.72	1.62	30.31	1.21	14.66	1.02	22.08	0.72	26.24	0.94	16.03	1.14	20.15	0.81	24.41	1.05	15.84	0.97
Luxembourg	24.43	0.81	28.06	1.27	21.44	0.99							25.80	0.69	26.48	0.91	25.16	0.98
Mexico	40.81	1.84	44.72	1.34	35.49	1.51	34.19	0.94	39.67	1.04	29.38	1.44	42.18	0.95	46.42	1.48	38.59	1.04
Netherland	26.17	3.56	27.68	1.79	21.46	1.50							24.47	0.78	19.36	0.84	29.69	1.16
New Zealand	28.35	1.22	31.86	1.37	25.67	1.32							26.45	0.80	23.95	1.14	28.58	1.07
Norway	28.46	0.91	29.38	1.09	28.09	1.24							30.22	0.79	27.39	1.10	32.93	1.18
Poland	31.60	8.24	39.27	4.46	31.65	2.32	27.21	0.73	30.35	0.98	24.16	1.03	35.26	0.77	39.55	1.14	31.21	1.09
Portugal	37.15	2.48	38.62	1.39	33.56	1.40	36.53	0.96	33.61	1.20	39.14	1.37	39.31	0.97	36.51	1.36	41.93	1.09
Slovak Republic							18.81	1.12	21.83	1.58	15.69	0.99	22.72	1.22	26.44	1.53	19.11	1.42
Spain	34.29	1.38	35.00	1.18	32.06	1.09							35.02	0.94	34.98	1.17	35.05	1.00
Sweden	26.06	0.66	28.50	0.90	23.68	0.90												
Switzerland	23.48	1.64	24.69	1.34	20.85	0.83												
Turkey													23.86	0.75	22.46	1.13	25.27	1.05

United Kingdom	21.66	5.65	20.69	1.03	16.80	0.75	27.01	0.90	30.08	1.28	24.04	1.20	25.23	0.68	24.76	0.91	25.67	0.83
United States	42.79	1.21	38.36	1.74	46.45	1.40	42.98	0.89	37.74	1.32	47.92	0.98	40.33	0.82	35.38	1.34	45.23	0.96
Partners																		
Albania	31.45	1.65	30.48	1.60	31.20	1.31												
Argentina	32.95	1.56	31.69	1.71	34.92	1.69							34.08	1.06	32.21	1.33	35.65	1.44
Azerbaijan													26.04	1.22	22.4	1.69	29.61	1.51
Brazil	41.54	4.07	39.15	1.39	47.04	1.61							43.03	0.92	37.73	1.18	47.13	1.11
Bulgaria	26.22	4.49	29.92	2.31	26.49	2.22							30.00	0.74	29.04	1.09	31.00	0.96
Chile	36.10	1.62	37.54	1.12	33.57	1.14							45.07	1.30	46.02	1.55	44.00	1.82
Chinese Taipei													25.31	1.12	31.64	0.80	18.46	2.01
Columbia													53.45	0.84	53.63	1.31	53.31	1.08
Croatia													19.89	1.53	22.08	1.46	17.91	2.11
Estonia													24.39	0.83	23.84	1.06	24.95	1.13
Hong Kong	18.62	0.64	20.31	0.93	16.66	0.85	17.33	0.83	18.66	1.16	16.09	1.13	24.45	0.71	28.19	1.04	21.04	1.05
Indonesia	20.26	1.99	15.21	1.09	26.45	2.24	23.84	1.10	17.99	1.22	29.36	1.58	31.83	1.96	30.75	3.42	32.94	1.63
Israel	28.80	4.64	33.15	2.12	22.39	1.69							35.58	1.28	34.44	1.97	36.54	1.46
Jordan													53.71	1.06	60.70	1.61	48.64	1.38
Kyrgyzstan													31.83	0.97	24.34	1.27	36.85	1.23
Latvia	22.04	1.03	25.81	1.52	18.31	1.20	19.22	1.17	24.99	1.79	14.08	1.21	22.82	0.66	25.27	1.07	20.78	0.98
Liechtenstein	16.22	2.25	21.50	3.59	10.91	2.74							22.38	2.50	26.44	3.54	19.03	3.42
Lithuania													25.00	0.70	26.23	1.11	23.79	0.95
Macao-China							20.47	1.50	20.75	2.28	20.22	1.82	21.11	0.62	22.93	1.22	19.33	0.81
Macedonia	29.21	2.49	33.94	1.32	27.21	1.20												
Montenegro													20.43	0.77	19.01	1.10	21.88	0.93
Peru	48.42	1.35	51.27	1.78	44.92	1.42												
Romania	24.91	6.23	23.52	1.40	20.45	1.31							24.02	1.40	24.31	1.64	23.74	1.51
Russian Federation	22.17	0.98	20.69	1.51	23.35	1.34							25.38	0.93	28.41	1.70	22.92	0.83
Serbia													26.12	1.80	26.49	1.54	25.76	2.60
Slovenia													35.96	0.75	39.49	1.03	32.73	1.16
Thailand	17.23	3.51	9.33	0.96	19.78	1.08	21.24	0.91	12.37	1.21	27.86	1.11	38.88	1.09	29.92	1.47	44.50	1.54
Tunisia													39.21	1.11	39.59	1.40	38.90	1.32
Uruguay													34.00	1.19	31.38	1.48	36.35	1.34
Yugoslavia							22.44	1.71	22.43	1.67	22.44	2.59						

Table 2.2 Percentage of Students Expecting Computing and Engineering (CE) Occupations (ISCO-88 Major Groups 2 and 3) around Age 30, Total and by Gender

	PISA 2000						PISA 2003						PISA 2006					
	All students		Boys		Girls		All students		Boys		Girls		All students		Boys		Girls	
OECD	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)
Australia	11.42	1.86	20.57	1.11	3.35	0.82	10.45	0.35	17.55	0.58	3.44	0.28	9.02	0.35	15.54	0.62	2.67	0.19
Austria	9.40	3.38	19.34	1.70	3.54	0.54	10.42	0.62	17.48	1.15	3.54	0.40	7.59	0.79	12.74	1.31	2.84	0.40
Belgium	15.76	0.96	24.76	1.23	5.57	0.51	12.81	0.57	19.39	1.00	5.95	0.46	10.77	0.51	16.77	0.78	4.43	0.38
Canada	10.68	1.93	19.38	0.49	4.09	0.26							9.36	0.37	16.11	0.61	2.82	0.28
Czech Republic	7.73	0.90	14.67	1.31	2.16	0.45	9.93	0.86	16.13	1.15	3.67	0.59	10.93	1.01	16.91	1.40	4.03	0.98
Denmark	11.96	1.05	19.16	1.68	3.39	0.71							7.02	0.39	11.10	0.71	3.00	0.38
Finland	14.11	0.61	24.44	1.12	4.57	0.48							4.94	0.34	8.29	0.58	1.85	0.30
France	7.37	0.60	12.72	1.14	2.32	0.35	12.46	0.80	22.93	1.26	3.55	0.44	10.06	0.70	17.68	1.13	3.54	0.48
Germany	10.84	1.76	16.06	1.02	4.23	0.43	7.60	0.54	11.82	0.85	3.54	0.49	8.16	0.50	12.47	0.87	3.82	0.46
Greece	10.23	0.53	13.99	0.79	6.67	0.58												
Hungary	9.14	0.99	14.09	1.27	3.81	0.55	13.00	0.81	17.96	1.01	8.43	0.97	11.53	0.61	17.56	0.92	6.44	0.62
Iceland	14.34	0.64	24.89	1.08	4.16	0.56	12.11	0.86	17.44	1.16	6.14	0.65	9.65	0.84	16.09	1.33	3.34	0.43
Ireland	11.01	0.80	19.41	1.18	3.27	0.42	11.74	0.54	16.82	0.99	6.56	0.61	10.65	0.52	14.15	0.89	7.48	0.68
Italy	10.31	1.00	15.76	1.46	4.98	0.63	9.78	0.55	17.00	0.97	2.75	0.45	9.74	0.54	16.89	0.90	3.14	0.49
Japan	7.39	0.74	11.03	1.17	3.73	0.60	12.82	0.75	21.10	1.06	5.28	0.62	12.17	0.83	20.00	1.22	4.59	0.47
Korea	13.3	0.83	20.37	1.04	4.46	0.66							7.13	0.59	11.74	0.94	2.58	0.34
Luxembourg	10.73	0.62	18.93	1.11	3.38	0.45	9.71	0.52	13.77	0.81	3.82	0.44	7.34	0.55	12.05	0.81	2.58	0.35
Mexico	19.15	2.30	28.00	1.20	8.41	0.80							8.92	0.41	14.02	0.81	4.11	0.41
Netherland	9.60	1.05	16.53	1.02	1.77	0.42	15.15	0.59	23.62	0.96	7.72	0.63	15.32	0.44	24.90	0.89	7.23	0.43
New Zealand	11.03	0.63	17.67	1.04	4.50	0.68							5.23	0.38	7.77	0.65	2.64	0.35
Norway	12.68	0.76	19.66	1.08	5.27	0.57							6.62	0.41	10.54	0.81	3.27	0.37
Poland	19.21	4.38	33.53	4.76	7.54	1.30												
Portugal	15.25	0.87	25.61	1.22	5.30	0.50	14.37	0.64	23.85	1.02	5.12	0.62	11.81	0.64	17.51	1.05	6.36	0.59
Slovak Republic							12.64	0.66	19.82	1.12	6.20	0.51	17.82	0.68	29.78	1.15	6.51	0.53
Spain	13.83	1.01	22.53	0.93	4.55	0.48	9.20	0.90	15.12	1.35	3.07	0.43	12.58	0.63	19.72	1.07	5.88	0.52
Sweden	13.63	0.54	20.81	0.88	6.10	0.56							11.25	0.91	20.10	1.33	2.67	0.43
Switzerland	9.08	0.74	16.42	1.08	1.89	0.28							13.29	0.57	21.82	0.86	5.63	0.45
Turkey													8.69	0.51	13.49	0.81	3.87	0.47

United Kingdom	8.49	3.23	12.25	0.72	1.57	0.25	10.25	0.69	18.92	1.30	1.89	0.42	6.56	0.33	11.51	0.57	1.89	0.23
United States	11.63	0.96	20.45	1.27	4.52	0.60	10.73	0.55	18.24	0.90	3.65	0.47	8.77	0.42	14.94	0.74	2.72	0.34
Partners																		
Albania	8.26	1.33	12.98	0.86	3.28	0.59												
Argentina	10.61	2.12	17.78	1.56	3.96	0.66							11.18	0.88	17.61	1.39	5.75	0.76
Azerbaijan													5.00	0.51	8.09	0.91	1.96	0.41
Brazil	11.28	2.54	21.15	1.29	5.47	0.71							11.28	0.51	17.52	0.86	6.44	0.53
Bulgaria	14.11	3.88	23.78	2.06	7.52	1.94							10.12	0.51	10.83	0.79	9.39	0.63
Chile	15.09	0.82	23.60	1.06	7.10	0.63							15.40	0.88	24.20	1.32	5.53	0.45
Chinese Taipei													11.49	0.52	18.91	0.66	3.45	0.35
Columbia													16.45	0.58	26.62	1.07	8.18	0.76
Croatia													7.69	0.89	13.28	1.46	2.64	0.37
Estonia													11.81	0.55	15.94	0.94	7.61	0.59
Hong Kong	6.40	0.38	11.02	0.54	1.69	0.26	5.67	0.47	9.42	0.76	2.17	0.38	7.62	0.36	13.03	0.69	2.70	0.35
Indonesia	2.52	1.06	5.06	0.73	1.08	0.32	4.58	0.45	7.74	0.75	1.60	0.26	8.69	2.25	11.04	4.44	6.26	0.89
Israel	12.11	2.70	19.05	1.29	5.50	0.82							8.54	0.64	12.33	1.24	5.34	0.60
Jordan													23.1	0.90	30.94	1.68	17.41	0.94
Kyrgyzstan													4.66	0.41	8.01	0.82	2.41	0.36
Latvia	12.15	0.83	19.29	1.40	5.18	0.66	12.01	0.88	20.28	1.71	4.65	0.76	13.22	0.61	19.37	1.07	8.11	0.69
Liechtenstein	8.11	1.55	13.97	2.78	2.34	1.34							10.01	1.51	19.24	2.94	2.39	1.23
Lithuania													10.06	0.49	15.80	0.91	4.45	0.49
Macao-China							7.14	1.12	12.96	2.12	1.78	0.61	5.30	0.47	9.09	0.82	1.62	0.37
Macedonia	11.51	0.78	18.89	0.84	4.12	0.49												
Montenegro													4.12	0.38	4.27	0.54	3.96	0.51
Peru	22.25	1.22	34.23	1.55	10.17	0.85												
Romania	12.52	3.75	15.67	1.27	6.29	0.77							10.31	0.87	15.87	1.30	4.86	0.56
Russian Federation	9.45	0.81	14.55	1.49	4.30	0.49							11.20	0.91	18.94	1.53	4.91	0.58
Serbia													9.84	0.89	16.24	1.33	3.47	0.56
Slovenia													14.19	0.48	25.88	0.86	3.48	0.55
Thailand	5.10	0.62	6.84	0.81	3.83	0.69	4.27	0.57	7.00	1.19	2.23	0.28	14.46	0.77	17.48	1.25	12.58	0.79
Tunisia													9.84	0.69	13.65	1.08	6.69	0.72
Uruguay													9.64	0.55	14.05	0.92	5.70	0.53
Yugoslavia							9.68	0.91	15.02	1.48	4.64	0.61						

Table 2.3 Percentage of Students Expecting Health Services (Including Nursing) Occupations (ISCO-88 Major Groups 2 and 3) around Age 30, Total and by Gender

OECD	PISA 2000						PISA 2003						PISA 2006					
	All students		Boys		Girls		All students		Boys		Girls		All students		Boys		Girls	
	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)
Australia	10.89	0.72	5.87	0.62	16.56	1.15	12.47	0.46	6.50	0.46	18.37	0.70	12.66	0.40	7.87	0.48	17.32	0.59
Austria	7.53	1.16	2.63	0.39	12.91	0.99	9.95	0.80	2.89	0.50	16.84	1.31	10.42	0.70	3.81	0.55	16.53	1.07
Belgium	10.86	1.23	3.53	0.39	17.63	0.86	7.86	0.47	3.38	0.42	12.53	0.72	10.11	0.49	5.59	0.46	14.89	0.64
Canada	17.14	2.33	7.77	0.39	24.04	0.54							18.50	0.46	10.12	0.56	26.62	0.68
Czech Republic	6.66	1.21	1.95	0.36	11.26	1.68	4.88	0.41	1.86	0.24	7.93	0.78	5.56	0.60	2.40	0.35	9.21	1.09
Denmark	9.52	0.89	3.43	0.71	16.37	1.59							10.46	0.48	4.54	0.42	16.27	0.85
Finland	11.31	0.56	1.91	0.34	19.95	0.91							8.76	0.47	3.71	0.44	13.42	0.83
France	8.33	0.52	3.13	0.41	13.05	0.82	10.28	0.57	4.97	0.53	14.79	0.89	18.53	0.80	8.90	0.76	26.77	1.02
Germany	9.04	0.76	1.96	0.32	15.14	0.85	8.89	0.43	2.46	0.46	15.09	0.78	8.40	0.49	3.52	0.48	13.34	0.89
Greece	8.78	1.53	6.34	0.73	12.51	1.02	9.52	0.69	5.20	0.55	13.50	1.10	9.63	0.55	6.69	0.71	12.11	0.74
Hungary	4.48	1.11	2.66	0.47	7.37	0.95	3.84	0.37	1.52	0.27	6.44	0.60	6.66	0.59	3.28	0.48	9.98	0.93
Iceland	9.51	0.61	3.60	0.44	15.25	1.08												
Ireland	9.15	0.58	3.12	0.42	15.01	0.98	10.4	0.53	6.06	0.68	14.84	0.93	15.75	0.66	10.11	0.84	20.86	1.09
Italy	9.64	0.61	5.43	0.81	13.59	0.93	10.88	0.60	4.38	0.57	17.21	1.07	15.59	0.62	8.85	0.87	21.8	0.77
Japan	7.54	1.04	3.37	0.57	11.03	1.61	9.99	0.72	6.00	0.61	13.62	1.05	11.64	0.68	7.96	0.94	15.20	0.72
Korea	6.89	0.94	6.19	0.80	8.66	0.66							9.07	1.06	4.96	0.53	13.11	1.74
Luxembourg	8.10	0.57	3.28	0.56	12.55	0.91	9.66	0.49	9.23	0.66	10.28	0.87	7.18	0.45	5.04	0.38	9.35	0.75
Mexico	14.26	1.40	10.9	0.79	18.6	1.39							10.39	0.53	5.61	0.48	14.90	0.86
Netherland	10.30	2.11	3.65	0.50	15.00	1.28	12.87	0.97	10.38	0.96	15.06	1.20	15.44	0.61	11.31	0.78	18.92	0.78
New Zealand	9.96	0.88	5.99	0.79	14.34	0.89							14.06	0.74	5.39	0.56	22.91	1.02
Norway	9.15	0.48	2.58	0.41	15.74	0.85							14.08	0.64	8.09	0.69	19.19	0.93
Poland	7.76	2.40	3.63	0.70	14.25	1.73												
Portugal	14.54	1.72	7.61	0.66	19.36	0.99	7.67	0.47	3.83	0.44	11.4	0.80	11.65	0.57	4.21	0.45	18.75	1.00
Slovak Republic							16.03	0.75	7.78	0.65	23.44	1.24	10.13	0.42	5.16	0.46	14.82	0.72
Spain	12.16	0.59	5.83	0.61	17.90	0.94	5.12	0.42	2.25	0.47	8.09	0.66	16.83	0.65	8.44	0.79	24.69	0.87
Sweden	7.01	0.46	2.48	0.38	11.86	0.73							6.53	0.68	2.84	0.47	10.10	1.09
Switzerland	9.28	0.73	2.40	0.42	15.06	0.87							13.65	0.53	6.78	0.61	19.81	0.73
Turkey													9.01	0.50	4.06	0.51	13.99	0.76

United Kingdom	9.19	1.55	3.82	0.51	12.84	0.66	10.00	0.67	3.65	0.48	16.12	1.19	11.83	0.44	7.17	0.51	16.22	0.65
United States	21.99	1.68	9.35	0.81	31.64	1.44	22.28	0.68	9.95	0.88	33.92	0.88	21.93	0.67	11.03	0.70	32.65	0.94
Partners																		
Albania	19.67	1.03	14.4	1.24	23.75	1.20												
Argentina	15.13	0.99	9.31	1.18	19.81	1.24							13.34	0.79	7.32	0.84	18.42	0.99
Azerbaijan													17.1	0.98	10.11	1.12	23.97	1.39
Brazil	23.34	1.15	12.82	0.84	32.54	1.26							22.47	0.82	12.93	0.96	29.86	1.15
Bulgaria	8.51	0.82	2.96	0.61	14.01	1.14							16.54	0.65	15.17	0.91	17.98	0.98
Chile	13.41	0.65	7.69	0.68	18.19	0.83							20.58	0.95	13.29	0.76	28.75	1.68
Chinese Taipei													8.46	1.21	6.02	0.60	11.11	2.10
Columbia													25.01	0.82	15.08	0.97	33.10	1.07
Croatia													8.29	1.36	4.74	0.84	11.50	1.92
Estonia													5.61	0.40	1.90	0.28	9.38	0.77
Hong Kong	8.41	0.48	5.89	0.55	10.77	0.73	7.47	0.52	4.76	0.60	9.99	0.78	11.3	0.56	8.98	0.64	13.42	0.79
Indonesia	16.11	1.08	7.75	0.74	23.77	2.07	16.98	0.81	7.86	0.82	25.59	1.39	17.3	1.40	14.06	1.73	20.67	1.39
Israel	9.66	0.98	8.27	1.34	10.16	1.25							16.57	0.97	11.30	1.20	21.02	1.15
Jordan													25.81	0.75	23.52	1.14	27.48	1.02
Kyrgyzstan													24.31	0.90	12.73	1.08	32.08	1.12
Latvia	4.72	0.72	0.96	0.22	7.60	0.80	3.38	0.44	1.20	0.33	5.32	0.81	5.23	0.40	2.20	0.36	7.75	0.65
Liechtenstein	5.41	1.41	3.02	1.50	7.80	2.33							7.12	1.43	2.16	1.23	11.21	2.61
Lithuania													6.45	0.42	2.87	0.41	9.94	0.67
Macao-China							9.76	1.06	5.07	1.19	14.08	1.52	9.61	0.46	7.13	0.68	12.02	0.69
Macedonia	13.25	3.14	9.98	0.89	19.23	0.91												
Montenegro													10.36	0.46	8.13	0.69	12.66	0.77
Peru	23.79	1.01	13.61	1.13	33.54	1.44												
Romania	9.36	1.28	5.82	0.67	11.55	0.95							9.77	0.61	4.72	0.58	14.72	1.01
Russian Federation	9.34	0.80	3.40	0.41	15.23	1.36							8.38	0.53	3.24	0.39	12.56	0.82
Serbia													11.59	1.67	6.92	1.01	16.25	2.46
Slovenia													14.62	0.58	7.63	0.67	21.03	0.93
Thailand	11.09	3.03	1.95	0.42	14.94	1.13	16.11	0.74	4.25	0.51	24.97	1.06	18.96	0.73	7.67	0.68	26.03	1.13
Tunisia													20.33	0.69	13.76	0.79	25.76	0.96
Uruguay													15.67	0.71	9.52	1.02	21.17	0.88
Yugoslavia							9.17	1.66	4.52	0.82	13.56	2.53						

Table 2.4 Percentage of Students Expecting Health Services (Excluding Nursing) Occupations (ISCO-88 Major Groups 2 and 3) around Age 30, Total and by Gender

	PISA 2000						PISA 2003						PISA 2006					
	All students		Boys		Girls		All students		Boys		Girls		All students		Boys		Girls	
OECD	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)
Australia	9.20	0.61	5.80	0.62	12.72	1.02	10.51	0.41	6.40	0.45	14.57	0.63	10.74	0.38	7.79	0.47	13.61	0.53
Austria	4.52	1.21	2.29	0.37	7.72	0.63	6.12	0.52	2.39	0.43	9.75	0.92	6.31	0.39	3.38	0.52	9.00	0.62
Belgium	6.30	0.54	2.85	0.37	9.68	0.75	5.41	0.36	2.89	0.38	8.05	0.58	7.54	0.40	5.14	0.41	10.08	0.59
Canada	15.40	1.59	7.67	0.39	21.43	0.50							16.43	0.47	9.91	0.56	22.75	0.68
Czech Republic	4.23	0.56	1.84	0.35	6.05	0.84	3.44	0.28	1.81	0.24	5.09	0.55	4.49	0.44	2.38	0.35	6.92	0.73
Denmark	7.52	0.75	3.43	0.71	12.08	1.31							8.69	0.48	4.54	0.42	12.77	0.84
Finland	6.73	0.47	1.86	0.34	11.17	0.77							7.50	0.46	3.67	0.46	11.05	0.78
France	6.60	0.45	2.90	0.40	10.05	0.69	7.82	0.53	4.52	0.49	10.63	0.83						
Germany	5.60	0.98	1.52	0.28	8.50	0.62	5.87	0.41	2.23	0.43	9.48	0.71	15.24	0.69	8.03	0.70	21.4	0.90
Greece	7.78	1.15	6.27	0.72	10.24	0.75	7.42	0.51	4.82	0.53	9.82	0.82	6.44	0.39	3.28	0.45	9.63	0.70
Hungary	3.52	0.79	2.66	0.47	5.14	0.68	3.31	0.37	1.48	0.26	5.36	0.63	8.31	0.48	6.37	0.69	9.95	0.65
Iceland	7.80	0.51	3.60	0.44	11.85	0.87							5.63	0.43	3.19	0.47	8.01	0.66
Ireland	6.16	0.45	3.06	0.42	9.16	0.75	8.94	0.52	5.40	0.62	12.55	0.91	14.62	0.63	10.03	0.86	18.78	0.99
Italy	8.85	0.56	5.33	0.79	12.12	0.88	8.03	0.50	4.20	0.54	11.77	0.85	12.82	0.60	8.76	0.87	16.57	0.74
Japan	7.54	1.04	3.37	0.57	11.03	1.61	9.36	0.69	5.95	0.61	12.47	1.01	11.05	0.67	7.79	0.94	14.20	0.71
Korea	5.69	1.11	6.19	0.80	6.20	0.59							9.07	1.06	4.96	0.53	13.11	1.74
Luxembourg	4.10	0.43	2.69	0.46	5.40	0.68	8.86	0.48	9.15	0.65	8.43	0.85	5.88	0.35	5.00	0.38	6.78	0.63
Mexico	11.82	0.79	10.51	0.80	13.27	1.08							7.08	0.43	4.80	0.47	9.23	0.69
Netherland	5.78	1.58	2.97	0.46	7.12	0.88	10.23	0.41	9.13	0.60	11.19	0.62	13.99	0.60	11.2	0.76	16.34	0.76
New Zealand	8.91	0.86	5.93	0.79	12.36	0.85							8.28	0.49	4.61	0.55	12.02	0.63
Norway	6.32	0.65	2.55	0.41	9.67	0.63							12.51	0.62	8.09	0.69	16.29	0.92
Poland	7.57	2.22	3.63	0.70	13.66	1.70												
Portugal	11.54	1.20	6.70	0.62	14.99	0.91	7.28	0.47	3.77	0.44	10.71	0.81	8.87	0.48	4.21	0.45	13.33	0.82
Slovak Republic							12.41	0.68	6.36	0.67	17.84	1.05	9.67	0.41	4.77	0.45	14.31	0.71
Spain	10.48	0.51	5.47	0.56	15.11	0.84	4.65	0.39	2.25	0.47	7.15	0.60	14.39	0.59	7.46	0.70	20.88	0.90
Sweden	5.35	0.46	2.34	0.39	8.71	0.65							5.39	0.54	2.67	0.45	8.02	0.76
Switzerland	6.07	0.53	2.19	0.41	9.61	0.74							12.06	0.47	6.49	0.59	17.05	0.66
Turkey													7.23	0.47	3.77	0.49	10.71	0.69

United Kingdom	6.94	0.91	3.69	0.50	9.18	0.58	7.21	0.45	3.65	0.48	10.64	0.77	9.53	0.36	7.14	0.50	11.79	0.53
United States	17.97	0.92	9.24	0.82	25.78	1.47	17.92	0.70	9.70	0.86	25.68	0.95	18.3	0.59	10.92	0.71	25.57	0.86
Partners																		
Albania	16.90	0.99	13.55	1.16	19.36	1.11												
Argentina	14.45	0.79	8.71	1.12	18.39	1.17							12.87	0.78	7.19	0.82	17.67	0.99
Azerbaijan													14.87	0.85	9.59	1.01	20.07	1.20
Brazil	21.74	1.43	12.66	0.81	30.16	1.21							20.81	0.7	12.21	0.76	27.49	1.04
Bulgaria	7.96	0.83	2.88	0.54	12.93	1.18							15.76	0.64	14.5	0.91	17.08	0.97
Chile	11.75	0.58	7.40	0.68	15.32	0.75							19.2	0.91	13.27	0.76	25.85	1.59
Chinese Taipei													5.95	0.42	5.82	0.57	6.10	0.50
Columbia													22.95	0.78	14.91	0.98	29.5	1.01
Croatia													7.29	1.12	4.38	0.77	9.93	1.56
Estonia													5.55	0.40	1.81	0.27	9.34	0.76
Hong Kong	6.78	0.45	5.57	0.55	7.82	0.64	6.14	0.45	4.76	0.60	7.43	0.67	9.56	0.54	8.74	0.65	10.31	0.74
Indonesia	12.96	1.02	7.40	0.75	18.40	1.75	14.90	0.77	7.82	0.82	21.6	1.27	15.2	1.39	12.61	1.67	17.88	1.42
Israel	8.66	1.33	7.04	0.96	8.53	1.18							15.08	0.90	10.82	1.07	18.67	1.11
Jordan													17.91	0.69	17.38	0.97	18.3	0.89
Kyrgyzstan													22.52	0.83	12.62	1.08	29.16	1.03
Latvia	4.34	0.71	0.96	0.22	6.88	0.77	3.33	0.44	1.20	0.33	5.23	0.79	4.80	0.37	2.20	0.36	6.97	0.60
Liechtenstein	3.09	1.06	3.02	1.50	3.08	1.50							5.52	1.24	2.16	1.23	8.29	2.21
Lithuania													6.44	0.42	2.87	0.41	9.91	0.67
Macao-China							7.66	0.99	5.07	1.19	10.05	1.44	8.64	0.46	7.13	0.68	10.1	0.62
Macedonia	11.70	2.74	9.81	0.87	16.00	0.90												
Montenegro													8.67	0.43	6.53	0.63	10.86	0.73
Peru	17.01	1.54	12.98	1.07	19.86	1.31												
Romania	9.23	1.35	5.75	0.66	11.29	0.95							9.77	0.61	4.72	0.58	14.72	1.01
Russian Federation	8.33	0.74	3.40	0.41	13.33	1.19							7.48	0.46	3.24	0.39	10.93	0.68
Serbia													10.7	1.49	6.87	1.00	14.52	2.16
Slovenia													11.97	0.59	7.12	0.67	16.42	0.88
Thailand	4.88	2.08	1.94	0.42	5.22	0.49	7.69	0.55	4.08	0.49	10.39	0.82	12.84	0.70	7.51	0.68	16.18	1.04
Tunisia													19.44	0.71	13.76	0.79	24.13	1.04
Uruguay													14.79	0.71	9.30	1.02	19.69	0.88
Yugoslavia							7.51	1.18	4.27	0.76	10.56	1.69						

CHAPTER 3. Cross-National Variation in Students' STEM Occupational Expectations: The Significance of Features of Secondary Education Systems

Levels of student interest in the pursuit of education and occupations in the fields of science, technology, engineering, and mathematics (STEM) are of great concern to policymakers and educational researchers in many countries. Low levels of expectations of obtaining STEM education and occupations among students are viewed as problematic because such expectations matter for students' educational and occupational attainment in STEM. Several international reports have documented cross-national variation in STEM occupational expectations among students; for example, Korean and Japanese students report relatively low levels of interest in science-related careers compared to other developed countries such as Iceland, Portugal, and the United States. However, little is known about the sources of these cross-national differences (OECD, 2007b; 2009b). Recent international reports have suggested that education systems in Korea and Japan have been less successful at fostering students' career expectations in STEM (OECD, 2009b; Sikora & Pokropek, 2011). In this chapter, I investigate the extent to which the features of national education systems are associated with country-level differences in students' STEM occupational expectations.

NATIONAL EDUCATION SYSTEMS AND STUDENTS' STEM OCCUPATIONAL EXPECTATIONS: A COMPARATIVE PERSPECTIVE

Sociological research on the occupational expectations of adolescents and young adults has arisen out of the study of social stratification. Beginning with the Wisconsin model of status attainment in the 1960s, a large body of research has shown that social psychological factors such as students’ educational and occupational expectations play an important role in mediating the effects of family socioeconomic status (SES) on students’ later educational and occupational outcomes (Sewell, Haller, & Ohlendorf, 1970; Sewell, Haller, & Portes, 1969). This line of research found that children’s educational expectations are strongly linked to their educational attainment, even when measured mental ability and socioeconomic status are held constant. In an extension of the Wisconsin model, occupational expectations have a persistent influence on both the occupational standing and the earnings of men and women in the United States and other countries (Sewell & Hauser, 1975, 1993).

A number of studies have examined the effects of individual and school characteristics on students’ occupational expectations (Alwin & Otto, 1977; Hauser, Sewell, & Alwin, 1976; Jacobs, Karen, & McClelland, 1991; Plucker, 1998; Wang & Staver, 2001). Using data from a large-scale international survey such as the Program for International Student Assessment (PISA), several comparative studies have investigated the degree to which individual- and school-level factors are associated with students’ expectations across countries. At the individual level, academic ability, female gender, and family socioeconomic background have significant positive associations with occupational expectations in most countries (Marks, 2010; Sikora & Saha, 2007, 2009). These cross-national studies also found that schools exert a significant influence on students’ occupational expectations. For example, using PISA 2000 and 2003 data, Sikora and Saha (2007) found that, compared to their peers, 15-year-old students who attended a school in which most students were from socioeconomically advantaged families had higher educational and occupational expectations.

Over the past decade, cross-national studies on educational and occupational expectations among students have shifted the focus of research from individual- and school-level factors to country-level factors (e.g., national education systems) as well as interactions between individual characteristics and macro-level social contexts (Buchmann & Dalton, 2002; Buchmann & Park, 2009; McDaniel, 2010; Sikora & Pokropek, 2011, 2012). These studies employed the stratification-standardization framework proposed by Allmendinger (Allmendinger, 1989) to classify national education systems. In this context, standardization refers to “the degree to which the quality of education meets the same standards nationwide” (Allmendinger, 1989, p. 233). Standardization is generally higher when the central government controls curricular, learning, and assessment standards **(**Kerckhoff, 2001)**.** Countries with highly standardized education systems (e.g., Japan and Korea) have national curriculum standards or courses of study that define the content to be taught by grade and subject. In Allmendinger’s framework, stratification (differentiation) refers to “the degree to which systems have clearly differentiated kinds of schools whose curricula are defined as higher and lower” (Kerckhoff, 2001, p. 4). Stratified educational systems most often refers to tracking, streaming, or grouping *between* secondary schools. Compared to comprehensive (unstratified) educational systems, stratified systems are more likely to provide diverse vocational education programs for secondary students. Within the standardization-stratification framework, the U.S. education system is characterized by low levels of both standardization and stratification, while the Japanese education system is characterized by high levels of standardization but low levels of stratification (Shavit, Müller, & Tame, 1998). The Netherlands and Germany have highly stratified and standardized education systems, while education systems in France and Italy are characterized by high levels of standardization and moderate levels of stratification (Shavit, et al., 1998).

Prior research has focused specifically on the stratification of educational systems as a potential explanation for cross-national variation in educational and occupational expectations among youths (Buchmann & Park, 2009; McDaniel, 2010). Researchers found that higher levels of stratification in a country's secondary education system were associated with significantly lower student expectations of completing academic tertiary education (McDaniel, 2010), and students in highly stratified educational systems tend to have more realistic occupational expectations than those in undifferentiated systems (Buchmann & Park, 2009). Similarly, several studies have examined how the effects of individual- and school-level characteristics on student expectations are moderated by the level of stratification of national education systems. For example, using the Trends in International Mathematics and Science Study (TIMSS) 1995 data for the middle school population, Buchmann and Dalton (2002) found that interpersonal influences have much weaker effects on students' educational expectations in highly stratified systems that place students in more rigid tracks than in less stratified systems. This pattern may be due to the greater restriction of students' options for educational and occupational trajectories at the secondary level in highly differentiated systems.

Recently, cross-national research on students' occupational expectations has shifted its focus from the vertical dimension of variation to the horizontal dimension. In particular, a number of international studies have reported significant cross-national differences in students' science-related career expectations (Martin, Mullis, Gonzalez, & Chrostowski, 2004; Mullis, Martin, Gonzalez, & Chrostowski,2004; OECD, 2007b; 2009b). According to a recent Organization for Economic Co-operation and Development (OECD) report (2007b), across OECD nations, an average of 25 percent of students expect to attain a science-related career by age 30. However, only 8 percent of Japanese 15-year-olds expected to have a science related career at age 30 while about 40 percent of 15-year-olds in Portugal expected to have a science-related career around age 30. Levels in the United States (38 percent) trail closely behind those in Portugal, and are followed by Canada (37 percent), Mexico (35 percent), Iceland (32 percent), Italy (32 percent), and Poland (31 percent). Little is known about the sources of this cross-national variation in career expectations.

In this chapter, I contribute to this line of comparative research by incorporating the level of standardization, a crucial feature of educational systems, in the examination of cross-national variation in students' STEM occupational expectations. Since the early 1980s, national education reform in many countries, including the United States and Germany, has focused on improving the quality and equity of student outcomes by increasing the standardization of the education system, specifically by creating and enforcing centrally prescribed curricular, learning, and assessment standards for all students, teachers, and schools (Ertl, 2006; National Commission on Excellence in Education, 1983; OECD, 2010c; Sahlberg, 2006). Several comparative studies have investigated the effects of curriculum and assessment standardization on student achievement with mixed results (Bishop & Woessmann, 2004; Fuchs & Woessmann, 2007; Woessmann, 2002; 2003). Evidence from international student achievement tests, for example, indicates that students perform substantially better in countries with central exit exams compared to those in countries lacking central exams (Hanushek & Woessmann, 2010). However, cross-national studies have found that centralized control over curricular affairs, such as the organization of instruction and textbook-purchasing decisions, is negatively associated with student achievement (Fuchs & Woessmann, 2007; Woessmann, 2003). Despite these initial findings in the field, researchers have paid little attention to the extent to which the standardization of curriculum is associated with cross-national differences in non-cognitive domains such as students' STEM occupational expectations.

In standardized education systems, schools have little autonomy in determining course offerings and course content because curriculum and textbooks are established at the national level. Teachers in standardized systems are expected to teach a centrally prescribed curriculum and use the same textbooks, and all students within a given grade level are expected to meet the same standards. Classroom instruction in standardized systems is less likely to be adjusted to match the characteristics of students (Stevenson & Baker, 1991). In this chapter, I conduct the first analysis of whether standardized education systems are associated with students' STEM occupational expectations.

RESEARCH QUESTIONS

Using insights from comparative studies of educational and occupational expectations among youths, I examine the degree to which the characteristics of national education systems are associated with cross-national variation in students' STEM occupational expectations. I pay particular attention to the features of national secondary education systems, especially standardization and stratification. The analysis proceeds in three main steps.

First, I examine the association between the degree of standardization of educational systems and students' STEM occupational expectations. I also investigate whether any associations are consistent across STEM subfields. This is important because students' occupational preferences differ within STEM subfields. Students tend to avoid the study of science, engineering, and mathematics, and prefer to study medicine. I empirically examine whether the association between the degree of standardization and students' STEM occupational expectations remain across two STEM subfields: (a) computing and engineering (CE) and (b) health services.

Second, I examine the association between the degree of stratification of educational systems and students' STEM occupational expectations. As discussed in the literature review, previous studies have indicated that students in more differentiated secondary education systems tend to have lower educational and occupational expectations due to greater restriction of students' options for educational and occupational trajectories. Because the focal STEM occupations in this study require at least tertiary degrees at job entry, I expect negative to find associations between stratified systems and students' STEM occupational expectations.

Finally, I assess the degree to which the associations between features of secondary education systems and students' STEM occupational expectations differ by student ability. High-performing students may want to pursue STEM occupations, which are among the highest-paying and fastest-growing of any occupational areas, no matter how national education systems are organized. Given that low-achieving students are less likely to enroll in math and science courses in systems that maximize individual freedom of choice, low-performing students in standardized systems may have a greater interest in STEM occupations than low-performing students in unstandardized systems. In contrast, standardized education systems may make STEM occupations less attractive to low-performing students because classroom instruction is ruled by a nationally prescribed curriculum and does not allow schools or teachers to tailor the science curriculum to meet the needs and interests of individual students. To tease out these potentially contradictory influences, I empirically examine the interaction effects of the features of secondary education systems and student performance levels on STEM occupational expectations. These interaction effects are important because policymakers and researchers in many countries have concerns about academically talented students' engagement in STEM education and occupations.

SELECTION OF COUNTRIES

As described in Chapter 2 (Data & Methods), I use data from the 2000, 2003, and 2006 waves of the Programme for International Student Assessment (PISA) with a primary focus on PISA 2006. Several countries are excluded from the analyses due to missing data: No data on the dependent variables are available for Qatar in 2006; no data on the characteristics of the educational system are available for Albania; and no data on the school variables are available for France in 2003 and 2006. Data on several school-level variables, including school type (i.e., public, government-dependent private, or government-independent private), school community location, and academic selectivity, are not available for Australia, Canada, Iceland, and Italy; therefore, these countries are excluded from this chapter. The final analytic sample includes 35 countries from PISA 2000, 20 countries from PISA 2003, and 46 countries from PISA 2006 (see Appendix 3.1).

MEASURES

Dependent Variables

The outcome measures for this study are binary variables, each indicating whether or not a student expects to have a certain type of STEM-related occupation around the age of 30. The study examines expectations for two skill levels in each of three different STEM fields (a total of six types of expectations). The three STEM fields are: (a) general STEM-related fields including mathematics, natural science, engineering/computing, and health service; (b) computing and engineering (CE); and (c) health services.[6] The two skill levels are: (a) professional, technician, and associate professional occupations (International Standard Classification of Occupations 88 [ISCO-88], major group 2 and 3) and (b) only professional occupations (ISCO-88, major group 2).

Individual-Level Independent Variables

At the student level, I control for gender, age, grade level, parental educational attainment, family SES, immigration background of both students and parents, language spoken at home, whether parents have STEM-field occupations, parental occupational level (blue collar vs. white collar), mother's working status, and number of books at home.[7]

School-Level Independent Variables

At the school level, I control for school's mean SES, school size, school community location, the proportion of enrolled students who are female, school type (public, government-dependent private, and government-independent private), academic selectivity, degree of teacher shortage in math and science, and quality of educational resources.

Country-Level Independent Variables

The main independent variables in this chapter are country-level indicators of characteristics of national education systems. These variables include:

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[6] I created two dependent variables (within each skill level) for health services occupational expectations: (1) health services occupations including nursing, and (2) health services occupations excluding nursing. When findings were consistent, I presented only outputs for health services including nursing.

[7] I ran two types of models: (a) three models in which student ability was controlled (using reading, math, and science test scores, respectively) and (b) a model with no controls for student ability. All findings were consistent across the models; I reported results from the model that did not include student ability.

Standardization of educational systems. Standardization refers to “the degree to which the quality of education meets the same standards nationwide” (Allmendinger, 1989). In general, standardization is higher when the central government exercises control over the educational system, for example by determining curriculum, assessments, and school budgets (Kerckhoff, 2001). Data on the standardization of curriculum were gathered from *World Data on Education* (Amadio, 2000). The curricular policies of each country were reviewed, and countries were classified into three groups: (a) countries in which there is no central government control over curriculum (coded 0), (b) countries in which regional or local agencies have some ability to adapt a centrally prescribed curriculum (coded 1), and (c) countries in which the central government determines the curriculum (coded 2). I compared this index of standardization to three external data sources: (a) TIMSS curriculum questionnaires; (b) reports on national contexts for mathematics and science education produced by experts from ministries of education, research institutes, or institutions of higher education who have extensive knowledge about their nations’ education systems (Mullis, et al., 2008; Robitaille, 1997); and (c) the work of Asitz, Wiseman, and Baker (2002), in which the authors rated TIMSS countries according to the degree of curricular centralization in each, and classified each country as either a decentralized administration, a mix of centralized and decentralized administration, or a centralized administration for mathematics curricula. Despite minor inconsistencies in the classification of a few countries, all four studies resulted in generally similar classifications with regard to the degree of curricular standardization.

Stratification of educational systems. Stratification refers to “the degree to which systems have clearly differentiated kinds of schools whose curricula are defined as higher and lower” (Kerckhoff, 2001, p. 4). The level of stratification of each education system is measured by the number of school types available to 15-year-olds in each country, and the age of first selection into different school types or tracks. Among the PISA participating countries, the number of school types ranged from one to five. The age of first selection is a dummy variable for early tracking, coded 1 when countries sort students into different tracks before the age of 14. The source of data for both indicators is *Education at a Glance, OECD Indicators* (the data in this source was derived from OECD PISA database and the OECD education database).

National economic development indicators. I used three indicators to capture national economic development levels: (a) a measure of the Gross Domestic Product (GDP) per capita (in current U.S. dollars); (b) an indicator of the level of educational investment, as measured by public education expenditures per student in secondary education as a percent of the GDP per capita; and (c) an OECD member country indicator. The first two indicators were collected from the UNESCO Institute for Statistics and the World Bank. The OECD member indicator is a dummy variable, coded 1 when countries are OECD member countries.

Descriptive statistics for all variables used in the HGLM analyses are presented in Table 3.1.

METHODS

As described in Chapter 2 (Data & Methods), this study employs three-level hierarchical generalized linear models (HGLMs) in which the level 1 sampling model is a Bernoulli distribution (Raudenbush & Bryk, 2002). The models nest students (level 1) within schools (level 2) and countries (level 3); separate models are run for PISA 2000, 2003, and 2006 data. An additional model uses a pooled data set with observations from from the countries that participated in every cycle of PISA 2000, 2003, and 2006; in this model, controls for the study year are included at the school level. The final student weights are normalized at the country level to ensure that each country contributes equally to the analysis.

To examine possible interactions between student performance and the features of secondary education systems, three-level HGLMs are run separately by science performance quartile; the models are run only for PISA 2006 data.[8] This approach reveals whether the associations between the features of secondary education systems and students' STEM occupational expectations differ at various levels of academic performance.

RESULTS

Several international studies have reported cross-national differences in students' science-related career expectations, although these studies have not controlled for individual, school, and country characteristics (Martin, et al., 2004; Mullis, et al.,2004; OECD, 2007b; 2009b). In addition, according to an OECD report (2009b), top performers' intentions to pursue science careers vary across countries. As shown in Table 3.2 and Table 3.3, the country-level variance component indicates that students' STEM occupational expectations varied across countries in 2000, 2003, and 2006, even after controlling for student, school, and country characteristics. There is also cross-national variation in the occupational expectations of youths in the specific subfields of computing and engineering, and health services (for details, see the country-level variance components in Table 3.4, Table 3.5, and Table 3.6).

In this chapter, I investigate the associations between these cross-national differences in students' STEM occupational expectations and features of national education systems by fitting a

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[8] Science test scores were not available for all sampled students in PISA 2000 because science was a minor domain in this cycle. In PISA 2000, science test scores were available for five-ninths of the sampled students. In PISA 2003, information on students' occupational expectations was available for 24 countries because an educational career questionnaire was administered as an international option.

three-level HGLM separately for each PISA data set (2000, 2003, and 2006). Table 3.2 and Table 3.3 include results for STEM occupational expectations by skill levels; Table 3.4 presents results for computing and engineering (CE) occupational expectations; Table 3.5 shows the results for health services including nursing occupational expectations; and Table 3.6 includes results for health services excluding nursing occupational expectations. All models include controls for 24 student background variables, 13 school-level variables, and 6 national-level variables—including an indicator of OECD member status, educational expenditures as a percent of GDP per capita, and GDP per capita. .

The Standardization of Education Systems and Students' STEM Occupational Expectations

The analyses revealed no evidence that higher levels of standardization in educational systems are negatively associated with students' expectations of having STEM occupations (including technician or associate professional positions). As shown in Table 3.2, the coefficients for standardization are not statistically significant in the models using PISA 2000 or PISA 2003 data. However, in the model using PISA 2006 data, the coefficient for standardization is statistically significant (β=-0.211): a one-level increase in the standardization of a country's secondary schools is associated with a 19 percent decrease in the odds of expecting to have a STEM occupation (including technician or associated professional positions) after controlling for individual, school, and other national characteristics. Table 3.3 includes coefficients for the associations between the features of national education systems and students' expectations of having STEM professional occupations that require a BA degree or above at entry (i.e., not including technician or associated professional positions). For all PISA survey waves, the coefficients for standardization are negative but not statistically significant.

Next, I assess whether the mixed findings about the association between standardization and students' STEM occupational expectations across PISA survey waves are due to the samples including different countries across cycles. The analytic sample for the PISA 2006 model is limited to countries that participated in both PISA 2000 and PISA 2006 (N=35). In this model, the standardization level of education systems is not associated with cross-national variation in students' STEM expectations (including technicians and associate professionals).

The association between the standardization level of educational systems and students' STEM occupational expectations differs across STEM subfields. While there is no association between standardization and students' CE occupational expectations (Table 3.4), higher levels of standardization are linked to lower expectations for health service occupations (including nursing) (Table 3.5). An additional level of standardization in a country's secondary schools is associated with a 16 percent drop in the odds of expecting to have a health services occupation (including nursing) in PISA 2000 (β=-0.174) and a 19 percent drop in PISA 2006 (β=-0.216). When nursing careers in health services are excluded (Table 3.6), however, the associations between standardization and students' health occupational expectations remain negative, but are not statistically significant for either 2000 or 2006 data.

For health service (including nursing) occupations, the negative association between the standardization of education systems and students' occupational expectations differs by skill level. That is, the negative association between standardization and health service occupational expectations is stronger for careers requiring lower skill levels and educational attainments for job entry than for careers requiring higher skill levels and educational qualifications.[9] As shown in Table 3.5, in PISA 2006, a higher level of standardization is linked to lower expectations for

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[9] I compared results for health service including nursing occupational expectations by skill levels: (a) health service including technician or associate professional positions and (b) health service professional occupations that require a BA degree or above at entry (i.e., not including technician or associated professional positions).

health services occupations (including technician and associate professional positions). When lower-skill health service occupations (those that require only an associate's degree or above at job entry) are excluded, the main coefficient for standardization remains negative, but statistically insignficiant (β = -0.144).

The Stratification of Education Systems and Students' STEM Occupational Expectations

In this study, the stratification of education systems is measured using two indicators: (a) the number of school types available to 15-year-old students and (b) the presense of an early tracking into different school types (implemented before age 14). The analytical results show that a higher number of school types is linked to lower student STEM occupational expectations, but early tracking is not associated with STEM expectations. As shown in Table 3.2, the coefficients for the number of school types are -0.137 in PISA 2000, -0.288 in PISA 2003, and -0.148 in PISA 2006.[10] The odds ratios for the number of school types are 0.872, 0.750, and 0.862, respectively, indicating that each additional school type available to 15-year-old students is associated with a drop in the odds of expectations of a 13 percent in PISA 2000, a 25 percent in PISA 2003, and a 14 percent in PISA 2006. Similarly, the number of school types available is negatively associated with students' expectations of having a STEM profession (Table 3.3). In the pooled HLGM (Table 3.7), the negative association between stratification and STEM occupational expectations remains.

This association between the differentiation of education systems and students' STEM occupational expectations differs across STEM subfields: while there is no association between the number of school tracks and CE occupational expectations (Table 3.4), the number of school

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[10] To examine the association between the number of school types and student expectations, I ran HGLMs using five dummy variables indicating the number of school types available. The results showed a linear association between the number of school types and student expectations.

tracks is negatively associated with occupational expectations for health services (Table 3.5 and Table 3.6).[11] As shown in Table 3.5, in PISA 2006, the coefficient for the number of school types is -0.219, meaning that each additional school type available in secondary schools is linked to a 20 percent decrease in the odds of expecting a health services (including nursing) occupation. When nursing is excluded, each additional school type is tied to a 22 percent decrease in the odds of expecting a health services occupation (β = -0.247).

The negative association between the number of school tracks and students' occupational expectations for health services is consistent across skill level.[12] In PISA 2006, each additional school track is linked to a 25 percent decrease in the odds of expecting health service professions (including nursing) (β = -0.293). When nursing is excluded from health service occupations, each additional school track is tied to a 26 percent drop in the odds of expectations (β = -0.300). Compared to the results of PISA 2006 in Table 3.5 and Table 3.6, these results suggest that higher levels of differentiation are linked to lower student expectations for health services occupations in both relatively higher-status and relatively lower-status occupations.

Interactions between the Features of Secondary Education Systems and Student Performance

Using PISA 2006 data, the next set of models examines whether the association between features of secondary education systems and students' STEM occupational expectations differ across science performance quartiles.[13] Table 3.8 includes the results for STEM occupational

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[11] I included technician or associate professional positions in health service occupation categories.

[12] I examined two health service professional occupations that require a BA degree or above at entry (i.e., not including technician or associated professional positions): (a) health service including professional occupations and (b) health service excluding professional occupations. These results were compared to those in Table 3.5 and Table 3.6.

[13] PISA adopted a balanced incomplete block design for assessment, which pairs every block with every other block, but does not include all possible orderings of block pairs. Because of this design, PISA student test scores were

expectations, including technician and associate professional positions, by performance quartile, and Table 3.9 shows the results for STEM professional occupational expectations by performance quartile. The first column in each table displays the coefficients for the features of secondary education systems for the top quartile of students in each country; the second, third, and fourth rows show results for students in the upper-middle, lower-middle, and lowest quartiles, respectively.

Table 3.8 reveals that higher levels of standardization in secondary education are associated with lower STEM occupational expectations among students when technician and associate professional positions are included, particularly in the health services field. This negative association is stronger for students at the bottom of the academic performance distribution than students at the top. In contrast, the level of standardization is not associated with STEM professional occupational expectations across all performance quartiles (Table 3.9). These findings suggest that higher levels of standardization are linked to lower expectations of having semi-professional STEM occupations among relatively poor-performing students, but are not associated with expectations of having professional STEM occupations among relatively high-performing students.

The results shown in Panel C of Table 3.8 and Table 3.9 suggest that higher levels of stratification in education systems—as measured by the number of school types available to 15-year-old students—are tied to lower expectations of having both semi-professional and professional health service occupations across all performance quartiles. Further, as shown in Panel B of Table 3.8 and Table 3.9, higher levels of stratification are linked to lower CE occupational expectations among students in the bottom performance quartile.

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estimated as five plausible values. I used the first plausible value for science to create each performance quartile in each country.

Trends in Student STEM Occupation Expectations

The HGLMs using data pooled across PISA survey waves reveal some noteworthy trends; for example, students' likelihood of expecting to have a STEM occupation around age 30 increased over time. The survey year coefficient for PISA 2006 is 0.188, indicating that students had a 20 percent increase in the odds of expecting STEM occupations in 2006 than in 2000, controlling for student, school, and national characteristics (Table 3.7). However, there was no change in students' CE career expectations over time: the increase in the likelihood of expecting a STEM occupation occurred only for health service occupations.

To increase the number of countries (from 20 to 35) in the pooled HGLM analyses, only data from 2000 and 2006 were combined and utilized (while 2003 data was excluded). Results showed that increases in the likelihood of expecting STEM occupations among 15-year-old students occurred in OECD partner countries, but not in OECD countries. In OECD partner countries, students' intentions to pursue STEM subfields occupations—CE and health services occupations increased over time. In contrast, students' CE occupational expectations in OECD countries decreased over time. In PISA 2000, students in OECD countries and OECD partner countries had similar levels of expecting CE occupations at age 30, after taking into account individual, school, and country characteristics. However, in PISA 2006 the gap between OECD member and OECD partner countries was substantial. Trends in students' STEM occupational expectations based on repeated cross-sectional data should be interpreted with caution, because population changes in participating countries between 2000 and 2006 can masquerade as trends (Raudenbush & Kim, 2002).

CONCLUSIONS

Despite concerns that students have low levels of interest in STEM education and occupations in many countries, little is known about the association between the features of national education systems and cross-national variation in the STEM occupational expectations of youths. Using data from a large-scale international survey of student achievement, the Programme for International Student Assessment (PISA), this study examined the extent to which features of secondary education systems are associated with STEM occupational expectations across countries.

The results of the three-level HGLMs show that several features of national education system are associated with cross-national variation in students' STEM occupational expectations, but that these associations differ across STEM subfields. Students' CE occupational expectations are not associated with any of the characteristics of secondary education systems measured in the current study—the standardization of curriculum, the number of school types available to 15-year-old students, or early tracking. However, higher levels of both standardization and stratification in secondary education are linked to lower expectations of having a career in health services across countries.

In addition, HGLM analyses run separately by science performance quartile suggest that associations between the features of secondary education systems and students' STEM occupational expectations vary by student performance level. Specifically, the negative association between standardization and students' STEM occupational expectations is stronger for students at the bottom of the distribution than for students at the top, but the negative association between stratification and STEM occupational expectations is constant across academic performance levels.

The results of these analyses using cross-sectional data on student performance across nations do not indicate that the standardization of curriculum decreases students' STEM occupational expectations. However, the findings suggest that policymakers and education researchers must pay attention to the role of curricular standardization in shaping students' non-cognitive outcomes as well as their academic performance. Japan, Korea, and Hong Kong are top-performing countries in international assessments, and educational policymakers and researchers have frequently identified the national curricula, standards, and assessment practices in these countries as the sources of students' excellent performance in math and science. Students' STEM occupational expectations in Japan and Korea are low compared to student expectations in other OECD countries (Sikora & Pokropek, 2011). In Korea, educational researchers and professors in STEM fields have argued that standardized instruction (such as teacher-oriented lectures) in secondary science education are leading students to avoid science and engineering fields when they attend college (Korea Research Institute for Vocational Education & Training, 2002). This chapter's finding that higher levels of standardization in a country's education system are linked to lower student STEM occupational expectations suggest that highly standardized education systems in Japan and Korea might make STEM education and occupations less attractive to students.

Several countries, including the United States and Australia, have recently initiated attempts to increase the number of students who pursue advanced degrees and careers in STEM fields and thus expand the capabilities of their STEM workforces (National Research Council, 2011; Tytler, et al., 2008). The current findings—that associations between the features of secondary education systems and students' occupational expectations differ across STEM subfields and student performance levels—suggest that as policymakers and education researchers attempt to increase students' interest in STEM education and occupations, they must pay attention to a variety of factors that might be associated with students' engagement in STEM subfields.

While the findings presented in this chapter are informative, they must be interpreted with caution due to the limitations of cross-sectional data. Future research is needed to examine the causal effects of standardization in education systems on students' expectations of obtaining STEM education and occupations. For example, investigations of how changes in the features of national education systems affect students' STEM occupational expectations *within* countries can shed light on the role of standardization in decreasing students' STEM occupational expectations. Some countries (e.g., the United States and Germany) have attempted to implement a national curriculum and assessment standards, while others (e.g., Japan) have focused on liberalizing their education systems by reducing government control over curriculum and lowering the number of required courses (OECD, 2010c). A small number of PISA countries, including Bulgaria, Israel, Jordan, Latvia, and Poland, reduced the number of school tracks available to 15-year-old students between 2000 and 2006; however, fully capturing changes in national education systems and their association with student outcomes is difficult with only six years of PISA data.

Table 3.1 Descriptive Statistics – Variables Used in HGLM analyses

	PISA 2000		PISA 2003		PISA 2006	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Occupational Expectations (ISCO-88, Major Groups 2 and 3)						
STEM, general	0.26		0.27		0.31	
Computing and Engineering (CE)	0.11		0.11		0.11	
Health services including nursing	0.10		0.11		0.13	
Health services excluding nursing	0.08		0.09		0.11	
Occupational Expectations (ISCO-88, Major Group 2)						
STEM, general	0.21		0.22		0.26	
Computing and Engineering (CE)	0.10		0.10		0.10	
Health services including nursing	0.08		0.09		0.11	
Health services excluding nursing	0.07		0.08		0.10	
Student Characteristics						
Grade in school						
7th or lower	0.01		0.01		0.01	
8th	0.06		0.04		0.05	
9th	0.43		0.33		0.37	
10th	0.42		0.54		0.53	
11th or higher	0.08		0.08		0.04	
Age (years)	15.67	0.34	15.78	0.29	15.78	0.29
Female gender	0.51		0.51		0.50	
Student Ability						
Reading	479.39	103.54	472.05	101.25	471.30	108.36
Mathematics	483.78	110.37	479.55	103.91	479.87	102.22
Science	486.00	104.24	486.05	103.59	484.20	102.07
Family Background						
Parents' education						
None	0.01		0.03		0.02	
Primary	0.12		0.09		0.06	
Lower secondary	0.13		0.13		0.10	
Upper secondary 1	0.15		0.11		0.08	
Upper secondary 2	0.25		0.28		0.31	
University	0.34		0.35		0.43	
Parents' job						
Blue collar low-skilled	0.14		0.17		0.11	
Blue collar high-skilled	0.17		0.16		0.16	
White collar low-skilled	0.22		0.20		0.23	
White collar high-skilled	0.47		0.46		0.50	
Parents have STEM occupation	0.19		0.16		0.17	
Immigration status						
Native	0.92		0.94		0.91	
Second-generation immigrant	0.03		0.03		0.05	
First-generation immigrant	0.05		0.03		0.04	
Language spoken at home						
Test language	0.89		0.88		0.86	

Other national dialect	0.07		0.10		0.10	
Foreign language	0.04		0.02		0.04	
Mother works	0.65		0.62		0.81	
Number of books at home						
0-10 books	0.14		0.16		0.15	
11-100 books	0.43		0.49		0.49	
101-500 books	0.33		0.28		0.29	
More than 500 books	0.10		0.07		0.07	
Family SES	-0.27	1.08	-0.30	1.10	-0.20	1.08
School Characteristics						
School community location						
Village (less than 3,000)	0.15		0.13		0.14	
Small town (3,000 to 15,000)	0.22		0.21		0.22	
Town (15,000 to 100,000)	0.30		0.33		0.31	
City (100,000 to 1,000,000)	0.20		0.20		0.22	
Large city (more than 1,000,000)	0.13		0.13		0.11	
School mean SES	-0.32	0.78	-0.33	0.76	-0.23	0.35
School size	723.29	611.92	750.84	608.95	731.03	650.51
Percent girls in student body	0.51	0.19	0.50	0.18	0.49	0.19
Public vs. private operation and funding						
Public	0.83		0.84		0.84	
Private, government-dependent	0.07		0.07		0.06	
Private, not government-dependent	0.10		0.10		0.10	
Academic selectivity						
Not considered	0.32		0.34		0.35	
Considered	0.25		0.27		0.29	
High priority or prerequisite	0.42		0.39		0.36	
Teacher shortage in math and science	-0.06	0.99	0.00	1.00	-0.03	0.98
Quality of educational resources	0.20	1.11	-0.14	1.05	-0.24	1.12
National Economic Development						
GDP per capita ($1,000)	18101.74	15800.16	16993.27	12672.23	25432.36	24110.10
Educational expenditure (percent	21.03	5.90	21.66	5.82	20.27	6.64
OECD members	0.63		0.75		0.52	
Characteristics of National Education Systems						
Standardization						
Low	0.14		0.09		0.11	
Medium	0.38		0.39		0.38	
High	0.48		0.52		0.52	
Number of school types	1.26	0.74	2.80	1.32	2.46	1.21
Early tracking	0.29		0.40		0.36	

Table 3.2 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for General STEM Occupations (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-0.928	0.395	0.327**	-0.278	0.757	0.634	-0.177	0.838	0.567
Country-level:									
Standardization	-0.132	0.876	0.103	-0.165	0.848	0.176	-0.211	0.810	0.101*
Number of school type	-0.137	0.872	0.065*	-0.288	0.750	0.146†	-0.148	0.862	0.068*
Early tracking	-0.008	0.992	0.202	0.072	1.074	0.336	-0.005	0.995	0.173
Student controls [24]		√			√			√	
School controls [13]		√			√			√	
National controls [6]		√			√			√	
N									
Students (unit of observations)		132,815			119,759			226,417	
Schools		5,048			4,161			8,077	
Countries		35			20			46	
Variance components									
School level		0.178***			0.209***			0.186***	
County level		0.159***			0.165***			0.183***	

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 3.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 3.3 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for General STEM Occupations (ISCO-88 Major Group 2)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-0.946	0.388	0.366*	-0.653	0.569	0.700	-0.461	0.630	0.565
Country-level:									
Standardization	-0.102	0.903	0.116	0.014	1.014	0.195	-0.146	0.864	0.118
Number of school type	-0.195	0.823	0.074*	-0.352	0.704	0.161*	-0.184	0.832	0.079*
Early tracking	-0.022	0.978	0.229	0.042	0.959	0.373	-0.056	0.945	0.206
Student controls [24]		√			√			√	
School controls [13]		√			√			√	
National controls [6]		√			√			√	
N									
Students (unit of observations)		132,815			119,759			226,417	
Schools		5,048			4,161			8,077	
Countries		35			20			46	
Variance components									
School level		0.178***			0.194***			0.166***	
County level		0.206***			0.203***			0.249***	

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 3.1 except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 3.4 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Computing & Engineering (CE) Occupational Expectations (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-2.086	0.124	0.407***	-1.789	0.167	0.836†	-1.437	0.238	0.847†
Country-level:									
Standardization	0.000	1.000	0.104	0.046	1.047	0.172	-0.083	0.921	0.098
Number of school type	0.021	1.021	0.067	-0.153	0.858	0.143	-0.009	0.991	0.066
Early tracking	-0.080	0.923	0.205	0.139	1.149	0.325	-0.046	0.955	0.169
Student controls [24]	√			√			√		
School controls [13]	√			√			√		
National controls [6]	√			√			√		
N									
Students (unit of observations)	132,815			119,759			226,417		
Schools	5,048			4,161			8,077		
Countries	35			20			46		
Variance components									
School level	0.271***			0.270***			0.229***		
County level	0.156***			0.149***			0.163***		

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 3.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 3.5 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for Health Service Occupations (Including Nursing) (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-2.561	0.077	0.416***	-1.579	0.206	0.855†	-1.831	0.160	0.664**
Country-level:									
Standardization	-0.174	0.840	0.102†	-0.333	0.717	0.230	-0.216	0.805	0.116†
Number of school types	-0.209	0.811	0.065**	-0.337	0.714	0.191	-0.219	0.803	0.078**
Early tracking	-0.013	0.987	0.201	-0.040	0.960	0.441	0.030	1.030	0.206
Student controls [24]		√			√			√	
School controls [13]		√			√			√	
National controls [6]		√			√			√	
N									
Students (unit of observations)		132,815			119,759			226,417	
Schools		5,048			4,161			8,077	
Countries		35			20			46	
Variance components									
School level		0.243***			0.279***			0.262***	
County level		0.149***			0.278***			0.236***	

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 3.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 3.6 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for Health Service Occupations (Excluding Nursing) (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-2.439	0.087	0.479***	-1.678	0.187	0.920†	-1.745	0.175	0.700*
Country-level:									
Standardization	-0.157	0.846	0.114	-0.261	0.770	0.235	-0.185	0.831	0.119
Number of school type	-0.251	0.778	0.073**	-0.374	0.688	0.194†	-0.247	0.781	0.079**
Early tracking	-0.150	0.861	0.225	-0.157	0.855	0.448	-0.005	0.995	0.216
Student controls [24]		√			√			√	
School controls [13]		√			√			√	
National controls [6]		√			√			√	
N									
Students (unit of observations)		132,815			119,759			226,417	
Schools		5,048			4,161			8,077	
Countries		35			20			46	
Variance components									
School level		0.221***			0.247***			0.202***	
County level		0.186***			0.286***			0.246***	

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 3.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 3.7 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for STEM Occupations (ISCO-88 Major Groups 2 and 3) for Pooled Data from PISA 2000, 2003, and 2006

	STEM			Computing & Engineering			Health [a]		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-0.480	0.619	0.423	-1.867	0.155	0.440***	-2.286	0.102	0.572**
School-level:									
PISA 2003	-0.034	0.967	0.051	-0.060	0.942	0.084	0.023	1.023	0.076
PISA 2006	0.188	1.207	0.079*	0.005	1.005	0.126	0.216	1.241	0.071**
Country-level:									
OECD	0.390	1.476	0.299	0.356	1.427	0.278	0.125	1.133	0.406
Standardization	-0.242	0.785	0.138	-0.056	0.945	0.129	-0.186	0.830	0.188
Number of school type	-0.178	0.837	0.100†	0.016	1.016	0.093	-0.132	0.876	0.135
Early tracking	-0.160	0.852	0.230	-0.190	0.827	0.217	-0.218	0.804	0.316
Student controls [24]		√			√			√	
School controls [15]		√			√			√	
National controls [6]		√			√			√	
N									
Students (unit of observations)		324,510			324,510			324,510	
Schools		11,742			11,742			11,742	
Countries		20			20			20	
Variance components									
School level		0.186***			0.242***			0.232***	
County level		0.202***			0.151***			0.245***	

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 3.1, except for student ability. Additionally, two indicators for the study year (i.e., PISA 2003 and PISA 2006) are included at the school level.

a. Findings are consistent even after excluding nursing careers from health service occupations

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 3.8 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for STEM Occupations (ISCO-88 Groups 2 and 3) by Performance Quartile for PISA 2006 data

	Top-quartile			Upper-middle-quartile			Lower-middle-quartile			Bottom-quartile		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Panel A: STEM												
Intercept	0.522	1.685	0.466	0.106	1.112	0.404	-0.557	0.573	0.378	-0.754	0.471	0.479
Standardization	-0.106	0.899	0.106	-0.181	0.834	0.094†	-0.224	0.799	0.098*	-0.292	0.747	0.135*
Number of school type	-0.082	0.922	0.074	-0.118	0.889	0.062†	-0.155	0.856	0.066*	-0.292	0.747	0.095**
Early tracking	-0.141	0.869	0.192	-0.118	0.889	0.159	-0.013	0.987	0.167	0.197	1.218	0.231
Panel B: CE												
Intercept	-1.160	0.314	0.652†	-1.320	0.267	0.566*	-1.649	0.192	0.522**	-1.627	0.196	0.693*
Standardization	-0.009	0.991	0.096	-0.137	0.872	0.107	-0.037	0.964	0.113	-0.231	0.794	0.146
Number of school type	0.024	1.025	0.068	0.020	1.021	0.071	0.018	1.018	0.076	-0.209	0.811	0.099*
Early tracking	-0.048	0.954	0.174	-0.134	0.874	0.181	-0.147	0.863	0.194	-0.064	0.938	0.244
Panel C: Health Services (Including Nursing)												
Intercept	-1.095	0.335	0.550†	-1.281	0.278	0.547*	-2.181	0.113	0.520***	-2.588	0.075	0.634***
Standardization	-0.068	0.934	0.122	-0.181	0.834	0.107†	-0.321	0.726	0.114**	-0.291	0.747	0.147†
Number of school type	-0.150	0.861	0.086*	-0.197	0.822	0.071**	-0.228	0.796	0.078**	-0.311	0.733	0.105**
Early tracking	-0.169	0.845	0.222	-0.010	0.990	0.182	0.155	1.168	0.196	0.481	1.618	0.253†

Each column in each panel reports results from one regression

All regressions control for all the student-level, school-level, and national-level variables reported in Table 31, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 3.9 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for STEM Professional Occupations (ISCO-88 Group 2) by Performance Quartile for PISA 2006 data

	Top-quartile			Upper-middle-quartile			Lower-middle-quartile			Bottom-quartile		
	β	O.R.	S.E.	B	O.R.	S.E.	B	O.R.	S.E.	β	O.R.	S.E.
Panel A: STEM												
Intercept	0.366	1.442	0.478	-0.198	0.820	0.448	-0.834	0.434	0.439†	-1.459	0.232	0.588*
Standardization	-0.068	0.934	0.110	-0.122	0.885	0.113	-0.097	0.908	0.122	-0.089	0.914	0.172
Number of school type	-0.104	0.901	0.078	-0.166	0.847	0.074*	-0.212	0.809	0.082*	-0.349	0.705	0.121**
Early tracking	-0.117	0.889	0.200	-0.123	0.884	0.190	-0.077	0.926	0.208	0.139	1.149	0.293
Panel B: CE												
Intercept	-1.153	0.316	0.676†	-1.478	0.228	0.616*	-1.824	0.161	0.574**	-2.163	0.115	0.780**
Standardization	-0.003	0.997	0.104	-0.117	0.889	0.120	0.007	1.007	0.124	-0.134	0.874	0.164
Number of school type	-0.002	0.998	0.073	-0.019	0.981	0.079	-0.004	0.996	0.083	-0.201	0.818	0.111*
Early tracking	-0.070	0.932	0.188	-0.149	0.861	0.202	-0.137	0.872	0.213	-0.044	0.956	0.272
Panel C: Health Services (Including Nursing)												
Intercept	-1.019	0.361	0.573†	-1.343	0.261	0.600*	-2.069	0.126	0.597***	-3.081	0.046	0.790***
Standardization	-0.038	0.962	0.129	-0.094	0.911	0.125	-0.187	0.830	0.142	-0.007	0.993	0.195
Number of school type	-0.190	0.827	0.091*	-0.276	0.759	0.083**	-0.353	0.702	0.096***	-0.451	0.637	0.137**
Early tracking	-0.157	0.855	0.235	-0.053	0.948	0.211	-0.015	0.985	0.242	0.321	1.378	0.328

Each column in each panel reports results from one regression

All regressions control for all the student-level, school-level, and national-level variables reported in Table 3.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

CHAPTER 4. Cross-National Variation in Gendered STEM Occupational Expectations: The Significance of Features of Secondary Education Systems

The underrepresentation of women in STEM education and occupations has become a more prominent concern for policymakers and researchers in the United States and most developed countries. An extensive body of research has examined why girls have more limited access to, and less opportunity and success in, the educational trajectories leading to STEM occupations. Studies of gender inequality suggest that horizontal gender segregation by fields of study in higher education is not explained by differences in academic preparation, including course-taking patterns and grades in secondary math and science courses (Morgan, et al., 2013; Xie & Shauman, 2003). Rather, high school students' expectations of pursuing science/engineering careers is the most important factor in gender differences in the likelihood of majoring in science/engineering in college (Xie & Shauman, 2003). According to several international reports (OECD, 2007b; OECD & UNESCO, 2003), the occupational expectations of adolescents are gender segregated in many countries, although to different degrees. A small group of researchers have investigated the sources of between-country differences in the gender gap in science-related career expectations (Sikora & Pokropek, 2011, 2012). This prior research focused primarily on the level stratification of secondary education systems in explaining cross-national variation of gender gaps in science-related career expectations. In this chapter, I extend earlier research by using the stratification-standardization framework to examine gender gaps in STEM occupational expectations across countries.

NATIONAL EDUCATION SYSTEMS AND GENDER GAPS IN STEM OCCUPATIONAL EXPECTATIONS: A COMPARATIVE PERSPECTIVE

Since the inception of large-scale international survey studies of educational achievement such as the First and Second International Mathematics Studies (FIMS, SIMS), the Third International Mathematics and Science Study (TIMSS), and the Programme for International Student Assessment (PISA), a rich body of research has investigated cross-national differences in average student performance and the sources of these differences (e.g., Akiba, LeTendre, & Scribner, 2007; Husén, 1967; Schmidt, 2001; Woessmann, Luedemann, Shuetz, & West, 2009). One area that has received far less attention, however, is how countries differ in the ways they shape students' non-cognitive domains, for example, educational and occupational expectations (Buchmann & Dalton, 2002; Buchmann & Park, 2009; Marks, 2010; Sikora & Saha, 2007). In an effort to understand cross-national variation in student expectations, a small number of studies have examined gender gaps in educational and occupational expectations across countries (McDaniel, 2010; Sikora & Pokropek, 2011, 2012; Sikora & Saha, 2009).

Several studies have investigated the ways in which the institutional arrangement of educational systems—namely, the level of standardization, stratification, and vocational specificity—affect patterns of educational inequality and occupational attainments (Allmendinger, 1989; Kerckhoff, 1995, 2001; Shavit, et al., 1998); these studies have inspired cross-national research on students' expectations. Standardization refers to the degree to which education systems meet the same standards throughout a society (Allmendinger, 1989); stratification (differentiation) refers to the degree to which educational systems have differentiated curricular, programs, or tracks, defined as "higher" and "lower"; and vocational specificity refers to the degree to which educational systems offer vocational training opportunities and award vocationally specific credentials (Kerckhoff, 2001). Stratification and vocational specificity overlap to a degree because stratified education systems tend to offer pre-vocational or vocational programs. Using these three features of national education systems, prior research has examined the extent to which the characteristics of national education systems shape students' educational and occupational expectations (Buchmann & Dalton, 2002; Buchmann & Park, 2009; McDaniel, 2010).

This previous research focused primarily on the extent to which stratification in educational systems explains cross-national variation of gender gaps in educational and occupational expectations (McDaniel, 2010; Sikora & Pokropek, 2011, 2012). Several studies found that while girls have higher educational and occupational expectations than boys in most countries, the size of this gender gap in expectations varies across countries (Marks, 2010; McDaniel, 2010; OECD, 2007a; Sikora & Pokropek, 2011; Sikora & Saha, 2009). Researchers have found that the level of stratification in a country's secondary education system (as measured by the number of school types available to 15-year-old students) is negatively associated with students' expectations, and this negative association is consistent across student gender (McDaniel, 2010). That is, both boys and girls have lower educational expectations in differentiated educational systems than in undifferentiated educational systems.

In addition to gender gaps in the vertical dimension of educational and occupational expectations (e.g., expectations of completing a bachelor's degree or above, plans to be a highly qualified professional such as a lawyer, medical specialist, or teaching professional), researchers are paying greater attention to gender gaps in the horizontal dimension of expectations (e.g., expecting to have a science-related career versus a career in another field) (Sikora & Pokropek, 2011, 2012). Recent cross-national studies have shown that the occupational expectations of adolescents remain gender segregated in that boys and girls expect to have careers in different fields (OECD & UNESCO, 2003; Sikora & Pokropek, 2011). For example, among boys and girls who expect to have professional occupations, male students more often expect careers associated with physics, mathematics, or engineering, while female students more often expect careers in the life sciences or health-related professions. This horizontal gender segregation in occupational expectations occurs across all OECD member and partner countries, although there is cross-national variation in the magnitude of the gender gaps (Sikora & Pokropek, 2011)

Using the framework of stratification to measure cross-national differences in education systems, a few studies have investigated cross-national variation of gender gaps in science-related career expectations (Sikora & Pokropek, 2011, 2012). These studies analyzed PISA 2006 data and measured the level of stratification in education systems by the number of school types available to 15-year-olds. However, the classification of science-related careers differed slightly across these studies. Using three-level hierarchical generalized linear models (HGLMs) run separately by gender, Sikora and Pokropek (2011) found that the level of stratification in a country's secondary education system affected boys and girls differently. Specifically, for girls but not boys, higher levels of stratification lowered the likelihood of planning a career in computer science or engineering. When Sikora and Pokropek incorporated the cross-level interactions between country-level variables and student gender, however, they found that the level of stratification was not associated with gender segregation in expectations for science careers in either developed or developing countries (Sikora & Pokropek, 2012).

Comparative studies of gender inequality have paid little attention to the extent to which the standardization of education systems is associated with cross-national variation of gender gaps in STEM occupational expectations. Several country-level case studies have shown that when education systems allow individual freedom of choice in curriculum, gender segregation tends to increase (Catsambis, 1994; Kontogiannopoulou-Polydorides, 1991; Plateau, 1991). In these more flexible systems, for example, girls are less likely to enroll in physics courses because they tend to prefer soft science to hard science. These prior findings suggest that lower levels of standardization might be associated with larger gender gaps in STEM occupational expectations. In this chapter, I extend prior research by considering both standardization and stratification as features of national education systems.

RESEARCH QUESTIONS

In this chapter, I examine gender gaps in STEM occupational expectations across countries and the association between these gender gaps and the features of secondary education systems. While a small number of comparative studies have examined how differences in national education systems are linked to gendered science career expectations (Sikora & Pokropek, 2011, 2012), these studies focused only on *the number of schools types available to students* as a national characteristic of educational systems. In this chapter, I expand on the extant literature by investigating two issues: First, I examine the degree to which the level of standardization in a country's secondary education system is associated with gender gaps in STEM occupation expectations. Specifically, I investigate whether girls in countries with highly standardized education systems are more likely to expect occupations in STEM subfields characterized by substantial gender gaps (e.g., computing and engineering) than girls in countries with unstandardized educational systems. Second, I investigate the extent to which the level of stratification in educational systems is associated with cross-national variation of gender gaps in STEM occupational expectations across countries, when other features of education systems, including the standardization of curriculum, are held constant. In addition, I investigate whether the associations between stratification and gender gaps are consistent across PISA survey waves, given that prior research found inconsistent associations.

SELECTION OF COUNTRIES

As described in Chapter 2, I use data from the 2000, 2003, and 2006 waves of the Programme for International Student Assessment (PISA). Several countries are excluded from the analyses due to missing data: No data on the dependent variable are available for Qatar in 2006; no data on the characteristics of the educational system are available for Albania; no data on the Gender Empowerment Measure (GEM) are available for Chinese Taipei, Hong Kong, Liechtenstein, Luxembourg, Macao-China, Montenegro, and Yugoslavia; and no data on the school variables are available for France in 2003 and 2006. Data on several school-level variables, including school type (i.e., public, government-dependent private, or government-independent private), school community location, and academic selectivity, are not available for Australia, Canada, Iceland, and Italy; therefore, these countries are excluded from this chapter. The final analytic sample includes 26 countries from PISA 2000, 19 countries from PISA 2003, and 40 countries from PISA 2006 (see Appendix 4.1).

MEASURES

Dependent Variables

The outcome measures for this study are binary variables, each indicating whether or not a student expects to have a certain type of STEM-related occupation around the age of 30. The study examines expectations for two skill levels in each of three different STEM fields (a total of six types of expectations). The three STEM fields are: (a) general STEM-related fields; (b) computing and engineering (CE); and (c) health services.[14] The two skill levels are: (a) professional, technician, and associate professional occupations (International Standard Classification of Occupations 88 [ISCO-88], major group 2 and 3) and (b) only professional occupations (ISCO-88, major group 2).

Individual-Level Independent Variables

At the student level, I control for several student characteristics and their home backgrounds such as gender, age, grade level, family SES, immigration backgrounds of students and their parents, and whether either of the respondent's parents have a job in STEM fields.[15]

School-Level Independent Variables

At the school level, I control for school mean SES, school size, school community location, the proportion of school enrollment that is female, school type (public, government-dependent private, government-independent private), school academic selectivity, degree of teacher shortage in math and science, and level of educational resources.

Country-Level Independent Variables

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[14] I created two dependent variables (within each skill level) for health services occupational expectations: (a) health services including nursing and (b) health services excluding nursing. When findings were consistent, I presented only outputs for health services including nursing.

[15] I ran two types of models: (a) three models in which student ability was controlled (using reading, math, and science test scores, respectively) and (b) a model with no controls for student ability. In addition, by comparing the findings from these models, I examined the degree to which taking into account student ability affected patterns of gender gaps in STEM occupational expectations. All findings were consistent across the models; I reported results from the model that did not include student ability.

The main independent variables in this chapter are country-level indicators of characteristics of national education systems. These variables include:

Standardization of educational systems. Standardization refers to “the degree to which the quality of education meets the same standards nationwide” (Allmendinger, 1989, p. 233). In general, standardization is higher when the central government exercises control over the educational system, for example by determining curriculum, assessments, and school budgets (Kerckhoff, 2001). Data on the standardization of curriculum were gathered from *World Data on Education* (Amadio, 2000). The curricular policies of each country were reviewed, and countries were classified into three groups: (a) countries in which there is no central government control over curriculum (coded 0), (b) countries in which regional or local agencies have some ability to adapt a centrally prescribed curriculum (coded 1), and (c) countries in which the central government determines the curriculum (coded 2). I compared this index of standardization to three external data sources: (a) TIMSS curriculum questionnaires; (b) reports on national contexts for mathematics and science education produced by experts from ministries of education, research institutes, or institutions of higher education who have extensive knowledge about their nations’ education systems (Mullis, et al., 2008; Robitaille, 1997); and (c) the work of Asitz, Wiseman, and Baker (2002), in which the authors rated TIMSS countries according to the degree of curricular centralization in each, and classified each country as either a decentralized administration, a mix of centralized and decentralized administration, or a centralized administration for mathematics curricula. Despite minor inconsistencies in the classification of a few countries, all four studies resulted in generally similar classifications with regard to the degree of curricular standardization.

Stratification of educational systems. Stratification refers to “the degree to which systems have clearly differentiated kinds of schools whose curricula are defined as higher and lower” (Kerckhoff, 2001, p. 4). The level of stratification of each education system is measured by the number of school types available to 15-year-olds in each country, and the age of first selection into different school types or tracks. Among the PISA participating countries, the number of school types ranged from one to five. The age of first selection is a dummy variable for early tracking, coded 1 when countries sort students into different tracks before the age of 14. The source of data for both indicators is *Education at a Glance, OECD Indicators* (the data in this source was derived from OECD PISA database and the OECD education database).

National economic development indicators. I used three indicators to capture national economic development levels: (a) a measure of the Gross Domestic Product (GDP) per capita (in current U.S. dollars); (b) an indicator of the level of educational investment, as measured by public education expenditures per student in secondary education as a percent of the GDP per capita; and (c) an OECD member country indicator. The first two indicators were collected from the UNESCO Institute for Statistics and the World Bank. The OECD member indicator is a dummy variable, coded 1 when countries are OECD member countries.

Gender empowerment measure (GEM). The Gender Empowerment Measure (GEM) is a composite index of levels of gender inequality across nations. This measure was developed by the United Nations Development Programme (UNDP). This measure is based on three basic dimensions of women’s empowerment: political participation and decision-making, participation in high-paying positions with economic power, and economic income relative to men. The GEM ranges from 0 to 1, where higher values indicate greater gender equality.

Descriptive statistics for all variables used in the HGLM analyses are presented in Table 4.1.

METHODS

This study employs three-level hierarchical generalized linear models (HGLMs) in which the level 1 sampling model is a Bernoulli distribution (Raudenbush & Bryk, 2002). The models nest students (level 1) within schools (level 2) and countries (level 3) (see Chapter 2 for detailed descriptions of the statistical models). Using cross-level interactions between female gender and the country-level measures of characteristics of secondary education systems, I assess the extent to which gender gaps in STEM occupational expectations are associated with the features of national education systems. The model is run separately for data from three waves of PISA: 2000, 2003, and 2006. Additional models use a combined data set that pools the observations from the countries that participated in every cycle of PISA 2000, 2003, and 2006; in these models, controls for the study year are included at the school level.

RESULTS

In this chapter, I examine the cross-national variation of gender gaps in STEM occupational expectations and the association between this variation and features of national education systems. Recent cross-national studies have shown that girls have higher educational expectations than boys in the majority of OECD countries (McDaniel, 2010). Further, female high school students have higher average occupational expectations than males in most OECD countries (OECD, 2004; Sikora & Saha, 2009). However, gender differences in the types of careers boys and girls want to pursue persist. According to PISA 2006 data from OECD countries, girls are less likely than boys to have plans for a career in the fields of computing and engineering, and career plans in the fields of health and medicine are more prevalent among girls than boys even after nursing and midwifery are excluded from the list of health-related careers (Sikora & Pokropek, 2011).

Gender differences in STEM occupational expectations are observed in the data from all PISA study waves. Compared to boys, girls are less likely to expect to have CE occupations (Table 4.3) and more likely to expect to have health-related occupations even when student, school, and national characteristics are taken into account (Table 4.4). Even when the dependent variable is restricted to only computing occupations (i.e., engineering occupations are excluded), girls are less likely than boys to have computing-related occupational plans at age 30. When nursing is excluded from health service occupations, girls are more likely than boys to expect health service occupations. Accounting for academic ability (i.e., reading, science, and mathematics ability) does not change these cross-national gender patterns in STEM occupational expectations—the same patterns occur in expectations for STEM-related professional occupations that require a bachelor’s degree or above at job entry. However, the gender gaps in career expectations in both STEM subfields (CE and health services) vary across countries (see the country-level variance components for girls in Table 4.3 and Table 4.4).

The HGLM analysis of the pooled data (across all PISA study years) indicates that for girls, the likelihood of expecting CE occupations has increased over time, although their CE occupational expectations still lag well behind those of boys (Table 4.5). Health services occupational expectations have increased over time for both boys and girls, but the growth has been faster among boys than among girls. The same pattern of growth holds, even when nursing-related careers are excluded from health-related occupations. In the following sections, I use cross-level interactions between female gender and the country-level variables to assess the extent to which cross-national variation of gender gaps in STEM occupational expectations is associated with features of secondary education systems.

The Standardization of Education Systems and Gender Gaps in STEM Occupational Expectations

In this section I assess the extent to which cross-national variation of gender gaps in STEM occupational expectations is associated with the level of standardization of education systems. First, I focus on the interaction between female gender and the level of standardization to examine whether the association between standardization and STEM occupational expectations varies by gender by using interactions between gender and the level of standardization. Second, I investigate whether higher levels of standardization in education systems are associated with smaller gender gaps in STEM occupational expectations.

The analytical results provide some evidence that a higher level of standardization is linked to lower STEM occupational expectations for girls only. As shown in Table 4.2, neither the main coefficients for standardization nor the interactions between female gender and the level of standardization are statistically significant in the STEM occupational expectation models using PISA 2000 and PISA 2003 data.[16] These results suggest that for both boys and girls the level of standardization is not reliably associated with STEM occupational expectations. However, in the pooled HGLM models (Table 4.5), the coefficient for the interaction between

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[16] In models using PISA 2006, the main coefficient for standardization is -0.230, indicating that a one-level increase in the standardization of a country's secondary schools is linked to a 21 percent decrease in the odds of expecting to have a STEM occupation. Whether these inconsistencies across PISA survey waves are due to the countries in the analytical sample differing across PSIA survey cycles is unclear. I ran an additional model limiting the PISA 2006 analytic sample to the countries that participated in PISA 2000; in this model the level of standardization is not associated with students' STEM occupational expectations. This indicates that a negative association between standardization and STEM occupational expectations in PISA 2006 (Table 4.2) is due to additional countries participating in the wave of PISA 2006.

female gender and standardization is negative, and the main coefficient of standardization on STEM occupational expectations is negative, but statistically insignificant. As revealed in Table 4.5, for boys a one-level increase in the standardization of a country's secondary schools is linked to a 19 percent decrease in the odds of expecting a STEM occupation ($\beta_{\text{standardization}}$ = -0.212). For girls, a one-level increase in standardization is associated with a 34 percent decrease in the odds of expecting a STEM occupation (β = -0.212 [$\beta_{\text{standardization}}$] - 0.201 [$\beta_{\text{female*standardization}}$] = -0.413).[17] These results indicate that standardized education systems are not associated with STEM occupational expectations among boys, but higher levels of standardization are linked to lower expectations among girls.

Further analyses revealed that the negative interaction between female gender and the level of standardization differs across STEM subfields. Standardization is not associated with CE occupational expectations for either boys or girls; the HGLM results presented in Table 4.3 and Table 4.5 show that the term for the interaction between gender and standardization is close to zero in the models using PISA 2000 and PISA 2006 data. Moreover, the coefficients for the main effect of standardization are close to zero across cycles. These findings indicate that the level of standardization is not associated with either gender gaps in CE occupational expectations or cross-country differentials in average CE occupational expectations.

In contrast to the results for CE careers, the results for health service occupations provide partial evidence that a higher level of standardization is linked to lower occupational expectations among girls. As seen in Table 4.4 (PISA 2003) and Table 4.5 (pooled data), the terms for the interaction between female gender and standardization are negative and statistically

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[17] Using PISA 2000 and 2006 data, I ran an additional model limiting the analytic sample to the 19 countries that participated in all PISA survey cycles in order to assess whether this finding is consistent in PISA 2000 and PISA 2006. The model was run separately for PISA 2000 and PISA 2006 data. Both the main coefficients for standardization and the interaction between female gender and standardization are negative and statistically significant in PISA 2006.

significant.[18] In the pooled HGLM, for example, the main coefficient for the standardization of the educational system is negative and statistically insignificant (β = -0.044 [$\beta_{standardization}$]). For girls, a one-level increase in standardization is associated with a 37 percent decrease in the odds of expecting to have a health service occupation (including nursing) (β = -0.044 [$\beta_{standardization}$] - 0.412 [$\beta_{female*standardization}$] = -0.456). The pattern remains the same when nursing is excluded from the list of health-related occupations. These results suggest the presence of a gender difference in the association between the standardization of education systems and health service occupational expectations: among boys, health service occupational expectations are not associated with standardized education systems, but among girls, those in countries with highly standardized education systems are substantially less likely to have plans for health service occupations than those in countries with unstandardized systems.

The analytical results also shed light on the association between standardization and the magnitude of the gender gaps in health service occupational expectations: higher levels of standardization are linked to narrower gender gaps. Figure 4.1 shows how gender gaps in the expectations of having a health service occupation (excluding nursing) change across levels of standardization in an education system, when all other variables are held constant at the grand mean. The left panel of Figure 4.1 displays coefficients for health service occupational expectations including technician and associate professional positions, while the right panel shows expectations for only professional-level health service occupations. Boys' health service occupational expectations remain constant across the levels of standardization, but girls' expectations decrease as the level of standardization increases. The same pattern occurs across

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[18] As shown in Table 4.4, the interaction between female gender and standardization is not significant in either PISA 2000 or PISA 2006. I reran the HGLMs using an analytic sample of the 19 countries that participated in all PISA survey cycles. The model was run separately for PISA 2000 and 2006 data. The interactions between female gender and standardization are negative in both PISA 2000 and PISA 2006, but are statistically significant for PISA 2000 data only.

skill levels in health service occupations—expectations remain constant among boys, but girls in countries with highly standardized education systems are less likely to expect professional occupations in health services than those in unstandardized systems. Because girls' expectations of having health service occupations are higher than boys' expectations, gender gaps in these expectations are larger in countries with lower levels of educational standardization after accounting for student, school, and national characteristics.

The Stratification of Education Systems and Gender Gaps in STEM Occupational Expectations

I next examine the extent to which cross-national variation of gender gaps in STEM occupational expectations is associated with the level of stratification of education systems, once other features of national education systems such as standardization are controlled. By examining the cross-level interaction terms between female gender and the level of stratification, I assess whether the association between students' STEM occupational expectations and the stratification of education systems varies by gender. The degree of stratification of education systems is measured via two indicators in this study: (a) the number of school types available to 15-year-old students and (b) the presence of an early tracking system (implemented before age 14).

The results provide no support for an association between the degree of stratification in education systems and gender gaps in STEM occupational expectations. As shown in Table 4.2, neither the main coefficients for stratification nor their interactions with female gender are statistically significant.[19] Mirroring the overall results for STEM occupational expectations, the

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[19] The result of models using PISA 2006 data is an exception. For boys, each additional type of school available is linked to a 8 percent decrease in the odds of expecting a STEM occupation ($\beta_{\text{number of school types}}$ = -0.079); for girls, each additional school type is associated with an18 percent decrease in the odds of expecting a STEM occupation (β

level of stratification is not associated with CE occupational expectations for either boys or girls in any PISA survey wave.[20] These results suggest that highly stratified systems are not linked to cross-national variation of gender gaps in CE occupational expectations.

The analytical results provide partial evidence that both boys' and girls' expectations of having a health service occupation are negatively associated with the level of stratification in education systems. That is, this negative association does not vary by gender. Table 4.4 shows that the main effect for the number of school types available is negative and statistically significant for both PISA 2000 and PISA 2006 data. This negative association holds even after nursing is excluded from the list of health service occupations; it also holds for professional careers as well as technician and associate professional positions. However, the term for the interaction between the level of stratification and female gender is close to zero in PISA 2003 and PISA 2006,[21] which suggests that stratification is not associated with cross-national variation of gender gaps in health service occupation expectations.

Gender Inequality at the Societal Level and Gender Gaps in STEM Occupational Expectations

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$= -0.079$ [$\beta_{\text{number of school types}}$] - 0.119 [$\beta_{\text{female*number of school types}}$] = -0.198). However, when I limited the analytic sample to the 19 countries that participated in each PISA survey cycle, there was no association between the degree of stratification in education systems and the gender gaps in STEM occupational expectations.

[20] In models using PISA 2006 data for boys (Table 4.3), each additional available school type is associated with only a 2.5 percent increase in the odds of expecting to have a CE career around age 30 ($\beta_{\text{number of school types}} = 0.025$). In contrast, for girls, each additional school type is tied to a 17 percent decrease in the odds of expecting a CE career ($\beta = -0.025$ [$\beta_{\text{number of school types}}$] - 0.159 [$\beta_{\text{female*number of school types}}$] = -0.184). This pattern suggests that higher levels of stratification are linked to larger gender gaps in CE occupational expectations. However, when I limited the analytic sample to the 19 countries that participated in each PISA survey cycle, there was no association between the degree of stratification in education systems and gender gaps in CE occupational expectations, which indicates that a positive association between stratification and gender gaps in CE expectations in PISA 2006 (Table 4.3) is due to additional countries participating in the wave of PISA 2006.

[21] In PISA 2000 (Table 4.4), the interaction between female gender and number of school types is positive and marginally statistically significant. However, when I limited the analytic sample to the 19 countries that participated in each PISA survey cycle, there was no association between stratification and gender gaps in health service occupational expectations in PISA 2000.

To conduct cross-national comparisons of gender gaps in STEM occupational expectations, the gender empowerment measure (GEM) is included in all models as an index of gender inequality at the national level. I examine the degree to which the improvement in women's standing in political and economic forums has a positive association with girls' expectations of having a STEM occupation.

The results of the HGLM analyses indicate that gender equality at the societal level is not linked to CE occupational expectations for either boys or girls. As shown in Table 4.3 and Table 4.5, neither the main coefficients for GEM nor the terms for the interaction between GEM and female gender are statistically significant.[22] These results indicate that societal-level gender equality is not associated with either gender gaps in CE occupational expectations or cross-national differentials in the average level CE occupational expectations.

With regard to health-related fields, the association between gender empowerment at the national level and girls' occupational expectations is inconsistent across PISA survey waves. As shown in Table 4.4, greater gender equality is linked to higher levels of health service occupational expectations for girls in PISA 2000 ($\beta = -0.734\ [\beta_{GEM}] + 2.684\ [\beta_{female*GEM}] = 1.950$). In contrast, societal-level gender empowerment is negatively associated with both boys' and girls' expectation for health service occupations in PISA 2003, while there is no association between the two variables in PISA 2006.

The association between societal-level gender equality and gender gaps in heath service occupational expectations is also inconsistent across PISA survey cycles. Figure 4.2 presents the predicted probabilities of expectations for health service occupations for boys and girls across national levels of gender inequality, when all other variables are held constant at the grand mean.

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[22] The result from models using PISA 2000 data is an exception. However, when I use PISA 2000 data but limit the analytic sample to the 19 countries that participated in all PISA survey cycles, GEM is not associated with cross-national differences in gender gaps in CE occupational expectations.

The results for PISA 2000 data show that boys' health service occupational expectations are constant across levels of gender equality, while girls' expectations increase as gender equality increases. This pattern suggests that students in more gender equal societies are more likely to have gender-typed occupational expectations, and such societies have wider gender gaps in expectations for health service occupations. However, in models using PISA 2006 data, the gender gaps in expectations for health service occupations are not associated with gender inequality.

Next, to assess whether these inconsistencies in findings across PISA survey waves are due to variation in the countries included in the analytic sample, I conduct additional analyses with only the 19 countries that participated in all PISA survey cycles. The results of these additional HGLM analyses are also inconsistent across cycles. For example, in the PISA 2006 models, neither the main coefficient for GEM nor the interaction between GEM and female gender are statistically significant, suggesting that for both boys and girls gender equality at the societal level is not associated with STEM occupational expectations. However, in the models using PISA 2003 data (Figure 4.2), greater gender equality at the societal level is linked to lower health service occupational expectations for both boys and girls. This indicates that these inconsistencies in findings across cycles are not explained by the countries in the analytic sample differing across PISA survey cycles.

CONCLUSIONS

Gender segregation in STEM expectations is a matter of concern for educational policymakers and researchers in the United States and other countries because this segregation can lead to gender inequality in STEM education and occupations. While a small number of cross-national comparative studies have investigated whether differences in secondary education systems are associated with gender gaps in science-related career expectations across countries, these studies have limited their focus to curricular stratification in secondary schools. In this chapter, I extended the prior research by focusing on two features of secondary education systems—standardization and stratification—and their association with cross-national variation of gender gaps in STEM occupational expectations. Standardization refers to the degree to which school curricula are standardized nationwide and stratification indicates the degree to which students are sorted into different types of schools that are valued differently by higher education institutions and labor markets.

The analytical results show that, across all PISA survey waves and all skill levels, girls tended to have higher expectations for health service occupations than boys, but lower expectations for computing and engineering (CE) occupations. There was considerable variation in the magnitude of gender gaps across countries: the results for the cross-level interactions of country-level variables (i.e., standardization of curriculum, the number of school types available to 15-year-olds, and early tracking) and gender showed that the associations between national education systems and students' STEM occupational expectations differed by gender and across STEM subfields.

First, higher levels of standardization in secondary education systems were linked to lower expectations for health service occupations among girls, while boys' expectations were constant across the levels of standardization. Girls' expectations of having a health service career being higher than boys' expectations suggests that higher levels of standardization are linked to narrower gender gaps in health service occupational expectations. Notably, the smaller gender gaps in health service occupational expectations observed in standardized education systems were not due to higher levels of interest in female-dominated occupations among boys, but rather lower levels of interests in health service occupations among girls. In contrast to the results for health services, standardized education systems were not associated with either gender gaps in CE occupational expectations or cross-national differentials in the average level of CE occupational expectations.

Second, higher levels of stratification in secondary education were not associated with gender gaps in either STEM subfield. Both boys' and girls' CE occupational expectations were constant across stratification levels, while both boys' and girls' health service occupational expectations were negatively associated with the stratification of education systems. Prior research has found that highly stratified systems provide more opportunities for gender-differentiated choices and placements by offering gender-typed secondary programs (e.g., health care, education, and industrial design) (Bradley & Charles, 2004; UNESCO, 1995), and thus suggests the possibility of associations between gender segregation in STEM occupational expectations and stratification in education systems. However, this study found no evidence that students were more likely to have gender-typed occupational expectations in countries with stratified education systems than in countries with unstratified systems.

The literature on gender differences in students' occupational expectations suggests that a high level of gender inequality at the societal level can be a source of gender-typed socialization, which serves as a basis for gendered career expectations among youths (Xie & Shauman, 1997). However, the results of this study showed no consistent patterns in the associations between gender empowerment at the societal level and girls' STEM occupational expectations. Whereas prior research has shown that girls in more egalitarian countries tend to have more ambitious educational and occupational plans than boys (McDaniel, 2010), the results of the current study provided no evidence that the status women in political and economic domains at the societal level was positively linked to girls' expectations of having high-status occupations in male-dominated fields. However, these findings should be interpreted with caution due to the limitations of the gender inequality measure used in this study. For example, one concern is that GEM may be too broad to reflect the multiple dimensions of gender equality.

This study highlights the possibility that cross-national differences in secondary education systems, in particular standardization, facilitate gender segregation in STEM occupational expectations, which are a pivotal factor in creating gender gaps in STEM educational and occupational attainment (Xie & Shauman, 2003). However, this study utilized somewhat limited measures to capture features of national education systems, and further research is needed to examine the degree to which the features of science education shape gendered occupational expectations. For example, a recent OECD report (2007b) found important cross-national differences in the organization of science content: students in some countries experience a general science curriculum that exposes them to broad concepts drawn from the physical, biological, and earth sciences, while students in other countries take distinct courses in biology, physics, chemistry, and earth sciences, and those in still other countries do not take science as a separate course but rather follow a thematic approach in which students are required to integrate their scientific knowledge and skills with the knowledge and skills learned in other disciplines, such as geography or writing. Moreover, a substantial body of research has revealed cross-national differences in the patterns of science instructional practices such as inquiry-based science teaching and learning (Kobarg, et al., 2011; Korsnakova, McCrae, & Bybee, 2009; Martin, Mullis, & Foy, 2008; Thomson, 2009). High-quality instruction is critical not only to improve students' achievement, but also to develop their interest in STEM occupations. Given the findings that hands-on or inquiry-based science learning is more beneficial for girls than boys (AAUW, 1992; Burkam, Lee, & Smerdon, 1997; Lee & Burkam, 1996), these types of high-quality instructional techniques may have particular benefits for girls. Research on cross-national differences in the organization of science instruction, as well as how the association between science instruction and STEM occupational expectations differs by gender would further understanding of how to reduce gender gaps in STEM occupational expectations.

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Table 4.1 Descriptive Statistics – Variables Used in HGLM analyses

	PISA 2000		PISA 2003		PISA 2006	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Occupational Expectations (ISCO-88, Major Groups 2 and3)						
STEM, general	0.27		0.27		0.31	
Computing and Engineering (CE)	0.12		0.11		0.11	
Health service including nursing	0.10		0.11		0.13	
Health service excluding nursing	0.08		0.09		0.11	
Occupational Expectations (ISCO-88, Major Group 2)						
STEM, general	0.21		0.22		0.26	
Computing and Engineering (CE)	0.11		0.10		0.10	
Health service including nursing	0.07		0.09		0.11	
Health service excluding nursing	0.06		0.08		0.10	
Student Characteristics						
Grade in school						
7th or lower	0.01		0.01		0.01	
8th	0.04		0.04		0.05	
9th	0.41		0.33		0.37	
10th	0.44		0.54		0.53	
11th or higher	0.10		0.08		0.04	
Age (years)	15.66	0.35	15.78	0.29	15.77	0.29
Female gender	0.51		0.51		0.50	
Student Ability						
Reading	493.25	99.73	472.05	101.25	469.28	109.43
Mathematics	498.82	102.02	474.06	105.14	480.56	102.68
Science	497.71	100.47	482.06	104.61	485.14	104.14
Family Background						
Parents' education						
None	0.01		0.03		0.02	
Primary	0.07		0.09		0.05	
Lower secondary	0.12		0.13		0.09	
Upper secondary 1	0.17		0.11		0.08	
Upper secondary 2	0.26		0.28		0.30	
University	0.37		0.35		0.45	
Parents' job						
Blue collar low-skilled	0.10		0.17		0.10	
Blue collar high-skilled	0.15		0.16		0.16	
White collar low-skilled	0.23		0.20		0.23	
White collar high-skilled	0.51		0.46		0.51	
Parents have STEM occupation	0.21		0.16		0.18	
Immigration status						
Native	0.93		0.94		0.93	
Second-generation	0.03		0.03		0.03	
First-generation	0.05		0.03		0.03	
Language spoken at home						
Test language	0.93		0.88		0.89	
Other national dialect	0.03		0.10		0.07	

Foreign language	0.04		0.02		0.03	
Mother's working status	0.68		0.62		0.82	
Number of books at home						
0-10 books	0.11		0.16		0.14	
11-100 books	0.41		0.49		0.49	
101-500 books	0.36		0.28		0.30	
More than 500 books	0.12		0.07		0.07	
Family SES	-0.11	0.98	-0.30	1.10	-0.17	1.07
School Characteristics						
School community location						
Village (less than 3,000)	0.15		0.13		0.14	
Small town (3,000 to 15,000)	0.23		0.21		0.22	
Town (15,000 to 100,000)	0.31		0.33		0.31	
City (100,000 to 1,000,000)	0.19		0.20		0.22	
Large city (more than 1,000,000)	0.12		0.13		0.11	
School mean SES	-0.14	0.64	-0.33	0.76	-0.20	0.74
School size	669.06	528.01	750.84	608.95	671.46	559.72
Percent girls in student body	0.51	0.19	0.50	0.18	0.49	0.19
Public vs. private operation and funding						
Public	0.84		0.84		0.86	
Private, government-dependent	0.04		0.07		0.05	
Private, not government-dependent	0.12		0.10		0.08	
Academic selectivity						
Not considered	0.35		0.34		0.36	
Considered	0.25		0.27		0.29	
High priority or prerequisite	0.40		0.39		0.34	
Teacher shortage in math and science	-0.11	0.93	0.00	1.00	-0.02	0.98
Quality of educational resources	0.14	1.07	-0.14	1.05	-0.24	1.11
National Economic Development						
GDP per capita ($1,000)	17254.01	11226.91	16993.27	12672.23	22265.44	18274.07
Educational expenditure (percent	22.03	5.87	21.66	5.82	21.01	6.23
OECD members	0.77		0.75		0.57	
Gender Empowerment Measure (GEM)	0.61	0.14	0.60	0.13	0.64	0.16
Characteristics of National Education Systems						
Standardization						
Low	0.11		0.11		0.13	
Medium	0.42		0.42		0.40	
High	0.47		0.47		0.47	
Number of school types	2.65	1.29	2.80	1.32	2.42	1.24
Early tracking	0.31		0.40		0.35	

Table 4.2 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for General STEM Occupations (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-1.324	0.266	0.430**	-0.706	0.494	0.579	-0.403	0.668	0.277
Student-level:									
Female Gender	-0.068	0.934	0.182	0.724	2.062	0.396†	0.388	1.474	0.136**
Country-level:									
GEM	0.719	2.050	1.337	0.072	1.075	1.612	-1.451	0.234	0.924
Standardization	-0.049	0.952	0.151	-0.038	0.962	0.226	-0.230	0.795	0.111*
Number of school type	-0.095	0.910	0.099	-0.219	0.804	0.153	-0.079	0.924	0.072
Early tracking	-0.091	0.913	0.274	0.040	1.041	0.363	-0.049	0.952	0.189
Female gender*GEM	0.222	1.248	0.480	-0.599	0.549	0.838	0.430	1.537	0.284
Female gender* Standardization	-0.081	0.922	0.080	-0.289	0.749	0.171	-0.086	0.918	0.067
Female gender*Number of school type	-0.022	0.978	0.056	-0.155	0.856	0.121	-0.119	0.888	0.042**
Female gender*Early tracking	0.012	1.013	0.160	0.124	1.133	0.312	0.076	1.079	0.111
N									
Students (unit of obs.)	97,769			111,462			193,674		
Schools	3,892			4001			7,479		
Countries	26			19			40		
Variance components									
School-level									
Intercept	0.201***			0.246***			0.194***		
Slope of Female gender	0.222***			0.227***			0.071***		
Country-level									
Intercept	0.182***			0.182***			0.177***		
Slope of Female gender	0.040***			0.141***			0.052***		

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 4.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 4.3 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Computing and Engineering (CE) Occupational Expectations (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-1.935	0.144	0.475***	-1.692	0.184	0.706*	-1.542	0.214	0.324***
Student-level:									
Female Gender	-1.488	0.226	0.264***	-1.627	0.197	0.366***	-0.966	0.381	0.245***
Country-level:									
GEM	0.588	1.801	1.290	0.473	1.606	1.566	-0.345	0.708	0.893
Standardization	-0.055	0.947	0.142	0.023	1.024	0.228	-0.144	0.866	0.110
Number of school type	0.006	1.006	0.094	-0.158	0.854	0.155	0.025	1.025	0.071
Early tracking	-0.182	0.834	0.260	0.133	1.143	0.382	-0.139	0.870	0.187
Female gender*GEM	-1.426	0.240	0.671*	-0.272	0.762	0.700	-0.572	0.564	0.505
Female gender* Standardization	0.036	1.037	0.114	0.240	1.272	0.136†	0.060	1.062	0.120
Female gender*Number of school type	-0.099	0.906	0.081	-0.040	0.961	0.110	-0.159	0.853	0.075*
Female gender*Early tracking	0.215	1.240	0.226	0.021	1.021	0.289	0.121	1.128	0.196
N									
Students (unit of obs.)		97,769			111,462			193,674	
Schools		3,892			4001			7,479	
Countries		26			19			40	
Variance components									
School-level									
Intercept		0.253***			0.271***			0.238***	
Slope of Female gender		Fixed			Fixed			Fixed	
Country-level									
Intercept		0.155***			0.192***			0.167***	
Slope of Female gender		0.073***			0.046***			0.168***	

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 4.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 4.4 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for Health Service Occupations (Including Nursing) (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-3.005	0.050	0.056***	-2.083	0.125	0.807*	-1.936	0.144	0.376***
Student-level:									
Female Gender	1.131	3.097	0.301***	1.983	7.261	0.428***	1.228	3.414	0.209***
Country-level:									
GEM	-0.734	0.480	1.431	-4.006	0.018	1.954†	-1.816	0.163	1.079
Standardization	-0.025	0.975	0.192	-0.219	0.803	0.286	-0.142	0.868	0.156
Number of school type	-0.306	0.736	0.130*	-0.273	0.761	0.197	-0.120	0.819	0.100†
Early tracking	0.256	1.291	0.367	-0.013	0.988	0.477	0.096	1.100	0.262
Female gender*GEM	2.684	14.639	0.785**	0.883	2.420	0.885	0.867	2.379	0.431†
Female gender* Standardization	-0.110	0.895	0.132	-0.517	0.596	0.184*	-0.162	0.850	0.104
Female gender*Number of school type	0.184	1.202	0.094†	-0.042	0.959	0.137	0.019	1.019	0.065
Female gender*Early tracking	-0.385	0.680	0.280	0.163	1.177	0.367	0.001	1.001	0.171
N									
Students (unit of obs.)	97,769			111,462			193,674		
Schools	3,892			4001			7,479		
Countries	26			19			40		
Variance components									
School-level									
Intercept	0.254***			0.277***			0.279***		
Slope of female gender	Fixed			Fixed			Fixed		
Country-level									
Intercept	0.264***			0.285***			0.340***		
Slope of female gender	0.088***			0.135***			0.122***		

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 4.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 4.5 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for STEM Occupations (ISCO-88 Major Groups 2 and 3) for Pooled Data from PISA 2000, 2003, and 2006

	STEM			Computing & Engineering			Health [a]		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-0.770	0.463	0.449	-2.086	0.124	0.463***	-2.676	0.069	0.647**
Student-level:									
Female Gender	0.401	1.494	0.220†	-1.026	0.358	0.304**	1.737	5.683	0.291***
School-level:									
PISA 2003	-0.067	0.935	0.062	-0.108	0.897	0.096	0.118	1.126	0.116
PISA 2006	0.148	1.160	0.086	-0.109	0.897	0.137	0.435	1.545	0.096***
Female Gender*PISA 2003	0.077	1.080	0.051	0.101	1.106	0.104	-0.111	0.895	0.111
Female Gender*PISA 2006	0.075	1.078	0.046	0.190	1.209	0.074*	-0.295	0.744	0.077***
Country-level:									
OECD	0.598	1.819	0.378	0.086	1.089	0.323	0.391	1.478	0.485
GEM	0.044	1.045	0.733	1.073	2.923	0.690	-0.129	0.879	0.938
Standardization	-0.212	0.809	0.173	0.067	1.069	0.163	-0.044	0.957	0.256
Number of school type	-0.150	0.861	0.107	0.127	1.135	0.100	-0.216	0.806	0.157
Early tracking	-0.239	0.788	0.255	-0.410	0.664	0.244	-0.232	0.792	0.386
Female gender*GEM	0.029	1.030	0.375	0.249	1.283	0.478	-0.358	0.699	0.469
Female gender*Standardization	-0.201	0.818	0.095†	-0.062	1.064	0.123	-0.412	0.662	0.127**
Female gender*Number of school type	-0.108	0.898	0.060†	-0.212	0.809	0.082*	0.043	1.043	0.080
Female gender*Early tracking	0.181	1.198	0.149	0.230	1.258	0.192	0.140	1.150	0.202
N									
Students (unit of obs.)	320,105			320,105			320,105		
Schools	11,261			11,261			11,261		
Countries	18			18			18		

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 4.1, except for student ability. Additionally, two indicators for the study year (i.e., PISA 2003 and PISA 2006) are included at the school level.

a. Findings are consistent in students' health career expectations even after excluding nursing career in health service occupations

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Figure 4.1 Gender Gaps in Expectations for Health Service Occupations (Excluding Nursing) by Levels of Standardization in Education Systems

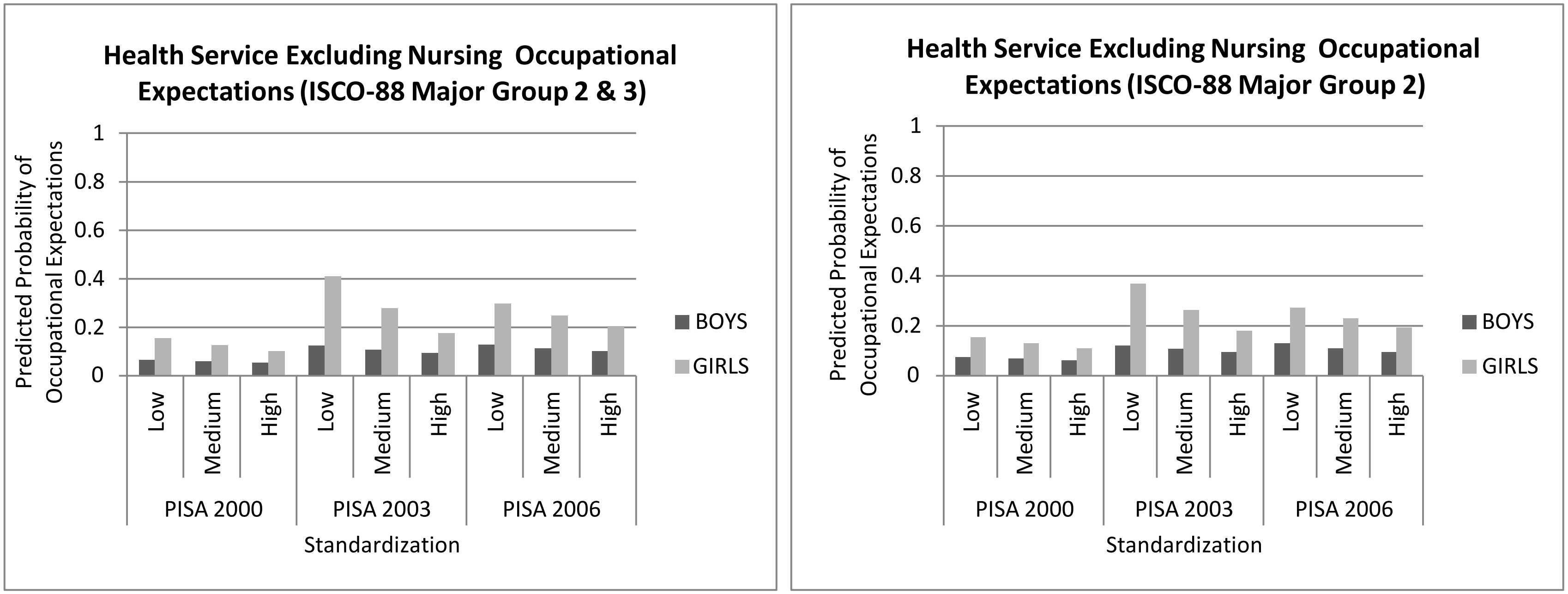
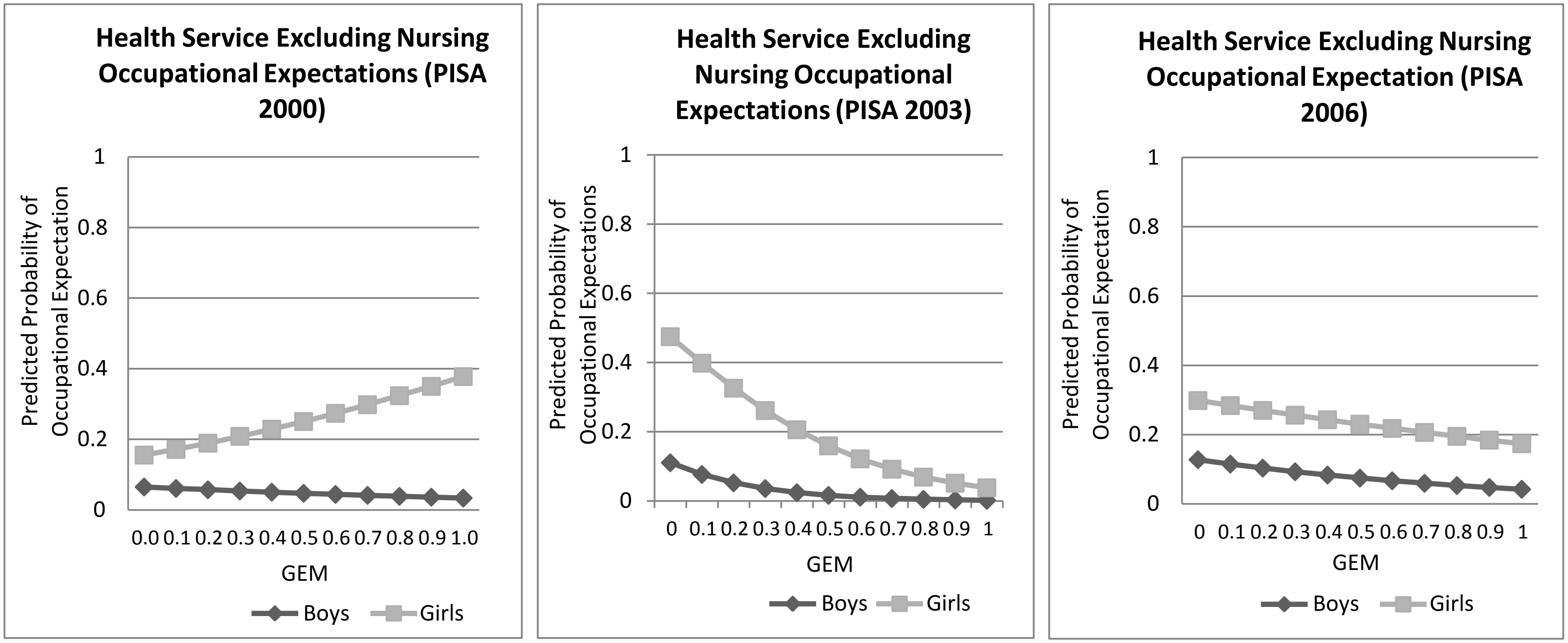


Figure 4.2 Gender Gaps in Health Service Occupational Expectations (ISCO-88 Major Groups 2 and 3) by Gender Empowerment Measure (GEM)



CHAPTER 5. Cross-National Variation in Students’ STEM Occupational Expectations: The Significance of Features of Labor Markets and STEM Wage Expectations

Recently, cross-national research on occupational expectations has focused on inter-country differences in science-related occupational expectations. However, prior research has focused on creating a descriptive portrait of expectations and their association with student characteristics such as gender and student performance. In Chapter 3, employing the stratification-standardization framework, I examined cross-national variation in students’ STEM occupational expectations and the association between this variation and the features of national education systems. While several cross-national studies have suggested that social, cultural, and economic factors are related to cross-national differences in student performance and educational and occupational expectations (e.g., expectations of completing a bachelor’s degree or above, plans to be a highly qualified professional such as a lawyer, medical specialist, or teaching professional) (McDaniel, 2010; Penner, 2008; Sikora & Saha, 2007), little attention has been paid to the association between these factors and science-related occupational expectations.

In addition to focusing on national education systems, sociologists have asserted that labor market conditions are associated with students’ occupational expectations. At the same time, an economic perspective assumes that students may develop preferences for occupations that offer them the greatest economic incentives. Policymakers and researchers also contend that macro-social and economic conditions, including the overall labor market structure and relative wage premiums for STEM workers, might be associated with shortages of STEM workers (Cervantes, 1999; Korea Research Institute for Vocational Education & Training, 2002). No researchers have yet empirically examined whether social and economic factors are linked to students' interests in pursuing STEM education and occupations. In this chapter, I move from examining national education systems to a broader focus on economic contexts by investigating the degree to which labor market conditions and STEM wage expectations are associated with cross-national variation in students' STEM occupational expectations.

THE SIGNIFICANCE OF MACRO-ECONOMIC CONTEXTS FOR THE OCCUPATIONAL EXPECTATIONS OF STUDENTS

Within a sociological perspective, the features of labor markets are important influences on students' occupational preferences because the characteristics of labor markets at the societal level can either make specific occupations widely available or limit an individual's career choices. Human capital theory emphasizes the importance of economic incentives (e.g., monetary rewards) in the development of occupational preferences among students. In this section, I review these two perspectives and use them to examine the association between macro-economic contexts and cross-national variation in students' STEM occupational expectations. Specifically, I review the influence of postindustrial economies, income inequality, and wage expectations on students' occupational expectations.

Features of Labor Markets and Occupational Expectations

Prior cross-national research has focused mainly on national education systems in explaining cross-national variation in students' educational and occupational expectations (e.g., Buchmann & Dalton, 2002; Buchmann & Park, 2009; McDaniel, 2010; Sikora & Pokropek, 2011). Recently, however, researchers in this area have shifted their attention to structural trends in labor markets as they seek to examine this cross-national variation (e.g., Sikora & Saha, 2007, 2010). This line of research, for example, has examined whether the growth of the service sector or severe economic inequality at the societal level lead students to pursue professional and managerial employment.

Prior research has employed a variety of indicators to conceptualize and measure the features of labor markets. Some studies have used the proportion of the labor force employed in the service sector and the service sector’s rate of growth (Sikora & Saha, 2010). These studies assume that students’ occupational expectations are affected not only by family and school environments, but also by the knowledge of labor market opportunities. Using data from the Programmes for International Student Assessment (PISA) 2006, Sikora and Saha (2010) found that 15-year-old students were more likely to have plans to obtain professional and managerial occupations in countries where economic prosperity was modest but the service sector was expanding.

Postindustrialism refers to a global trend of countries moving away from industry-based economies (including manufacturing, mining, construction, electricity, water, and gas) and toward service-based economies. With this economic shift, employment opportunities in the service sector, including the fields of health, education, entertainment, modern communications, information, and others, tend to expand. Because producing services requires relatively less physical capital and more human capital than producing agricultural or industrial goods, as the service sector grows, demand increases for more educated workers (Soubbotina & Sheram, 2000). The rational choice perspective would predict that students respond to this shift in labor market conditions by pursuing occupations in growing service sectors, including teaching, creative arts, information technology (IT), health, and care-related professions.

Other studies have used an index of inequality such as the Gini coefficient to capture the economic opportunity structure at the country level (Sikora & Saha, 2007, 2009, 2010). The Gini index is a commonly used measure of income inequality that measures the extent to which the distribution of income or consumption among individuals or households within a country deviates from a perfectly equal distribution. In these studies, researchers have argued that the Gini index can be treated as an indicator of wage differentials, corrected by redistributive mechanisms of the national welfare state. Sikora and Saha (2007; 2010) found that income inequality at the country level was positively associated with high levels of educational and occupational expectations among 15-year-old students; however, they acknowledged the presence of sample selectivity in developing countries—only the most affluent and determined students stay in school in developing countries, whereas almost all students stay in school in developed countries. These studies have attempted to take into account for unequal access to secondary educations in developing countries by comparing elite students across countries (Sikora & Saha, 2007, 2010).[23] The authors found that positive associations between income inequality at the country-level and students' occupational expectations held even when controlling for sample selectivity in developing countries.

Two theories—different rationality (Little, 1978) and relative deprivation theory (Runciman, 1966)—have been used to explain the positive association between income inequality at the societal level and student expectations. The former argues that individuals in countries with high levels of inequality may engage in different sorts of rational calculations than those in countries with low levels of inequality, and that this "different rationality" may cause different expectations. For example, students are more likely to be ambitious when only a few

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[23] When 100 percent of 15-year old students are enrolled in high school, for example, they selected students in the top 20 percent of reading score distribution in a country. However, when only 63 percent of students are enrolled, they selected 32 percent (i.e., 20.63) from the top.

high-paying jobs are available, because the only alternative prospect is poverty. Relative deprivation refers to the gap between what an individual has and what he or she expects. The theory asserts that when people feel they have less than they deserve relative to some other group, they may raise their expectations in an attempt to obtain their fair share of resources and rewards even though the structural possibilities of attaining their goals are remote. Based on this theory, for example, Sikora and Saha (2007) argued that with the rapid global expansion of education, students in countries that are less developed and have greater income inequality may develop a sense of relative deprivation and thus raise their expectations. Given that jobs in STEM fields are among the highest paying and the fastest growing, relative deprivation theory would predict that students in countries with high levels of income inequality are more likely to want to pursue occupations in STEM fields than students in countries with low levels of income inequality.

Wage Expectations and Occupational Expectations

The human capital theory of occupational choice assumes that individuals rationally choose occupations that provide maximum benefits—potential earnings and, for some, nonmonetary returns—across all potential occupations. Bostkin (1974), for example, emphasized the importance of expected earnings on individuals' choice of occupation. The application of human capital theory to occupational expectations is simple and straightforward: students develop occupational preferences based on the expected future earnings of occupations.

Several studies have suggested that STEM occupations are less attractive to students because jobs in the STEM sector are known to be demanding and inflexible but not have sufficiently competitive rewards (Roberts, 2002; van Langen & Dekkers, 2005). Specifically, economic incentives have been considered one important factor in raising high-performing students' engagement in STEM education and occupations, because more attractive and better paid employment opportunities are often open to high-performing students in math and science.

In several countries, including the United States, median salaries are higher for STEM graduates than for non-STEM graduates at all levels of university degrees (i.e., a bachelor's degree, a master's degree, a PhD) (Cervantes, 1999). The International Average Salary Income Database (http://www.worldsalaries.org) reported internationally comparative wages for people in a limited number of occupations, including accountancy, computer programming, engineering, medicine, and teaching. The database indicates that personal average incomes for professional STEM workers, including engineers, computer programmers, general physicians, and professional nurses, are higher than the average annual per capita income across countries. However, wage premiums for STEM occupations vary across countries. For example, the ratio of the annual personal income of a general physician to the average annual income in each country ranges from 2.9 in the Czech Republic to 5.0 in the United States. Likewise, the ratio of the annual personal income of engineers (measured by the average annual personal income of power distribution and transmission engineers and chemical engineers) to the annual overall personal average income ranges from 1.5 in Austria to 6.0 in Mexico. If students choose occupations based on their projected future earnings, students in Mexico are more likely than those in Austria to have plans to obtain engineering-related occupations. This framework assumes that students predict their future earnings based on the experiences of adult workers and then choose occupations that would maximize their expected earnings.

RESEARCH QUESTIONS

Several studies have indicated that macro-level economic contexts are associated with students' occupational expectations. However, no cross-national studies have examined whether macro-economic contexts are associated with cross-national variation in STEM occupational expectations. In this chapter, I broaden the focus of research on student expectations by examining the degree to which the features of labor markets and wage expectations for STEM occupations are associated with students' STEM occupational expectations across countries.

First, I examine whether students are more or less likely to plan to have STEM occupations in postindustrial economies than in industrial economies. The economic shift toward postindustrial economies and the subsequent massive growth of service-related jobs make service occupations widely available; students who acknowledge the increasing employment opportunities in the service sector are expected to develop preferences for occupations in this sector. Specifically, I investigate whether the association between a postindustrial economy and occupational expectations differs across STEM subfields. Because there is a growing demand for health and care-related occupations in a postindustrial economy, I expect that students in countries with postindustrial economies are more likely to expect to have health services occupations than students in countries with industrial economies. In postindustrial economies also experience a growing demand for information technology (IT) service. Thus, I expect that students in countries with postindustrial economies are more likely to expect computing-related occupations than students in countries with industrial economies, whereas students in industrial economies are more likely to plan for engineering-related occupations than those in countries with postindustrial economies.

Second, I examine the degree to which income inequality within nations is associated with cross-national variation in STEM occupational expectations. Prior research has shown that students in countries with greater income inequality have higher average educational and occupational expectations than those in countries with less income inequality (Sikora & Saha, 2007, 2009, 2010). Because jobs in STEM fields are high-paying jobs, students in countries with high levels of income inequality should be more likely to expect STEM occupations than those in countries with low levels of income inequality.

Third, I examine the degree to which STEM wage expectations are associated with students' STEM occupational expectations across countries. Based on the assumption that students choose occupations to maximize their future earnings, I expect to find a positive association between relative STEM wage premiums and students' expectations for STEM occupations, after controlling for individual, school, and national characteristics. That is, I expect that students in countries where jobs in STEM fields are high-paying relative to average personal earnings in the total economy are more likely to expect to have STEM occupations than students in countries where STEM occupations do not provide such competitive economic rewards.

SELECTION OF COUNTRIES

I use data from the 2000, 2003, and 2006 waves of the Programme for International Student Assessment (PISA), with a primary focus on PISA 2006. Several countries are excluded from the analyses due to missing data: No data on the dependent variables are available for Qatar in PISA 2006; no data on the share of the labor force working in service industries and the share of the labor force working as employees are available for several countries, including Albania, Jordan, Liechtenstein, Luxembourg, and Tunisia; no data on wages in STEM occupations are available for several countries, including Belgium, Colombia, Croatia, France, Greece, Hong

Kong, Iceland, Ireland, the Netherlands, New Zealand, Spain, Sweden and Switzerland; and no data on the school variables are available for France in PISA 2003 and 2006. Data on school-level variables, including school type (i.e., public, government-dependent private or government-independent private), school community location, and academic selectivity, are not available for Australia, Canada, Iceland, and Italy; therefore, these countries are excluded from this chapter. The final analytic sample includes 33 countries from PISA 2000, 20 countries from PISA 2003, and 41 countries from PISA 2006 (see Appendix 5.1). For STEM wage expectations, only 22 countries in PISA 2006 are analyzed because wage in STEM occupations are not available in many countries in PISA 2000 and PISA 2003.

MEASURES

Dependent Variables

The outcome measures for this study are binary variables, indicating whether or not a student wants to have a STEM-related occupation around age 30. The study examines six types of STEM occupational expectations (3 different STEM fields * two skill levels). The three STEM fields are: (a) general STEM-related fields; (b) computing and engineering (CE)[24]; and (c) health services. The two skill levels are: (a) professional, technician, and associate professional occupations (International Standard Classification of Occupations 88 [ISCO-88], major group 2 and 3) and (b) only professional occupations (ISCO-88, major group 2).[25]

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[24] In addition to CE occupational expectations, I differentiated expectations for computing-related occupations from expectations for engineering-related occupation. All computing-related occupations were required to have a university degree or above at job entry. To make a comparable measure of occupational expectations, engineering-related occupations were limited to professionals that require a BA degree or above.

[25] I created two dependent variables (within each skill level) for health service occupations: (1) health services including nursing and (2) health services excluding nursing. When the findings were consistent, I presented results only for health services including nursing. When the findings were consistent across skill levels for a particular STEM field, I presented only results when including the lower-level skill group (ISCO-88 major group 3: technicians and associate professionals) for that STEM occupational field.

Individual-Level Independent Variables

At the student level, I control for gender, age, grade level, parental educational attainment, family SES, immigration backgrounds of students and their parents, language spoken at home, whether the parents have STEM-field occupations, parental occupational level (blue-collar vs. white collar), mother's working status, and number of books at home.[26]

School-Level Independent Variables

At the school level, I control for school mean SES, school size, school community location, the proportion of school enrollment that is female, school type (public, government-dependent private, government-independent private), school academic selectivity, degree of teacher shortage in math and science, and level of educational resources.

Country-Level Independent Variables

The main independent variables of interest in this chapter are country-level indicators of macro-economic conditions. These include:

Postindustrial economy. Postindustrialization refers a process in which an economy becomes less reliant on industry and more reliant on service. I use the mean of the standardized values of two variables—the share of the labor force working in service industries and the share of the labor force working as employees—to indicate a postindustrial economy (Charles, 1992; Charles & Bradley, 2009; Charles & Grusky, 2004). Data are from the International Labour Organization's (ILO) online LABORSTA database (http://laborsta.ilo.org/default.html). The

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[26] I ran two types of models: (a) three models in which student ability was controlled (using reading, math, and science test scores, respectively) and (b) a model with no controls for student ability. All findings were consistent across the models; I reported results from the model that did not include student ability.

share of the labor force working in the service industry is calculated by dividing the number of workers in four industrial categories (“wholesale and retail trade, restaurants and hotels”; “transport, storage and communications”; “finance, insurance, real estate and business service”; and “community, social and personal services”) by the total number of individuals in the labor force, excluding those whose industrial locations are “not adequately defined.” [27] The proportion of individuals in the labor force working as employees is constructed by dividing workers with the status of “employee” by the total number of individuals in the labor force. Average values for the five years prior to each PISA study wave are used in hierarchical generalized liner models (HGLMs) analyses.

Gini index. The Gini index measures the extent to which the distribution of income or consumption expenditures among individuals or households within an economy deviates from a perfectly equal distribution. A score of 0 on the index represents perfect equality, while a score of 100 implies perfect inequality. The Gini index data are collected from the World Bank.

Relative STEM wage expectations. Five indicators of relative STEM wage expectations are constructed by dividing the annual personal average wages in five STEM occupations by the average annual wages per full-time equivalent dependent employee in the overall economy.[28] The five STEM occupations are chemical engineers, power distribution engineers, computer programmers, general physicians, and professional nurses. Because there is missing data on the wages of non-STEM professional occupations, including lawyers, corporate managers, business professionals, and government officials, this study uses average annual wages for full-time

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[27] When countries used the International Classification of All Economic Activities (ISIC-Rev.2, 1968) for reporting general employment levels by economic activity, the service sector corresponded to major divisions 6 through 9 of ISIC-Rev.2. When countries used the International Classification of All Economic Activities (ISIC-Rev.3), the service sector comprised categories G through Q of ISIC-Rev.3.

[28] Because data on wages were missing for several STEM professional occupations, I did not create average STEM wage expectations.

employees in the overall economy, rather than the wages of employees in non-STEM professional occupations, as a reference for measuring STEM wage premiums. Data on the wages of five STEM occupations are from the International Labour Organization's (ILO) online LABORSTA database. Data for the average annual wages per full-time and full-year equivalent employee in the overall economy are from the Organization for Economic Co-operation and Employment (OECD) labor statistics (http://stats.oecd.org/index.aspx?r=332730). In the analytic sample countries, the ranges of the wage premiums for the five STEM occupations are as follows: 1.117 to 5.977 times the average annual wage for chemical engineers, 1.417 to 5.977 times the average annual wage for power distribution engineers, 0.874 to 5.372 times the average annual wage for computer programmers, 1.188 to 5.027 times the average annual wage for general physicians, and 0.889 to 3.191 times the average annual wage for professional nurses.

National economic development. I used three indicators to capture national economic development levels: (a) a measure of Gross Domestic Product (GDP) per capita (in current U.S. dollars); (b) an indicator for the level of educational investment, measured by public educational expenditure per student in secondary education as a percent of GDP per capita; and (c) an OECD member country indicator. The first two indicators are collected from the UNESCO Institute for Statistics and the World Bank. Additionally, an OECD member indicator is a dummy variable, coded 1 when countries are OECD member countries.

Descriptive statistics for all variables used in the HGLM analyses are presented in Table 5.1. Correlations among country-level variables are presented in Appendix 5.2.

METHODS

As described in Chapter 2 (Data & Methods), this study employs three-level hierarchical generalized linear models (HGLMs) in which the level 1 sampling model is a Bernoulli distribution. The models nest students (level 1) within schools (level 2) and within countries (level 3); separate models are run for PISA 2000, 2003, and 2006 data. An additional model uses a pooled data set that includes observations from the countries that participated in all cycles of PISA 2000, 2003, and 2006; in this model, controls for the study year are included at the school level. The final student weights are normalized at the country level to ensure that each country contributes equally to the analysis. Three-level HGLMs using only PISA 2006 data examine the association between STEM wage expectations and STEM occupational expectations,.

RESULTS

Macro-Level Features of Labor Markets and STEM Occupational Expectations

Using PISA 2000, 2003, and 2006 data, I assess the degree to which income inequality and postindustrial labor markets are associated with cross-national variation in STEM occupational expectations among students. Table 5.2 presents results for students' general STEM occupation expectations, including technicians and associate professionals; Table 5.3 presents results for computing and engineering (CE) occupations; and Table 5.4 presents results for health services, including nursing occupations. Table 5.5 shows the results of HGLM analyses for pooled data from PISA 2000, 2003, and 2006.

The results of the HGLM analyses for all PISA survey waves show that students in countries with high levels of income inequality as measured by the Gini index are more likely to expect to have STEM occupations than students in countries with low levels of income inequality. As shown in Table 5.2, the association between the Gini index and students' STEM expectations is positive across all PISA survey waves. This positive association remains when technicians or associated professional positions are excluded (i.e., only professional positions that require a university degree or above at job entry are included).

The association between income inequality and students' STEM occupational expectations also remains positive across STEM subfields. As shown in Table 5.3 and Table 5.4, greater income inequality is linked to higher expectations of having both CE and health service occupations; however, this positive association differs within CE subfields.[29] The Gini coefficient for computing-related occupational expectations is close to zero for all PISA survey waves, while the coefficient for engineering-related occupational expectations is positive and statistically significant for all PISA survey waves. This pattern suggests that income inequality at the societal level is not associated with students' computing-related occupational expectations. The Gini coefficients for engineering-related professional occupational expectations are 0.043 in PISA 2000, 0.069 in PISA 2003, and 0.062 in PISA 2006, indicating that a one-unit increase in the Gini Index is associated with 4 percent, 7 percent, and 6 percent increases in the odds of expecting engineering-related occupations, respectively.

Prior research on occupational expectations has found that income inequality at the country level is positively associated with high levels of educational and occupational expectations among 15-year-olds (Sikora & Saha, 2007, 2009, 2010). Further, findings from the current study show that students in countries with high levels of income inequality are more likely to expect to obtain STEM occupations, including engineering jobs and health professions, than students in countries with low levels of income inequality. This pattern suggests that students in countries with greater economic inequality are more likely to want to pursue

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[29] All computing-related occupations analyzed here required a university degree or above at job entry. Thus, to make a comparable measure, engineering-related occupations were limited to professional jobs that required a bachelor's degree or above at job entry.

professional and managerial employment, particularly in STEM fields, than students in countries with less income inequality.

Next, I assess whether postindustrial economies are associated with students' STEM occupational expectations. Postindustrial economies lead to a growing demand for service sector employees, including those who can work in teaching, creative arts, information technology (IT), health, and care-related professions. The associations between postindustrial economies and students' STEM occupational expectations may differ across STEM subfields. As discussed in the previous section, students' occupational expectations in the fields of computing and health services might be positively associated with postindustrial economies, whereas students' expectations in engineering might be lower when economies move away from manufacturing-based economies.

The negative association between postindustrial economy and CE occupational expectations differs across CE subfields.[30] The subfield-specific HGLM analyses show that, compared to students in countries with industrial economies, those in countries with postindustrial economies are more likely to plan to have computing-related professional occupations and less likely to plan to have engineering-related professional occupations.[31] The postindustrial economy coefficient for computing-related professional occupations is 0.471 in PISA 2003, indicating that a one-standard-deviation increase in the indicator of a postindustrial

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[30] The results of the HGLM analyses provide partial support for a negative association between postindustrial economies and students' occupational expectations in computing and engineering (CE). As shown in Table 5.3, the coefficients for postindustrial economy are close to zero in PISA 2000 and PISA 2003. However, in models using PISA 2006 data, the postindustrial economy coefficient is -0.181 after controlling for individual, school, and other national characteristics. These results indicate that a one-standard-deviation increase in the indicator of a postindustrial economy is linked to a 17 percent decrease in the odds of expecting CE occupations (including technicians and associate professionals). This negative association remains for CE professional occupations that require a bachelor's degree or above at job entry.

[31] All computing-related occupations analyzed here were required to have a university degree or above at job entry. Thus, to make a comparable, engineering-related occupations were limited to professional jobs that require a bachelor's degree or above at job entry.

economy is linked to a 60 percent increase in the odds of expecting a computing-related professional occupation. In contrast, the postindustrial economy coefficients for engineering-related professional occupations are -0.234 in PISA 2000, -0.242 in PISA 2003, and -0.311 in PISA 2006. The odds ratios for postindustrial economy are -0.791, -0.785, and -0.733 respectively; thus, a one-standard-deviation increase in the indicator of a postindustrial economy is associated with a 21 percent decrease in the odds of engineering-related occupational expectations in PISA 2000 and PISA 2003, and a 27 percent decrease in PISA 2006.

Because postindustrial economies lead to a greater demand for jobs in the health and care-related service sectors, I expected that postindustrial economies would be positively associated with students' expectations of obtaining health services occupations. As shown in Table 5.4 and Table 5.5, however, the results of the HGLM analyses show that students in postindustrial economies are less likely to plan to have health services occupations than students in industrial economies. This association is consistently negative across skill levels of health service occupations, both including and excluding nursing.

In summary, the results show that, compared to students in countries with low levels of income inequality, those in countries with high levels of income inequality are more likely to expect STEM-related occupations, including CE and health service occupations. Students in postindustrial economies are more likely to expect to have computing-related occupations but less likely to expect to have engineering and health service occupations than those in industrial economies.

STEM Wage Expectations and STEM Occupational Expectations

Using PISA 2006 data, I assess the degree to which STEM wage premiums are associated with cross-national variation in students' STEM occupational expectations. Human capital theory assumes that students choose their occupations to maximize their projected earnings (based on their reflections about the experiences and wages of adult workers). When students expect to earn higher incomes in STEM occupations than in other occupations, they are more likely to develop preferences for occupations in STEM fields. STEM wage premiums are calculated as the ratio of the annual personal average wages for five STEM occupations to the average annual wages for full-time employees in the overall economy. Five STEM occupations are included in the analyses: chemical engineers, power distribution engineers, computer programmers, general physicians, and professional nurses.

Table 5.6 shows the results of HGLM analyses of the associations between STEM wage premiums and students' expectations of obtaining general STEM occupations, including technician and associate professional careers. The coefficients for STEM wage premiums are close to zero for all five STEM occupations. These findings suggest that the economic incentives measured by STEM wage premiums are not associated with cross-national variation in STEM occupational expectations. This lack of association between STEM wage premiums and occupational expectations remains when technicians and associate professionals are excluded from the list of STEM occupations.

Like students' expectations for general STEM occupations, cross-national differences in economic incentives are not associated with students' CE occupational expectations. The wage premium coefficients for chemical engineers, power distribution engineers, and computer programmers are close to zero. The same patterns are observed when technicians and associate professionals are excluded from the lists of CE occupations.

However, the results of this study provide partial evidence that students in countries where the earnings of general physicians are relatively high compared to average personal earnings in the overall economy are more likely to expect health service-related professional occupations than those in countries where the wage premium for general physicians is relatively small. As shown in Table 5.7, the general physician wage expectation coefficient for health service professionals (including nursing) is 0.140, indicating that a one-standard-deviation increase in general physicians' wage premium index is linked to a 12 percent increase in the odds of expecting to have a professional health service occupation, including nursing. When nursing is excluded, the wage expectation coefficient drops to 0.128, and is no longer statistically significant.

The findings in this section provide little evidence linking economic incentives (as measured by STEM wage premiums) to students' expectations for STEM occupations. In particular, this study finds that wage premiums for CE-related occupations are not associated with cross-national variation in CE occupational expectations. However, the results provide partial support for a positive association between wage premiums for general physicians and students' expectations for health-related professions that require at least a university degree or above at job entry.

An Additional Analysis: Education Systems and Features of Labor Markets

In this section, I assess the extent to which the macro-level features of education systems and labor markets are associated with cross-national variation in students' STEM occupational expectations. Because of the small number of countries in PISA 2003, analytic samples are limited to data from 2000 and 2006.

As shown in Table 5.8, all findings concerning the associations between macro-economic contexts and students' expectations for STEM subfields remain consistent, even after taking into account differences in national education systems: income inequality is positively associated with students' expectations for both CE and health service occupations and postindustrial labor markets are negatively associated with engineering and health service-related occupations.

In addition, the findings regarding the associations between national education systems and students' expectations for STEM subfields hold, even after controlling for macro-economic contexts. In Chapter 3, I assessed the degree to which features of national education systems are associated with STEM occupational expectations across countries. The results of three-level HGLM analyses showed that higher levels of stratification in secondary education are linked to lower health service occupation expectations among students, whereas students' CE occupational expectations are not associated with any characteristics of secondary education systems measured in the current study (the standardization of curriculum, the number of school types available to 15-year-olds students, or early tracking). As shown in Table 5.8, these findings remain, even after controlling for income inequality as measured by the Gini Index and postindustrial economy status. After including these control variables, the results of the HGLM analysis for PISA 2006 data show that early tracking is positively associated with students' expectations for health service occupations, while in PISA 2000 early tracking is not linked to students' health service occupational expectations.[32] The coefficient for early tracking is 0.385 in PISA 2006, indicating that being a student in a country where tracking begins before age 14 is

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[32] To test whether these mixed findings across PISA survey waves were due to the 2000 and 2006 samples including different countries, I conducted supplementary analyses (not shown) using only data from countries that participated in both PISA 2000 and PISA 2006. In this analysis, early tracking was positively associated with students' health service occupational expectations in PISA 2006, which suggests that the mixed findings about early tracking were not associated with different analytic sample countries across PISA cycles.

linked to a 47 percent increase in the odds of expecting a health service occupation; this positive association is consistent across skill levels.

CONCLUSIONS

This study broadened the focus of the dissertation research from national education systems to macro-level features of labor markets and STEM wage premiums and their association with cross-national variation in the STEM occupational expectations of youths. Several features of labor markets were associated with students' STEM occupational expectations, but these associations differed across STEM subfields. The analytical results highlight four important conclusions.

First, students in countries with greater income inequality were more likely to plan for STEM occupations. Several international studies have shown that while Finland, Japan, and Korea are the top-performing countries in international assessments, these countries have the lowest levels of student interest in STEM occupations (OECD, 2007b; Sikora & Pokropek, 2011). These countries also have lower levels of income inequality than other countries such as the United States. Findings in this chapter suggest that the relatively low levels of income disparity in these countries might make STEM education and occupations less attractive to students, because jobs in the STEM sector are known to be demanding.

Second, students in countries with postindustrial economies were less likely to expect STEM occupations than those in countries with industrial economies, although this negative association differed across STEM subfields. The results of the HGLM analyses showed that, compared to those in postindustrial economies, students in industrial economies were more likely to expect STEM occupations, particularly engineering and health service-related occupations, and were less likely to expect computing-related occupations. Postindustrial economies lead to an increased demand for service workers such as IT workers and health care workers, so I expected to find a positive association between postindustrial economy and students' expectations for health service occupations. The underlying assumption in this study was that students would develop occupational preferences that reflected the growing demand in the service sector; however, the results of the HGLM analyses revealed a negative association.

The negative association between postindustrial economies and students' expectations for health service occupations should be interpreted cautiously, given that this study did not consider the balance (or imbalance) between the supply of and the demand for health service workers. If the supply of and demand for health service workers is relatively balanced in postindustrial economies, but the demand for health service workers is higher than the supply in industrial economies, students in industrial economies may be more likely to pursue health service occupations than those in postindustrial economies.

Third, the analytical results did not support rational choice accounts, which assert that students choose occupations that will maximize their expected earnings. Economic incentives (as measured by STEM wage premiums) were not tied to cross-national variation in students' STEM occupational expectations, with one exception: there was a positive link between wage premiums for general physicians and students' expectations for health service occupations. Because data on wages in medical professions were available for only a small number of countries, the analytic sample was limited to 18 countries. Future cross-national research using data from a large number of nations is needed to further examine the associations between wage expectations and students' expectations.

Policymakers and educational researchers in many developed countries have two primary concerns about students' occupational preferences: (1) students prefer medical professions to engineering, and (2) students prefer business-related professions (e.g., finance) to STEM occupations. Policymakers and researchers in Japan and Korea, for example, are concerned that high-performing students in math and science tend to prefer medical professions to engineering professions because the wage premiums for engineers are relatively low compared those for medical professions. By using information on wages for a variety of engineering-related occupations, future research can shed light on why students prefer medical school to engineering programs. Policymakers and researchers in several countries have concerns that students prefer occupations in easier and better-paying fields such as finance and banking to STEM occupations. To address this question, future research should investigate the degree to which differences between the wage premiums for STEM occupations and non-STEM occupations, including financing and banking, are associated with students' STEM occupational expectations. In addition, further research is needed to reveal whether associations between STEM wage premiums and students' STEM occupational expectations differ across students' math and science performance levels. Such research would help policymakers understand whether economic incentives make STEM occupations attractive to academically talented students.

Finally, the analysis in this chapter showed that macro-economic contexts were associated with cross-national variation in students' occupational expectations, even when other national characteristics such as the features of national education systems were taken into account. These results imply that policymakers must pay attention to macro-economic conditions, in addition to reforms in education, as they work to improve student engagement in STEM education and occupations.

Table 5.1 Descriptive Statistics – Variables Used in HGLM analyses

	PISA 2000		PISA 2003		PISA 2006	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Occupational Expectations (ISCO-88, Major Groups 2 and 3)						
STEM, general	0.26		0.27		0.30	
Computing and Engineering (CE)	0.11		0.11		0.11	
Health services including nursing	0.10		0.11		0.13	
Health services excluding nursing	0.08		0.09		0.11	
Occupational Expectations (ISCO-88, Major Groups 2)						
STEM, general	0.21		0.22		0.25	
Computing and Engineering (CE)	0.10		0.10		0.09	
Computing	0.03		0.04		0.03	
Engineering	0.07		0.06		0.06	
Health services including nursing	0.08		0.09		0.10	
Health services excluding nursing	0.07		0.08		0.09	
Student Characteristics						
Grade in school						
7th or lower	0.01		0.01		0.01	
8th	0.05		0.04		0.05	
9th	0.42		0.33		0.36	
10th	0.43		0.54		0.50	
11th or higher	0.08		0.08		0.08	
Age (years)	15.67	0.34	15.78	0.29	15.77	0.29
Female gender	0.51		0.51		0.50	
Student Ability						
Reading	480.19	103.54	472.05	101.25	477.91	108.25
Mathematics	478.38	110.95	479.55	103.91	485.41	101.47
Science	481.15	104.17	486.05	103.59	490.23	102.81
Family Background						
Parents' education						
None	0.01		0.03		0.02	
Primary	0.12		0.09		0.05	
Lower secondary	0.13		0.13		0.10	
Upper secondary 1	0.15		0.11		0.09	
Upper secondary 2	0.25		0.28		0.30	
University	0.34		0.35		0.45	
Parents' job						
Blue collar low-skilled	0.13		0.17		0.10	
Blue collar high-skilled	0.17		0.16		0.15	
White collar low-skilled	0.22		0.20		0.24	
White collar high-skilled	0.48		0.46		0.51	
Parents have STEM occupation	0.19		0.16		0.18	
Immigration status						
Native	0.92		0.94		0.91	
Second-generation immigrant	0.03		0.03		0.05	
First-generation immigrant	0.04		0.03		0.04	
Language spoken at home						
Test language	0.90		0.88		0.91	

Other national dialect	0.07		0.10		0.05	
Foreign language	0.03		0.02		0.04	
Mother works	0.65		0.62		0.85	
Number of books at home						
0-10 books	0.14		0.16		0.14	
11-100 books	0.43		0.49		0.48	
101-500 books	0.33		0.28		0.31	
More than 500 books	0.10		0.07		0.07	
Family SES	-0.27	1.08	-0.30	1.10	-0.11	1.03
School Characteristics						
School community location						
Village (less than 3,000)	0.15		0.13		0.14	
Small town (3,000 to 15,000)	0.22		0.21		0.22	
Town (15,000 to 100,000)	0.30		0.33		0.31	
City (100,000 to 1,000,000)	0.20		0.20		0.22	
Large city (more than 1,000,000)	0.13		0.13		0.11	
School mean SES	-0.32	0.78	-0.33	0.76	-0.14	0.69
School size	722.27	610.97	750.84	608.95	700.99	574.81
Percent girls in student body	0.51	0.19	0.50	0.18	0.49	0.17
Public vs. private operation and funding						
Public	0.83		0.84		0.86	
Private, government-dependent	0.07		0.07		0.04	
Private, not government-dependent	0.10		0.10		0.10	
Academic selectivity						
Not considered	0.33		0.34		0.38	
Considered	0.25		0.27		0.28	
High priority or prerequisite	0.42		0.39		0.34	
Teacher shortage in math and science	-0.05	0.99	0.00	1.00	-0.09	0.92
Quality of educational resources	0.20	1.12	-0.14	1.05	-0.18	1.07
National Economic Development						
GDP per capita ($1,000)	15502.60	11402.53	16993.27	12672.23	23967.03	17665.0
Educational expenditure (percent	21.05	6.03	21.66	5.82	21.13	6.27
OECD members	0.64		0.75		0.59	
Income Inequality						
Gini Index	34.73	9.09	33.58	5.82	34.84	8.43
Characteristics of Labor Market Conditions						
Postindustrial economies	-0.02	1.06	-0.14	1.04	0.13	0.88
STEM wage premiums						
Chemical engineer					2.47	0.58
Power distribution engineer					2.40	1.01
Computer programmer					2.21	1.15
General physician					2.59	1.24
Professional nurse					1.51	0.58

Table 5.2 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for General STEM Occupations (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-1.350	0.259	0.244***	-1.096	0.334	0.528†	-1.014	0.363	0.222***
Country-level:									
Gini Index	0.045	1.046	0.008***	0.053	1.054	0.009***	0.058	1.060	0.007***
Postindustrial economies	-0.228	0.796	0.080**	-0.426	0.653	0.083***	-0.330	0.719	0.066***
Student controls [24]		√			√			√	
School controls [13]		√			√			√	
National controls [5]		√			√			√	
N									
Students (unit of observations)		134,368			123,960			211,745	
Schools		5,050			4,181			7,595	
Countries		33			20			41	
Variance components									
School level		0.180***			0.209***			0.184***	
County level		0.093***			0.043***			0.057***	

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 5.1, except for student reading ability and STEM wage expectations.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 5.3 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Computing & Engineering (CE) Occupational Expectations (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-1.978	0.138	0.347***	-2.106	0.122	0.799*	-1.789	0.167	0.348***
Country-level:									
Gini Index	0.024	1.024	0.009*	0.048	1.049	0.012***	0.032	1.032	0.009**
Postindustrial economies	-0.068	0.934	0.097	-0.038	0.963	0.111	-0.181	0.834	0.089*
Student controls [24]	√			√			√		
School controls [13]	√			√			√		
National controls [5]	√			√			√		
N									
Students (unit of observations)	134,368			123,960			211,745		
Schools	5,050			4,181			7,595		
Countries	33			20			41		
Variance components									
School level	0.273***			0.271***			0.211***		
County level	0.127***			0.072***			0.103***		

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 5.1, except for student ability and STEM wage expectations.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 5.4 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for Health Service Occupations (Including Nursing) [a] (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-3.238	0.039	0.357***	-2.666	0.070	0.732**	-2.659	0.070	0.308***
Country-level:									
Gini Index	0.043	1.044	0.009***	0.044	1.045	0.014**	0.058	1.060	0.009***
Postindustrial economies	-0.273	0.761	0.093**	-0.702	0.496	0.124***	-0.404	0.668	0.087***
Student controls [24]		√			√			√	
School controls [13]		√			√			√	
National controls [5]		√			√			√	
N									
Students (unit of observations)		134,368			123,960			211,745	
Schools		5,050			4,181			7,595	
Countries		33			20			41	
Variance components									
School level		0.245***			0.279***			0.248***	
County level		0.120***			0.099***			0.101***	

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 5.1, except for student ability and STEM wage expectations.

a. Findings are consistent even after excluding nursing careers from health service occupations

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 5.5 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for STEM Occupations (ISCO-88 Major Groups 2 and 3) for Pooled Data from PISA 2000, 2003, and 2006

	STEM			Computing & Engineering			Health [a]		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-1.259	0.284	0.255***	-2.057	0.128	0.372***	-2.821	0.060	0.341***
School-level:									
PISA 2003	-0.044	0.957	0.050	-0.065	0.937	0.084	0.031	1.031	0.074
PISA 2006	0.182	1.200	0.077*	-0.002	0.998	0.124	0.222	1.249	0.070**
Country-level:									
OECD	0.249	1.282	0.156	0.496	1.642	0.180*	-0.081	0.921	0.200
Gini Index	0.050	1.052	0.009***	0.038	1.039	0.011**	0.052	1.053	0.011***
Postindustrial economies	-0.397	0.672	0.082***	-0.048	0.953	0.098	-0.606	0.545	0.106***
Student controls [24]	√			√			√		
School controls [13]	√			√			√		
National controls [5]	√			√			√		
N									
Students (unit of observations)	336,369			336,369			336,369		
Schools	11,655			11,655			11,655		
Countries	20			20			20		
Variance components									
School level	0.186***			0.243***			0.232***		
County level	0.094***			0.110***			0.165***		

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 5.1, except for student ability and STEM wage expectations.

a. Findings are consistent even after excluding nursing careers from health service occupations

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 5.6 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for General STEM Occupations (ISCO-88 Major Groups 2 and 3) for PISA 2006 data

	Model1		Model2		Model3		Model4		Model5	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.	β	S.E.
Intercept	-1.160	0.338**	-1.171	0.313**	-1.202	0.331**	-1.313	0.375**	-1.160	0.338**
Country-level:										
Gini Index	0.082	0.013***	0.070	0.012***	0.084	0.011***	0.083	0.016***	0.082	0.013***
Postindustrial economies	-0.304	0.097**	-0.385	0.076***	-0.194	0.103†	-0.273	0.103*	-0.304	0.097**
STEM wage premiums										
Chemical Engineer	-0.058	0.140								
Power Distribution Engineer			0.007	0.078						
Computer Programmer					-0.076	0.061				
Physician							0.007	0.066		
Nurse									-0.058	0.140
Student controls [24]	√		√		√		√		√	
School controls [13]	√		√		√		√		√	
National controls [6]	√		√		√		√		√	
N										
Students (unit of observations)	129,104		143,030		123,779		112,702		129,104	
Schools	4,617		5,079		4,444		3,994		4,617	
Countries	20		22		19		18		20	
Variance components										
School level	0.164***		0.225***		0.166***		0.215***		0.164***	
County level	0.041***		0.043***		0.029***		0.040***		0.041***	

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 5.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, S.E. = Standard Error

Table 5.7 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for Health Service Occupations (ISCO-88 Major Group 2) for PISA 2006 data

	Health Service Professionals			Health Service Professionals		
	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-3.520	0.030	0.560***	-3.507	0.031	0.643***
Country-level:						
Gini Index	0.103	1.109	0.014***	0.090	1.094	0.016***
Postindustrial economies	-0.463	0.629	0.094***	-0.437	0.646	0.105**
STEM wage premium						
Physician	0.140	1.150	0.073†	0.128	1.136	0.083
Student controls [24]		√			√	
School controls [13]		√			√	
National controls [6]		√			√	
N						
Students (unit of observations)		112,702			112,702	
Schools		3,994			3,994	
Countries		18			18	
Variance components						
School level		0.173***			0.137***	
County level		0.021***			0.030***	

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 5.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 5.8 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for STEM subfields Occupations (ISCO-88 Major Groups 2 and 3)

	Computing & Engineering (PISA2000			Computing & Engineering (PISA2006)			Health Including Nursing [a] (PISA2000)			Health Including Nursing [a] (PISA2006)		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-2.066	0.127	0.367***	-1.732	0.177	0.326***	-2.732	0.065	0.348***	-2.247	0.106	0.281***
Country-level:												
Gini Index	0.026	1.026	0.010*	0.031	1.031	0.010**	0.034	1.035	0.008***	0.055	1.057	0.082***
Postindustrial economies	-0.069	0.934	0.100	-0.203	0.816	0.099*	-0.206	0.814	0.086*	-0.507	0.602	0.128***
Standardization	-0.023	0.977	0.103	-0.065	0.937	0.083	-0.116	0.891	0.089	-0.104	0.901	0.070
Number of school type	0.056	1.057	0.064	0.017	1.018	0.055	-0.153	0.867	0.055*	-0.149	0.861	0.047**
Early tracking	-0.100	0.904	0.187	0.032	1.033	0.152	0.018	1.018	0.164	0.385	1.470	0.128**
Student controls [24]		√			√			√			√	
School controls [13]		√			√			√			√	
National controls [8]		√			√			√			√	
N												
Students (unit of observations)		134,368			211,745			134,368			211,745	
Schools		5,050			7,595			5,050			7,595	
Countries		33			41			33			41	
Variance components												
School level		0.273***			0.211***			0.245***			0.249***	
County level		0.124***			0.101***			0.090***			0.069***	

Each column reports results from one regression.

All regressions control for all the student-level, school-level, and national-level variables reported in Table 5.1, except for student ability and STEM wage expectations.

a. Findings are consistent even after excluding nursing careers from health service occupations

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

CHAPTER 6. Cross-National Variation in Gendered STEM Occupational Expectations: The Significance of Gender Inequality in the Labor Market

The underrepresentation of women in STEM education and its implications for occupational and wage inequality have become major concerns for policymakers and researchers in the United States and most developed countries. A substantial amount of research has attempted to investigate the sources of gender gaps in STEM education and occupations (Charles, 1992; Charles & Bradley, 2002, 2006, 2009; Morgan, et al., 2013; Turner & Bowen, 1999; Xie & Shauman, 2003). Research on gender inequality has shown that student expectations of pursuing a science/engineering career in high school are an important influences on gender differences in the likelihood of majoring in science/engineering in college (Xie & Shauman, 2003).

Several international studies have revealed that girls have higher educational and occupational expectations than boys, but in many countries, boys and girls expect careers in different fields (McDaniel, 2010; OECD, 2007b; OECD & UNESCO, 2003). Girls are less likely than boys to make career plans in the fields of computing and engineering, and more likely than boys to make career plans in the fields of health and medicine. Recently, cross-national research has attempted to explain the factors underlying this gender gap in science-related career plans (Sikora & Pokropek, 2011, 2012). These studies have focused on the features of national education systems as potential sources of cross-national variation in the magnitude of the gender gap. Social and economic contexts, however, have received little attention as a possible source of the gender gaps in STEM occupational expectations. In this chapter, I broaden the main focus of research in this area from national education systems to labor markets. In particular, I investigate the degree to which gender inequality in the labor market is associated with cross-national variation of gender gaps in STEM occupational expectations.

GENDER STRATIFICATION AT THE SOCIETAL LEVEL AND GENDERED OCCUPATIONAL EXPECTATIONS

Sociological and psychological perspectives postulate that students' occupational preferences are learned during childhood and adolescence. The socialization mechanisms proposed in the literature focus on individual-level influences such as parents, older siblings, or significant persons in social, educational, and occupational contexts. For example, the gendered behavior of parents (e.g., traditional or egalitarian gender role behavior) is considered important determinant of gendered occupational preferences. A considerable body of research has shown that the daughters of working mothers are more likely to plan to have careers than the daughters of nonworking mothers (Banducci, 1967; Marini, 1978; Rosenfeld, 1978). There is also evidence that a mother's employment in a male-dominated occupation influences girls' expectations of having a sex atypical occupation (Shu & Marini, 1998).

In addition to the importance of significant others (e.g., parents, peers, and teachers) for gender-typed socialization, the social environment at the societal level may be another important source of gender-typed socialization. Two theories identify social environments as the source of gender-role learning: social learning theory (Bandura, 1977) and cognitive developmental theory (Kolberg, 1966). These theories view specific single actors such as parents, teachers, and peers as socializing agents of the larger social environment (Xie & Shauman, 2003). In these perspectives, the transmission of sex-role information to children is the product of family and social systems encountered in everyday life. These theories favor a multifaceted transmission model.

A substantial body of literature on gender-related socialization has emphasized that the gender-related experiences of adult women in their families, jobs, and societies play an important role in shaping the behaviors and expectations of girls and boys in younger generations (Ma, 2011; Marini & Brinton, 1984; Xie & Shauman, 1997). Several comparative studies have focused on the association between gender stratification at the societal level and cross-national variation in gender inequality in educational outcomes (Baker & Jones, 1993; Charles & Bradley, 2009; Guiso, Monte, Sapienza, & Zingales, 2008; Marks, 2008; Penner, 2008; Riegle-Crumb, 2005; Wiseman, Baker, Riegle-Crumb, & Ramirez, 2009). These studies assume that students' academic experiences, including performance, curricular choice, and attitudes toward specific subjects, reflect opportunities at the societal level. Researchers in this field argue that if girls perceive gender-stratified educational and occupational opportunities for adults, they will make educational and occupational choices based on these differential opportunities. A number of studies have employed multidimensional or societal indicators of gender equity to investigate the association between gender-stratified opportunity structure and cross-national gender differences in educational outcomes. Using data from a representative sample of eighth grade (13 year old) students from the 1982 Second International Mathematics Study (SIMS), for example, Baker and Jones (1993) examined the association between gender stratification at the national level and cross-national variation of gender gaps in mathematics achievement. The authors measured the extent of the gender stratification of future opportunity by using indicators of women's access to schooling and labor markets, including the percentage of females in higher education, the ratio of female university to nonuniversity higher education programs, the percentage of women in the labor force, and the percentage of women in the service sector of the labor force. The authors found that there was a smaller gender gap for math achievement in countries where women had more equal access to the labor market and higher rates of higher education. Using the data from the Third International Mathematics and Science Study (TIMSS) 1995, Riegle-Crumb (2005) found that countries in which women had higher labor force representation had smaller gender gaps in favorable math attitudes among seventh and eighth grade students. Using a representative sample of students in their final year of secondary school from the TIMSS 1995, Penner (2008) found that there were smaller female disadvantages in mathematics achievement in countries where there was little gender inequality in the labor market. The author also found that among high academic achievers, gender differences in math performance were more closely associated with labor market factors than educational gender inequality.

Recent cross-national research has shown that the size of the gender gap in expressed affinity for mathematics is the most important predictor of sex segregation by field of study in advanced industrial countries (Charles & Bradley, 2009). Charles and Bradley (2009) suggested that social and economic factors might be related to gender-differentiated curricular and career dispositions for mathematics and science. The authors argued that “national prosperity and the rise of [a] self-expressive value system promote development of gender-differentiated curricular dispositions” (Charles & Bradley, 2009, p. 951). The authors suggested that structural trends in labor markets, namely the economic shift toward postindustrial economies with their abundance of female-labeled service jobs, have encouraged the gender segregation of curricular dispositions and career expectations. Further, Charles and Bradley (2009) argued that “girls may be less likely to pursue and express affinity for mathematics and science curricular when a wide array of female-labeled and potentially fulfilling career options present themselves in the service sector of

[the] economy" (p. 960). Despite the possible link between postindustrial economies and the gender segregation of career expectations, no cross-national studies have empirically examined whether girls in postindustrial economies are less likely to expect to have a STEM occupation than girls in industrial economies.

RESEARCH QUESTIONS

Several comparative studies have shown that gender stratification at the societal level is associated with gender inequality in educational outcomes such as math test scores and attitudes toward math and science. However, prior research has focused primarily on the association between the characteristics of national education systems and cross-national variation of gender gaps in STEM occupational expectations (Sikora & Pokropek, 2011, 2012). In this chapter, I shift the main focus of research in this area from the features of national education systems to a broader economic context: I examine the degree to which macro-level features of labor markets are associated with cross-national variation of gender gaps in STEM occupational expectations.

First, I examine the degree to which gender stratification in the labor market is associated with gender gaps in STEM occupational expectations among students. As the literature I reviewed in the previous section shows, gender equality in the labor market—for example, a high representation of females in the labor force and professional occupations—might be linked to gender differences in educational and occupational outcomes. Specifically, I examine (a) whether gender equality in the labor market is positively associated with girls' occupational expectations for STEM fields, and (b) whether gender equality in the labor market is associated with smaller gender gaps in students' STEM occupational expectations.

Second, I examine the degree to which postindustrial economies are associated with cross-national variation of gender gaps in STEM occupational expectations. Specifically, I examine (a) whether girls in postindustrial economies are less likely to expect to have STEM occupations than girls in industrial economies, and (b) whether gender gaps in students' STEM occupational expectations are larger in postindustrial economies than in industrial economies.

SELECTION OF COUNTRIES

As described in Chapter 2 (Data and Methods), I use data from the 2000, 2003, and 2006 waves of the Programme for International Student Assessment (PISA). Several countries are excluded from the analyses due to missing data: No data on the dependent variables are available for Qatar in 2006; no data on the share of the labor force working in service industries and the share of the labor force working as employees are available for several countries, including Albania, Jordan, Liechtenstein, Luxembourg, and Tunisia; and no data on the school variables are available for France in 2003 and 2006. Data on several school-level variables, including school type (i.e., public, government-dependent private, or government-independent private), school community location, and academic selectivity, are not available for Australia, Canada, Iceland, and Italy; therefore, these countries are excluded from this chapter. The analytic sample includes 32 countries from PISA 2000, 20 countries from PISA 2003, and 41 countries from PISA 2006 (see Appendix 6.1).

MEASURES

Dependent Variables

The outcome measures for this study are binary variables, each indicating whether or not a student expects to have a certain type of STEM-related occupation around the age of 30. The study examines expectations for two skill levels in each of three different STEM fields (a total of six types of expectations). The three STEM fields are: (a) general STEM-related fields; (b) computing and engineering (CE); and (c) health services.[33] Two skill levels are (a) professional, technician and associate professional occupations (International Standard Classification of Occupations 88 (ISCO-88), major group 2 and 3) and (b) only professional occupations (ISCO-88, major group 2).

Individual-Level Independent Variables

At the student level, I control for several student characteristics and their home backgrounds such as gender, age, grade level, family SES, immigration backgrounds of students and their parents, whether either of the respondents' parents have a job in STEM fields, parental occupational level (blue-collar vs. white collar), and mother's working status.[34]

School-Level Independent Variables

At the school level, I control for school's mean SES, school size, school community location, the proportion of enrolled students who are female, school type (public, government-dependent private, and government-independent private), academic selectivity, degree of teacher shortage in math and science, and quality of educational resources.

Country-Level Independent Variables

The main independent variables of interest in this chapter are country-level indicators of economic conditions and gender equality in the labor market. These include:

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[33] I created two dependent variables (within each skill level) for health services occupations: (1) health service occupations including nursing, and (2) health service occupations excluding nursing. When findings were consistent across the two variables, I presented only outputs for health service occupations including nursing.

[34] I ran two types of models: (a) three models in which student ability was controlled (using reading, math, and science test scores, respectively) and (b) a model with no controls for student ability. By comparing the findings of these models, I examined the degree to which controlling for student ability affects patterns of gender gaps in STEM occupational expectations. All findings were consistent across the models; I reported results from the model that did not include student ability.

Gender equality in the labor market. Two indicators are used to measure the extent of gender stratification in the labor market: (a) female labor force participation and (b) opportunities for high-status employment for women. Female labor force participation is measured as the share of the labor force that is female. Opportunities for high-status employment for women are measured as the proportion of professional workers who are female.[35] Labor force data are collected from the International Labour Organization's (ILO) online LABORSTA database (http://laborsta.ilo.org/default.html). The average values for the five years prior to each PISA study wave are used in hierarchical generalized linear model (HGLM) analyses.

Postindustrial economy. Postindustrialization refers a process in which an economy becomes less reliant on industry and more reliant on service. I use the mean of the standardized values of two variables—the share of the labor force working in service industries and the share of the labor force working as employees—to indicate a postindustrial economy (Charles, 1992; Charles & Bradley, 2009; Charles & Grusky, 2004). Data are from the International Labour Organization's (ILO) online LABORSTA database (http://laborsta.ilo.org/default.html). The share of the labor force working in the service industry is calculated by dividing the number of workers in four industrial categories ("wholesale and retail trade, restaurants and hotels"; "transport, storage and communications"; "finance, insurance, real estate and business service"; and "community, social and personal services") by the total number of individuals in the labor

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[35] Most countries, including Belgium, Canada, Denmark, Finland, Germany, Poland, and Portugal, used the International Standard Classification of Occupations, ISCO-88 when they reported data on employment by occupation. In this case, the occupations in ISCO-88 major group 2 (professionals) and major group 3 (technicians and associate professionals) were considered professional occupations. However, a few countries, including Columbia, Japan, and the United States (1995-2002), used the International Standard Classification of Occupations, ISCO-68 when they reported data on employment by occupation. In this case, the jobs in ISCO-68 major group 0/1 (professional, technical, and related workers) were considered professional occupations.

This study used the share of professional workers who were women instead of the share of STEM professional workers who were women, because data were not available on the share of STEM professional workers who were women in several countries, including Canada, Japan, Mexico, New Zealand, and Norway. I checked the correlations between the share of professional workers who were women and the share of STEM professional workers (excluding life science/health service professionals) who were women. Across all PISA survey waves, the two variables were highly correlated. For example, in PISA 2006, the correlation was 0.821 (N =29).

force, excluding those whose industrial locations are "not adequately defined." [36] The proportion of individuals in the labor force working as employees is constructed by dividing workers with the status of "employee" by the total number of individuals in the labor force. The average values for the five years prior to each PISA study wave are used in hierarchical generalized linear model (HGLM) analyses.

Gini index. The Gini index measures the extent to which the distribution of income or consumption expenditures among individuals or households within an economy deviates from a perfectly equal distribution. A score of 0 on the index represents perfect equality, while a score of 100 implies perfect inequality. The Gini index data are collected from the World Bank.

National economic development. I used three indicators to capture national economic development levels: (a) a measure of Gross Domestic Product (GDP) per capita (in current U.S. dollars); (b) an indicator for the level of educational investment, measured by public educational expenditure per student in secondary education as a percent of GDP per capita; and (c) an OECD member country indicator. The first two indicators are collected from the UNESCO Institute for Statistics and the World Bank. Additionally, an OECD member indicator is a dummy variable, coded 1 when countries are OECD member countries.

Descriptive statistics for all variables used in the HGLMs analyses are presented in Table 6.1. Correlations among country-level variables are presented in Appendix 6.2.

METHODS

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[36] When countries used the International Classification of All Economic Activities (ISIC-Rev.2, 1968) for reporting general employment levels by economic activity, the service sector corresponded to major divisions 6 through 9 of ISIC-Rev.2. When countries used the International Classification of All Economic Activities (ISIC-Rev.3), the service sector comprised categories G through Q of ISIC-Rev.3.

As described in Chapter 2 (Data & Methods), this study employs three-level hierarchical generalized linear models (HGLMs) in which the level 1 sampling model is a Bernoulli distribution. The models nest students (level 1) within schools (level 2) and within countries (level 3). Using cross-level interactions between female gender and the country-level variables measuring the characteristics of labor markets, I assess the extent to which gender gaps in STEM occupational expectations are associated with gender stratification in the labor market. This model is run separately for data from PISA 2000, 2003, and 2006. Additional models use a combined data set that pools the observations from the countries that participated in every cycle of PISA 2000, 2003, and 2006; in these models, controls for the study year are included at the school level.

RESULTS

Several international studies have revealed that the occupational expectations of adolescents are still gender segregated—boys and girls expect careers in different fields (OECD & UNESCO, 2003; Sikora & Pokropek, 2011, 2012). As shown in Table 6.3, Table 6.4, Table 6.5, and Table 6.6, across all PISA survey waves, the coefficients for female are negative in the models for computing and engineering (CE) occupational expectations and positive in the models for health service occupational expectations. These results indicate that, compared to boys, girls are less likely to expect CE occupations and more likely to expect health-related occupations. Even when the dependent variable is restricted to only computing occupations (i.e., engineering occupations are excluded), girls are less likely than boys to expect these careers. When nursing is excluded from health service occupations, girls are more likely than boys to expect health service occupations around age 30. Accounting for academic ability (i.e., reading, science, and math performance) does not change these cross-national patterns in gendered STEM occupational expectations. This pattern of gender segregation in occupational expectations is consistent across skill levels. However, gender gaps in occupational expectations for STEM fields vary across countries even after controlling for student, school, and country characteristics.

Gender Equality in the Labor Market and Gender Gaps in STEM Occupational Expectations

I assess the extent to which macro-level indicators of gender equality in the labor market are associated with cross-national variation of gender gaps in STEM occupational expectations. In particular, I examine (a) whether gender equality in the labor market is positively associated with girls' STEM occupational expectations, and (b) whether greater gender equality in the labor market is associated with smaller gender gaps in STEM occupational expectations. Gender equality in the labor market is measured via two indicators: (a) the share of the labor force that is women and (b) the proportion of professional workers who are women.

Overall, the analytic results show that neither boys' nor girls' STEM occupational expectations are associated with the share of the labor force that is female, and thus gender gaps in STEM occupational expectations are not associated with the share of the labor force that is female. As shown in Table 6.2 and Table 6.6, both the main coefficients for the share of the labor force that is female (labor force % female) and the interactions between students' gender and the female share of the labor force are close to zero across PISA survey waves and for the pooled data. Likewise, for both boys and girls the representation of women in the labor force is not associated with CE occupational expectations (Table 6.3 and Table 6.6). This pattern indicates that the female share of the labor force is not linked to cross-national variation of gender gaps in CE occupational expectations.

The results for health services occupations (Table 6.4, Table 6.5, and Table 6.6) show mixed findings about the association between economic opportunities for women and girls' expectations. The HGLM results presented in Table 6.4 show that the terms for the interaction between student gender and the female share of the labor force are positive and statistically significant in the models using PISA 2000 and PISA 2006 data. In the models using PISA 2000 data, for example, a one-unit (i.e., one percentage point) increase in the female share of the labor force is linked to a 4 percent increase in the odds of expecting a health services (including nursing) occupation among girls ($\beta = -0.029$ [$\beta_{\text{Labor force \% female}}$] + 0.065 [$\beta_{\text{female*Labor force \% female}}$] = 0.036), but a 3 percent decrease among boys ($\beta = -0.029$ [$\beta_{\text{Labor force \% female}}$]). These findings indicate that the female share of the labor force is associated with higher health service occupational expectations among girls but not boys. In addition, these findings suggest that countries in which women have a higher labor force representation have larger gender gaps in health service occupational expectations, because girls' health service occupational expectations are higher than boys' expectations. In models using PISA 2006 data, however, the female share of the labor force is not associated with either girls' health services occupational expectations or gender gaps in these expectations. When nursing is excluded from health service occupations (Table 6.5), neither boys' nor girls' health services occupational expectations are associated with the share of the labor force that is female, and thus gender gaps in health services occupational expectations are not associated with the share of the labor force that is female.

Next, I explore the association between economic opportunities for women in high-status occupations and girls' expectations for STEM occupations. The analytic results (Table 6.2) are mixed. In models using PISA 2006 data, the main coefficient for the female share of the professional workforce is positive ($\beta = 0.019$ [$\beta_{\text{Labor force \% female}}$]), indicating that both boys and girls are more likely to expect STEM occupations in countries where economic opportunities for women are greater. The results of models using PISA 2003 data, however, show that girls are less likely to expect STEM occupations in countries where economic opportunities for women are greater. In these models, a one-unit increase in the female share of the professional workforce is linked to a 2 percent decrease in the odds of expecting STEM occupations among girls ($\beta = -0.008\ [\beta_{\text{Professionals \% female}}] - 0.015\ [\beta_{\text{female*Professionals \% female}}] = -0.023$), while boys' expectations are not associated with the female share of the professional workforce.

The analytic results for CE occupations provide some evidence that greater economic opportunities for women in professional occupations are linked to higher CE occupational expectations among girls. As shown in the models using PISA 2006 data (Table 6.3) and pooled data (Table 6.6), the main coefficients for the female share of the professional workforce are positive, but the terms for the interaction between students' gender and the female share of the professional workforce are close to zero. In the models using pooled data (Table 6.6), a one-unit increase in the share of the professional workforce that is female is linked to about a 5 percent increase in the odds of expecting a CE occupation among both boys and girls ($\beta = 0.044\ [\beta_{\text{Labor force \% female}}]$).

In contrast, economic opportunities for women in professional occupations, are not associated with gender gaps in CE occupational expectations. As seen in Table 6.3 and Table 6.6, the terms for the interaction between students' gender and the female share of the professional workforce are not statistically significant in the models using PISA 2003 data, PISA 2006 data, and pooled data. The results of the models using PISA 2000 data, however, follow a different pattern (Table 6.3). In PISA 2000, the term for the interaction between female and the share of the professional workforce that is female is positive ($\beta = 0.025[\beta_{\text{female*Professionals \% female}}]$). The main coefficient for the female share of the professional workforce is not statistically significant, which suggests that greater economic opportunities for women in high-status occupations are associated with higher CE expectations among girls but not boys. Figure 6.1 depicts the predicted probability of occupational expectations for two STEM subfields for boys and girls across varying levels of women in the labor force, when all other variables are held constant at the grand mean. As shown in the upper panel of Figure 6.1, the result of models using PISA 2000 data suggest that economic opportunities for women in professional occupations are linked to smaller gender gaps in CE occupational expectations.

Overall, the analytic results show that neither girls' occupational expectations for health service jobs including nursing nor gender gaps in occupational expectations are associated with the female share of the professional workforce. When nursing is excluded, however, the results of the HGLM analyses (Table 6.5) provide at least some evidence that economic opportunities for women in professional occupations are linked to higher expectations for health service occupations among girls. As shown in Table 6.5, the terms for the interaction between female and the share of the professional workforce that is female are positive in the models using PISA 2000 data and PISA 2006 data, but the main coefficients for the female share of the professional workforce are close to zero. In models using PISA 2006 data, for example, a one-unit increase in the index of women's representation in professional occupations is linked to a 3 percent increase in the odds of expecting a health service occupation (excluding nursing) among girls ($\beta = 0.000$ [$\beta_{\text{Professions \% female}}$] + 0.026 [$\beta_{\text{female*Professions \% female}}$] = 0.026). This finding suggests that greater economic opportunities for women in professional occupations are linked to higher expectations for health service occupations among girls, but boys' expectations are fairly constant across levels of women in the professional workforce. Occupational expectations for health services are higher for girls than for boys, which suggests that in PISA 2006 greater economic opportunities for women in professional occupations are linked to larger gender gaps in health service occupational expectations, net of student, school, and national characteristics (see Figure 6.1). However, the results of the models using PISA 2003 data follow a different pattern. As shown in Table 6.4 and Table 6.5, the main coefficients for the female share of the professional workforce are negative, indicating that both boys and girls are less likely to expect health service occupations in countries where economic opportunities for women are greater. The interaction between female and this index is close to zero in models using PISA 2003 data, suggesting that economic opportunities for women are not linked to gender gaps in health service occupational expectations.

In summary, the HGLM analyses provide partial evidence that greater gender equality in the labor market is associated with higher CE occupational expectations among girls. However, the associations between gender inequality in the labor market and health service occupational expectations among girls are not consistent across PISA survey waves. The associations between economic opportunities for women in high-status occupations and gender gaps in occupational expectations in the two STEM subfields vary across PISA study cycles.

Robustness of the Findings: Gender Stratification in the Labor Market

Overall, this study shows that the associations between gender inequality in the labor market and gender gaps in STEM occupational expectations differ across PISA survey waves (see Figure 6.1). One possible explanation for the inconsistent findings across cycles is that the countries in the analytic sample differ across PISA survey cycles. To test whether the mixed findings are due to sample differences, I re-ran the analyses using samples limited to the countries that participated in every cycle of PISA 2000, 2003, and 2006.[37] Regarding CE occupational expectations, the associations between economic opportunities for women in high-status occupations and gender gaps differ across PISA survey waves, a pattern consistent with the results reported in the previous section. The female share of the professional workforce is associated with larger gender gaps in health service (excluding nursing) occupational expectations only in models using PISA 2006 data; there are no associations between these variables in models using data from PISA 2000 and PISA 2003.[38] This inconsistency was not explained by variation in the countries included in the analytic sample across cycles, which suggests that the association between gender inequality and health service occupational expectations has changed over time.

Next, I explore whether the associations between either boys' or girls' expectations and gender inequality in the labor market vary across PISA survey waves by fitting three-level HGLMs (one for each gender) using pooled data from PISA 2000, 2003, and 2006 (see appendices 6.3, 6.4, and 6.5). In addition, these models include terms for the interaction between PISA study years and labor market indicators to investigate whether there are trends in the association between occupational expectations and labor market conditions across PISA survey waves.[39]

For boys, there is no consistent trend in the association between occupational expectations and labor market conditions. For example, the interaction terms between PISA study years and labor market indicators for CE occupational expectations are close to zero in the

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[37] Three-level HGLMs were run separately for data from PISA 2000, 2003, and 2006.

[38] In the models using PISA 2006 data, the main coefficient for the female share of the professional workforce is -0.004 and the term for the interaction between female gender and the female share of the professional workforce is 0.038 ($p<0.05$). This pattern indicates that a one-unit increase in the index of the female share of the professional workforce is linked to a 4 percent increase in the odds of expecting a health services (excluding nursing) occupation among girls.

[39] Labor market conditions were time-varying across PISA survey waves. However, in these models, I used labor market indicators from 2003.

model for boys (see the left panel of Appendix 6.3), indicating that the association between occupational expectations and labor market conditions remained constant across PISA survey waves for boys. The associations between boys' health service (excluding nursing) occupational expectations and labor market conditions fluctuate across PISA survey cycles. In the models using PISA 2000 data and PISA 2006 data, boys' health service occupational expectations are not associated with economic opportunities for women in high-status occupations, while in the model using PISA 2003 data, boys' health service occupational expectations are negatively associated with economic opportunities for women in high-status occupation (see the left panel of Appendix 6.5).

However, the association between girls' occupational expectations and labor market conditions changed across PISA survey waves. For example, the association between girls' CE occupational expectations and gender inequality in the labor market differs across PISA survey waves (see the right panel of Appendix 6.3). For girls, a one-unit (i.e., one percentage point) increase in the index of the female share of the professional workforce is linked to a 4 percent increase in the odds of expecting CE occupations in models using PISA 2000 data ($\beta = 0.037$ [$\beta_{Professions\%female}$]), but a 2 percent increase in models using PISA 2006 data ($\beta = 0.016 = 0.037$ [$\beta_{Professions\%female}$]) – 0.021 [$\beta_{PISA2006*Professions\%female}$]).[40] This pattern indicates that while greater economic opportunities for women are positively associated with expectations for CE occupations among girls, this positive association has weakened in recent PISA survey waves. With respect to health services occupations (excluding nursing), girls' expectations are negatively associated with economic opportunities for women in models using PISA 2000 data,

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[40] I tested whether the difference between these two coefficients was statistically significant (H_0: $\beta_{Professions\%female}= \beta_{PISA2006*Professions\%female}=0$). The results showed that the association between the female share of the professional workforce and girls' CE occupational expectations differed between PISA 2000 and PISA 2006 ($\chi^2=10.26$, $P<0.01$).

but this negative association is weaker in models using PISA 2006 data (see the right panels of Appendix 6.5).[41]

Taken together, the results provide evidence that greater economic opportunities for women are associated with girls' occupational expectations for STEM-related fields. In particular, for girls, greater economic opportunities for women in high-status employment are associated with higher CE occupational expectations and lower health service occupational expectations. However, the magnitude of these associations differs across PISA survey waves. Inconsistencies across survey waves in the association between gender inequality in the labor market and gender gaps in occupational expectations might be partially due to changes in these associations among girls.

Postindustrial Economy and Gender Gaps in STEM Occupational Expectations

I investigate (a) whether a postindustrial economy is negatively associated with girls' occupational expectations for STEM fields, and (b) whether a postindustrial economy is linked to larger gender gaps in STEM occupational expectations. Postindustrial economy status is measured by the mean of the standardized values on two variables: (a) the share of the labor force working in service industries and (b) the share of the labor force working as employees.

The results of HGLM analyses show that both boys and girls are less likely to expect STEM occupations in postindustrial economies than in industrial economies. As shown in Table 6.2, the main coefficients for a postindustrial economy are negative across all PISA survey waves, but the terms for the interaction between students' gender and a postindustrial economy

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[41] I tested whether the difference between these two coefficients was statistically significant (H_0: $\beta_{Professions\%female} = \beta_{PISA2006*Professions\%female} = 0$). The results showed that the association between the female share of the professional workforce and girls' health service (excluding nursing) occupational expectations differed between PISA 2000 and PISA 2006 (χ^2=16.53, P-value<0.001).

are close to zero in models using data from PISA 2000 and PISA 2006. For example, in the models using PISA 2006 data, a one-standard-deviation increase in the postindustrial economy indicator is linked to a 24 percent decrease in the odds of expecting STEM occupations for boys ($\beta_{\text{postindustrial economy}} = -0.279$) and a 29 percent decrease in the odds for girls ($\beta = -0.286\ [\beta_{\text{postindustrial economy}}] - 0.057\ [\beta_{\text{female*postindustrial economy}}] = -0.343$). The same pattern is observed across both skill levels in STEM occupations. Expectations of having STEM professional occupations (i.e., those requiring at least a bachelor’s degree at job entry) are negatively associated with postindustrial economy status for both boys and girls.

Scholars have often suggested that postindustrial economies with their massive growth in female-labeled service occupations might encourage gender segregation in career expectations. However, this study provides no evidence that postindustrial economies are associated with gender gaps in STEM occupational expectations. Figure 6.2 depicts the predicted probability of STEM occupational expectations for boys and girls across varying levels on the postindustrial economy index, when all other variables are held constant at the grand mean; the graph shows that gender gaps are constant, no matter where a country falls on the postindustrial economy index.

Next, I assess whether the negative association between postindustrial labor markets and students’ occupational expectations remains constant across STEM subfields. Girls in postindustrial economies are less likely to expect CE occupations than those in industrial economies; for boys, however, the association between expectations and postindustrial economies differs across PISA survey waves. In the models using PISA 2000 (Table 6.3) and pooled data (Table 6.6), the terms for the interaction between female gender and postindustrial economies are negative and statistically significant, but the main coefficients for postindustrial economies are not significant. This pattern suggests that CE expectations are negatively associated with postindustrial economies among girls but not boys. As shown in the models using PISA 2006 data (Table 6.3), the main coefficient for postindustrial economy is negative, indicating that for both boys and girls those in postindustrial economies are less likely to plan CE occupations than those in industrial economies.

This study finds no consistent pattern in the associations between postindustrial economy and gender gaps in CE expectations—each PISA study cycle shows mixed results. As shown in the models using PISA 2000 data (Table 6.3), a one-standard-deviation increase in the index of postindustrial economy status is linked to an 11 percent decrease in the odds of expecting CE occupations for boys ($\beta_{\text{postindustrial economy}} = -0.112$), and a 26 percent decrease in the odds for girls ($\beta = -0.112$ [$\beta_{\text{postindustrial economy}}$] – 0.188 [$\beta_{\text{female*postindustrial economy}}$]= -0.300). This pattern indicates that postindustrial economies are linked to larger gender gaps in CE occupational expectations in PISA 2000, because boys’ CE expectations are higher than girls’ expectations. However, in the models using PISA 2003 and 2006 data (Table 6.3), the term for the interaction between students’ gender and the index of postindustrial economy status is close to zero, which indicates that postindustrial economies are not linked to cross-national variation of gender gaps in CE occupational expectations.

Next, I test whether the mixed findings concerning the association between postindustrial economies and gender gaps in CE occupational expectations are due to the analytic sample including different countries across PISA survey waves. In models using data from only the countries that participated in all three PISA survey waves, the interaction terms between student gender and postindustrial economies are close to zero, which suggests that postindustrial labor markets are not associated with cross-national variation of gender gaps in CE occupational expectations.

Overall, for both boys and girls, those in postindustrial economies are less likely to expect health service occupations than those in industrial economies, but postindustrial economies are not associated with gender gaps in these expectations. As shown in Table 6.4, the main coefficients for the index of postindustrial economy status are negative in the models using PISA 2003 and PISA 2006 data, but the terms for the interaction between students' gender and the index of postindustrial economy status are close to zero across all PISA survey waves. The same patterns are observed even when nursing-related occupations are excluded from the list of health service occupations.

In summary, the results of this study suggest that for both boys and girls, those in postindustrial economies are less likely to plan STEM-related occupations than those in industrial economies. The analytical results provide no evidence that the economic shift toward postindustrial economies and the massive growth of female-labeled occupations is associated with gender gaps in occupational expectations for either of the two STEM subfields.

CONCLUSIONS

Recent cross-national research on science-related career expectations has investigated the sources of cross-national variation in gender gaps (Sikora & Pokropek, 2011, 2012). These studies have focused primarily on national education systems in explaining this cross-national variation. Despite the importance of gender stratification at the societal level for gender inequality in educational outcomes, researchers have paid little attention to the macro-level features of labor markets in explanations of cross-national variation of gender gaps in STEM occupational expectations. In this chapter, I broadened the main focus of the research in this area from national education systems to economic contexts by examining the degree to which the macro-features of labor markets are associated with cross-national variation of gender gaps in STEM occupational expectations. I focused on: (a) gender equality in the labor market as measured by female labor force participation and opportunities for women in high-status employment, and (b) postindustrial economies in this examination of cross-national variation of gender gaps in STEM occupational expectations.

Overall, the results of the current study support gender-related socialization accounts that emphasize the importance of the gender-related experiences of adult women in their jobs and societies as influences on the occupational preferences of younger generations. Greater economic opportunities for women in high-status employment were linked to higher expectations for CE occupations among girls, indicating that women's high status in employment might motivate girls to pursue high-status occupations in male-dominated fields. However, the magnitude of this positive association differed across PISA survey waves. The positive association between economic opportunities for women at the societal level and girls' CE occupational expectations was weaker in models using PISA 2006 data than in models using PISA 2000 data.

This study has several limitations. First, it is difficult to capture changes in the associations between gender inequality in the labor market and students' STEM occupational expectations with only six years of PISA data. Future research using data collected over a longer period is needed to investigate whether the association between economic opportunities for women and girls' CE occupational expectations is declining over time. Second, this study did not take into account time-varying aspects of labor market conditions. Future research should examine what time-varying factors would explain the declining association between economic opportunities for women and girls' occupational expectations for CE.

This study found that, across all PISA survey waves, compared to boys, girls were more likely to expect health service occupations, but less likely to expect CE occupations, even after controlling for student, school, and national characteristics. However, there were no consistent patterns in the association between economic opportunities for women and cross-national variation of gender gaps in STEM occupational expectations. The association between the female share of the professional workforce and gender gaps in expectations differed across STEM subfields. Regarding gender gaps in CE occupational expectations, results were mixed. Greater economic opportunities for women in high-status employment were linked to smaller gender gaps in CE occupational expectations in models using PISA 2000 data, but were not associated with gender gaps in models using data from PISA 2003 and PISA 2006. At the same time, economic opportunities for women in high-status employment (as measured by the female share of the professional workforce) were not associated with gender gaps in health service occupational expectations in models using either PISA 2000 and PISA 2003 data, but were linked to larger female-favorable gender gaps in models using PISA 2006 data.

Because the study focused on a limited aspect of gender stratification in the labor market, the association between gender inequality in the labor market and gender gaps in STEM occupational expectations should be interpreted with caution. In addition to further exploring gender composition in STEM professional occupations, future research must focus on other aspects of gender inequality in the labor market, such as earnings and promotions.

The results of HGLM analyses across PISA survey waves found that for both boys and girls, those in postindustrial economies were less likely to expect STEM occupations than those in industrial economies. However, there was no evidence that an economic shift toward a postindustrial economy encourages gender segregation in STEM occupational expectations. The findings suggest that among students in PISA-participating countries, there is no gender difference in occupational expectations when female-labeled occupations grow in the service sector of the economy. Although a number of countries in earlier stages of economic development participated in PISA assessments, the most economically developed countries in the world participated in all three PISA survey waves. Further research using additional international data from a larger group of developing countries is needed to examine whether postindustrial economies encourage gender segregation in STEM occupational expectations.

Table 6.1 Descriptive Statistics – Variables Used in HGLMs analyses

	PISA 2000		PISA 2003		PISA 2006	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Occupational Expectations (ISCO-88, Major Groups 2 and 3)						
STEM, general	0.27		0.27		0.30	
Computing and Engineering (CE)	0.11		0.11		0.11	
Health service including nursing	0.10		0.11		0.13	
Health service excluding nursing	0.08		0.09		0.11	
Occupational Expectations (ISCO-88, Major Group 2)						
STEM, general	0.21		0.22		0.25	
Computing and Engineering (CE)	0.10		0.10		0.09	
Health service including nursing	0.08		0.09		0.10	
Health service excluding nursing	0.06		0.08		0.09	
Student Characteristics						
Grade in school						
7th or lower	0.01		0.01		0.01	
8th	0.05		0.04		0.05	
9th	0.42		0.33		0.36	
10th	0.43		0.54		0.50	
11th or higher	0.08		0.08		0.08	
Age (years)	15.67	0.34	15.78	0.29	15.77	0.29
Female gender	0.51		0.50		0.50	
Student Ability						
Reading	486.62	101.38	473.17	101.25	477.91	108.25
Mathematics	484.03	108.61	479.55	103.91	485.41	101.47
Science	485.60	103.08	486.05	103.59	490.23	102.81
Family Background						
Parents' education	0.01		0.03		0.02	
Primary	0.10		0.09		0.05	
Lower secondary	0.13		0.13		0.10	
Upper secondary 1	0.15		0.11		0.09	
Upper secondary 2	0.25		0.28		0.30	
University	0.35		0.35		0.45	
Parents' job						
Blue collar low-skilled	0.12		0.17		0.10	
Blue collar high-skilled	0.17		0.16		0.15	
White collar low-skilled	0.23		0.20		0.24	
White collar high-skilled	0.48		0.46		0.51	
Parents have STEM occupation	0.20		0.16		0.18	
Immigration status						
Native	0.92		0.94		0.91	
Second-generation	0.03		0.03		0.05	
First-generation	0.04		0.03		0.04	
Language spoken at home						
Test language	0.92		0.88		0.91	

Other national dialect	0.04		0.10		0.05	
Foreign language	0.03		0.02		0.04	
Mother's working status	0.67		0.62		0.85	
Number of books at home						
0-10 books	0.13		0.15		0.14	
11-100 books	0.43		0.49		0.48	
101-500 books	0.34		0.28		0.31	
More than 500 books	0.11		0.07		0.07	
Family SES	-0.21	1.04	-0.33	1.10	-0.11	1.03
School Characteristics						
School community location						
Village (less than 3,000)	0.14		0.13		0.14	
Small town (3,000 to 15,000)	0.22		0.21		0.22	
Town (15,000 to 100,000)	0.30		0.33		0.31	
City (100,000 to 1,000,000)	0.20		0.20		0.22	
Large city (more than 1,000,000)	0.13		0.13		0.11	
School mean SES	-0.26	0.74	-0.33	0.76	-0.14	0.69
School size	733.45	617.51	746.64	603.14	700.99	574.81
Percent girls in student body	0.51	0.19	0.50	0.16	0.49	0.17
Public vs. private operation and funding						
Public	0.85		0.83		0.86	
Private, government-dependent	0.05		0.06		0.04	
Private, not government-dependent	0.11		0.11		0.10	
Academic selectivity						
Not considered	0.34		0.35		0.38	
Considered	0.26		0.27		0.28	
High priority or prerequisite	0.41		0.38		0.34	
Teacher shortage in math and science	-0.08	0.96	-0.01	1.00	-0.09	0.92
Quality of educational resources	0.16	1.09	-0.14	1.05	-0.18	1.07
National Economic Development						
GDP per capita ($1,000)	15961.94	11270.51	18055.65	13276.21	23967.03	17665.07
Educational expenditure (percent	21.28	5.97	21.55	5.70	21.13	6.27
OECD members	0.66		0.76		0.59	
Income Inequality						
Gini Index	34.91	9.18	33.45	5.70	34.84	8.43
Characteristics of Labor Market Conditions						
Postindustrial economies	0.07	0.95	-0.12	1.01	0.13	0.88
Characteristics of Gender Inequality in Labor Market						
Labor force % female	43.22	3.88	42.89	3.73	44.58	3.37
Professions % female	49.78	7.11	48.22	12.56	51.96	7.40

Table 6.2 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for General STEM Occupations (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-1.607	0.201	0.230***	-1.352	0.259	0.395**	-1.122	0.326	0.170***
Student-level:									
Female Gender	-0.152	0.859	0.055**	-0.099	0.906	0.075	-0.014	0.986	0.052
Country-level:									
Labor force % female	-0.023	0.978	0.029	0.006	1.006	0.030	-0.032	0.968	0.021
Professions % female	0.009	1.009	0.015	-0.008	0.992	0.008	0.019	1.019	0.009†
Postindustrial economy	-0.145	0.865	0.099	-0.185	0.831	0.091†	-0.286	0.751	0.069***
Female Gender*Labor force % female	0.001	1.001	0.018	0.055	1.057	0.028†	0.025	1.026	0.022
Female Gender*Professions % female	0.010	1.011	0.010	-0.015	0.985	0.008†	-0.008	0.992	0.010
Female Gender*Postindustrial economy	-0.058	0.944	0.063	-0.209	0.811	0.084*	-0.057	0.945	0.066
N of Control Variables									
Student controls [24]		√			√			√	
School controls [13]		√			√			√	
National controls [7]		√			√			√	
N									
Students (unit of observations)		128,773			123,960			211,745	
Schools		4,836			4,181			7,595	
Countries		32			20			41	

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 6.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 6.3 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Computing and Engineering (CE) Occupational Expectations (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-2.077	0.125	0.320***	-1.771	0.170	0.569**	-1.905	0.149	0.253***
Student-level:									
Female Gender	-1.616	0.199	0.058***	-1.424	0.241	0.084***	-1.316	0.268	0.075***
Country-level:									
Labor force % female	-0.036	0.965	0.034	-0.051	0.950	0.042	-0.026	0.975	0.027
Professions % female	0.012	1.012	0.017	0.009	1.009	0.011	0.027	1.027	0.012*
Postindustrial economy	-0.112	0.894	0.114	-0.064	0.938	0.120	-0.185	0.831	0.089*
Female Gender*Labor force % female	-0.018	0.983	0.019	-0.016	0.984	0.038	0.033	1.034	0.032
Female Gender*Professions % female	0.025	1.025	0.010*	0.002	1.002	0.010	-0.004	0.996	0.014
Female Gender*Postindustrial economy	-0.188	0.829	0.070*	-0.010	0.991	0.095	-0.084	0.920	0.098
N of Control Variables									
Student controls [24]		√			√			√	
School controls [13]		√			√			√	
National controls [7]		√			√			√	
N									
Students (unit of observations)		128,773			123,960			211,745	
Schools		4,836			4,181			7,595	
Countries		32			20			41	

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 6.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 6.4 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for Health Service Occupations (Including Nursing) (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-3.638	0.026	0.317***	-3.618	0.027	0.562***	-2.801	0.061	0.240***
Student-level:									
Female Gender	1.348	3.850	0.086***	1.186	3.275	0.108***	1.050	2.858	0.064***
Country-level:									
Labor force % female	-0.029	0.972	0.032	0.074	1.077	0.029*	-0.039	0.962	0.036
Professions % female	-0.010	0.990	0.017	-0.043	0.958	0.008***	0.002	1.002	0.016
Postindustrial economy	-0.146	0.864	0.114	-0.317	0.728	0.086**	-0.440	0.644	0.114***
Female Gender*Labor force % female	0.065	1.067	0.028*	0.086	1.090	0.043†	0.026	1.026	0.027
Female Gender*Professions % female	0.004	1.004	0.015	-0.002	0.998	0.011	0.013	1.013	0.012
Female Gender*Postindustrial economy	0.070	1.072	0.100	-0.156	0.856	0.115	-0.008	0.992	0.082
N of Control Variables									
Student controls [24]		√			√			√	
School controls [13]		√			√			√	
National controls [7]		√			√			√	
N									
Students (unit of observations)		128,773			123,960			211,745	
Schools		4,836			4,181			7,595	
Countries		32			20			41	

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 6.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 6.5 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for Health Service Occupations (Excluding Nursing) (ISCO-88 Major Groups 2 and 3)

	PISA 2000			PISA 2003			PISA 2006		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-3.684	0.025	0.364***	-3.616	0.027	0.625***	-2.730	0.065	0.255***
Student-level:									
Female Gender	1.057	2.878	0.071***	0.935	2.546	0.095***	0.867	2.380	0.061***
Country-level:									
Labor force % female	-0.002	0.998	0.034	0.069	1.071	0.032*	-0.039	0.962	0.036
Professions % female	-0.024	0.977	0.017	-0.047	0.954	0.008***	0.000	1.000	0.016
Postindustrial economy	-0.157	0.855	0.120	-0.301	0.740	0.091**	-0.454	0.635	0.113***
Female Gender*Labor force % female	0.037	1.038	0.022	0.080	1.083	0.040†	0.007	1.007	0.025
Female Gender*Professions % female	0.022	1.022	0.012†	-0.002	0.998	0.010	0.026	1.027	0.012*
Female Gender*Postindustrial economy	0.122	1.130	0.084	-0.090	0.914	0.098	-0.019	0.981	0.078
N of Control Variables									
Student controls [24]	√			√			√		
School controls [13]	√			√			√		
National controls [7]	√			√			√		
N									
Students (unit of observations)	128,773			123,960			211,745		
Schools	4,836			4,181			7,595		
Countries	32			20			41		

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 6.1, except for student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Table 6.6 Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for STEM Occupations (ISCO-88 Major Groups 2 and 3) for Pooled Data from PISA 2000, 2003, and 2006

	STEM			Computing & Engineering			Health [a]		
	β	O.R.	S.E.	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-1.707	0.181	0.217***	-2.028	0.132	0.308***	-3.846	0.021	0.301***
Student-level:									
Female Gender	-0.202	0.817	0.066**	-1.545	0.213	0.085***	1.254	3.506	0.091***
School-level:									
PISA 2003	-0.051	0.950	0.059	-0.114	0.892	0.088	0.149	1.161	0.110
PISA 2006	0.166	1.181	0.083†	-0.080	0.923	0.119	0.424	1.527	0.086**
Female Gender*PISA 2003	0.064	1.066	0.049	0.132	1.141	0.099	-0.146	0.864	0.106
Female Gender*PISA 2006	0.075	1.078	0.043†	0.143	1.154	0.070*	-0.246	0.782	0.070***
Country-level:									
OECD	0.781	2.183	0.126***	0.538	1.712	0.162**	0.819	2.268	0.163***
Labor force % female	0.008	1.008	0.016	-0.026	0.975	0.020	0.036	1.037	0.025
Professions % female	0.014	1.014	0.006*	0.044	1.045	0.008***	-0.052	0.949	0.010***
Postindustrial economy	-0.099	0.906	0.050†	0.075	1.078	0.066	-0.249	0.780	0.074**
Female Gender*Labor force % female	0.036	1.036	0.021	0.027	1.028	0.028	0.034	1.034	0.028
Female Gender*Professions % female	-0.010	0.990	0.009	-0.003	0.997	0.012	0.031	1.032	0.013*
Female Gender*Postindustrial economy	-0.166	0.847	0.066*	-0.299	0.741	0.087**	-0.045	0.956	0.088
N									
Students (unit of observations)	336,369			336,369			336,369		
Schools	11,655			11,655			11,655		
Countries	20			20			20		

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 6.1, except for student ability. Additionally, two indicators for the study year (i.e., PISA 2003 and PISA 2006) are included at the school level.

a. Findings are consistent in students' health career expectations even after excluding nursing career in health service occupations

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Figure 6.1 Gender Gaps in STEM-Subfields Occupational Expectations (ISCO-88 Major Groups 2 and 3) by Women's Share of Professional Workers

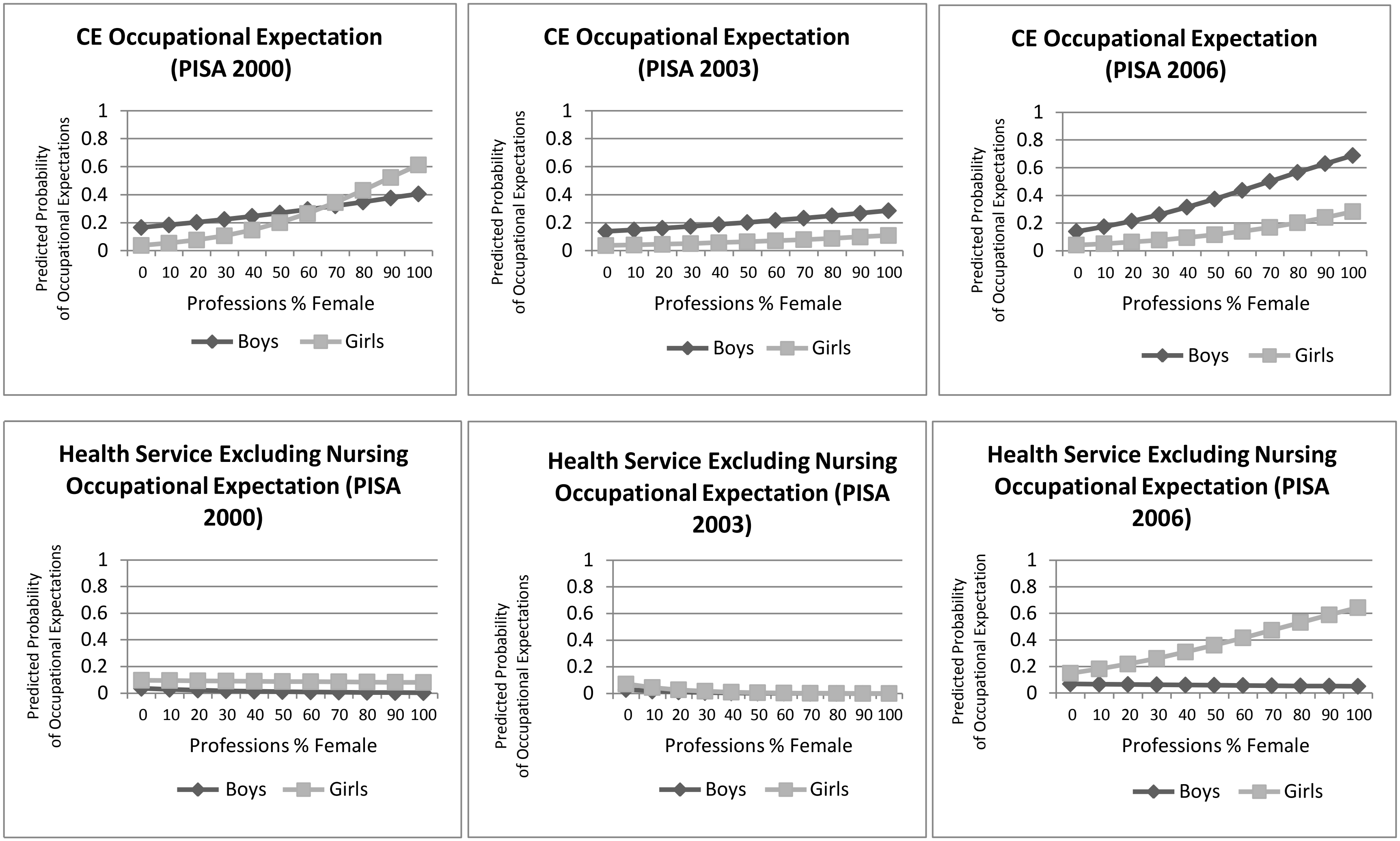
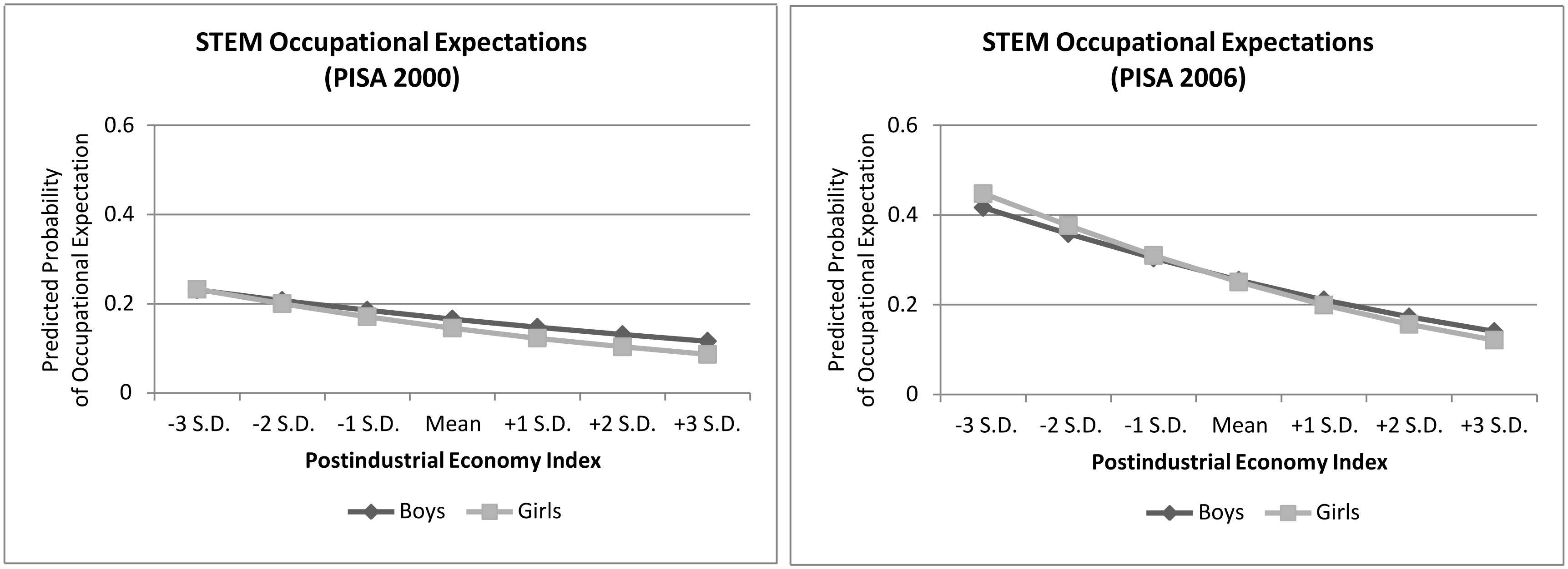


Figure 6.2 Gender Gaps in STEM Occupational Expectations (ISCO-88 Major Groups 2 and 3) by Postindustrial Economies



CHAPTER 7. National Trends in STEM Occupational Expectations

Over the past several decades, researchers and policymakers in several countries have focused on trends in STEM education, including the number of high school students taking math and science courses, test scores in math and science, and enrollment and degree attainment in STEM fields (Education, Audiovisual and Culture Executive Agency, 2012; National Science Board, 2012). Several international reports have also documented national trends in student performance in reading, mathematics, and science (Martin, Mullis, Foy, & Stanco, 2012; Mullis, Martin, Foy, & Arora, 2012; OECD, 2010b). However, there has been little analysis of national trends in non-cognitive STEM-related student outcomes such as the proportion of students who, before entry into college, indicate an interest in pursuing STEM education and occupations.

Policymakers and education researchers in many countries have concerns about declines in students' interest in pursuing STEM education and occupations (Roberts, 2002; Tytler, et al., 2008). The Japanese government, for example, has expressed concerns about lagging student interest in studying natural science or engineering (National Science Board, 2008). Despite such concerns, however, no cross-national studies have examined national trends in students' interest in pursuing STEM occupations. In this chapter, I examine national trends in STEM occupational expectations among students by using repeated cross-sectional international data. Specifically, I investigate net country trends in STEM occupational expectations after controlling for heterogeneity at the student and school levels.

THE CHALLENGES OF EXAMINING NATIONAL TRENDS THROUGH REPEATED CROSS-SECTIONAL DATA

Typically, large-scale international comparative survey studies of educational achievement, including the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS), use a cross-sectional design to measure achievement within samples of age or grade cohorts in a set of participating countries. These data have been widely used to compare student performance across countries and track national trends in student performance (Martin, et al., 2012; Mullis, et al.2012; OECD, 2010b). In addition, these international data have been used to produce a vast amount of knowledge about cross-national differences in students' attitudes, motivations, and perceptions.

Using repeated cross-sectional data to compare national outcomes and trends entails several major challenges. One of the biggest challenges is obtaining comparable measures across countries over time; for example, when students report their occupational plans for science-related careers, the category "science-related careers" should be interpreted identically across countries, but this is not always the case.

Several comparative studies have highlighted an additional complication: the presence of systematic cross-national or cross-cultural differences in response style, which may introduce biases in both descriptive and inferential statistics (Buckley, 2009; Chen, Lee, & Stevenson, 1995). When responding to a Likert questionnaire item, students in Asian countries prefer midpoint responding, while students in Western countries tend to prefer extreme response categories. Several components of large-scale assessments including TIMSS and PISA have used conventional Likert-type response formats to collect information on students' attitudes, motivations, and perceptions. For example, in PISA 2006, the future-oriented science motivation scale, which measures students' expectations about tertiary science studies and working in science-related careers, is derived from items that employ Likert-type response formats. The cross-national differences in students' response style suggest that cross-national comparisons of science-related educational and occupational expectations based on the PISA 2006 index of future-oriented science motivation should be interpreted with caution. In the current study, measures of STEM occupational expectations are derived from students' responses to an open-ended question about their occupational plans around the age of 30, rather than the PISA index.

Another challenge in using repeated cross-sectional data to compare national trends is managing the demographic changes between cohorts due to immigration, outmigration, and differential fertility across subgroups (Raudenbush & Kim, 2002). To accurately describe national changes over time, it is important to control for any demographic changes that are associated with the outcomes of interest. For example, prior research has found that in many countries migrant students were more likely than native students to plan to have science-related careers (Sikora & Pokropek, 2011). Thus, the trends in science-related career expectations revealed in quantitative analyses can be inaccurate when demographic changes between cohorts resulting from immigration are not taken into account. In the current study, I control for the immigration backgrounds of students and their parents at the student level; however, other sources of demographic change between cohorts are not taken into account.

RESEARCH QUESTIONS

This study investigates national trends in students' STEM occupational expectations from 2000 through 2006 by using students' responses to an open-ended question about their occupational plans. Specifically, the study examines net country trends after controlling for student and school characteristics.

First, the study analyzes whether students’ STEM occupational expectations in several countries have increased or decreased over time. Relative to students in other countries, those in top-performing countries including Japan and Korea report low levels of expectations for science-related careers (Martin, et al., 2004; Sikora & Pokropek, 2011). Policymakers and researchers in these countries are concerned that students’ interest in science-related careers has declined. I empirically examine whether or not students’ STEM occupational expectations have declined in these countries.[42] In this chapter, I examine national-level changes in students’ STEM occupational expectations between the PISA 2000 and PISA 2006 survey waves after taking into account student and school characteristics such as the immigration background of both students and parents. I also examine whether the national trends are consistent across two STEM subfields.

Second, this study examines whether national trends in STEM occupational expectations differ by students’ science performance. In other words, I investigate whether increases or decreases in STEM occupational expectations remain consistent across the distribution of student performance.

Third, this study examines whether national trends in STEM occupational expectations differ by gender. Gender patterns are important because policymakers and education researchers in many countries have concerns about the underrepresentation of women in STEM education and occupations.

SELECTION OF COUNTRIES

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[42] Japan was excluded from this chapter. Japan participated in every PISA cycle since 2000, but Japan did not administer an educational career questionnaire which included a question about students’ occupational expectations in PISA 2003.

As described in Chapter 2 (Data & Methods), I use data from the 2000, 2003, and 2006 waves of the Programme for International Student Assessment (PISA). PISA is a triennial survey that measures the performance of 15-year-old students in reading, math, and science literacy in OECD member and partner countries. In total, 43 countries took part in PISA 2000, 41 in PISA 2003, and 57 in PISA 2006. The PISA 2000, 2003, and 2006 assessments included a question about student occupational expectations. In the PISA 2003 survey, however, the question about students' occupational expectations was included as an international option in an educational career questionnaire, and only 18 OECD and 6 partner countries (24 in total) administered the PISA educational career questionnaire that year. Trend analyses are restricted to the countries that participated in all three PISA cycles (2000, 2003, and 2006). In addition, a few countries are excluded from the analyses in this chapter because of missing data on school-level variables. The final analytic sample comprises 17 countries, including Germany, Korea, the United Kingdom, and the United States (see Appendix 7.1).

MEASURES

Dependent Variables

Recently, data from the PISA 2006 index of future-oriented science motivations (OECD, 2009a) have been widely used in cross-national comparisons of student expectations of pursuing tertiary science studies and working in science-related careers (Caygill, 2008; OECD, 2009b; Tytler, et al., 2008). The index is derived from the following items: (a) I would like to work in a career involving broad science; (b) I would like to study broad science after secondary school; (c) I would like to spend my life doing advanced broad science; and (d) I would like to work on broad science projects as an adult; the response categories for each item are "strongly agree,"

"agree," "disagree," and "strongly disagree" (OECD, 2009a). Because the items used Likert-type response formats, I assessed whether students interpreted "science-related career" identically across countries by checking the polychoric correlation between the PISA 2006 index and students' responses to an open-ended question about their future occupational plans (the outcome measure used in the current study). The polychoric correlation between the two variables ranged from .216 in Poland to .635 in Australia. In addition, I checked the polychoric correlation between each individual item (listed above) and students' responses to the open-ended question; these correlations also varied across countries. These results suggest that students' understanding of the meaning of "science-related career" differs across countries, and thus the PISA index is not comparable across countries, and alternative measures are required to compare students' STEM career expectations across countries.

Given these data limitations, I used three binary variables as the outcome measures for the current study; each variable indicates whether or not a student expects to have a STEM occupation around age 30. All measures are derived from students' responses to the following open-ended question about their occupational plans that was included in the PISA student questionnaires: "What kind of job do you expect to have when you are about 30 years old?" The study examines expectations for three STEM fields: (a) general STEM-related fields; (b) computing and engineering (CE); and (c) health services.[43] STEM-related occupations are limited to occupations that require an associate's degree or above at job entry.

Individual-Level Independent Variables

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[43] In analyses of overall national trends by science performance quartile, nursing-related occupations were included in health service occupations; however, for the comparison of health service occupational expectations by gender, nursing-related occupations were excluded.

At the student level, I controlled for gender, age, grade level, parental educational attainment, family SES, immigration background of both students and parents, language spoken in the home, whether either of the respondents' parents had a job in STEM fields, parental occupational level (blue collar vs. white collar), mother's working status, number of books in the home, and student science ability.

School-Level Independent Variables

At the school level, I controlled for school-level mean SES, school size, school community location, the proportion of school enrollment that is female, school type (public, government-dependent private, government-independent private), school's academic selectivity, degree of teacher shortage in math and science, and quality of educational resources. Time and country dummy variables are included at the school level. Descriptive statistics for all variables used in the analyses are presented in Table 7.1.

METHODS

As described in Chapter 2 (Data and Methods), the current study employs two-level hierarchical generalized linear models (HGLMs) in which the level 1 sampling model is a Bernoulli distribution. The models nest students (level 1) within schools (level 2). Using time and country dummy variables and terms for the interaction between time and country at the school level, this study examines whether students' STEM occupational expectations have increased or decreased over time in several countries. In addition, two-level HGLMs are run separately by science performance quartile level to examine whether the national trends in STEM occupational expectations are consistent across the distribution of student science performance. Finally, HGLMs are run separately by gender to compare trends in STEM occupational expectations between boys and girls.

RESULTS

Trends in STEM Occupational Expectations

Figure 7.1 presents the predicted probabilities of occupational expectations for general STEM and both of the STEM subfields by country, when all other variables are held constant at the grand mean. As shown in Figure 7.1, in several countries including Austria, the Czech Republic, Latvia, Portugal, and the United States, students' likelihood of expecting STEM occupations remained constant from PISA 2000 to PISA 2006. In contrast, in Greece, Hong Kong, Hungary, Thailand, and the United Kingdom, students' expectations for STEM occupations increased across successive PISA assessments. In Thailand, students' STEM occupational expectations increased dramatically. Compared to those in other OECD countries, in the UK, students' likelihood of expecting STEM occupations was low in PISA 2000, but increased slightly over time. Notably, Korea was the only country that showed decreased levels of occupational expectations for STEM over time. In Chapter 2, descriptive statistics showed that Korean students' STEM occupational expectations remained constant from PISA 2000 to PISA 2006. However, when differences at the student and school levels across PISA survey cycles were held constant, the predicted probability of expecting to have a STEM occupation decreased among Korean students.

The results of the HGLM analyses show that national trends in STEM occupational expectations differ across STEM subfields. As shown in Figure 7.1, in many countries, including Belgium, Germany, Korea, Mexico, and the United States, students' CE occupational expectations decreased across successive PISA assessments. However, students' expectations for CE increased in Hong Kong, Indonesia, Latvia, and Thailand. Unlike CE occupational expectations, students' expectations for health services occupations (including nursing) increased in many countries, including Austria, Belgium, Hong Kong, Ireland, Portugal, the UK, and the United States. The only country in which expectations for health services decreased across successive PISA assessments was Indonesia.

The analytic results revealed noteworthy trends in several countries. First, students' expectations for CE occupations increased in the non-OECD member countries in the sample, while the likelihood of expecting CE occupations decreased over time in a majority of OECD member countries. Second, relative to students in other OECD countries, students in the UK had low levels of interest in STEM occupations in PISA 2000; however, expectations for STEM occupations in the UK improved slightly across successive PISA assessments.[44] Third, among students in Germany, math performance increased over time, while CE occupational expectations decreased. Specifically, in mathematics, Germany performed close to the OECD average in 2003, but increased its performance by 10 points between 2003 and 2009, resulting in scores above the OECD average in 2009 (OECD, 2010a). In contrast, the predicted probability for expecting to have CE occupations in Germany decreased from .154 in PISA 2000 to .101 in PISA 2003, although there was no change between PISA 2003 and PISA 2006 after controlling for student and school characteristics. German students showed no change in science performance in learning trends analyses of PISA data (OECD, 2010a). Finally, Korea, one of the top-performing countries in international assessments of mathematics and science, showed a decrease in students' occupational expectations for STEM, in particular, computing and

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[44] The 2003 sample for the United Kingdom did not meet the PISA response rate standards and results from the United Kingdom were excluded from mathematics learning trends analyses in PISA reports (OECD, 2010). Thus, one needs to be careful in interpreting the results of PISA 2003 in the United Kingdom.

engineering. Korea has had the top performance levels in math and science in international assessments, including TIMSS and PISA, for the past 20 years. However, compared to students in other OECD countries, Korean students reported lower levels of interest in STEM occupations, and these STEM-related career expectations declined over time.

Trends in STEM Occupational Expectations by Performance Quartile

Figure 7.2 presents the predicted probabilities of expecting to have STEM occupations by science performance quartile, when all other variables are held constant at the grand mean. This figure shows that, across countries, while top performers in science are more likely to expect to have STEM occupations than any other group, trends in STEM occupational expectations among top performers vary across countries. In most countries, including Austria, the Czech Republic, Germany, Korea, Latvia, Portugal, and the United States, top performers' likelihood of expecting STEM occupations around age 30 remained constant over time. Of these countries, Korea is the only one that had an overall decline in the interest in STEM-related careers between 2000 and 2006; an examination of this downward trend by science performance quartile suggests that the overall decline in STEM occupational expectations among Korean students was driven by decreased expectations among students with science scores in the upper-middle quartile rather than top-quartile students.

As shown in Figure 7.2, students' STEM occupational expectations in Hong Kong, Hungary, Thailand, and the UK changed between 2000 and 2006, although the pattern of change differed across these countries. Analyses by science performance quartile indicate that in Thailand, student interest in STEM occupations increased across all quartiles, while in other countries, interest in STEM occupations increased only among top performers in science.

Figure 7.3 displays the predicted probabilities of expecting to have CE occupations by science performance quartile, when all other variables are held constant at the grand mean. Unlike general STEM occupational expectations, expectations for CE careers changed over time in many countries among top-performing students. Specifically, top performers in several countries, including Austria, Belgium, Germany, Korea, Mexico, Poland, Portugal, and the United States, showed declining interest in CE occupations between 2000 and 2006. In contrast, top performers in Greece, Hong Kong, Hungary, Indonesia, Thailand, and the UK showed increased levels of interest in CE occupations over time. In most countries, CE occupational expectations of students in the second, third, and fourth performance quartiles remained constant over time.

Figure 7.4 presents the predicted probabilities of expecting to have a health services occupation (including nursing) by science performance quartile, when all other variables are held constant at the grand mean. In contrast to the results for CE occupational expectations, in many countries the time trends in health services occupational expectations were consistent across science performance quartiles. Only in Belgium, Hungary, and Ireland did top performers increase their interest in health service occupations over time.

The analytic results revealed some noteworthy trends associated with science performance quartile. First, the chronological trends in STEM-related occupational expectations varied across science performance quartiles. The STEM-related occupational expectations of top performers changed between 2000 and 2006, but in many countries the occupational expectations of other groups remained constant during this period. Second, in several OECD member countries, including Germany, Korea, and the United States, the CE occupational expectations of top performers declined between PISA 2000 and PISA 2006, while top performers' health service occupational expectations remained constant. Third, in contrast to the patterns in other OECD member countries, in Greece, Hungary, and the UK, the CE occupational expectations of top performers increased over time.

Trends in STEM Occupational Expectations by Gender

Figure 7.5 displays the predicted probabilities of expecting to have an occupation in two STEM subfields by student gender, when all other variables are held constant at the grand mean. The left panel of Figure 7.5 presents the likelihood of students expecting CE occupations around age 30, while the right panel of Figure 7.5 shows the likelihood of students expecting health services occupations (excluding nursing). Because nursing-related occupations are traditionally considered female jobs, nursing-related occupations are excluded from the list of health services occupations.

The left panel of Figure 7.5 shows that in many countries girls' expectations for CE occupations remained unchanged between 2000 and 2006, but boys' expectations changed. Boys' likelihood of expecting CE occupations decreased in many countries including Austria, Belgium, Germany, Korea, Mexico, and the United States, while girls' likelihood remained constant in these countries. Overall, CE occupational expectations declined over time in these countries. These findings suggest that the downward trends in these countries were driven by boys' expectations. In addition, these countries had smaller gender gaps in CE occupational expectations in PISA 2006 than in PISA 2000. This convergence of boys' and girls' CE occupational expectations is partially due to declining interest in CE occupations among boys. However, different patterns emerged in a few countries. In Greece, Hong Kong, and Hungary boys' expectations for CE occupations increased between PISA 2000 and PISA 2006, while girls' expectations were constant over time. In Indonesia and Thailand, both boys' and girls' CE occupational expectations increased.

The right panel of Figure 7.5 shows that relative to girls' expectations, boys' expectations for health service occupations increased between 2000 and 2006, in Austria, Belgium, Hong Kong, the UK, and the United States. Most of these countries experienced overall increases in health service occupational expectations between 2000 and 2006 (results discussed in the previous section). These findings suggest that the increases over time were driven by boys' expectations. In Mexico, boys' health service expectations decreased over time, while girls' expectations did not. In Ireland, both boys' and girls' expectations for health service occupations increased. In Thailand, girls' expectations for health service increased but boys' expectations did not, while in Indonesia and Latvia, girls' expectations deceased across PISA survey waves.

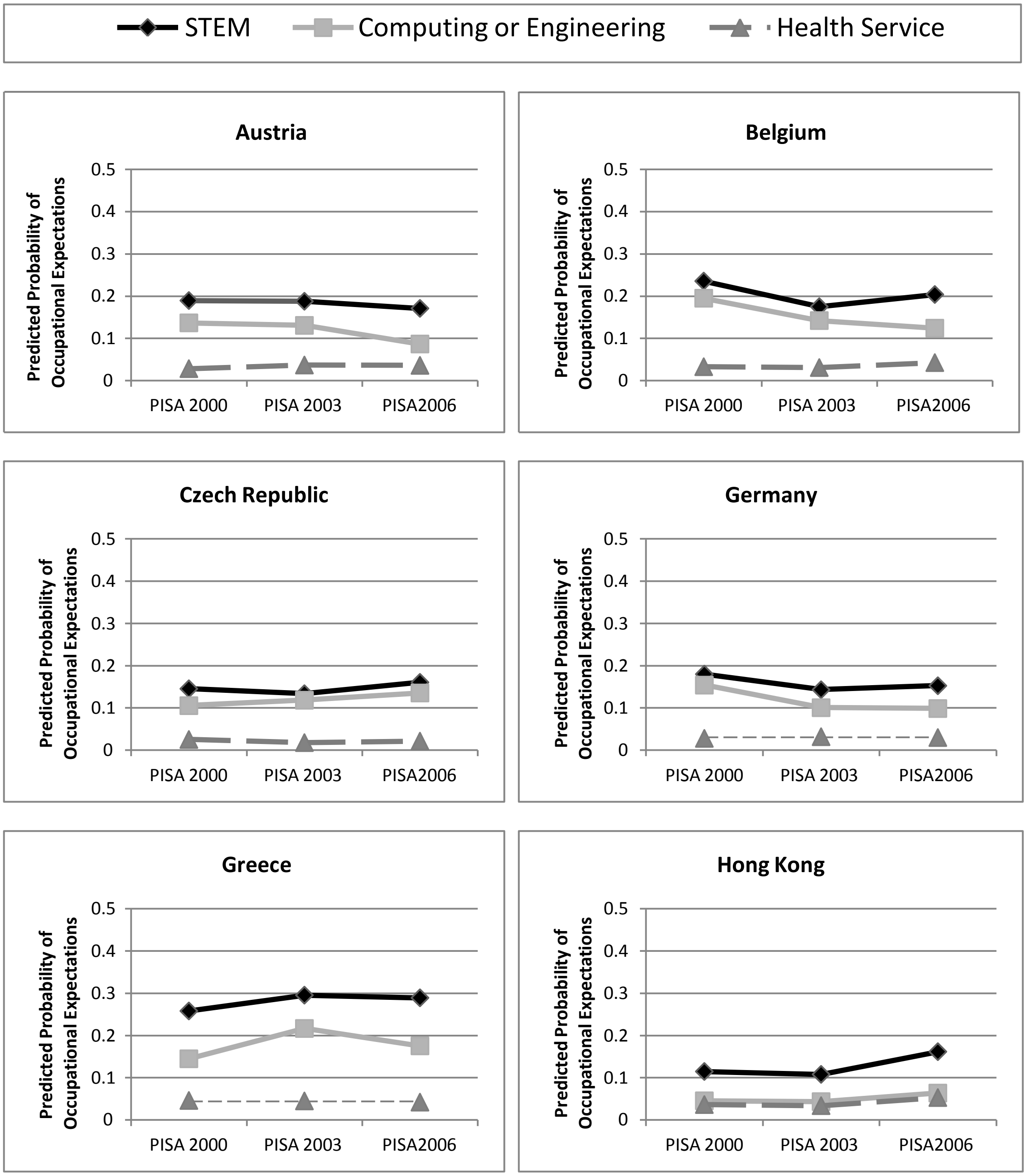
The analytic results revealed several important trends associated with student gender. As discussed in the previous section, students' CE occupational expectations decreased between PISA 2000 and PISA 2006 in many countries including Belgium, Germany, Korea, Mexico, and the United States. The results of HGLM analyses by gender suggest that declining interests in CE occupations in these countries were driven not by girls' expectations, but by boys' expectations. In Hong Kong, Indonesia, Latvia, and Thailand students' CE occupational expectations increased over time; these increases occurred for both boys and girls in all of these countries except Hong Kong). Finally, the gender gap in CE occupational expectations decreased in many countries including Austria, Belgium, Germany, Korea, Mexico, Portugal, and the United States. The trend toward convergence in these countries was due to declining interest among boys rather than increasing interest among girls.

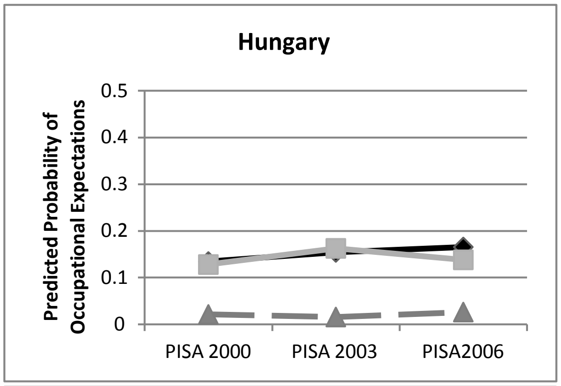
Table 7.1 Descriptive Statistics – Variables Used in HGLM analyses

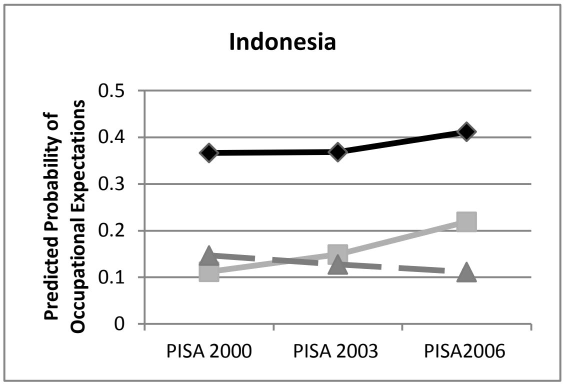
	Pooled	
	Mean	Std. Dev.
Occupational Expectations (ISCO-88, Major Groups 2 and3)		
STEM, general	0.29	
Computer and Engineering (CE)	0.11	
Health service including nursing	0.12	
Health service excluding nursing	0.10	
Student Characteristics		
Grade in school		
7th or lower	0.01	
8th	0.05	
9th	0.39	
10th	0.55	
11th or higher	0.11	
Age (years)	15.76	0.29
Female gender	0.51	
Science ability	478.13	103.53
Family Background		
Parents' education		
None	0.03	
Primary	0.09	
Lower secondary	0.14	
Upper secondary 1	0.11	
Upper secondary 2	0.27	
University	0.37	
Parents' job		
Blue collar low-skilled	0.14	
Blue collar high-skilled	0.16	
White collar low-skilled	0.22	
White collar high-skilled	0.48	
Parents have STEM occupation	0.16	
Immigration status		
Native	0.92	
Second-generation	0.04	
First-generation	0.04	
Language spoken at home		
Test language	0.88	
Other national dialect	0.09	
Foreign language	0.03	
Mother's working status	0.69	
Number of books at home		
0-10 books	0.15	
11-100 books	0.48	
101-500 books	0.29	
More than 500 books	0.08	
Family SES	-0.27	1.11
School Characteristics		

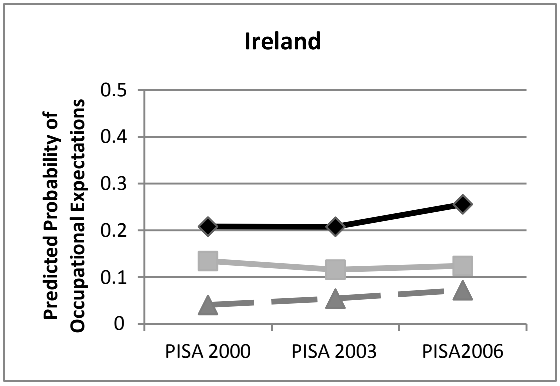
School community location		
Village (less than 3,000)	0.12	
Small town (3,000 to 15,000)	0.25	
Town (15,000 to 100,000)	0.32	
City (100,000 to 1,000,000)	0.20	
Large city (more than 1,000,000)	0.12	
School mean SES	-0.45	0.84
School size	752.97	660.35
Percent girls in student body	0.51	0.21
Public vs. private operation and funding		
Public	0.82	
Private, government-dependent	0.08	
Private, not government-dependent	0.09	
Academic selectivity		
Not considered	0.29	
Considered	0.28	
High priority or prerequisite	0.43	
Teacher shortage in math and science	0.05	1.00
Quality of educational resources	0.02	1.09

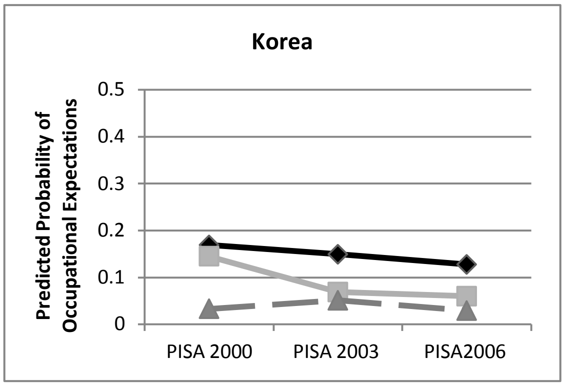
Figure 7.1 STEM-Related Occupational Expectations (ISCO-88 Major Groups 2 and 3) by Country

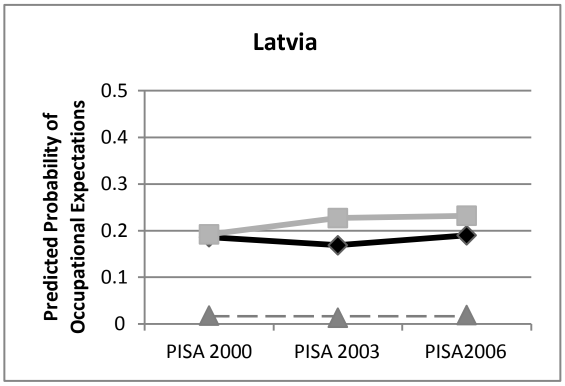


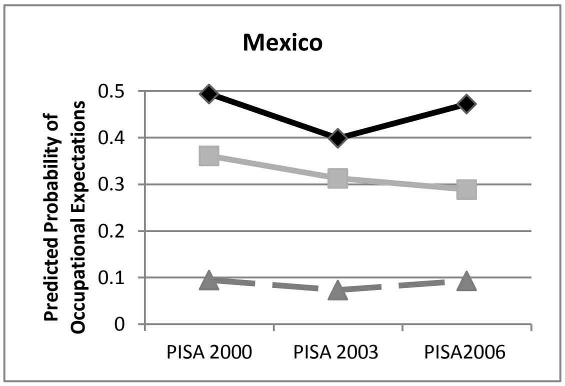

Hungary
Predicted Probability of Occupational Expectations
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA2006

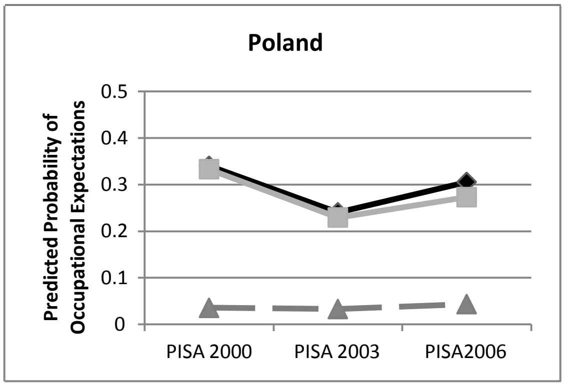

Indonesia
Predicted Probability of Occupational Expectations
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA2006

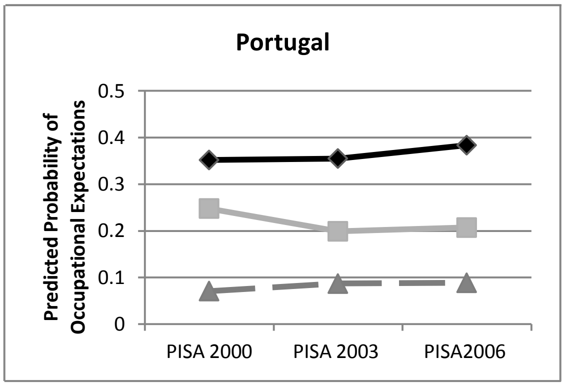

Ireland
Predicted Probability of Occupational Expectations
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA2006

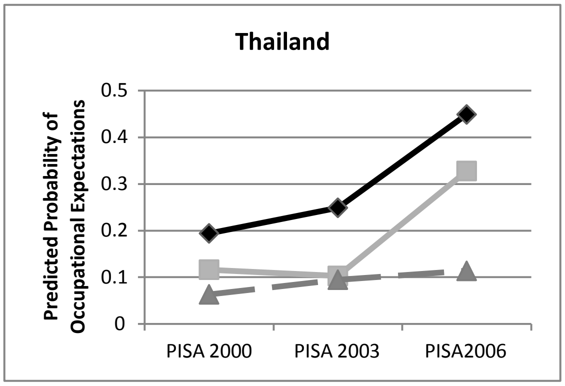

Korea
Predicted Probability of Occupational Expectations
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA2006

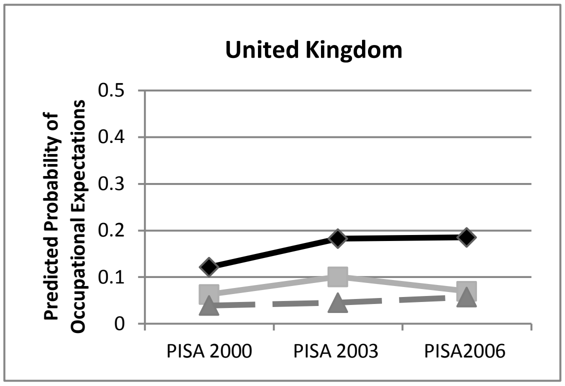

Latvia
Predicted Probability of Occupational Expectations
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA2006


Mexico
Predicted Probability of Occupational Expectations
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA2006


Poland
Predicted Probability of Occupational Expectations
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA2006


Portugal
Predicted Probability of Occupational Expectations
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA2006


Thailand
Predicted Probability of Occupational Expectations
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA2006


United Kingdom
Predicted Probability of Occupational Expectations
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA2006

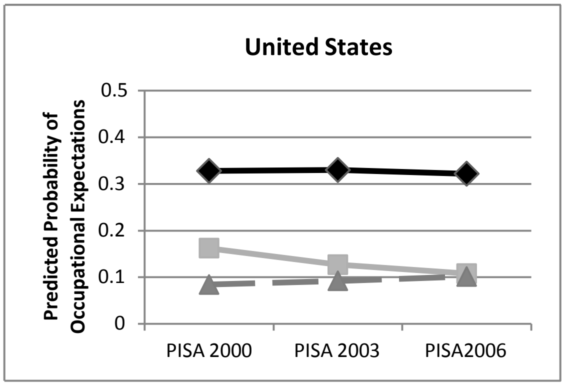
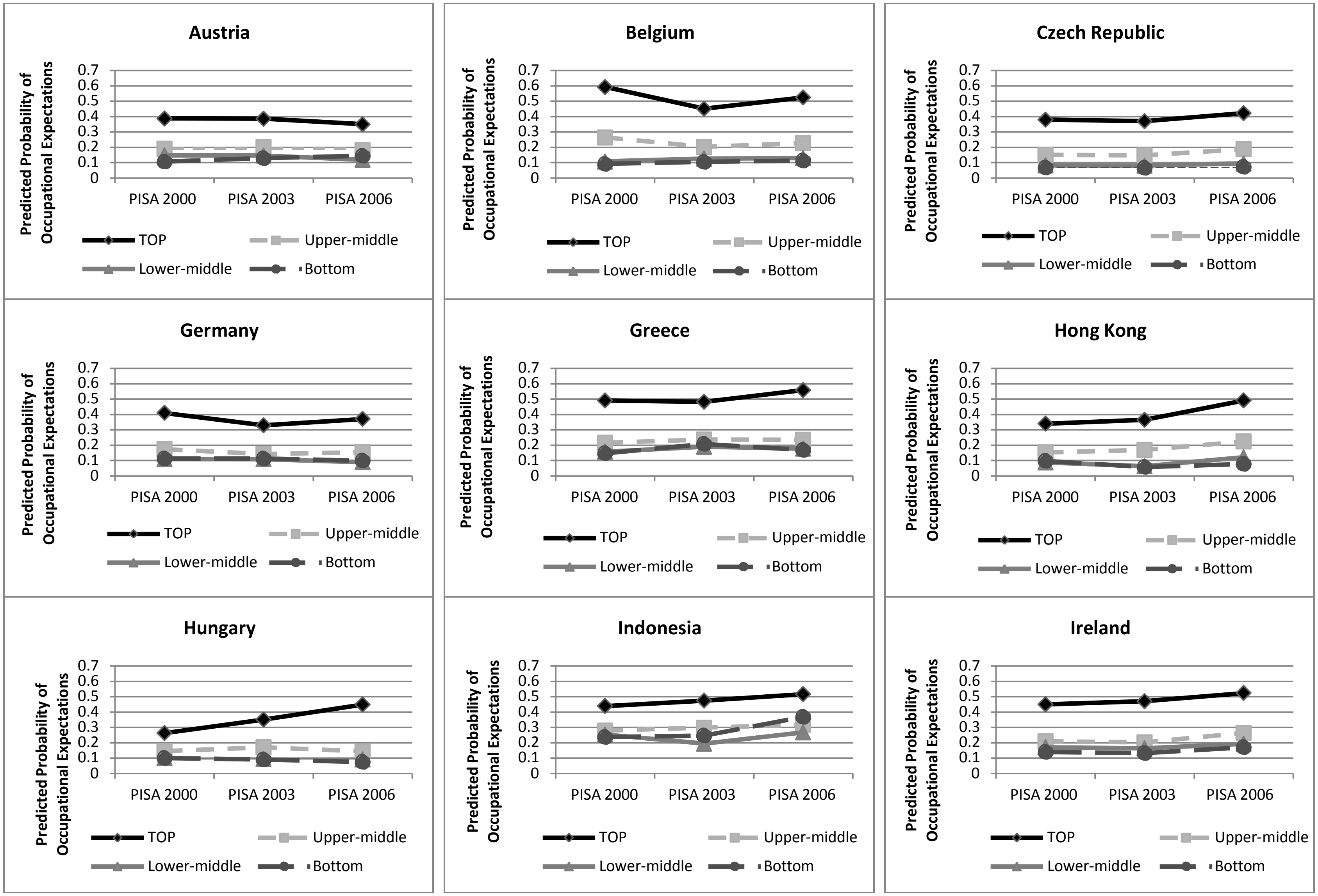
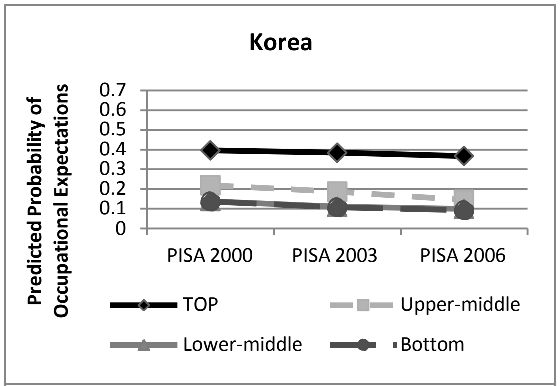
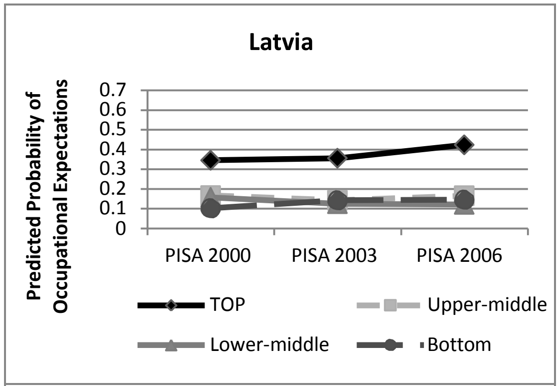
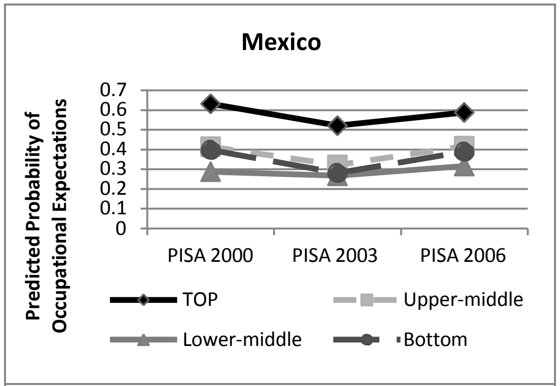

United States
Predicted Probability of Occupational Expectations
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA2006

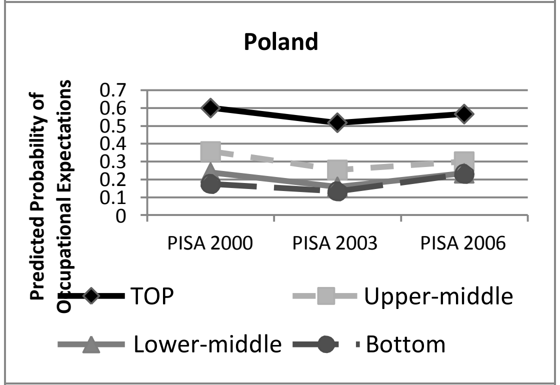
Figure 7.2 General STEM Occupational Expectations (ISCO-88 Major Groups 2 and 3) by Country and Science Performance Quartile

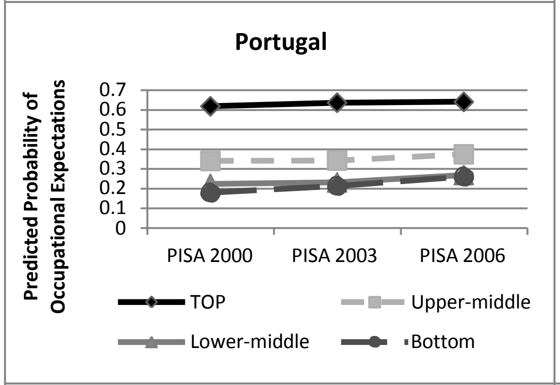


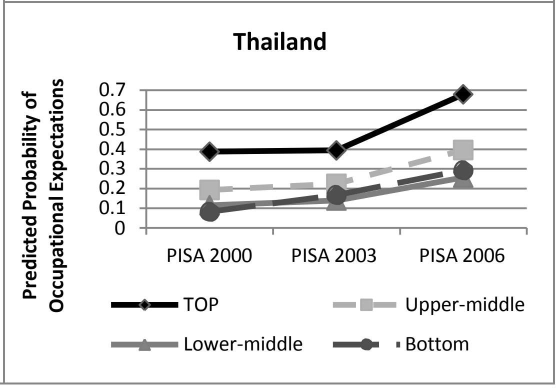

Korea
Predicted Probability of Occupational Expectations
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA 2006
TOP
Upper-middle
Lower-middle
Bottom

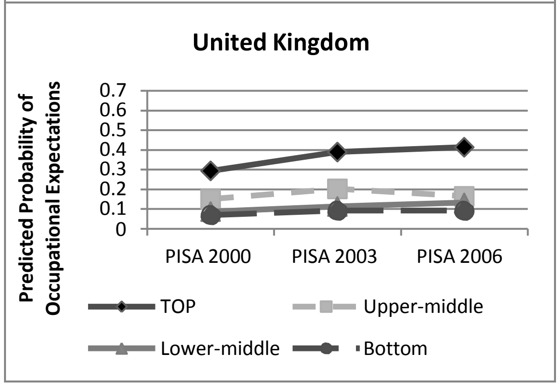

Latvia
Predicted Probability of Occupational Expectations
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA 2006
TOP
Upper-middle
Lower-middle
Bottom


Mexico
Predicted Probability of Occupational Expectations
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA 2006
TOP
Upper-middle
Lower-middle
Bottom


Poland
Predicted Probability of Occupational Expectations
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA 2006
TOP
Upper-middle
Lower-middle
Bottom


Portugal
Predicted Probability of Occupational Expectations
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA 2006
TOP
Upper-middle
Lower-middle
Bottom


Thailand
Predicted Probability of Occupational Expectations
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA 2006
TOP
Upper-middle
Lower-middle
Bottom


United Kingdom
Predicted Probability of Occupational Expectations
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA 2006
TOP
Upper-middle
Lower-middle
Bottom

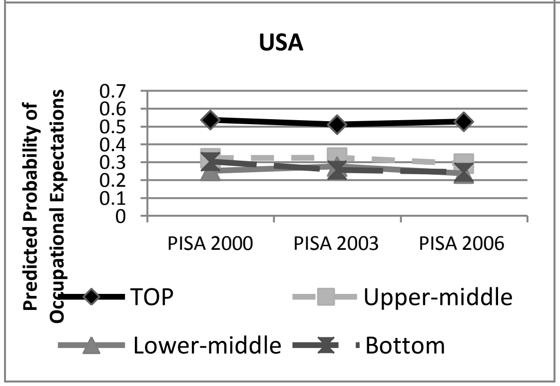
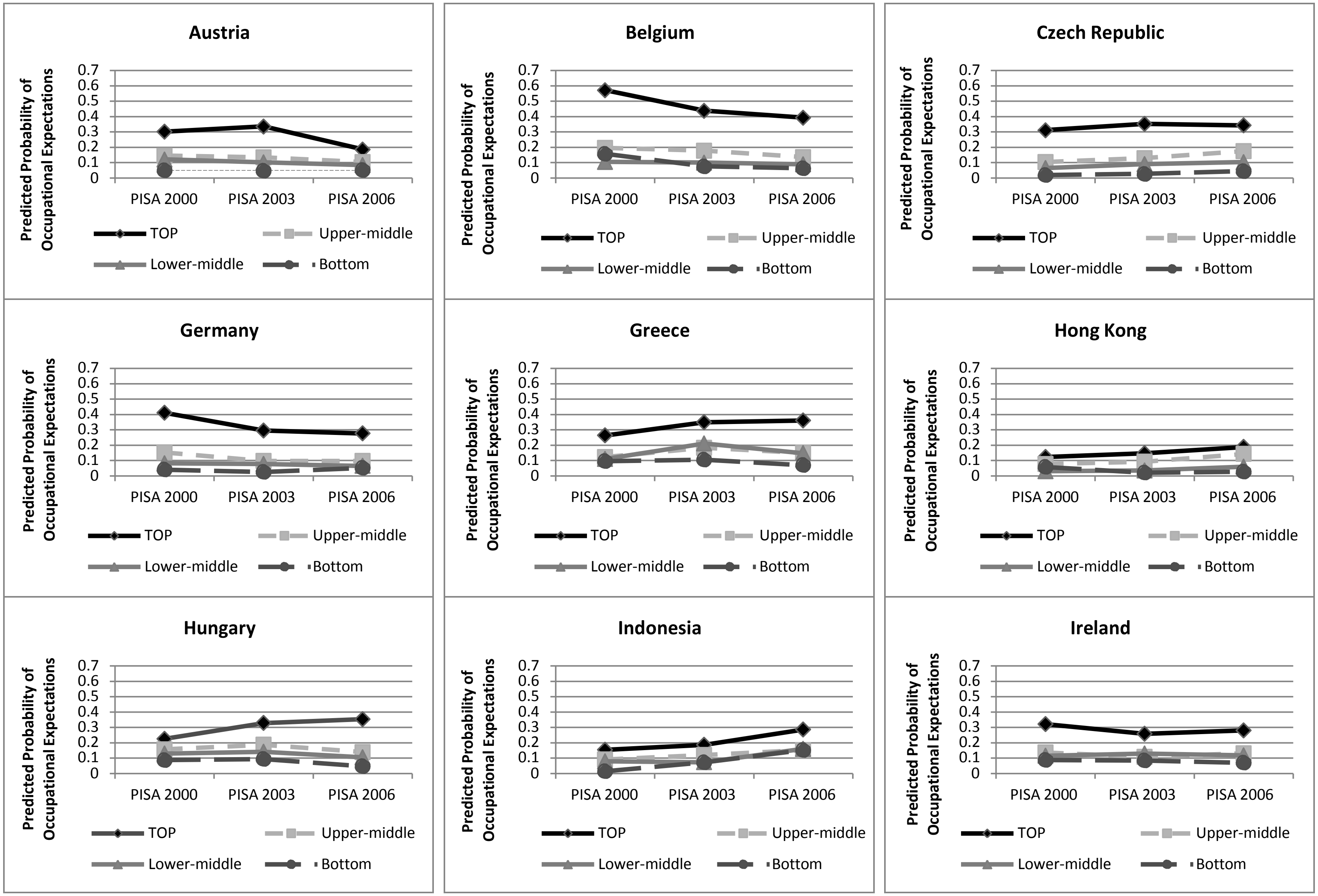

USA
Predicted Probability of Occupational Expectations
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA 2006
TOP
Upper-middle
Lower-middle
Bottom

Figure 7.3 Computing and Engineering Occupational Expectations (ISCO-88 Major Groups 2 and 3) by Country and Science Performance Quartile



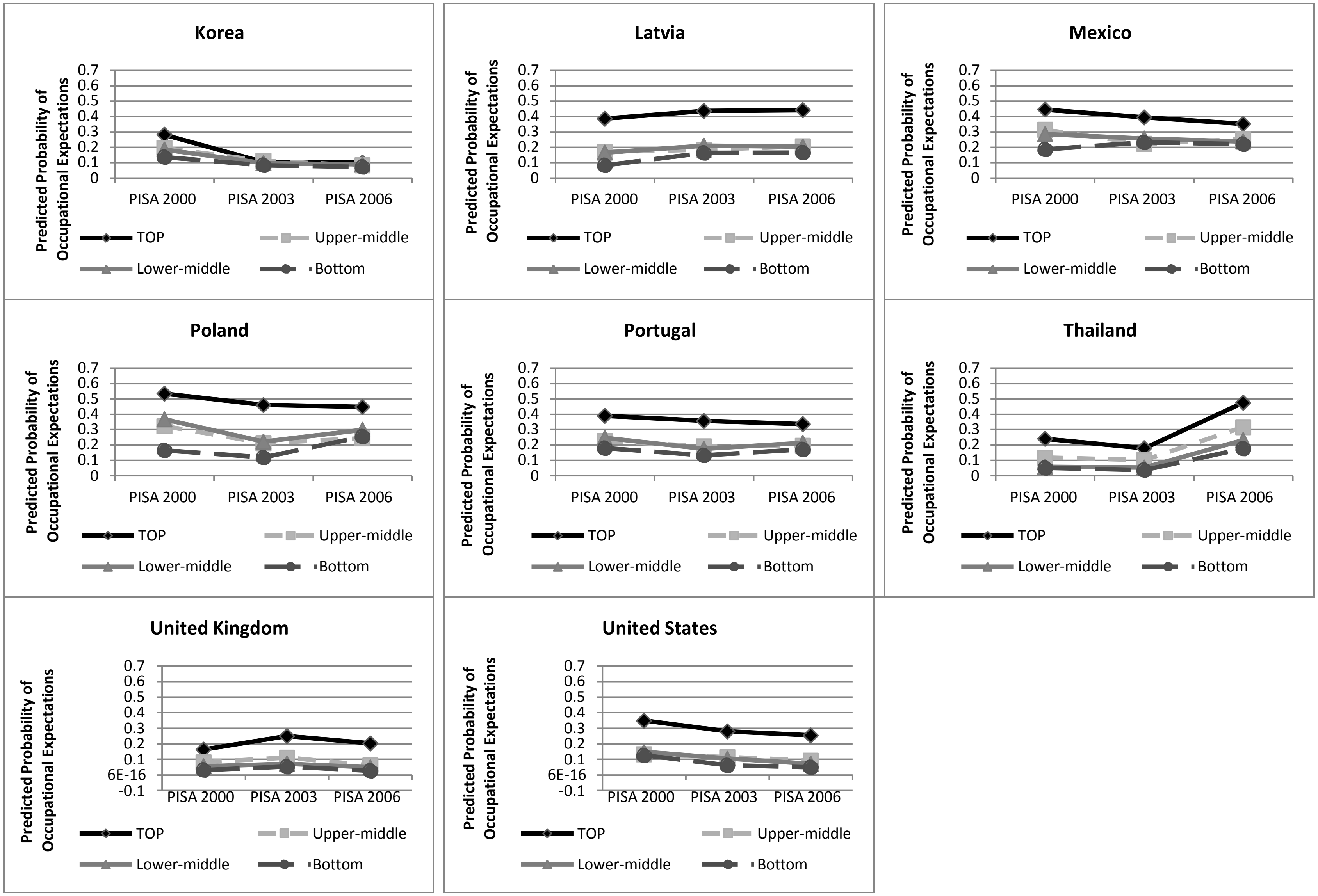
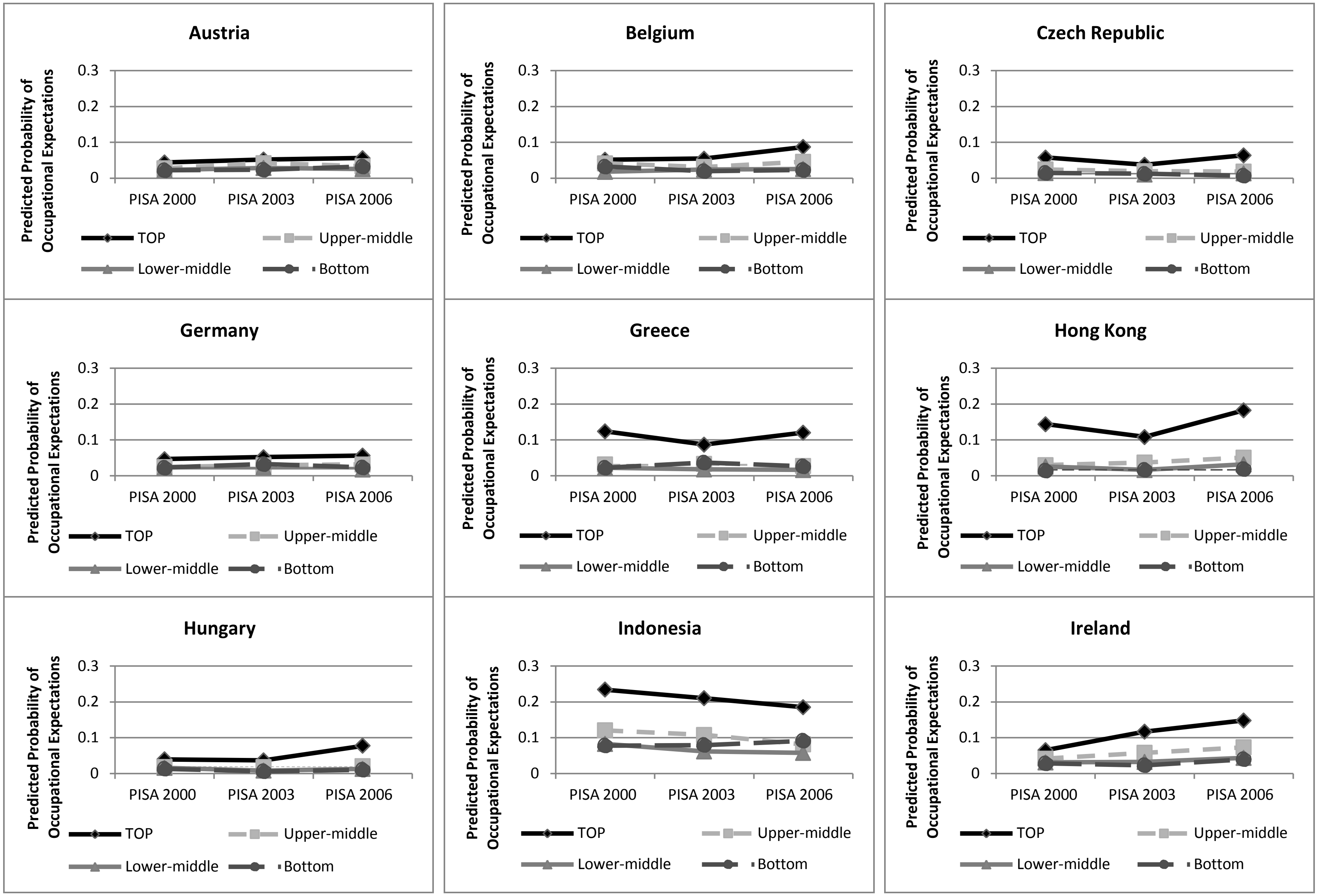

Korea
Latvia
Mexico
Poland
Portugal
Thailand
United Kingdom
United States
Predicted Probability of Occupational Expectations
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
6E-16
-0.1
PISA 2000
PISA 2003
PISA 2006
TOP
Upper-middle
Lower-middle
Bottom

Figure 7.4 Health Service Occupational Expectations (ISCO-88 Major Groups 2 and 3) by Country and Science Performance Quartile



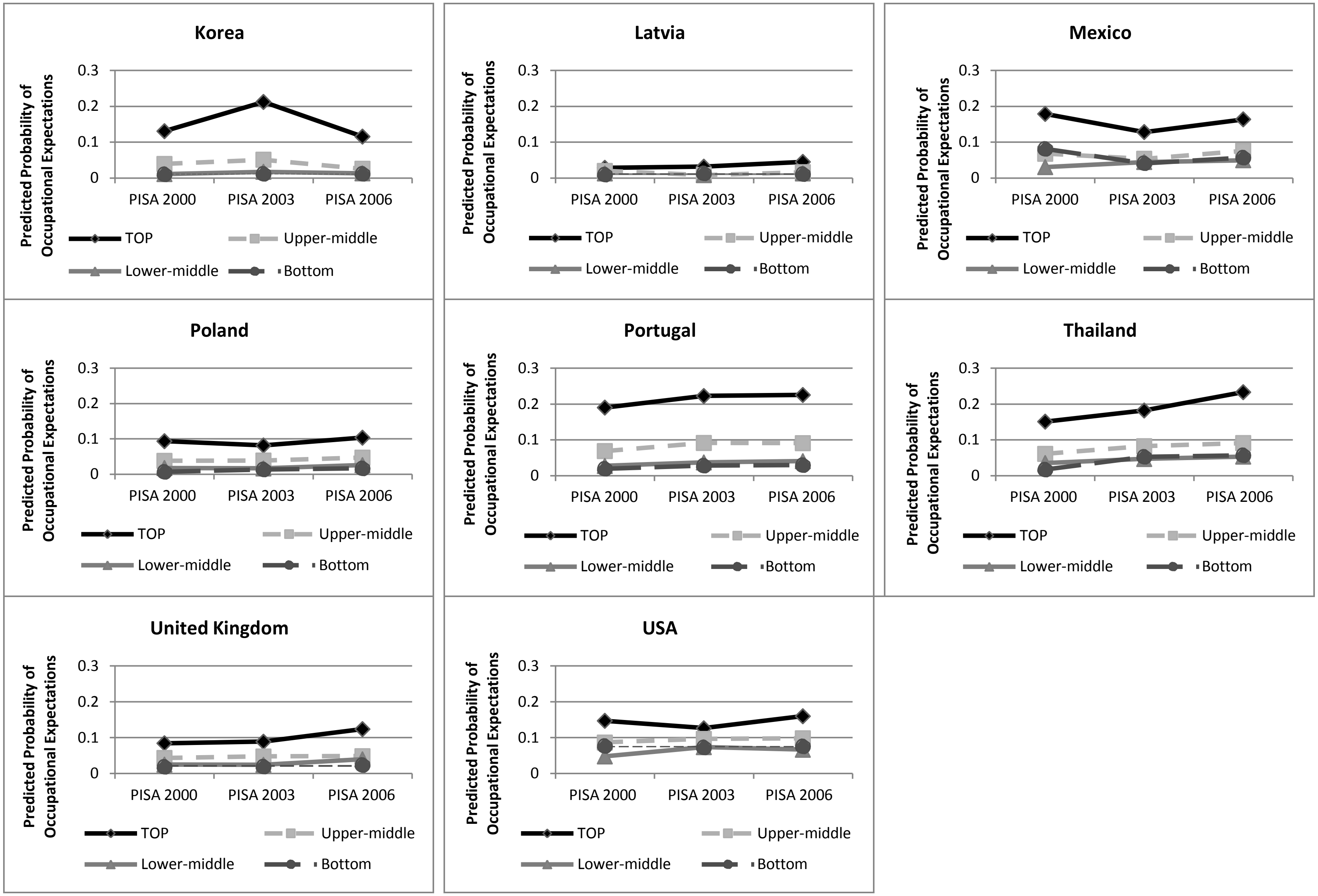
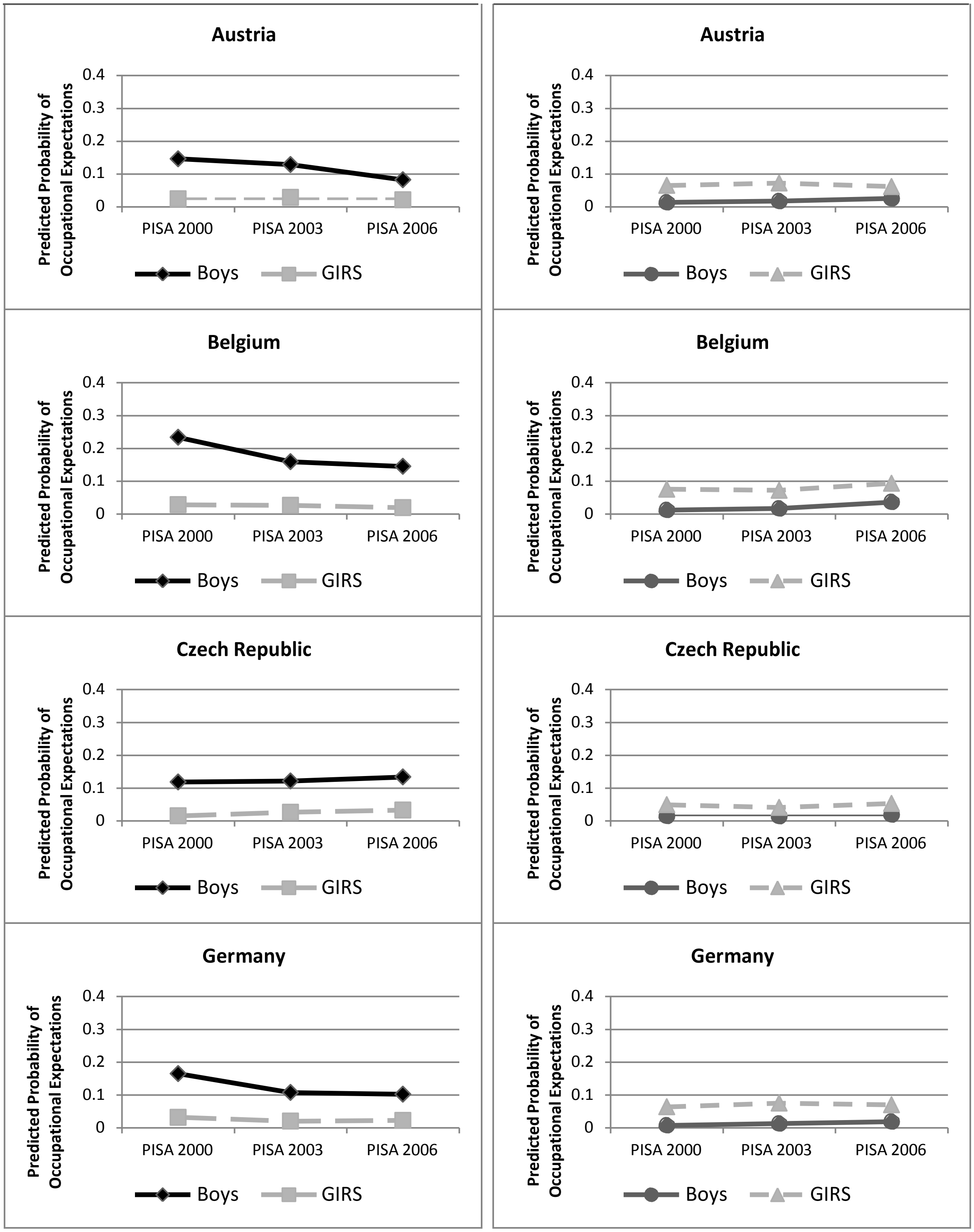
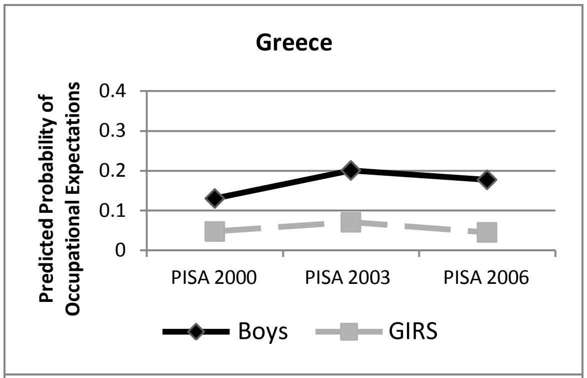

Korea
Latvia
Mexico
Poland
Portugal
Thailand
United Kingdom
USA
Predicted Probability of Occupational Expectations
0.3
0.2
0.1
0
PISA 2000
PISA 2003
PISA 2006
TOP
Upper-middle
Lower-middle
Bottom

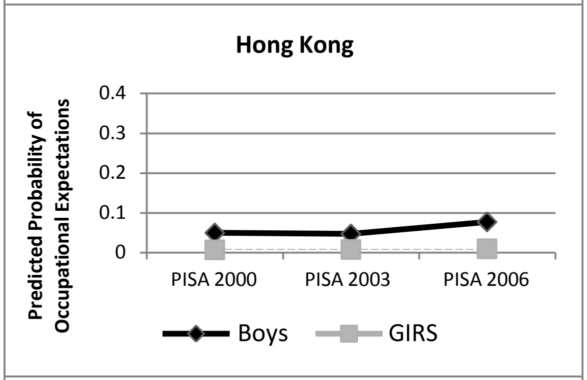
Figure 7.5 STEM-Related Occupational Expectations (ISCO-88 Major Groups 2 and 3) by Gender and Country

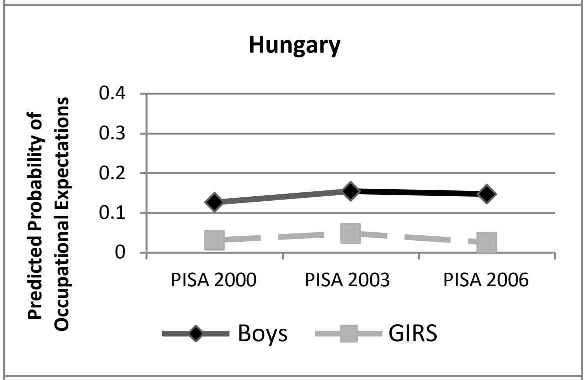
Computing and Engineering (CE) **Health Service (Excluding Nursing)**

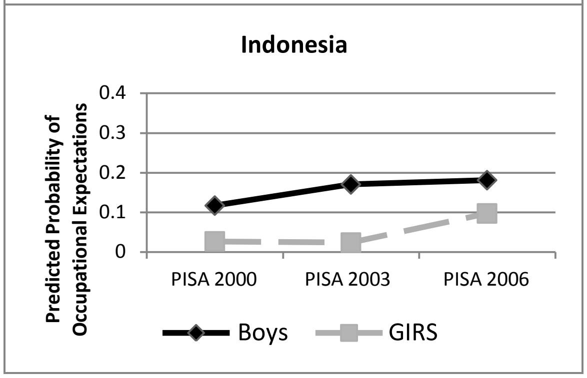


Computing and Engineering (CE)

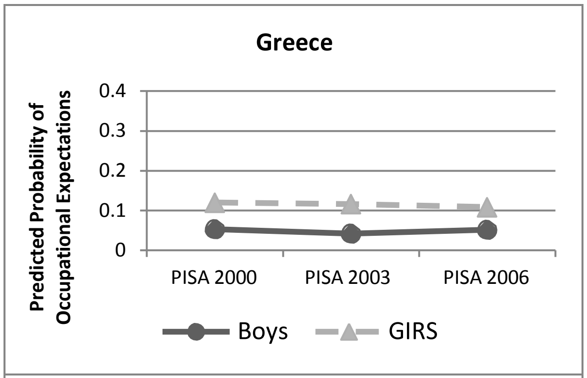


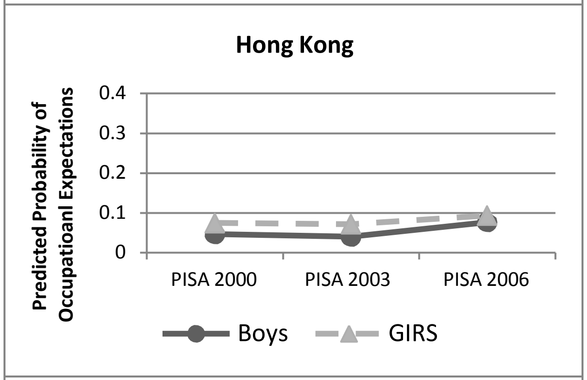


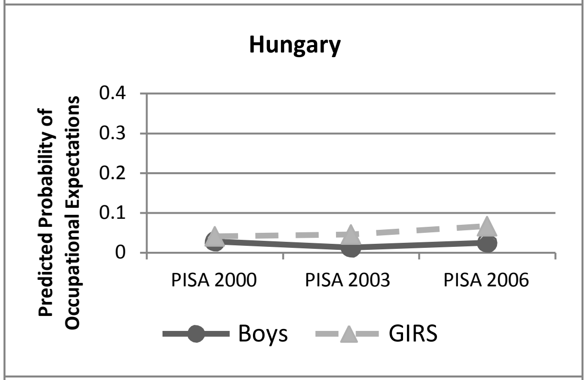


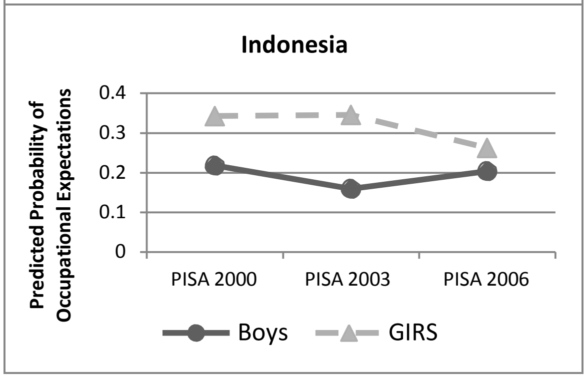


Health Service (Excluding Nursing)

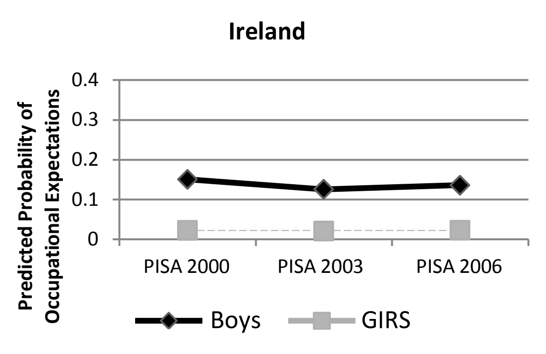


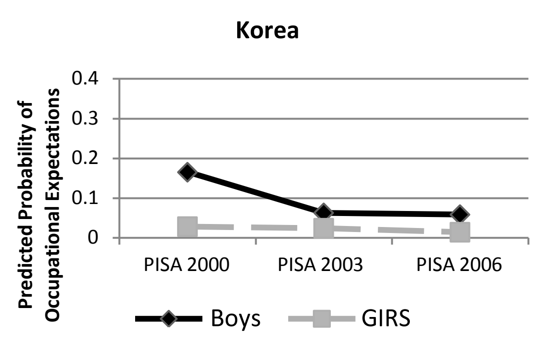


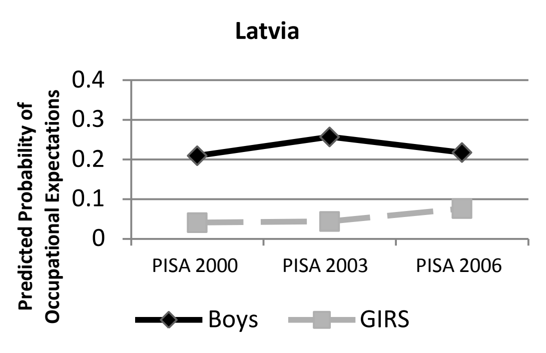


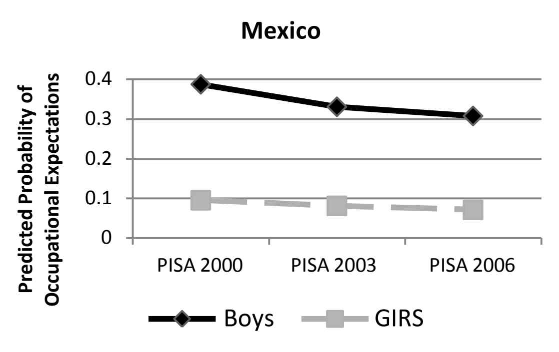


Computing and Engineering (CE)

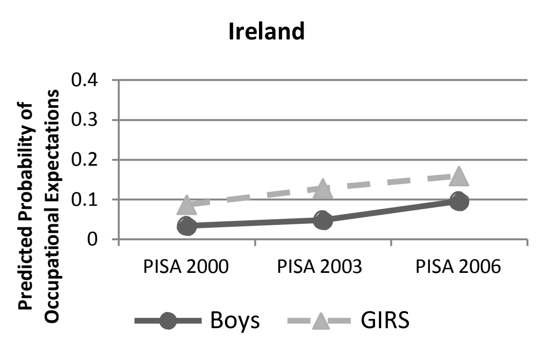


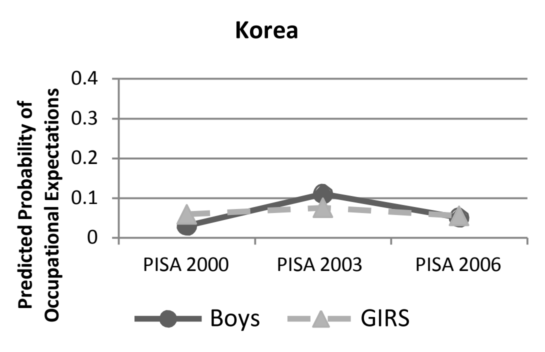


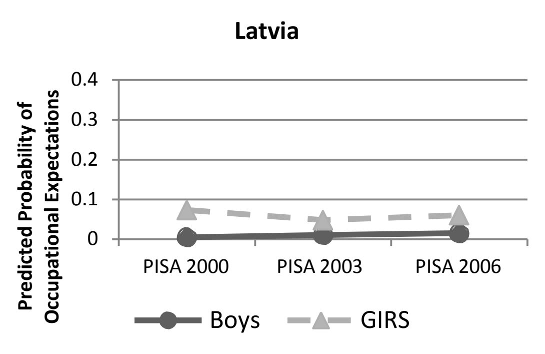


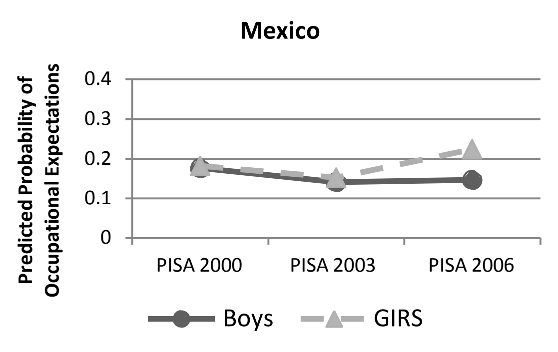


Health Service (Excluding Nursing)

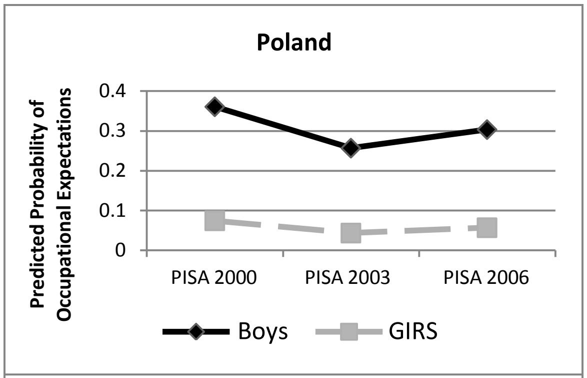


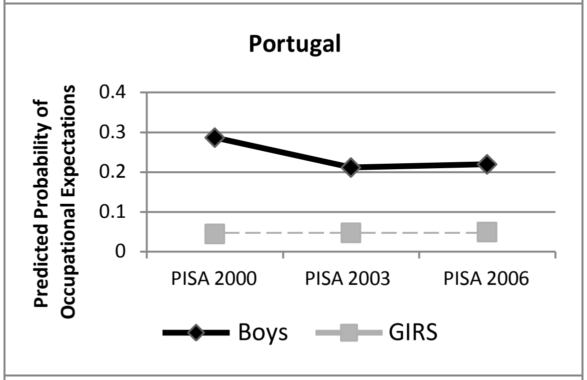


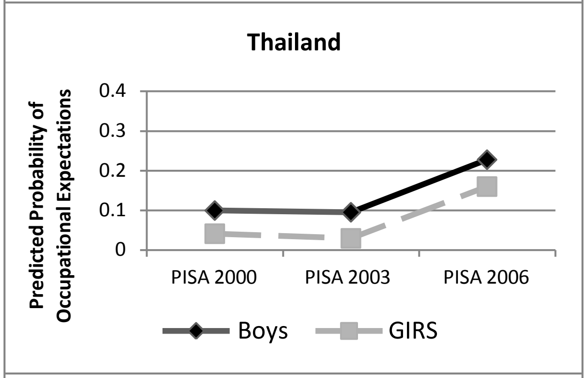


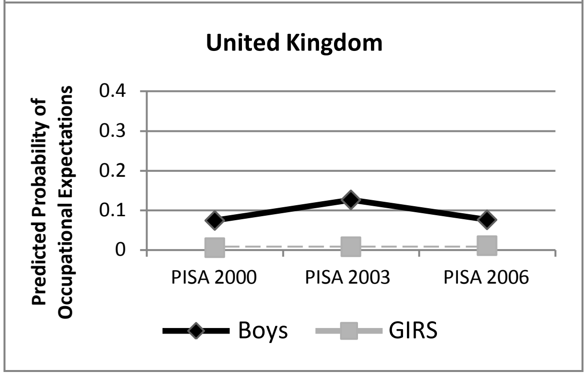


Computing and Engineering (CE)

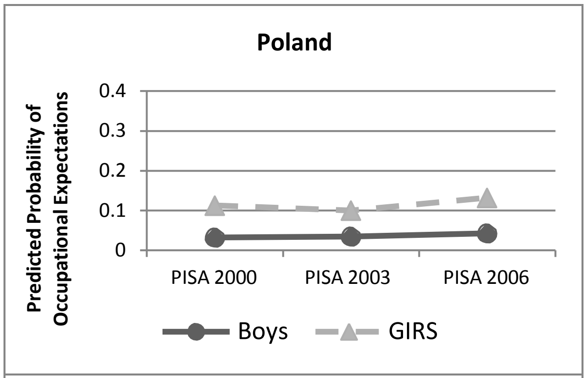

Poland

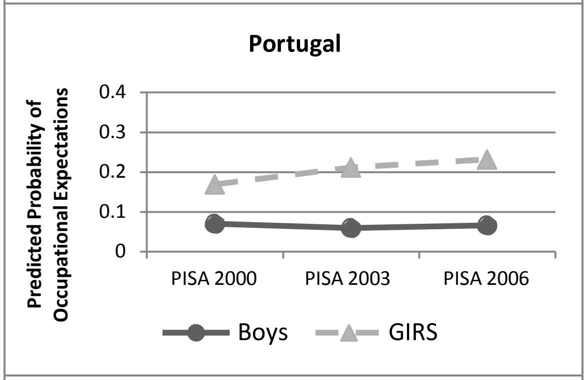

Portugal

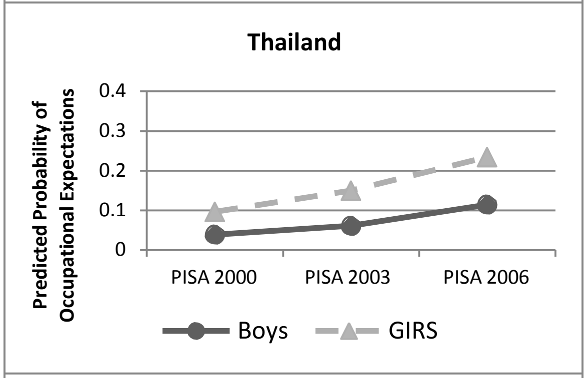

Thailand

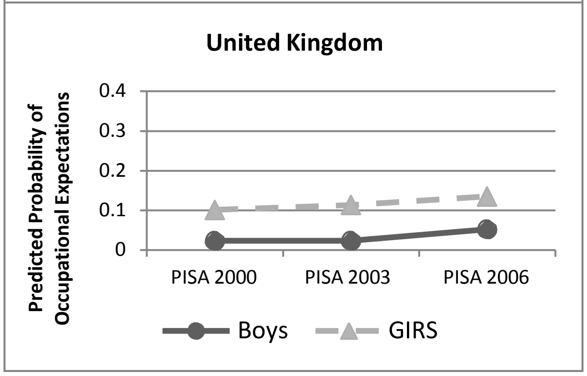

United Kingdom

Health Service (Excluding Nursing)

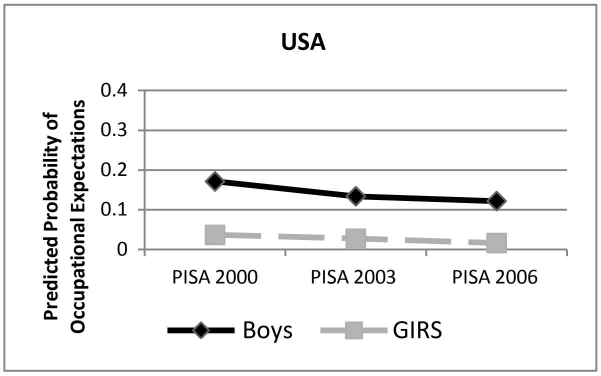

Poland


Portugal

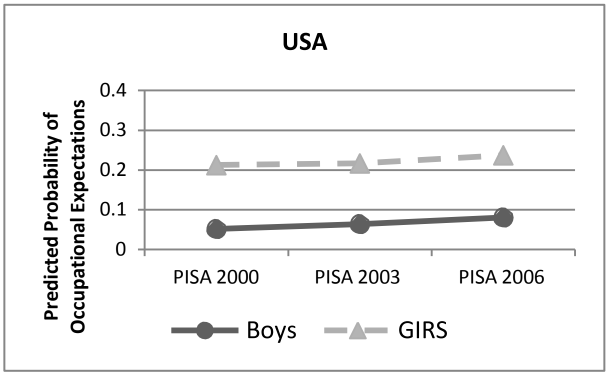

Thailand


United Kingdom

Computing and Engineering (CE)



Health Service (Excluding Nursing)



CHAPTER 8. Conclusions

In many countries, policymakers and researchers are concerned about low levels of interest in STEM education and occupations among students as well as the continuing underrepresentation of women in STEM fields. Prior research has revealed cross-national differences in students' STEM occupational expectations. In countries such as Japan and Korea, which have low levels of interest in STEM education and occupations compared to neighboring countries and other developed countries, this lack of interest is viewed as problematic because STEM graduates are increasingly central to national economic competitiveness in a global economy. While a small number of international reports have suggested that the characteristics of education systems might be linked to cross-national differences in STEM occupational expectations (OECD, 2009b), there has been little research on these associations. Using large-scale international surveys and student achievement data from the Programme for International Student Assessment (PISA) 2000, 2003, and 2006, I found that differences in both national education systems and labor markets were associated with cross-national variation in students' STEM occupational expectations. In this chapter, I summarize the findings from each chapter and discuss the implications for future research that could help researchers and policymakers better understand the sources of cross-national differences in STEM occupational expectations.

Schooling and STEM Occupational Expectations

First, the analyses in this study revealed that associations between features of secondary education systems and STEM occupational expectations differed across STEM subfields. The current study employed the standardization-stratification framework to classify national education systems. Standardization refers to the degree to which school curricula are standardized nationwide and stratification indicates the degree to which students are sorted into school types that are valued differently by higher education institutions and labor markets. Overall, higher levels of both curricular standardization and stratification in secondary education were linked to lower student expectations for health service occupations. In contrast, students' computing and engineering (CE) occupational expectations were not associated with any of the characteristics of secondary education systems measured in the current study—the standardization of curriculum, the number of school types available to 15-year-old students, or early tracking.

Second, the associations between the features of national education systems and STEM-related occupational expectations differed by gender. Across all levels of standardization, health services occupational expectations were higher among girls than among boys; however, higher levels of curricular standardization were associated with lower health service occupational expectations among girls, but boys' expectations remained constant across different levels of standardization. As a result of this pattern, higher levels of curricular standardization were tied to smaller gender gaps in health service occupational expectations. Notably, the smaller gender gap reflected low levels of expectations among girls in standardized systems, rather than high levels among boys.

Stratified education systems were not associated with cross-national variation of gender gaps in STEM occupational expectations. Levels of stratification in a country's secondary education system were not associated with either boys' or girls' occupational expectations for CE, indicating that levels of stratification were not linked to gender gaps in CE occupational expectations. In contrast, stratification in education systems was linked to lower health service occupational expectations for both boys and girls.

Finally, the association between the features of national education systems and certain types of student STEM occupational expectations differed across student performance levels. Specifically, the negative association between standardized systems and health service occupational expectations was stronger for low performers in science than for top performers. However, the negative association between stratified systems and heath service occupational expectations remained consistent across performance levels.

Due to the limitations of the cross-sectional data used in the current study, exactly *why* students in countries with higher levels of both curricular standardization and educational stratification are less likely to expect STEM occupations remains unclear. However, there are several possible mechanisms governing this association. For example, in standardized education systems, learning, teaching, and assessment standards are clear to students, which might lead students to make more realistic self-assessments and thus have lower levels of interest in STEM occupations. Another possible explanation is that standardized systems might lower students' interest in learning and pursuing STEM careers because teaching and learning in standardized systems are less likely to be customized to characteristics of individual students. Further research is needed to investigate the extent to which national education systems are associated with students' motivations and attitudes toward science, for example student engagement in and enjoyment of science learning. Research on the link between enjoyment of science learning and curriculum standardization policy, for example, could help researchers and policymakers better understand why curriculum standardization is linked to lower STEM occupational expectations among students.

The findings of the current research suggest that policymakers and researchers need to pay attention to the unintended consequences of educational reforms. For example, further research is needed to investigate whether educational reforms such as national curriculum and assessment standards have unexpected negative consequences. Findings from large-scale international comparative survey studies of educational achievement, such as TIMSS and PISA, have influenced educational policies and practices. In Germany, for example, the results of PISA surveys have influenced educational discourse and resulted in a wide-ranging reform agenda that includes national curriculum and assessment standards (Breakspear, 2012; Ertl, 2006). In addition, a new field of empirical educational research was created in Germany (Neumann, Fischer, & Kauertz, 2010); this research has focused mainly on examining the effects of educational reforms (e.g., national educational standards, central exit exam) on student performance, in particular test scores. Policymakers and researchers need to examine whether national curriculum and assessment policies lower students' interest in STEM education and occupations even though these policies may improve students' test scores.

Labor Markets and STEM Occupational Expectations

This study found that several macro-level features of labor markets were associated with cross-national variation in students' STEM occupational expectations. Specifically, students in countries with greater income inequality were more likely to expect STEM occupations. Students in postindustrial economies were less likely than students in industrial economies to plan STEM occupations, although this negative association differed across STEM subfields. Compared to students in industrial economies, those in postindustrial economies were less likely to expect engineering occupations and more likely to expect computing-related occupations. Because employment opportunities in the health-related service sector tend to expand in postindustrial economies, students in these economies would maximize their employment opportunities by seeking health service occupations. However, this study found that in postindustrial economies, students were less likely to expect health service occupations. This study provided no support for rational choice accounts, which assert that students choose occupations in a way that maximizes their expected earnings and employment opportunities. For example, the economic incentives measured by STEM wage premiums were not associated with students' expectations for STEM occupations, net of student, school, and national characteristics.

However, further investigations of rational choice arguments are needed because the current research has certain limitations. First, this study did not examine all growing sub-service sectors in postindustrial economies; for example, further research is needed to examine students' expectations for "socio-cultural" occupations (Sikora & Pokropek, 2011) including law, art, and teaching-related occupations. Other growing service sectors in postindustrial economies include education, entertainment, modern communications, and creative arts-related occupations. If students choose future occupations based on growing job opportunities in service sectors, then students in postindustrial economies will be more likely to expect to have "socio-cultural" occupations than students in industrial economies.

Second, in order to reveal whether rational choice arguments govern students' occupational expectations, further research should investigate whether high school students have accurate information about employment opportunities and expected earnings in STEM occupations in a rapidly changing economic environment. It may be that high school students believe employment opportunities and expected earnings are important aspects of job choices, but do not have accurate information about the labor market.

Finally, in contrast to rational choice accounts, the current findings suggest that as students develop occupational preferences, they might consider other aspects of a job more important than employment opportunities and expected earnings. For example, students may think that generous holidays and short working hours, which allow workers to enjoy more leisure time, are the most important aspects of a job. In particular, as countries move toward postindustrial and economically prosperous societies with greater income equality, students may think that non-economic incentives (e.g., not too much pressure, a job that is interesting, or generous holidays) are more important than economic rewards such as good pay and employment opportunities. Further research is needed to investigate what aspects of jobs students consider important. Given the argument that demanding and inflexible working conditions in STEM fields make students avoid STEM occupations (van Langen & Dekkers, 2005), such research would help policymakers and educational researchers better understand why STEM occupations are not attractive to high school students.

Gender Stratification in the Labor Market and Gender Gaps in STEM Occupational Expectations

This study provided partial evidence that the gender-related experiences of adult women in the labor market are associated with girls' STEM occupational expectations. Specifically, greater female economic opportunities for high-status employment were linked to higher CE occupational expectations among girls. However, the associations between gender stratification in the labor market and gender gaps in occupational expectations differed across STEM subfields and PISA survey cycles. For example, greater female economic opportunities were linked to smaller gender gaps in CE occupational expectations in PISA 2000, but were not associated with gender gaps in PISA 2003 or PISA 2006. These findings suggest that interpretations of cross-country evidence based on a single wave of cross-sectional international data must be undertaken with caution.

Prior research has suggested that postindustrial economies, with their abundance of female-labeled service jobs, might encourage gender segregation in career expectations. However, the current study provides no support for this pattern. Both boys and girls were less likely to expect STEM occupations in postindustrial economies than in industrial economies, indicating that postindustrial economies were not associated with gender gaps in STEM occupational expectations. This lack of an association between postindustrial economy and gender gaps in occupational expectations remained consistent across both STEM subfields.

The finding that greater economic opportunities for high-status employment are linked to higher occupational expectations for male-dominant fields among girls suggest that changes in women’s status at the macro level would influence the occupational preferences of young adults. Possible factors underlying the positive association between women’s status at the societal level and girls’ expectations for STEM include social views on STEM occupations. For example, in countries where female economic opportunities for high-status employment are greater, the images of STEM occupations might be less likely to be stereotyped as masculine in families and schools. Further research is needed to examine how macro-level factors interact with micro-level factors (e.g., family, teachers, and peers) to form the occupational preference of youths. From a cross-national comparative perspective, research on cross-national differences in the proportion of female math and science teachers in secondary schools, and the association between these differences and gender gaps in STEM occupational expectations would further the scholarly understanding of how gender gaps in STEM occupational expectations can be reduced.

National Trends in STEM Occupational Expectations

The analyses in this study revealed several noteworthy national trends in STEM occupational expectations. In many countries students’ CE occupational expectations changed between PISA 2000 and PISA 2006, while students’ health service occupational expectations remained constant. In particular, many developed countries experienced downward national trends in CE occupational expectations among top performers in science. This study also found gender differences in national trends in STEM occupational expectations. In many countries boys’ CE occupational expectations decreased between PISA 2000 and PISA 2006, while girls’ STEM occupational expectations remained unchanged in both subfields. Finally, the gender gaps in CE occupational expectations converged in many countries, but this convergence was not due to increases in CE occupational expectations among girls, but rather decreases in expectations among boys.

Recent studies in several countries, including Japan and Korea, have led to concerns that students in these countries have low levels of interest in STEM education and occupations compared to students in other countries. However, little attention has been paid to cross-national measurement issues. Researchers need to develop a measure that is comparable across countries to capture students’ intentions of pursuing science-related tertiary education and occupations.

One of the policy goals in many countries is to promote engagement in STEM education and occupations among students, especially academically talented students, because the demand for highly skilled STEM workers is growing rapidly in response to global economic competition. The current findings—national declines in CE occupational expectations among top performers in science—will most likely be viewed as problematic in several countries. However, these findings should be interpreted with caution because fully capturing changes in national trends with only six years of PISA data is difficult. Further research should use data collected over longer periods to investigate whether students' interest in STEM education and occupations increased or decreased in a variety of countries, and whether these patterns varied by student characteristics and performance levels. Moreover, future research must focus on factors that can explain the national trends in student interest in STEM education and occupations.

Implications

Policymakers and researchers in many countries assert that fostering students' interest in STEM careers is an important policy goal in its own right. The main finding of this study—that associations between students' STEM-related occupational expectations and macro-level educational and economic contexts differ across STEM subfields and by student gender—can guide efforts to foster student interest in STEM occupations. Current educational reform discourses about improving students' engagement in STEM education and occupations tend to focus on general STEM fields. However, to effectively promote students' engagement in STEM education and occupations, policymakers and researchers must narrow their policy goals and focus on the factors that are associated with students' engagement in specific STEM subfields.

Policymakers and researchers in many developed countries, including Korea and Japan, have concerns about top-performing students' flight from mathematics, the natural sciences, and engineering. However, little is known about the factors that make STEM occupations an attractive career choice among high school students who are talented in math and science. The finding of this research project—that the associations between the features of education systems and students' STEM occupational expectations differ across student performance levels—suggests that the factors that make STEM occupations attractive might differ across student performance levels. This study found that features of national education systems were not associated with the STEM occupational expectations of top performers in science. Thus, more attention should be focused a wide range of economic and social factors that may make STEM occupations attractive in the eyes of students who perform well in math and science. Further research should also investigate whether these factors vary across STEM subfields and by gender.

Over the past several decades, reducing gender inequality in STEM education and occupations has become a primary concern for education policymakers and researchers in many countries. To promote women's participation in STEM education and occupations, it is essential to promote girls' engagement in STEM education and occupations before they enter college. In the current study, both features of national education systems and gender stratification in the labor market were associated with girls' STEM occupational expectations. Higher levels of curricular standardization were linked to lower STEM occupational expectations among girls, whereas greater female economic opportunities were tied to higher expectations among girls. Because improving women's status at the macro level is a slow process, policymakers and education researchers must focus on how to emphasize gender-equitable approaches in educational settings. For example, featuring female math and science teachers and successful female figures in STEM fields as role models in textbooks might have a positive influence on girls' expectations for STEM careers. In particular, policymakers and education researchers in developing countries that have greater levels of gender inequality might need to focus on gender bias in textbooks and curriculum to promote girls' engagement in STEM education and occupations.

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Appendices

Appendix 2.1. Occupational tiles comprising science, engineering/computing and health employment

STEM-related careers

2100 physical, mathematical & engineering science professionals
2110 physicists, chemists & related professionals
2111 physicists & astronomers
2112 meteorologists
2113 chemists
2114 geologists & geophysicists [incl. geodesist]
2120 mathematicians, statisticians etc professionals
2121 mathematicians etc professionals
2122 statisticians [incl. actuary]
2130 computing professionals
2131 computer systems designers & analysts [incl. software engineer]
2132 computer programmers
2139 computing professionals not elsewhere classified
2140 architects, engineers etc professionals
2141 architects town & traffic planners [incl. landscape architect]
2142 civil engineers [incl. construction engineer]
2143 electrical engineers
2144 electronics & telecommunications engineers
2145 mechanical engineers
2146 chemical engineers
2147 mining engineers, metallurgists, etc, professionals
2148 cartographers & surveyors
2149 architects engineers etc professionals not elsewhere classified [incl. consultant]
2200 life science & health professionals
2210 life science professionals
2211 biologists, botanists zoologists etc professionals
2212 pharmacologists, pathologists etc profess. [incl. biochemist]
2213 agronomists etc professionals
2220 health professionals (except nursing)
2221 medical doctors
2222 dentists
2223 veterinarians
2224 pharmacists
2229 health professionals except nursing not elsewhere classified
2230 nursing & midwifery profess. [incl. registered nurses, midwives]
2445 psychologists
3000 technicians and associate professionals
3100 physical & engineering science associate professionals
3110 physical & engineering science technicians
3111 chemical & physical science technicians
3112 civil engineering technicians
3113 electrical engineering technicians
3114 electronics & telecommunications engineering technicians

3115 mechanical engineering technicians
3116 chemical engineering technicians
3117 mining & metallurgical technicians
3118 draughtspersons [incl. technical illustrator]
3119 physical & engineering science technicians not elsewhere classified
3130 optical & electronic equipment operators
3131 photographers & electronic equipment operators
3132 broadcasting & telecommunications equipment operators
3133 medical equipment operators [incl. x-ray technician]
3139 optical & electronic equipment operators not elsewhere classified
3140 ship & aircraft controllers & technicians
3141 ships engineers
3142 ships deck officers & pilots [incl. river boat captain]
3143 aircraft pilots etc associate professionals
3144 air traffic controllers
3145 air traffic safety technicians
3150 safety and quality inspectors
3151 building and fire inspectors
3152 safety, health & quality inspectors
3200 life science & health associate professionals
3210 life science technicians etc associate professionals
3211 life science technicians [incl. medical laboratory assistant]
3212 agronomy & forestry technicians
3213 farming & forestry advisers
3220 modern health associate professionals except nursing
3221 medical assistants
3222 sanitarians
3223 dieticians & nutritionists
3224 optometrists & opticians [incl. dispensing optician]
3225 dental assistants [incl. oral hygienist]
3226 physiotherapists etc associate professionals
3227 veterinary assistants [incl. veterinarian vaccinator]
3228 pharmaceutical assistants
3229 modern health associate professionals except nursing not elsewhere classified
3230 nursing & midwifery associate professionals
3231 nursing associate professionals [incl. trainee nurses]
3232 midwifery associate professionals [incl. trainee midwife]
3434 statistical, mathematical etc associate professionals

Careers in computing and engineering

2100 physical, mathematical & engineering science professionals
2130 computing professionals
2131 computer systems designers & analysts [incl. software engineer]
2132 computer programmers
2139 computing professionals not elsewhere classified
2140 architects, engineers etc professionals
2141 architects town & traffic planners [incl. landscape architect]
2142 civil engineers [incl. construction engineer]
2143 electrical engineers

2144 electronics & telecommunications engineers
2145 mechanical engineers
2146 chemical engineers
2147 mining engineers, metallurgists etc professionals
2148 cartographers & surveyors
2149 architects engineers etc professionals not elsewhere classified [incl. consultant]
3100 physical & engineering science associate professionals
3110 physical & engineering science technicians
3112 civil engineering technicians
3113 electrical engineering technicians
3114 electronics & telecommunications engineering technicians
3115 mechanical engineering technicians
3116 chemical engineering technicians
3119 physical & engineering science technicians not elsewhere classified
3141 ships engineers

Careers in health services

2200 life science & health professionals
2212 pharmacologists, pathologists etc profess. incl. biochemist
2220 health professionals (except nursing)
2221 medical doctors
2222 dentists
2223 veterinarians
2224 pharmacists
2229 health professionals except nursing nec
2230 nursing & midwifery profess. incl. registered nurses, midwives
3152 safety, health & quality inspectors
3220 modern health associate professionals except nursing
3221 medical assistants
3222 sanitarians
3223 dieticians & nutritionists
3224 optometrists & opticians incl. dispensing optician
3225 dental assistants incl. oral hygienist
3226 physiotherapists etc associate professionals
3227 veterinary assistants incl. veterinarian vaccinator
3228 pharmaceutical assistants
3229 modern health associate professionals except nursing nec
3230 nursing & midwifery associate professionals
3231 nursing associate professionals incl. trainee nurses
3232 midwifery associate professionals incl. trainee midwife

Appendix 2.2. Missing data on occupational expectations, total and by gender

	PISA 2000						PISA 2003						PISA 2006					
	All students		Boys		Girls		All students		Boys		Girls		All students		Boys		Girls	
OECD	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)	mean (%)	S.E. (%)
Australia	5.95	0.6	6.03	0.47	4.01	0.43	10.54	4.77	14.78	2.37	10.78	0.86	14.56	2.22	16.49	0.52	10.26	0.48
Austria	7.65	0.97	7.44	0.78	6.27	0.71	13.75	0.69	15.1	0.90	12.54	0.88	17.66	0.74	22.37	0.93	12.72	0.85
Belgium	21.89	0.82	21.84	0.86	20.53	0.9	11.23	1.23	13.65	0.69	9.75	0.69	9.82	0.69	11.3	0.72	7.65	0.48
Canada	6.44	0.65	6.20	0.34	4.26	0.29							5.45	0.87	7.00	0.46	3.05	0.24
Czech Republic	7.38	1.44	9.94	1.00	5.78	0.42	7.98	3.79	10.69	1.13	9.30	1.63	19.49	2.77	25.03	0.95	15.42	0.87
Denmark	63.28	0.85	60.89	1.1	65.42	1.00							6.16	0.72	6.69	0.84	5.98	0.65
Finland	15.63	0.59	16.57	0.74	14.71	0.80							9.59	0.46	12.48	0.69	6.66	0.47
France	8.56	0.91	9.22	0.86	7.32	0.82	11.67	0.99	14.71	0.81	9.73	0.67	21.71	0.86	25.62	1.21	17.89	0.96
Germany	16.87	4.05	21.49	1.07	15.82	1.04	16.33	2.33	19.87	1.02	15.1	0.83						
Greece	8.13	1.15	9.85	1.00	5.90	1.03	4.95	0.39	5.53	0.53	4.41	0.48	20.98	0.72	23.04	1.02	18.85	0.78
Hungary	8.19	0.71	8.41	0.68	8.24	0.72							20.44	0.86	27.56	1.30	13.41	0.76
Iceland	7.98	0.49	8.33	0.68	6.04	0.60	8.16	0.68	7.78	0.66	8.10	0.7	17.91	1.18	22.42	1.02	13.97	0.81
Ireland	4.75	0.46	5.58	0.61	2.81	0.39	9.94	0.46	11.95	0.69	7.94	0.73	23.49	0.76	28.01	1.02	19.28	0.92
Italy	6.58	0.69	7.81	0.63	5.31	0.55	9.18	0.96	11.32	0.83	7.60	1.17	10.32	0.66	12.98	0.91	7.93	0.68
Japan	22.98	1.81	23.4	2.1	23.24	1.66	7.99	0.59	8.57	0.65	7.09	0.56	7.95	0.42	8.68	0.55	7.26	0.44
Korea	5.84	0.67	5.85	0.61	5.00	0.53							13.78	0.56	14.59	0.80	12.86	0.82
Luxembourg	22.62	1.39	27.48	1.18	16.77	0.85	2.33	0.21	2.75	0.25	1.76	0.29	3.57	0.41	4.21	0.46	2.64	0.33
Mexico	10.98	0.64	10.73	0.62	7.37	0.63							7.40	0.40	11.14	0.56	3.71	0.42
Netherland	3.84	0.54	3.60	0.70	3.27	0.53	15.73	8.74	22.36	1.35	17.9	1.75	16.04	1.90	20.99	0.93	13.13	0.74
New Zealand	13.72	0.64	15.6	0.95	11.28	0.77							3.59	0.39	4.45	0.38	2.92	0.45
Norway	7.98	0.62	8.30	0.77	5.79	0.68							12.15	0.51	16.42	0.73	8.37	0.62
Poland	27.34	1.36	27.02	1.79	27.63	1.62												
Portugal	8.18	0.69	9.22	0.79	6.93	0.65	8.31	0.58	9.21	0.69	7.30	0.76	18.65	1.16	23.5	1.19	14.32	0.83
Slovak Republic							8.53	1.05	8.65	0.83	7.60	0.7	12.48	0.66	14.62	0.61	10.85	0.75
Spain	7.74	0.61	7.97	0.68	5.54	0.66	5.43	0.41	5.85	0.45	4.76	0.49	4.05	0.35	3.96	0.47	4.12	0.48
Sweden	5.64	0.48	5.21	0.51	5.22	0.60							12.60	0.80	16.42	1.08	8.91	0.69
Switzerland	11.69	0.66	14.85	0.78	8.22	0.67							19.11	1.91	25.19	0.91	14.73	0.57
Turkey													8.44	0.59	10.57	0.79	6.49	0.52
United													8.95	0.88	10.87	0.68	7.68	0.52
Kingdom	5.87	1.23	4.51	0.65	3.52	0.51							18.88	3.29	25.88	1.47	13.88	0.98

United States	21.74	2.07	24.59	2.2	18.48	2.04	15.65	0.96	19.14	0.83	12.89	0.69	7.41	0.77	9.21	0.76	5.14	0.65
Partners																		
Albania	23.13	1.39	29.11	1.78	16.45	1.32												
Argentina	15.72	5.18	21.61	1.93	15.66	2.51							10.28	2.98	14.07	1.67	9.50	1.01
Azerbaijan													32.2	2.67	36.43	1.72	29.78	1.51
Brazil	18.13	1.02	19.11	1.00	15.26	1.22							13.86	1.40	17.95	0.82	9.15	0.58
Bulgaria	2.30	0.46	2.82	0.59	1.84	0.47							20.77	1.04	22.27	1.00	19.99	1.00
Chile	0.10	0.03	0.00	0.00	0.00	0.00							13.91	1.86	16.41	1.21	12.54	1.11
Chinese Taipei													5.33	0.80	6.31	0.50	4.99	0.48
Columbia													8.42	0.76	11.02	1.01	6.35	0.69
Croatia													12.49	0.70	16.87	1.03	8.19	0.60
Estonia													14.35	0.75	15.75	0.90	12.99	0.96
Hong Kong	0.61	0.29	0.66	0.27	0.62	0.34	20.32	1.99	24.18	1.34	18.2	1.02	9.67	0.75	12.86	0.87	6.99	0.63
Indonesia	15.05	2.87	13.88	1.52	13.70	1.91	20.25	1.81	21.47	1.50	18.1	1.62	19.64	1.77	19.70	2.08	18.54	1.23
Israel	35.55	8.53	41.47	2.62	37.97	3.56							39.55	1.08	44.32	1.60	35.01	1.38
Jordan													22.08	4.72	36.08	2.01	12.75	0.53
Kyrgyzstan													30.95	2.89	41.51	1.56	24.13	1.17
Latvia	26.00	0.97	26.79	1.54	23.73	1.23	45.19	11.27	40.86	3.26	38.76	3.43	16.06	1.46	22.27	1.28	11.31	0.83
Liechtenstein	17.52	2.11	16.04	3.03	17.63	3.01							10.32	1.64	12.05	2.43	8.66	2.18
Lithuania													12.61	0.72	15.04	0.95	9.73	0.67
Macao-China							22.48	2.56	22.44	1.93	20.42	1.74	15.04	1.07	17.64	0.74	13.35	0.73
Macedonia	18.32	0.84	22.91	1.02	12.49	0.79												
Montenegro													20.43	0.65	22.09	0.96	18.83	0.90
Peru	22.35	1.39	23.94	1.30	20.61	1.19												
Romania	5.57	0.59	6.60	0.97	4.69	0.47							4.40	0.68	5.15	0.84	3.91	0.61
Russian Federation	10.8	0.73	12.38	1.03	9.14	0.83							15.30	0.67	20.61	0.77	10.10	0.71
Serbia													8.86	0.56	10.36	0.80	7.16	0.59
Slovenia													15.94	2.65	18.09	0.79	11.29	0.72
Thailand	7.49	1.60	8.89	1.15	5.36	0.78	11.82	1.84	17.17	1.43	8.97	0.68	20.62	3.11	29.48	1.53	16.65	0.97
Tunisia													13.15	0.84	17.70	1.26	8.90	0.84
Uruguay													8.49	1.76	12.33	0.93	6.35	0.49
Yugoslavia							13.55	1.00	14.77	0.90	11.65	0.95						

Appendix 3.1 List of countries used in HGLM analyses

	PISA2000	PISA2003	PISA2006	Pooled
OECD				
Australia				
Austria	√	√	√	√
Belgium	√	√	√	√
Canada			√	
Czech Republic	√	√	√	√
Denmark	√			
Finland	√		√	
France	√			√
Germany	√	√	√	√
Greece	√	√	√	√
Hungary	√	√	√	√
Iceland		√	√	√
Ireland	√		√	√
Italy		√	√	√
Japan			√	
Korea	√	√	√	√
Luxembourg	√		√	
Mexico	√	√	√	√
Netherland	√		√	
New Zealand	√		√	
Norway	√		√	
Poland	√	√	√	√
Portugal	√	√	√	√
Slovak Republic		√	√	
Spain	√			
Sweden	√		√	
Switzerland	√		√	
Turkey				
United Kingdom	√	√	√	√
United States	√	√	√	√
Partners				
Albania				
Argentina	√		√	
Azerbaijan				
Brazil	√			
Bulgaria	√		√	

Chile	√		√	
Chinese Taipei			√	
Columbia			√	
Croatia			√	
Estonia			√	
Hong Kong	√	√	√	√
Indonesia	√	√	√	√
Israel	√		√	
Jordan			√	
Kyrgyzstan			√	
Latvia	√	√	√	√
Liechtenstein	√			
Lithuania			√	
Macao-China			√	
Romania	√		√	
Russian Federation	√		√	
Serbia				
Slovenia			√	
Thailand	√	√	√	√
Tunisia			√	
Uruguay			√	
Yugoslavia		√		

Appendix 3.2 Variance decomposition in the unadjusted model

Intra-class correlation in the analysis of clustered or longitudinal data can be estimated for continuous data. Recently several researchers show how to extend the classic intra-class correlation formula to the estimation of intra-class correlation in random-effects models for binary data (Kaplan, Kim, & Kim, 2009, p. 233). This formula can be written as:

$$\rho_{Ic} = \frac{\tau_c^2}{\tau_c^2 + \pi^2/3}$$

where $\tau_c^2$is the level-2 variance and $\pi^2/3 \approx 3.29$. This formula can be extended to the three-level HGLM in estimating the proportion of total variance. The following tables report the proportion of total variance at the school and country level for each outcome measure analyzed in this study.

General STEM	PISA 2000		PISA 2003		PISA 2006	
Random Effect	Variance Component	Proportion of total variation	Variance Component	Proportion of total variation	Variance Component	Proportion of total variation
Level2 (r_{ojk})	0.261	0.070	0.314	0.084	0.284	0.077
Level3 (u_{00k})	0.161	0.043	0.134	0.036	0.132	0.036

Computing and Engineering	PISA 2000		PISA 2003		PISA 2006	
Random Effect	Variance Component	Proportion of total variation	Variance Component	Proportion of total variation	Variance Component	Proportion of total variation
Level2 (r_{ojk})	0.344	0.092	0.417	0.107	0.421	0.109
Level3 (u_{00k})	0.122	0.033	0.192	0.049	0.152	0.039

Health Service Including Nursing	PISA 2000		PISA 2003		PISA 2006	
Random Effect	Variance Component	Proportion of total variation	Variance Component	Proportion of total variation	Variance Component	Proportion of total variation
Level2 (r_{ojk})	0.333	0.086	0.366	0.093	0.306	0.082
Level3 (u_{00k})	0.247	0.064	0.276	0.070	0.148	0.040

Health Service Excluding Nursing	PISA 2000		PISA 2003		PISA 2006	
Random Effect	Variance Component	Proportion of total	Variance Component	Proportion of total	Variance Component	Proportion of total

		variation		variation		variation
Level2 (r_{ojk})	0.296	0.077	0.370	0.095	0.315	0.082
Level3 (u_{00k})	0.239	0.062	0.246	0.063	0.220	0.058

Appendix 4.1 List of countries used in HGLM analyses

	PISA2000	PISA2003	PISA2006	Pooled
OECD				
Australia				
Austria	√	√	√	√
Belgium	√	√	√	√
Canada			√	
Czech Republic	√	√	√	√
Denmark	√			
Finland	√		√	
France				
Germany	√	√	√	√
Greece	√	√	√	√
Hungary	√	√	√	√
Iceland		√	√	√
Ireland	√		√	√
Italy		√	√	√
Japan			√	
Korea	√	√	√	√
Luxembourg				
Mexico	√	√	√	√
Netherland	√		√	
New Zealand	√		√	
Norway	√		√	
Poland	√	√	√	√
Portugal	√	√	√	√
Slovak Republic		√	√	
Spain	√			
Sweden	√		√	
Switzerland	√		√	
Turkey				
United Kingdom	√	√		√
United States	√	√	√	√
Partners				
Albania				
Argentina			√	
Azerbaijan				
Brazil				
Bulgaria			√	
Chile	√		√	
Chinese Taipei				
Columbia			√	

Croatia			√	
Estonia			√	
Hong Kong				
Indonesia		√	√	√
Israel	√		√	
Jordan			√	
Kyrgyzstan			√	
Latvia	√	√	√	√
Liechtenstein				
Lithuania			√	
Macao-China				
Romania	√		√	
Russian Federation	√		√	
Serbia				
Slovenia				
Thailand		√	√	√
Tunisia				
Uruguay			√	
Yugoslavia		√		

Appendix 5.1 List of countries used in HGLM analyses

	Gini index and postindustrial economies				STEM wage expectations
	PISA2000	PISA2003	PISA2006	Pooled	PISA2006
OECD					
Australia					
Austria	√	√	√	√	√
Belgium	√	√	√	√	
Canada			√		√
Czech Republic	√	√	√	√	√
Denmark	√				
Finland	√		√		√
France	√			√	
Germany	√	√	√	√	√
Greece	√	√	√	√	
Hungary	√	√	√	√	√
Iceland		√	√	√	
Ireland	√		√	√	
Italy		√	√	√	√
Japan			√		√
Korea	√	√	√	√	√
Luxembourg					
Mexico	√	√	√	√	√
Netherland	√		√		
New Zealand	√		√		
Norway	√		√		√
Poland	√	√	√	√	√
Portugal	√	√	√	√	√
Slovak Republic		√	√		√
Spain	√				
Sweden	√		√		
Switzerland	√		√		
Turkey					
United Kingdom	√	√	√	√	√
United States	√	√	√	√	√
Partners					
Albania					
Argentina	√		√		
Azerbaijan					
Brazil	√				
Bulgaria	√		√		
Chile	√		√		

Chinese Taipei					
Columbia			√		
Croatia			√		
Estonia			√		
Hong Kong	√	√	√	√	
Indonesia	√	√		√	√
Israel	√		√		
Jordan					
Kyrgyzstan			√		
Latvia	√	√	√	√	√
Liechtenstein					
Lithuania			√		√
Macao-China			√		
Romania	√		√		√
Russian Federation	√		√		√
Serbia					
Slovenia			√		
Thailand	√	√	√	√	√
Tunisia					
Uruguay			√		
Yugoslavia		√			

Appendix 5.2 Correlation matrix for country-level variables

PISA 2006 Data	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Educational Expenditure as % of GDP	1								
(2) GDP per capita	0.391**	1							
(3) GINI index	-0.409**	-0.453**	1						
(4) Postindustrial Economy	0.528**	0.689**	-0.171	1					
(5) STEM Wage Premium (I): Chemical Engineer	-0.485**	-0.240	0.494**	-0.177	1				
(6) STEM Wage Premium (II): Power Distribution Engineer	-0.479**	-0.271	0.501*	-0.142	0.967**	1			
(7) STEM Wage Premium (III): Computer	-0.339	-0.344	0.425*	-0.001	0.800**	0.862**	1		
(8) STEM Wage Premium (IV): General Physician	-0.448*	0.056	0.429*	-0.088	0.768**	0.752**	0.298**	1	
(9) STEM Wage Premium (V): Professional	-0.450*	-0.197	0.546**	-0.107	0.836**	0.856**	0.848**	0.538*	1

PISA 2003 Data	(1)	(2)	(3)	(4)
(1) Educational Expenditure as % of GDP	1			
(2) GDP per capita	0.409*	1		
(3) GINI index	-0.303	-0.327	1	
(4) Postindustrial Economy	0.371	0.707**	-0.258	1

PISA 2000 Data	(1)	(2)	(3)	(4)
(1) Educational Expenditure as % of GDP	1			
(2) GDP per capita	0.452**	1		
(3) GINI index	-0.483**	-0.332*	1	
(4) Postindustrial Economy	0.479**	0.716**	-0.215	1

Appendix 6.1 List of countries used in HGLMs analyses

	PISA2000	PISA2003	PISA2006	Pooled
OECD				
Australia				
Austria	√	√	√	√
Belgium	√	√	√	√
Canada			√	
Czech Republic	√	√	√	√
Denmark	√			
Finland	√		√	
France	√			√
Germany	√	√	√	√
Greece	√	√	√	√
Hungary	√	√	√	√
Iceland		√	√	√
Ireland	√		√	√
Italy		√	√	√
Japan			√	
Korea	√	√	√	√
Luxembourg				
Mexico	√	√	√	√
Netherland	√		√	
New Zealand	√		√	
Norway	√		√	
Poland	√	√	√	√
Portugal	√	√	√	√
Slovak Republic		√	√	
Spain	√			
Sweden	√		√	
Switzerland	√		√	
Turkey				
United Kingdom	√	√	√	√
United States	√	√	√	√
Partners				
Albania				
Argentina	√		√	
Azerbaijan				
Brazil	√			
Bulgaria	√		√	
Chile	√		√	
Chinese Taipei				

Columbia			√	
Croatia			√	
Estonia			√	
Hong Kong	√	√	√	√
Indonesia	√	√		√
Israel	√		√	
Jordan				
Kyrgyzstan			√	
Latvia	√	√	√	√
Liechtenstein				
Lithuania			√	
Macao-China			√	
Romania	√		√	
Russian Federation	√		√	
Serbia				
Slovenia			√	
Thailand	√	√	√	√
Tunisia				
Uruguay			√	
Yugoslavia		√		

Appendix 6.2 Correlation matrix for country-level variables

PISA2006 Data	(1)	(2)	(3)	(4)	(5)	(6)
(1) Educational Expenditure	1					
(2) GDP per capita	0.391**	1				
(3) GINI index	-0.409*	-0.453**	1			
(4) Labor force % female	0.223	0.238	-0.301*	1		
(5) Professions % female	-0.005	-0.287*	-0.087	0.652**	1	
(6) Postindustrial Economy	0.538**	0.689**	-0.171	0.349*	-0.001	1

PISA2003 Data	(1)	(2)	(3)	(4)	(5)	(6)
(1) Educational Expenditure	1					
(2) GDP per capita	0.409*	1				
(3) GINI index	-0.303	-0.327	1			
(4) Labor force % female	0.331	0.189	-0.350	1		
(5) Professions % female	0.216	0.086	-0.068	0.587**	1	
(6) Postindustrial Economy	0.371	0.707**	-0.258	0.403	0.416*	1

PISA2000 Data	(1)	(2)	(3)	(4)	(5)	(6)
(1) Educational Expenditure	1					
(2) GDP per capita	0.452**	1				
(3) GINI index	-0.332*	-0.483**	1			
(4) Labor force % female	0.157	0.361*	-0.534**	1		
(5) Professions % female	-0.355*	-0.089	-0.220	0.611**	1	
(6) Postindustrial Economy	0.716**	0.479**	-0.215	0.301	-0.085	1

Appendix 6.3. Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for Computing and Engineering (CE) Occupations (ISCO-88 Major Groups 2 and 3) for Pooled Data from PISA 2000, 2003, and 2006 by Gender

	Boys			Girls		
	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-2.103	0.122	0.322***	-2.868	0.057	0.463***
School-level:						
PISA 2003	-0.065	0.937	0.068	0.035	1.036	0.090
PISA 2006	-0.110	0.896	0.091	0.083	1.086	0.104
Country-level:						
Labor force % female	-0.041	0.960	0.036	-0.095	0.909	0.046†
Professions % female	0.026	1.026	0.015	0.037	1.037	0.013*
Postindustrial economy	0.115	1.121	0.119	-0.187	0.829	0.139
PISA2003*Labor force % female	-0.006	0.994	0.026	0.003	1.003	0.031
PISA2003*Professions % female	0.018	1.018	0.011	-0.006	0.994	0.012
PISA2003*Postindustrial economy	0.123	1.131	0.089	0.146	1.157	0.097
PISA2006*Labor force % female	0.028	1.028	0.034	0.105	1.111	0.034**
PISA2006*Professions % female	0.012	1.012	0.015	-0.021	0.979	0.012†
PISA2006*Postindustrial economy	-0.203	0.816	0.113†	-0.337	0.714	0.109**
N						
Countries		20			20	

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 6.1, except for student gender and ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Appendix 6.4. Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for Health Service (including Nursing) Occupations (ISCO-88 Major Groups 2 and 3) for Pooled Data from PISA 2000, 2003, and 2006 by Gender

	Boys			Girls		
	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-3.755	0.023	0.690***	-2.344	0.096	0.267***
School-level:						
PISA 2003 (γ_{010})	0.019	1.020	0.083	-0.036	0.965	0.071
PISA 2006 (γ_{020})	0.404	1.498	0.107**	0.099	1.104	0.061
Country-level:						
Labor force % female (γ_{005})	0.031	1.031	0.042	0.061	1.062	0.029†
Professions % female (γ_{006})	-0.032	0.969	0.018	-0.026	0.974	0.007**
Postindustrial economy (γ_{007})	-0.299	0.742	0.142†	-0.462	0.630	0.080***
PISA2003*Labor force % female	0.059	1.061	0.029†	0.026	1.027	0.026
PISA2003*Professions % female	-0.021	0.979	0.013	-0.002	0.998	0.007
PISA2003*Postindustrial economy	-0.092	0.912	0.098	-0.048	0.953	0.073
PISA2006*Labor force % female	0.049	1.051	0.036	0.018	1.018	0.020
PISA2006*Professions % female	0.002	1.002	0.018	0.009	1.009	0.006
PISA2006*Postindustrial economy	-0.013	0.987	0.127	-0.033	0.967	0.060
N						
Countries		20			20	

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 6.1, except for student gender and ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Appendix 6.5. Results of Hierarchical Bernoulli Logit Models to Explain Variation in Expectations for Health Service (excluding Nursing) Occupations (ISCO-88 Major Groups 2 and 3) for Pooled Data from PISA 2000, 2003, and 2006 by Gender

	Boys			Girls		
	β	O.R.	S.E.	β	O.R.	S.E.
Intercept	-3.752	0.023	0.726***	-2.651	0.071	0.321***
School-level:						
PISA 2003	0.011	1.011	0.083	0.022	1.023	0.063
PISA 2006	0.424	1.527	0.111**	0.220	1.246	0.073**
Country-level:						
Labor force % female	0.023	1.023	0.044	0.073	1.075	0.040†
Professions % female	-0.032	0.969	0.018	-0.038	0.963	0.010**
Postindustrial economy	-0.295	0.744	0.147†	-0.418	0.658	0.115**
PISA2003*Labor force % female	0.062	1.064	0.028*	0.022	1.022	0.024
PISA2003*Professions % female	-0.023	0.977	0.013*	0.000	1.000	0.006
PISA2003*Postindustrial economy	-0.078	0.925	0.096	-0.013	0.987	0.063
PISA2006*Labor force % female	0.053	1.055	0.037	0.015	1.015	0.024
PISA2006*Professions % female	0.001	1.001	0.018	0.014	1.015	0.007*
PISA2006*Postindustrial economy	0.013	1.013	0.131	-0.099	0.906	0.074
N						
Countries		20			20	

Each column reports results from one regression. All regressions control for all the student-level, school-level, and national-level variables reported in Table 6.1, except for gender and student ability.

***p≤.001, **p≤.01, *p≤.05, †p≤.10

β = Coefficient, O.R. = Odds Ratio, S.E. = Standard Error

Appendix 7.1 List of countries used in HGLM analyses

	PISA2000	PISA2003	PISA2006
OECD			
Austria	√	√	√
Belgium	√	√	√
Czech Republic	√	√	√
Germany	√	√	√
Greece	√	√	√
Hungary	√	√	√
Ireland	√	√	√
Korea	√	√	√
Mexico	√	√	√
Poland	√	√	√
Portugal	√	√	√
United Kingdom	√	√	√
United States	√	√	√
Partners			
Hong Kong	√	√	√
Indonesia	√	√	√
Latvia	√	√	√
Thailand	√	√	√