OUT-OF-FIELD TEACHING: A CROSS-NATIONAL STUDY ON TEACHER LABOR MARKET AND TEACHER QUALITY

by

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ABSTRACT

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In the past two decades, the issue of out-of-field teaching (OFT) has concerned policy makers and researchers alike who see raising teachers' subject matter knowledge as the main policy lever to improve teacher quality. The study of OFT has emerged as one of the important subfields of teacher quality and teacher labour market research. Researchers in the United States have found widespread and high reliance on out-of-field teachers at the secondary level. They argue that out-of-field teachers are so great in number that the negative influence on student learning is spreading. Researchers have argued that OFT could undermine efforts to improve teacher quality through the professionalization of the teaching occupation. Outside the United States, studies have found that out-of-field assignments exist in several countries. However, OFT as a phenomenon remains understudied in the international comparative literature. We are unaware of the exact nature and spread of OFT internationally. This study examines OFT from an international comparative perspective using the newly published data from OECD. I focus on math and science teachers who teach in public schools in 21 countries. Three questions are examined in this study. First, is there cross-national variations in out-of-field teaching? Second, what is the distribution of out-of-field teachers across schools? Third, are there any differences in teaching practices and received professional support between out-of-field and in-field teachers? I find out-of-field teachers share certain similar attributes: young and inexperienced teachers with substantial educational attainment who work on short contract and part-time bases. Out-of-field teachers are disproportionally concentrated in rural, small, and low-SES schools. While out-of-field teachers do not differ from in-field teachers in several measures of teaching practices

and time allocation, they were not given enough on-the-job development opportunities to improve their teaching skills.

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INTRODUCTION

When I started teaching in Yangguo Township Middle School, a rural village school located in northwestern China, teaching was very different than I expected. My college major was Statistics. After graduation, I decided to participate in a public campaign to call college graduates to serve the western provinces (or "Go west!" as they called it), in which the harsh natural environment and the stagnated economy severely limited development in education. I joined a non-governmental organization (NGO) which ran a network of about one hundred schools. Schools submitted proposals to the network seeking different kinds of help (libraries, computers, personnel, etc). I went to Yangguo because they specifically said they needed teachers. I expected to be assigned to teach a subject such as mathematics or physics. Instead, when I reported to school in the summer of 2005, the principal assigned me to an English class.

I was puzzled at this decision and asked him why. "Because you are among the very few who have attended college and also are willing to teach in a rural school," he said. "We have enough math and physics teachers, but never have too many good English teachers here. Our teachers do not speak as fluently as you do. You have learned college-level English, something most of our teachers could not achieve. I am sure you will be an excellent English teacher. Don't worry about your skills." I was still not convinced, but I had no choice other than to spend my time maintaining some computers donated to the schools via the NGO. I really wished to be involved in academic teaching. That was how I started my experience as a volunteer teacher from Shanghai in a rural classroom.

I had not been formally trained to be a teacher though I attended a normal university[1];

[1]Historically, graduates from a normal university should all enter teaching. But a reform initiative in the 1990s gave more flexibility to universities. Many normal universities in China today have transformed into full-fledged research universities, but at the same time have kept their teacher-training programs. Students attending these institutions are no longer bound

neither did the NGO offered me any pedagogical training. I soon discovered that I had some advantages over my colleagues who were trained in the local teacher's college or normal schools. I had good training in the English language up to the college level, which means I had mastery of more vocabulary and more complex grammar than my colleagues. Perhaps equally important, I had ample testing experience; I had taken numerous English language tests from third grade through college, and I had just taken the Graduate Record Examination before I became a teacher. This skill of understanding the test helped me to get good scores on tests, which turned out to be useful to my students (and school) later. My colleagues, at the same time, mostly completed the local normal school's training at the secondary level, and some went to provincial teacher training institutions at the tertiary level. They hardly had any other exposure to English or western culture (movies, media, or direct contact with foreigners) outside of their training. Yet I also found myself in a somewhat awkward position when the semester started. When I opened my first class, I had no idea how to manage a class size of 73; neither did I know how to develop a lesson plan for the content I was going to cover. I asked for permission to observe my colleagues' classes, and I was amazed by how good they were at classroom management and understanding the curriculum. Though I picked up these essentials pretty fast, I still struggled from time to time with how to convey what I knew to my sixth graders, who knew nothing about the English language before our class.

This one-year experience was precious to me, both on a personal level and on professional grounds. I enjoyed being with my students.[2] Most of all, I realized the hard decisions with which rural schools educators are faced. There is little choice when it comes to staffing teaching positions. I also started to ponder what really constitutes a good teacher. Though many of my colleagues in the school did not receive professional training at college level, some of them were terrific teachers in the classrooms.

to be teachers.

[2]A photographic record of this one-year experience can be found here: http://www.flickr.com/photos/makzhou/sets/918243/

Later, when I was halfway through my doctoral program, I discovered a phenomenon in American classrooms similar to the situation I encountered during that one-year experience in China. "Out-of-field teaching" typically refers to teachers who are teaching subjects out of their field of training. Out-of-field teaching is long-rooted in American schools (Hechinger, 1985, October 8). This phenomenon has been extensively studied since the 1990s, with the publication of a series of reports from the National Center for Educational Statistics (Bobbitt & McMillen, 1994; Lewis et al., 1999; Mello & Broughman, 1996; Morton et al., 2008; Seastrom, Gruber, Henke, McGrath, & Cohen, 2002) and Richard Ingersoll's work (1999; 2002; 2003; 2005; 2006). Based on media coverage and commentary from influential think tanks, the reporting about out-of-field teaching seemed to inject new worries into the already dire image of American public school teachers. Out-of-field teaching, according to these portraits, has been a persistent and widespread phenomenon in public schools since the 1980s and well into the 2000s in most academic subjects. More often, out-of-field teachers are thought of as under-qualified teachers. Out-of-field teachers are automatically associated with a negative influence on student learning, though the evidence for such claims has never been clear.

Outside the United States, there are scattered statistics on out-of-field teaching. A 2006 UNESCO report showed that a large proportion of students in countries like Norway or Canada were taught by out-of-field teachers in mathematics (UNESCO Institute for Statistics, 2006, p. 65). An OECD report pointed out that lower qualification requirements in subject matter are often used as a means to cope with teacher shortages in certain areas (OECD, 2005). In countries like the Slovak Republic, it is estimated that "25% of primary classes, 30% of lower secondary classes, and 15% of vocational classes were taught by teachers who did not have teaching qualifications, or were teaching out-of-field, or who had already reached the official retirement age" (OECD, 2005, p. 49). Out-of-field teaching is likely an international phenomenon but with insufficient internationally comparable statistics. Currently there is no international database that tracks teachers' out-of-field status and experience across countries.

To understand the statistics that are available, we need to refer to a broader global dialogue in which teacher policy is the key component for educational reform (Schleicher, 2011; Wilson et al., 2009). It is probably obvious that "the quality of an education system cannot exceed the quality of its teachers" (Barber & Mourshed, 2007). Policymakers are increasingly recognizing this view. In the recent International Summit on the Teaching Profession 2011, the first of its kind, education ministers, teachers, and union leaders from around the world convened to discuss the best practices to build a high-quality teaching force. While teacher policy covers a whole spectrum of components, including teacher preparation, recruitment, development, retention of teachers, and teacher evaluation and compensation, out-of-field teaching connects to multiple aspects of these components. The study of out-of-field teaching involves how teachers are trained in subject matter, how they are deployed to schools, and how they are assigned to teaching posts. Out-of-field teaching also poses a potential threat to the efforts that have been made to improve teacher quality. As Richard Ingersoll put it, "highly qualified teachers may actually become highly unqualified if they are assigned to teach subjects for which they have little background" (2003, p. 5). Rising educational standards in curriculum are likely to require higher level mastery of subject knowledge and innovative ways to teach. It is hard to imagine that teachers with little training in the subject field are competent for such a task.

However, the research on out-of-field teaching has not yielded consensus among scholars. Several questions remain inadequately answered, both internationally and within the United States. To begin with, we do not fully understand the labor market mechanisms of supply and demand that give rise to out-of-field teaching in different contexts. We are also unclear about the prevalence of out-of-field teaching. Neither do we know out-of-field teachers' demographics and educational background, working conditions, and professional status. Do they work in systematically different schools than in-field teachers, and if so, what does their work environment look like? Finally, is there any association between out-of-field teaching and student learning?

This study aims to fill some of the gaps in the literature. I provide empirical evidence of the scale and nature of out-of-field teaching in different countries. Specifically, I use an international survey dataset with comprehensive and nationally representative data on teachers to provide empirical evidence of the current status of out-of-field teaching in math and science in public schools in 21 countries. This dataset, with a rich set of variables, provides a rare glimpse into how teachers are trained and how they performed daily on the job. The study aims to answer three main questions. First, are there cross-national variations in out-of-field teaching? Second, what are the attributes and distribution of out-of-field teachers across schools? Third, did out-of-field teachers engage in different teaching practices and received differential professional support compared to in-field teachers? I adopt a multi-level analysis approach to study the factors that correlate with the occurrence of out-of-field teaching. Multi-level analysis allows me to investigate how individual, school, and systemic-level factors play a part in shaping individual participation and school arrangements in out-of-field teaching.

The policy implications of this study are many. The very definition of out-of-field teachers invokes us to rethink the skills and knowledge that define today's teacher. To understand what constitutes an "out-of-field" teacher, one needs first to look into how teachers are trained and licensed. Why are these practices legitimate and favored? Why are some skills more important than others? From a school organizational point of view, out-of-field teaching reflects how teachers are structured in schools around teaching activities. While some schools are able to deploy teachers effectively to address learning needs in different subject areas, many others often fail to do so. Why is this the case? To answer this question, one needs to examine school-level characteristics related to teacher assignment and also regional and national regulatory regimes that oversee school administration. The study of out-of-field teaching could deepen our understanding of the operation of school organizations.

This study can inform policymakers about effective and innovative ways of regulating the teacher labor market to ensure a sufficiently qualified teaching workforce and an accurate match between teacher's expertise in subject areas and student learning needs. These themes have become increasingly important in today's diverse classrooms across the world, with the rising expectations for student achievement. Researchers and policymakers in education realize that there is no silver bullet in policymaking that could be applied to each and every situation. We need to equip them with a toolkit that they can apply in various settings. Such an effort should be based on scientific and empirically grounded evidence and theories.

In the next chapter, I present a theoretical framework to understand out-of-field teaching. Chapter 2 also reviews past studies on out-of-field teaching and their limitations. Chapter 3 introduces the data and research questions. Chapter 4 provides a descriptive analysis on the attributes of out-of-field teachers. Chapter 5 includes multivariate regression analysis comparing the relationship between the occurrence of out-of-field teaching at the school level and systemic characteristics of each nation. I use a regression approach to compare teaching practices between out-of-field and in-field teachers. In the last chapter, Chapter 6, I conclude with providing reflections on the relationship between out-of-field teaching study and teacher quality study.

Chapter 2
CONCEPTUAL FRAMEWORK AND REVIEW OF RELEVANT LITERATURE

In this chapter, I provide a conceptual framework to understand the policy concern of out-of-field teaching. I also summarize the empirical evidence from the United States on the origins of out-of-field teaching. In the following section, I first discuss the empirical measures of out-of-field teaching and their applications. I then review the scale of out-of-field teaching practice globally and current research on the effect of out-of-field teachers on student learning outcomes. In the last section, I discuss the limitation of current literature.

2.1 Theoretical framework

2.1.1 Conceptualization

Out-of-field teaching is first discussed within the context of the United States. Though this phenomenon has existed in American classrooms for at least fifty years, it was only recently that out-of-field teaching has become a policy issue. Not too long ago, the requirement for a person to become a teacher was just having the basic ability in reading and writing. Traditionally, some people believe that "pedagogical or methodological knowledge – is of primary importance to be qualified. . . in-depth knowledge of a subject is less important than in-depth skill at teaching" (Ingersoll, 2003, p. 10). Though the demand for teachers to have a good understanding of subject matter knowledge came in the 19th century, not many states required teachers to have subject matter knowledge beyond the secondary school level (Sedlak, 2008). In the post-WWII era, more states started to mandate a minimum of a four-year-college degree for new teachers. This movement aimed at professionalizing the teaching profession in reaction to a widely circulated claim that American teachers lacked basic content knowledge for the subjects they were teaching (Youngs & Grogan, 2010).

The professionalization movement gained new momentum after the No Child Left Behind (NCLB) Act was enacted in 2002, in which subject matter proficiency is the key component of the highly qualified teacher provision.[3]

The actual historical change in the definition of the teacher is beyond the scope of this project. For the purpose of this study, it is important to note that the problematizing of the out-of-field teacher is closely related to changing ideas on the skills and knowledge that define a teacher. The critics of contemporary teacher education first questioned the subject matter competency of elementary and secondary teachers (Conant, 1963; Koerner, 1963). In the 1980s, many of the critics and policymakers looked to reconstruct the identity of teachers around subject matter knowledge and competency (Judge, Lemosse, Paine, & Sedlak, 1994; Sedlak, 2008). The predominant view of the out-of-field teacher was thus from a knowledge-deficit perspective. Increasingly, more educational reforms have put emphasis on the subject matter training of teachers (Imig & Imig, 2008; Youngs & Grogan, 2010).

By definition, out-of-field teachers are those whose academic training does not match the subject they are teaching. Out-of-field teachers lack sufficient training in the subject matter. Thus they are deficient on two important aspects for being good teachers: subject matter content knowledge and pedagogical content knowledge. Shulman once argued that "subject matter knowledge and background in a content area affected the ways in which teachers select and structure content for teaching, choose activities and assignments for students, and use textbooks and other curriculum materials" (Shulman, 1988, p. 12). This stress on the importance of subject matter knowledge has become the basic criterion to define today's teachers, as many high-quality teacher education programs put emphasis on chosen content

[3]Subject matter proficiency is a key component in the highly qualified teacher provision in NCLB. It requires a teacher to have all of the following: 1) a bachelor's degree, 2) full state certification or licensure, and 3) proof that they know each subject they teach. Teachers must demonstrate competency by proving or obtaining one of these credentials: 1) a major in the subject they teach, 2) credits equivalent to a major in the subject, 3) passage of a state-developed test, 4) High, Objective, Uniform State Standard of Evaluation (HOUSSE), 5) an advanced certification from the state, 6) a graduate degree. For details, see U.S. Department of Education (2002).

areas. But it is not just how competent a teacher is in the subject area that should be the sole criterion to make a good teacher because “mere content knowledge is likely to be as useless pedagogically as content-free skills” (Shulman, 1986, p. 8). Shulman further argued that the content aspects of teaching entail knowledge about the subject and the way to teach it. He defined subject matter content knowledge as “the amount and organization of knowledge per se in the mind of the teacher,” and pedagogical content knowledge as “the ways of representing and formulating the subject that makes it comprehensible to others” (Shulman, 1986, p. 9). It is hard to argue that someone who does not have proper training in the subject matter could develop the full ability to teach that subject without any additional assistance. This argument is perhaps becomes the foremost reason to argue against out-of-field teaching. Thus it is not uncommon to characterize out-of-field teachers as underqualified teachers without basic competency (Ingersoll, 1999).

From an educational investment point of view, out-of-field teaching represents inefficiencies in the teacher labor market. Out-of-field teaching signifies the type of mismatch between teachers’ subject matter knowledge and students’ learning needs that rendered the human resources (i.e., skill sets and knowledge in the subject matter) accumulated throughout the teacher training process under-utilized. Whatever the reasons might be for the cause of out-of-field teaching, the fact that such practices exist shows the teacher market did not channel the supply of particular teaching skills into classroom demands properly. In an era where nations are investing in teacher training programs to prove educational quality, the phenomenon of out-of-field teaching calls into questions whether such an investment is yielding meaningful returns.

It should be noted that the lack of training in subject matter in itself may not undesirable. If these teachers are given sufficient help at the starting stage, or continuing into their service, they can still develop the essential skills and knowledge for teaching. This view probably explains why in some education systems educational authorities recognize out-of-field teaching as a temporary but legitimate practice in schools in order to cope with teacher shortage problems. Teachers of this sort are required to develop sufficient subject matter knowledge through a series of ad hoc training activities, and eventually to demonstrate qualification in the subject matter (Eurydice, 2002). However, not many empirical studies suggest that these policies are indeed being carried out.

2.1.2 The origins of out-of-field teaching

Apart from questioning the legitimacy of out-of-field teaching, another question has emerged along with the research on out-of-field teaching: why does it happen on a large scale in American classrooms? Out-of-field teaching does exist to a varying degree in many other countries. But in the United States, the phenomenon seems especially persistent and widespread.

Several explanations have surfaced over the years in discussions of the causes of out-of-field teaching in the United States. The first argument came after the publication of a report by the National Commission on Teaching and America's Future (NCTAF hence forward) in 1996, which claimed that out-of-field teaching, as a manifestation of the nation's poor teacher quality, was a result of inadequate teacher training. Several news commentaries echoed this view in their syndicated columns.[4] They claimed that teacher education in this country is not rigorous enough to equip future teachers with sufficient knowledge for teaching. The implication of this is that because teacher education in general is of poor quality, it makes little difference for the employers to differentiate among people with different subject matter background, thus leading to out-of-field teaching assignments. They proposed that all prospective teachers go through a four-year undergraduate program and an additional year of practice teaching to be fully qualified. Although such a view connects to the rhetoric of ailing teaching quality in the United States, it fails to address why out-of-field teaching

[4]See for example, *To Help our Children, Invest in Teachers* (David S. Broder, September 18, 1996, St. Petersburg Times, p. 10A). *Education Insiders Protect Their Turf* (Thomas Sowell, September 23, 1996, St. Louis Post-Dispatch, p. 13B). *A Need For Knowledge, Not Skills* (Maggie Gallagher, September 18, 1996, St. Louis Post-Dispatch, p. 7B).

continues to thrive in an era of increasing teacher qualification. Indeed, statistics show that most teachers in the U.S. do at least have a bachelor's degree, and a growing number of them have a master's degree (Ingersoll, 2003). The number of teachers with no certification or license are dropping (Ingersoll, 1999). Findings also suggest that out-of-field teachers typically have college training in a subject field (Ingersoll, 1999).

If the problem does not stem from teacher preparation (quality), could it be because of quantity (e.g., the number of teachers produced)? The second view states that out-of-field teaching is due to shortages of teachers in certain subject fields. This argument sounds reasonable, but it also lacks compelling evidence.

In the United States, several factors have altered the supply and demand of teachers historically including the fluctuation in population growth and shocks in the general labor market such as those caused by the Great Depression (Sedlak, 1989). More recently, the discussion on the supply of teachers has been focusing on the changing demographics and state economy. From the supply side, as teachers of the baby-boomer generation step into retirement age, more new teachers are needed to fill their positions (because the student population is projected to keep growing). At the same time, many states that face stringent economic constraints are proposing to cut the teacher workforce as a means to limit public expenditures (Cavanagh, 2011). On the demand side, in several states lawmakers have revamped the curriculum, which requires students to enroll in certain classes in order to graduate from high school.[5] These mandatory graduation requirements might also lead to increase in demand for teachers in the short run, whether they have the qualification or not. In addition, schools with tough working environments also use out-of-field teaching to cope with teacher shortages. All these conditions could trigger out-of-field teaching.

Although each of these explanations all have possible connection with out-of-field teaching, logical possibility does not necessarily mean causal relationship. Direct evidence supporting these arguments is rather limited. There are also conflicting findings. Using School

[5] For a summary of state requirements, see:
http://www.cehd.umn.edu/nceo/topicareas/graduation/StatesGrad.htm

and Staffing Survey (SASS) data, Ingersoll (1999) found that some schools with no difficulty in staffing reported a high level of out-of-field teaching. A closer look at the data also suggests that out-of-field teaching existed in subjects that traditionally have had a surplus of teachers, such as English and social studies (Ingersoll, 1999).[6]

Thus a direct link between teacher shortages and out-of-field teaching is not obvious. Figure 2.1 illustrates a generic relationship.[7] Out-of-field teacher hiring may be one of several measures that could be used to cope with teacher shortage, but it does not necessarily have a natural and necessary causal link with teacher shortage. Indeed, teacher shortage as a phenomenon is also merely a product of many other forces that shape the teacher labor market. From a policy perspective, to eliminate out-of-field teaching requires one to look at the root of the phenomenon. In the increasingly complex labor market, using teacher shortage as *the* explanation will only take us so far. A methodologically more plausible question might be: What is the effect of teacher shortage on out-of-field teaching? In other words, asking what is the effect of a specific cause, rather than asking what causes a given effect (Holland, 1986).

Since the quality of teacher training or the quantity of teachers available are both inadequate to explain the phenomenon of out-of-field teaching, we turn to a third explanation. This view is largely attributed to Richard Ingersoll in a series of studies (1999; 2002; 2003; 2005) in which he argued that the out-of-field teacher should be understood as an organizational issue (in the context of U.S. schools). The out-of-field assignment is not a phenomenon solely because of emergencies, but is a common practice in school organizations. School administration in the U.S. is fundamentally decentralized and highly autonomous. Much of the decision-making regarding the staffing and hiring process is made within a school or district, but there is a lack of direct inspection of the causes behind these decisions.[8] Under this

[6]Though less is known about whether the oversupply of teachers existed in certain subject matters outside the U.S.

[7]The figure is an illustration by the author based on study by Eurydice (2002); Gorard, See, Smith, and White (2007); Ingersoll and Perda (2010).

[8]Increasing inspection might raise administration costs.

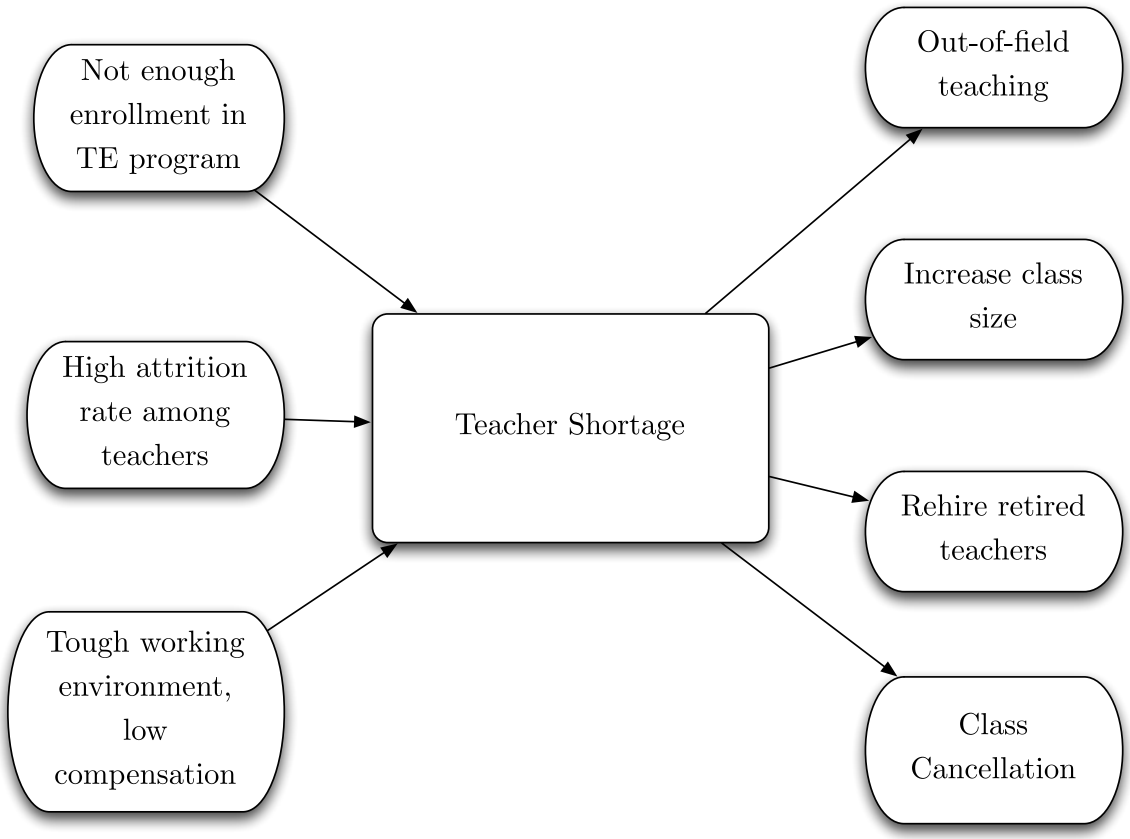

Figure 2.1: Factors and policies that relate to teacher shortage

scenario, the school principal has large discretionary power in terms of assigning a teacher to a teaching post. By contrast, teachers have little authority to decide their positions. In many cases, one's teaching assignment is made based on convenience or economic concern. To match each teacher's expertise with specific student learning needs is a time-consuming endeavor. The flip side of this is that neither the school principal nor teachers will be rewarded if they actually do so. Their compensation is not decided based on how well they teach (Lazear, 2003). Burdened by other issues, principals might simply make decisions based on their perception of a teacher's ability to teach certain subjects or in some cases, the decisions may be based simply on convenience. For many education administrators, although subject matter competency is an important criterion when they make hiring decision, more often they value other traits of a candidate: communicational skills, affection toward children, or working ethics. Therefore the idea of using teachers with less qualifications in certain subjects is legitimate on many occasions, especially in times of personnel absence or shortage on a short-term basis. Such practices but may well evolve into more regular practices if not addressed properly.

This view constitutes the basic lens this study used to examine out-of-field teaching. Empirical evidence is limited on this issue. To date, most studies of out-of-field teaching have been conducted in the United States. Arguably, if there are certain organizational features pertaining to U.S. schools, a single-country study might not be ideal because of limited variation on these features within the country. This study aimed to take advantage of a multi-national dataset to compare diverse countries with one another.

2.2 Review of relevant literature

2.2.1 Measuring out-of-field teaching

To empirically measure whether a teacher has sufficient content knowledge training, past studies typically followed one or several measures of out-of-field teaching suggested by the National Center for Education Statistics (NCES) in the United States (Morton et al., 2008; Seastrom et al., 2002):

- M-1 Out-of-field teaching by main assignments
- M-2 Out-of-field teaching by subject area taught
- M-3 Out-of-field teaching by class taught
- M-4 Number of students taught by teachers who are out-of field in a specific subject

All of these measures use one's college major, minor, or subject field of certification as the main *indicator*, but compare against different subjects. Out-of-field teaching status is defined by two elements of teachers' qualification: state certification/licensure and postsecondary education. Though state certification traditionally is based on postsecondary course work in the field to be taught, together with pedagogical coursework and teaching experience (Seastrom et al., 2002), recently in an effort to attract more people into the profession some states do allow individuals to obtain a state license as long as they take and pass the teacher certification test.[9] The literature suggests these following three *indicators* are used:

- I-1 Have at least a major or minor in the field of teaching
- I-2 Certified in the field
- I-3 Have a major or minor and is certified in the field

2.2.1.1 Out-of-field in main assignment

Using the three indicators, the main assignment measure is most straightforward. Each individual teacher will be asked about their main teaching assignment, which will then be compared to their educational credential indicators (i.e., I-1). The researcher could report how many teachers are teaching in- or out-of-field (i.e., as defined by college major or minor) by their main assignments (Bobbitt & McMillen, 1994; Mello & Broughman, 1996; National Commission on Teaching & America's Future, 1996). There are two issues with this measure. The first problem has to do with aggregation. In reality, individual teachers could have multiple assignments within schools (sometimes even across schools). If one only calculates the percent of out-of-field teaching using main assignments at the school level, both the numerator and denominator are artificially smaller than they should be because additional assignments are omitted. In survey data, information on the main assignment is often self-reported. For individuals with more than one academic assignment, they may be considered in-field by the main assignment but are teaching outside of their field of training

[9]The earliest case of such alternative route of certification is in the state of New Jersey. See Copperman and Klagholz (1985) for reference.

in other assignments (Seastrom et al., 2002). Only considering main assignments would underestimate the magnitude of out-of-field teaching.[10]

The second problem is that teachers are sometimes unclear about which assignment is "main," therefore omitting that additional assignment. In the Schools and Staffing Survey (SASS), a major database on teachers maintained by U.S. Department of Education, many teachers reported their first assignment and "simply categorize the second as 'other' " (Seastrom et al., 2002, p. 21) thus creating a noisy measure of out-of-field teaching. An example is special education teachers who provide individualized instruction to specific students. Even when the surveyor collects all the assignment data from teachers, the "other" category will not necessarily offer additional information on the out-of-field assignment scenario.

Third, assignments are not equal at full time equivalence (FTE)[11] levels. The same math assignments could account for one's full workload (therefore FTE=1), but to others they might only account for half (FTE=0.5). The cases of whole class math teaching and pull-out-individualized instruction are such examples.[12] In this sense, assignment needs to be weighted by FTE to reflect accurately the teaching load associated with each assignment. But many empirical works hardly did that. Despite all the shortcomings, the advantage of the main assignment measure is obvious: it is a straightforward measure and data are easy to obtain.

[10] The calculation will be: if Mr. A is certified in mathematics and teaches math for his main assignment and at the same time teaches physics as a second assignment, then he is an out-of-field physics teacher but not an out-of-field math teacher. The calculation of main assignment measure for both math and physics will not be affected. But this measure will not accurately reflect out-of-field teaching in physics because both numerator and denominator are smaller by not counting multiple assignments.

[11] FTE is a common way to measure and report teacher's involvement in teaching or student enrollment in school. An FTE of 1.0 means that the person being equivalent to a full-time teacher/student. State administrative data typically reports each teacher's FTE status.

[12] Teachers who only offer individualized instruction are often considered as teaching on part-time basis.

2.2.1.2 Out-of-field by subject area taught

The second measure (M-2) provides more detailed information of out-of-field teaching in subject matter. The calculation is similar to the first measure but considers all teaching assignments, separately by subject areas. Results using this measure usually report "among all teachers teaching at least one science course, 20 percent are out-of-field" (Seastrom et al., 2002, p. 22). The benefit of this measure is to allow the researcher to explore variations in out-of-field teaching across subject fields. This takes into consideration multiple assignments for a single teacher. The measure is constructed by subject area. A teacher who is teaching both math and science but is only licensed in math would be counted as in-field in math and out-of-field in science. Yet this measure also suffers from limitations similar to the first measure, because teachers are not equal in their teaching loads; the researcher needs to weigh each teacher by their full-time equivalence status. To account for multiple assignments across subjects remains a challenge when using survey data such as SASS. Teachers with multiple assignments need to be counted multiple times for different subject fields. If information on additional assignments is not available, then bias is inevitable. Ingersoll (1999; 2003) uses this measure. Like the first measure, the information is on the supply side, but "provides no information on number of students exposed to such teaching" (Seastrom et al., 2002, p. 22).

2.2.1.3 Out-of-field by class taught

The third measure can be used to report the percentage of classes given in each subject field that are taught by out-of-field teachers. This measure circumvents the challenge in measuring multiple assignments. It can provide some information on students' exposure to out-of-field teaching. It also avoids the problem of different FTE status because the class is used as the unit of calculation. Numbers of classes taught usually reflects the working load of an individual teacher. But the information might not be precise since the class size could vary by subject matter or grade level (especially at high school). In addition, this measure requires the number of classes taught by an individual teacher, which is not always available.

2.2.1.4 Student taught in-field or out-of-field

The fourth measure is derived from the demand side. It eases the complication caused by multiple assignments of teachers because the calculation no longer depends on teacher's feedback on assignment status. However it requires linkages between student and teacher level data. It also requires more refined data on student attendance in specific classes. The interpretation is also not easy. Researchers typically report a "percent of all students in each subject area taught by teachers who are outside their areas of preparation" (Seastrom et al., 2002, p. 23). SASS probably provides the most extensive measure of this kind (Bobbitt & McMillen, 1994; Mello & Broughman, 1996; Morton et al., 2008; Seastrom et al., 2002).

The estimates based on the third and fourth measure require caution when interpreting. Several NCES publications note that errors in estimation could be substantial. For example, Morton et al. (2008) say that the "the standard error of this estimation is equal to 50 percent or more of the estimates' value" (pp.25, 27). The exact nature of these estimation errors is not clear.

Practically, measures based on main assignments often give the lowest figure while measures based on classes taught give the highest estimates. The student-based estimates tend to fall in-between. Examples of comparing different measures can be found in Seastrom et al. (2002) tables B2, B4, B6, and B8.

2.2.2 Spread of out-of-field teaching

Most empirical work focuses on describing the level of out-of-field teaching. I start this section by a comprehensive survey of the findings within the United States where this literature is most well developed. International study on out-of-field teaching is emerging and the evidence is limited. I briefly introduce current international findings later in the section.

The NCTFA report first calculated the state-by-state percentages of the spread of out-of-field teaching. The numbers ranged from 11 percent in Connecticut to 63 percent in

Alaska (National Commission on Teaching & America's Future, 1996, p. 146).[13] Using SASS, Ingersoll (1999) later argued that over half of the teachers teaching physical science in secondary schools (including chemistry, physics, earth science, and space science) did not have an academic major or minor in any of these subject fields. About one-third of secondary math teachers do not have teaching certificates in math. Over half of secondary history teachers do not have an academic major or minor in history (Ingersoll, 1999). Several NCES reports confirmed similar findings over the years (Bobbitt & McMillen, 1994; Lewis et al., 1999; Mello & Broughman, 1996; Morton et al., 2008; Seastrom et al., 2002). Table 2-1 summarizes published statistics from NCES using the main assignment measure from 1987-2008. These statistics suggest that on average at the high school level, over time more teacher assignments have been made based on the teacher's college training. However, in some subjects, such as mathematics, physical science, chemistry, and earth science, there are still many out-of-field teachers.

[13] According to Ballou and Podgursky (1996), the analysis also used SASS data.

Table 2.1: Percentage of U.S. public school teachers who taught high school without an undergraduate or graduate major in their main assignments in selected subjects, 1987-88 to 2007-08

	1987-88	1990-91	1993-94	1999-00	2003-04	2007-08
English	22.9	22.6	15.4	19	15.5	17.2
Foreign Lanauge	na	46.6	30.5	37.5	na	na
Mathematics	26.2	27.4	19.5	20.9	24	27.5
Science	20	20.1	15.8	16.6	12.8	16
Biology/ Life Science	33.1	41.8	29.4	34	18.8	23.9
Physical science	57.2	64.2	65.1	53.9	45.7	51.5
Chemistry	51.2	62.8	51.9	54.2	50.1	51.8
Earth science	69.3	69	65.2	64.5	60.2	66.8
Physics	63.5	66.9	51.3	51.1	42.8	42.3
Social Science	23.5	18.6	16.4	16.3	16.4	16.7
ESL	79.3	74.1	72	64	na	na
Arts and music	11.1	7.9	5.5	7.9	8.4*	10.5*
Pysical Ed	12.1	8.4	7.1	11.1	na	na

"*" indicates only includes art teachers

Source: Morton et al. (2008, p. 21); Schools and Staffing Survey (2010); Seastrom et al. (2002, p. 56)

It is less clear about the characteristics of schools that are more likely to assign teachers out-of-field. Past study suggests that out-of-field teachers are more likely to be concentrated in high-poverty, small public schools (Ingersoll, 1999). Out-of-field teaching is more prevalent in middle grades (7-8 grades) than in high school (Ingersoll, 2003). Minority and poor students consistently receive fewer qualified teachers (Jerald & Ingersoll, 2002).

These studies all utilized SASS data and gave qualitatively similar findings. However, findings from other data sources do not always fall into the same line. A report to the California state legislature reviewed subject assignment for more than 300,000 California teachers. They found that the "misassignment" phenomenon, which is characterized as "the placement of a certificated employee in a teaching services position for which the employee does not hold a legally recognized certificate, credential, permit or waiver" (Credentialing and Certificated Assignments Committee, 2008, p. 1), represented a 145.3 percent increase from 1992-95 to 2003-07. Yet misassignments only represent 6.33 percent of all teaching assignments. And over half of the misassignments consist of teachers for English language learners (ELL). Using data from Michigan, Lynn and Keesler (2008) also reported no widespread mismatch between teachers' teaching assignments and fields of certification.[14] Note that these studies all utilized state administrative data in the post-NCLB era.

Using the National Education Longitudinal Study sample, Darling-Hammond, Berry, and Thoreson (2001) found that 45 percent of math and science teachers taught a subject other than their academic training. The authors argued that such a mismatch between teaching and teacher education could simply reflect that some teachers are "teaching in a new field while completing the requirements needed to be credentialed in the field"(p. 63). This finding reminds the researcher to distinguish out-of-field teaching between new and veteran teachers. It is reasonable that a new teacher may still be undertaking teacher training while teaching in the classroom. However this argument still cannot explain why teacher training is not

[14]The out-of-field teaching measure used in this report only considered teacher's main assignment against area of certification, but did not take into account of multiple assignments and FTE.

aligned with field of deployment in the first place on such a large scale.

At the state level, according to the newspaper Education Week's annual Quality Counts report in 2000, 11 states allowed teachers to teach outside of their certification areas for part of their daily teaching without the need for special permission (Jerald & Boser, 2000).

Since the implementation of the No Child Left Behind Act in 2002, there has been a steady increase in the number of state legislations that try to prevent out-of-field teaching. As of 2000, 22 states developed a law to penalize schools or districts implementing out-of-field teaching, yet there was barely any close monitoring or enforcement of the law. In the same report eight years later, Education Week again pointed out that 32 states had at least one policy, though not specified explicitly, to limit out-of-field teaching (Education Week, 2008). Eleven states now limit teacher's out-of-field employment exceptions. Nine states now require out-of-field teachers to earn additional alternative certification or accreditation. Five states notify parents when out-of-field teaching takes place in schools. Four states completely ban or cap the number of out-of-field teachers. It looks like out-of-field teaching has gradually caught the attention of state policymakers.

Outside of the U.S., statistics on out-of-field teaching are rather limited. The UNESCO report (UNESCO Institute for Statistics, 2006) gave two examples (Norway and Canada) of high levels of out-of-field teachers. Reports from Trends in International Math and Science Study (TIMSS) provide perhaps the most extensive information on teacher qualification.[15] TIMSS reports reveal some interesting findings. For example, Mullis, Martin, Gonzalez, and Chrostowski (2004) used TIMSS 2003 data and found that in many countries primary school math teachers are not required to specialize in math. As a result, on average, 80 percent of students are taught by teachers who majored in primary and elementary education. This seems to be a general pattern in a majority of the TIMSS countries. Specifically, among

[15] Because of the way TIMSS teacher survey is constructed, the teacher sample is not nationally representative, but the student sample is. Any generalized reference to teacher characteristics must be made in association with student population, which can be quite cumbersome in the out-of-field teaching case.

4^{th}-grade students, about one-fourth (26 percent) are taught by teachers specializing in mathematics, 4 percent are taught by teachers specialized in or with a major in science, but half (50 percent) of the students are taught by teachers who do not have any particular specialization (Mullis et al., 2004). The situation is similar for 4^{th}-grade science teachers. On average, science teachers for most 4^{th}-grade students major in primary or elementary education (80 percent). Martin and colleagues (2004) reported that "for primary education major, about one-fourth (23 percent) of students were taught by teachers specialized in science, 7 percent in mathematics, and half (50 percent) not having any particular specialization" (p. 253).

Similar findings are also found in the TIMSS 2007 report. Seventy two percent of 4^{th}-grade students are taught by math teachers whose major is in primary and elementary education (Martin, Mullis, Foy, Olson, Erberber, et al., 2008). Seventy-two percent of 4^{th}-grade students are taught by science teachers whose major is in primary and elementary education (Martin, Mullis, Foy, Olson, Preuschoff, et al., 2008). There is great variation across countries. For instance, 94 percent of students in Italy are taught by teachers who do not have a major either in elementary and primary education or mathematics and science, compared to 15 percent in the United States.

Teacher preparation for 8^{th}-grade math and science teachers is much different. On average, 70 percent of students enrolled in math classes were taught by teachers who specialized in mathematics; 81 percent of students enrolled in science classes were taught by teachers who specialized in biology, chemistry, physics or earth sciences (Martin, Mullis, Foy, Olson, Erberber, et al., 2008; Martin, Mullis, Foy, Olson, Preuschoff, et al., 2008). It is more likely for teachers who teach in higher grades to have a subject field specialization compared to most elementary teachers, who are more likely to enroll in general education training. The TIMSS data suggests that 27 percent of students enrolled in math classes at 8^{th}-grade and 19 percent of students enrolled in science classes at 8^{th}-grade were taught by out-of-field teachers. Table 2.2 summarizes the percentage of *students* taught by teachers who are out-of-field.[16]

The estimates from TIMSS show great across-national variation. Yet the statistics are not always consistent across years. For instance, math out-of-field estimates in Hong Kong vary from 54 percent in 2003 to 40 percent in 2007. The estimates for science out-of-field teaching is 22 percent in 2003 for Saudi Arabia and the it was 3 percent 4 years later in 2007. Also because the statistics used in TIMSS are measured by the percentage of students taught by out-of-field teachers, corresponding to the exposure measure mentioned in Section 2.2.1.4, they are therefore not directly comparable to other national statistics, which typically measure out-of-field teaching by the number of teachers.

[16]According to the definition used by TIMSS publications. Out-of-field refers to subject areas other than: general education, mathematics, education with specialization in math, education with specialization in science, or science for mathematics teachers. For science teachers, out-of-field major indicates major that other than education with specialization in science, education with specialization in mathematics, biology/physics/chemistry/earth science, or general education.

Table 2.2: Percentage of 8^{th}-grade students in TIMSS whose teachers' area of study is not in math or science

COUNTRY	2003		2007	
	Mathematics	Science	Mathematics	Science
Algeria	na	na	16	16
Armenia	25	13	40	42
Australia	42	39	39	30
Bahrain	7	13	7	12
Bosnia and Herzegovina	na	na	14	19
Belgium (Flemish)	24	35	na	na
Botswana	28	25	21	16
Bulgaria	39	43	38	35
Chile	23	18	na	na
Chiese Taipei	24	13	35	9
Colombia	na	na	29	16
Cyprus	10	12	11	10
Czech Republic	na	na	27	39
Egypt	7	13	12	7
El Salvador	na	na	41	47
Estonia	22	21	33	17
Georgia	na	na	17	8
Ghana	46	45	43	40
Hong Kong	54	25	40	30
Hungary	35	28	25	34
Indonesia	19	20	13	12
Iran	16	13	11	12
Israel	33	21	35	12
Italy	11	18	17	17
Japan	27	20	19	11
Jordan	7	9	18	16
Korea, Rep. of	5	7	4	6
Kuwait	na	na	2	9
Latvia	56	52	na	na
Lebanon	na	19	20	11

Table 2.2: cont'd

COUNTRY	2003		2007	
	Mathematics	Science	Mathematics	Science
Lithuania	15	28	11	19
Macedonia, Rep. of	1	6	na	na
Malaysia	46	38	41	29
Malta	na	na	26	26
Moldova, Rep. of	23	19	na	na
Morocco	na	7	11	8
Netherlands	27	24	na	na
New Zealands	53	31	na	na
Norway	64	52	61	53
Oman	na	na	12	3
Palestinian Nat'l Auth.	5	13	4	9
Qatar	na	na	6	10
Philippines	14	22	na	na
Romania	10	19	16	25
Russian Federation	na	na	17	20
Saudi Arabia	7	22	1	3
Scotland	37	15	22	14
Serbia	30	27	12	12
Singapore	44	25	50	31
Slovak Republic	29	35	22	na
Slovenia	19	22	28	16
South Africa	39	33	na	na
Sweden	37	34	28	22
Syrian Arab Republic	na	na	11	15
Thailand	na	na	23	29
Tunisia	10	10	13	5
Turkey	na	na	9	9
Ukraine	na	na	12	12
United States	35	40	34	34
England	38	17	33	17
International Avg	27	24	22	19

One European Union report gave qualitative information on the regulation each EU country issues to allow/prohibit out-of-field teaching (Eurydice, 2002). According to that report, out-of-field teaching, or by its definition "personnel who are not fully or appropriately qualified" in subject matter, seems a widely used measure to cope with teacher shortages.[17] Unlike the U.S., where out-of-field teaching is an inferior practice that causes much scrutiny, most EU countries accept out-of-field teaching as an emergency measure that can be used on a short-term basis. The exact nature of such acceptance of the out-of-field teacher is not clear. The regulatory regimes seem well-developed, although no empirical evidence is available on the scale of such practice. Neither do we know the degree to which those regulatory policies are being implemented, or their effectiveness.

2.2.3 Effect of out-of-field teaching

Though the prevalent assumption about out-of-field teachers is that they must be less effective than in-field counterparts in their ability to foster student learning (Ingersoll, 1999), surprisingly there is only limited evidence regarding the effects of out-of-field teaching. In an early study, Hawk, Coble, and Swanson (1985) used a small sample of 36 teachers and found that out-of-field teachers know less mathematics than their in-field counterparts. Boe, Shin, and Cook (2007) conducted a similar study using SASS data in 2007 and found that out-of-field teachers are less well prepared in several teaching-related activities than in-field teachers: ability to teach assigned subjects, select appropriate teaching materials, and plan lessons effectively. Out-of-field teaching is also said to be associated with decreased teacher morale and commitment (Ingersoll, 1999)

In terms of student achievement, Hawk, Coble and Swanson's (1985) study using ANOVA found that students perform relatively better when taught by in-field teachers in mathematics

[17] More specifically, the following countries allow such practices with no specific restriction: Belgium (Flemish and Germany), Denmark, France, Finland, Sweden, UK (England, Wales, and Northern Ireland), Iceland, Norway, Bulgaria, and Lithuania. Estonia, Luxembourg, Netherlands, Romania, Latvia, Slovenia, Czech, and Poland also allow such practice with certain restrictions. For detailed information, see Eurydice (2002, p. 74)

classes. Rowan, Chiang, and Miller (1997) used a subsample of the National Education Longitudinal Study of 1988 (NELS:88) and found a moderate effect of teachers who had majored in mathematics in undergraduate or graduate degree on students' mathematics achievement. Their two-level hierarchical linear model suggests that compared to students taught by teachers who did not have a major, students taught by teachers who majored in math scored on average a 0.02 standard deviation higher. The size of this effect varied depending on the average ability of students being taught in a school. Goldhaber and Brewer (2000) used student-level data from the NELS: 88 survey. They found that students who have been taught by teachers with no certification in the subject matter performed lower than those whose teachers had either a standard, probationary, or emergency certificate. Teachers who held a BA or MA degree in mathematics also positively influenced students' math achievement. The effects were statistically insignificant, though, and the authors admitted they were not able to disentangle the effect of out-of-field teaching from teacher certification because they had no information on subject assignment. Using a comprehensive dataset from Houston, Darling-Hammond, Holtzman, Gatlin, and Heilig (2005) found that out-of-field teaching had a positive effect on TLI Math, TLI reading,[18] SAT-9 Math, Aprenda Math, and Aprenda Reading scores (5 out of 6 total student achievement indicators). That study utilized student test data for several years and pooled data across time to conduct OLS regression. This finding is rather surprising and counter-intuitive. However, as Ingersoll suggested, out-of-field teachers might rely more on textbooks, and that kind of learning is best captured by a standardized test (Ingersoll, 1999). He argued that one needs to look beyond test scores to investigate teachers' motivation and allocation of time to comprehend the consequences of out-of-field teaching.

Another line of work is to use a direct measure of teacher's subject matter knowledge instead of using college major or license as a proxy. Hill, Rowan, and Ball (2005) designed a specific test to measure teacher's mathematical content knowledge. Their models show

[18] TLI math and reading tests are assessments developed by the Learning Institute.

that teacher's performance on this test is consistently positively related with student math achievement gains in first grade and third grade. Interestingly, they also found that this measure of teacher's math content knowledge had little correlation with whether or not the teacher was certified in math. Not surprising, using the same measure of teacher's mathematical knowledge, Hill, Ball, Blunk, Geoffney, and Rowan (2007) showed that those with higher measurable math knowledge provided math instruction that was rich in representations, explanations, reasoning, and meaning.

To my knowledge, there is no study on the effects of out-of-field teachers conducted outside of the United States.

2.2.4 Limitation of the literature

There are several limitations in previous studies. The data issue is perhaps the most important. To date, there are only a handful of large-scale assessments of out-of-field teaching. Data on teaching assignment and the educational background of individual teachers is hard to obtain. Ingersoll suggested that data on out-of-field teaching could be a politically sensitive issue for many local administrators at a time when more mandates are coming from federal and state policy requiring locals to improve teacher quality (Ingersoll, 2003). As mentioned before, in the United States most quantitative studies of out-of-field teaching rely on information from SASS data. The benefit, of course, is that SASS is not collected through local educational agencies but through teachers themselves. The teacher sample in the SASS data is nationally representative, and the survey is repeated for multiple years. Various researchers have used SASS data and others have reexamined their findings to assure the validity of the findings (Bobbitt & McMillen, 1994; Lewis et al., 1999; Mello & Broughman, 1996; Morton et al., 2008; Seastrom et al., 2002).

Yet even using a comprehensive dataset such as SASS could be limiting. For instance, SASS did not require teachers to report all their instructional assignments. Teacher labor force studies have pointed out that multiple assignments are a common phenomenon in schools (Lynn & Keesler, 2008; Lynn et al., 2007). These multiple assignments sometimes cover multiple subject fields and account for different amounts of workload (in terms of FTE). Failure to report them could underestimate the magnitude of out-of-field teaching.

Though there are several competing theories that try to show the mechanism that drives out-of-field teaching, there is little empirical evidence to support any of these theories. For example, Ingersoll argued that out-of-field teaching is an organizational phenomenon. But it is unclear to what extent school-level characteristics relate to the occurrence of out-of-field teaching. It could be that out-of-field teaching is pertinent to the educational enterprise in the United States. But a single country study is not likely to verify such a hypothesis simply because there is not enough institutional variation within one country. Methodologically, cross-sectional data such as SASS makes it difficult for researchers who try to quantify the relationship between organizational changes at school levels and out-of-field teaching. At the same time it is difficult to obtain quality indicators of out-of-field teaching and school organizational factors such as the principal's managerial style, teacher's participation in school management, and teacher supply and demand, which may partially explain why studies of this sort are scarce. If these variables are systematically correlated with out-of-field assignments but are not included as independent variables in estimating the likelihood of individuals becoming out-of-field teachers, then the estimated coefficients will not be consistent due to the omitted variable biases.

In addition, only a limited number of studies have evaluated whether out-of-field teachers have an effect on student learning, and the findings are not conclusive (Boe et al., 2007; Darling-Hammond et al., 2005; Goldhaber & Brewer, 2000; Rowan et al., 1997). There are also methodological limitations in the previous studies. Hardly any of these studies estimated the causal effects of students being taught by out-of-field teachers. Partly because longitudinal data on students and teachers are not available in most cases, it is hard to attribute the variation in student test score gains to teachers. In addition, a selection bias for both teacher and students can cause serious estimation problems. The literature has suggested that on the one hand, teachers are not randomly assigned to schools. Minority teachers and teachers who have had less rigorous teacher training are more likely to move to certain types of schools (Guarino, Santibanez, & Daley, 2006; Lankford, Loeb, & Wykoff, 2002). On the other hand, students and parents actively choose teachers as well (Lankford et al., 2002). This "double sorting" will not be an issue if the characteristics of schools that teachers and students choose to go to are independent of those characteristics associated with out-of-field teaching. Yet empirical evidence suggests this might not be the case (Ingersoll & Perda, 2010). Unfortunately no study to date has systematically taken this issue into consideration.

Lastly, seldom have previous studies considered policy alternatives for out-of-field teaching (including monitoring regulation). It is not clear what kind of regulation, school, or national management regime could effectively curb out-of-field teaching. In the following chapters I examine statistical evidence on how national and local policies can limit out-of-field teaching from a comparative perspective. The advantage of cross-national studies is to remind policymakers of the variety of practices in other countries. I will make policy recommendation on how to limit out-of-field teaching based on the empirical findings I generate in the next chapters.

To sum up, past studies of out-of-field teaching have mostly been done within the U.S. context. Studies have found widespread and persistent out-of-field teaching phenomena in U.S. classrooms. Internationally, there are emerging statistics reporting on out-of-field teachers, but the full scale of such practices is not clearly understood. There are competing theories on the mechanisms that drive out-of-field teaching in schools. But no study has systematically verified these arguments internationally. Lastly, the effect on student achievement of being taught by an out-of-field teacher is not known either. Guided by this literature review, I discuss my research question and the data utilized to answer these questions in the next chapter.

Chapter 3
RESEARCH QUESTIONS AND DATA DESCRIPTION

In this chapter, I describe the data I used and the research questions that are to be answered in the subsequent chapters. The research questions were derived from previous studies in the United States.

3.1 Research questions

Q1. What is the distribution of out-of-field math and science teachers in the public schools in the 21 study countries?

Q1 follows from the basic question: what is the prevalence of out-of-field practices in math and science? I chose to focus on math and science teachers in this project for several reasons. The first and foremost is the general agreement that a high-quality math and science teaching force is essential for higher students' performance in math and science (National Research Council, 2002). The importance of developing math and science talents has been discussed extensively by policymakers and researchers. They argue that people with high skills in these fields form the backbone of the economy, which is driven by service and technology in the 21st century (Lowell & Salzman, 2007; National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007). The obvious challenge toward achieving this goal is how to maintain an adequate supply of math and science teachers, which has proven to be difficult even for the developed nations (Ingersoll & Perda, 2010; Ladd, 2007; National Comprehensive Center for Teacher Quality, 2009). Compared to teachers in other fields, math and science teachers are facing unique labor market conditions. The demand for people who have a background in math and science is particularly high in service and high-end manufacturing sectors. Occupations outside of teaching that demand a great amount of math and science skills offer higher wages. This in turn causes the numbers of math and science teachers to be most susceptible to shortages compared to the numbers of teachers in other subjects (Ladd, 2007). These findings support the view that a math and science educator faces a different kind of supply and demand structure in the labor market, and that dedicated analysis is required to understand the factors related to such differences.

Another reason for emphasizing math and science teachers is that compared to other content areas, researchers have accumulated substantial knowledge on teacher preparation and teacher effectiveness in these two subject areas. The accumulated knowledge not only comes from the United States (Hill et al., 2005; Lee & Krapfl, 2002), but also internationally (Schmidt et al., 2008, 2007). Yet despite the growing efforts to strengthen teacher education at the higher education level globally (Luschei & Chudgar, 2011), we rarely ask whether qualified candidates are in fact assigned to teach the subject that they are trained to teach. Building on previous findings from the study of the teacher labor market, this study takes the position that it is not enough to focus only on the supply side of the story; it is also important to ensure that highly trained teachers are actually deployed to the positions that need them most. Thus by asking this question, I intend to examine formally the distribution of teachers in math and science, and the extent to which they do not have sufficient qualifications.

One distinction I make in this dissertation is that I focus only on public school teachers. The rationale behind this decision is that the teacher labor markets facing public and private schools are very different. There is compelling evidence showing that private schools operate under different conditions than public schools. In terms of teacher-related issues, public schools, typically enjoy a guaranteed supply of teachers from government-funded teacher education institutions, whereas private schools, depending on their purposes, are often recruiting from a different sector of the labor market. For example, Andrabi, Das, and Khwaja (2008) described the hiring process of private schools in Pakistan, in which the candidate pool is made up of largely young, single, moderately educated, and untrained women from the local labor market, while government schools are able to recruit male and educated teacher candidates because they are able to offer them higher wages and social status. Similar processes have been found in studies of private schools teachers in many other settings (McEwan & Carnoy, 2000; Muralidharan & Kremer, 2008; Psacharopoulos, 1987). Because the sustainability of private schools in many settings depends on the supply of low-cost teachers, it is clearly not meaningful to treat the teachers who work in different types of institutions as the same. Since I could not obtain more detailed information about the operation and hiring practices of private schools in TALIS countries, I decide to focus only on public school teachers. I should point out that in many developing nations where universal secondary education has not been achieved, public schools usually enjoy certain privileges compared to private schools in terms of filling teaching vacancies. Therefore the estimates of out-of-field teaching using only public school data probably underestimate the national out-of-field teaching in general.

Q2. What is the profile of out-of-field teachers within each of the study countries?

Q2.1 What is the demographic background of out-of-field teachers in each country?

Q2.2 What is the educational background of out-of-field teachers in each country?

Q2.3 What is the professional status of out-of-field teachers (e.g., opportunities for professional development; types of students they are teaching; whether or not they receive appraisal for their work)?

After examining the overall out-of-field teaching practices addressed by Q1, I will study the composition of this group of teachers and compare it to the majority of the teaching force in each country. Popular perceptions about out-of-field teachers are that they are young teachers who are assigned to subjects outside their training because there is no immediate opening for the kind of jobs that match their expertise. They are just completing their training for teaching another subject on the job (Darling-Hammond et al., 2001). Interestingly, there is not much empirical evidence to support this claim. There are scattered findings in the United States that show that out-of-field teachers tend to be veteran, experienced teachers (Ingersoll, 1999). Benefiting from the rich teacher background information provided in TALIS, this question addresses the demographic backgrounds of out-of-field teachers. It is also of interest to look at how demographic attributes of out-of-field teachers vary across nations. Several labor market mechanisms are also worth considering. Are out-of-field teachers used as a means of flexible labor deployment in schools (e.g., they are hired on a part-time basis with less job security)? Are out-of-field teachers actually temporary teachers who only cover the position in the short run? Do out-of-field teachers consist of a reserve of highly educated but less-experienced teachers? Some countries allow out-of-field teaching as long as the school provides teachers opportunities to acquire in-field status within a reasonable time. Can out-of-field teachers get enough help on the job to develop subject matter knowledge (e.g., professional development opportunities or appraisal from school administrators)?

Q3. At what kinds of schools do out-of-field teachers work?

Proposition 3.1 Out-of-field teachers are more likely to concentrate in schools that have difficulty in recruiting teachers.

Proposition 3.2 Out-of-field teaching exists in schools where the school principal lacks administrative leadership.

Proposition 3.3 Cross-nationally, the relative autonomy of hiring teachers at the school level should interact with the above two factors and collectively shape the level of out-of-field assignments.

Generally, there is no systematic information on the working environment of out-of-field teachers outside the United States. We have limited knowledge regarding the hiring strategies of schools that make out-of-field assignments. Ingersoll (1999) described some characteristics associated with American schools that have larger numbers of out-of-field teachers (small and private ones). Pertinent to my study, the labor market literature suggests that schools in large cities and rural areas are susceptible to shortages in math and science (Ladd, 2007). In large cities, alternative employment opportunities are likely to lure math and science talents away from teaching while in rural areas, tough working conditions and low living standards also offer less incentive for qualified math and science teachers. I empirically examined whether the distribution of out-of-field teachers follow these previous findings.

The three propositions were formulated according to current understandings of the relationship between out-of-field assignments and school factors. Proposition 3.1 aimed to test whether out-of-field teaching is associated with teacher shortages, which is widely believed to be the main cause of such practices. Proposition 3.2 tested another hypothesis: out-of-field assignment is due to the principal's discretionary power in staffing. If this argument is true, one would expect that out-of-field teaching occurs more often in schools where principals solely decide the assignment of teaching positions without being held accountable; out-of-field teaching is less prevalent in schools where daily management is collectively controlled by teachers or through a centralized regime with high external accountability. Since these arguments arise in the context of American public schools, which is also characterized by a high degree of localized autonomy in hiring teachers with little external inspection (Ingersoll, 2006), one would expect that in the international context, the autonomy of hiring may interact differently with the administrative leadership and teacher shortage factors in nations where the institutional arrangements of hiring and assignment vary. This will be examined in Proposition 3.3.

Q4. How do math and science out-of-field teachers in public schools differ from their in-field colleagues?

Q4.1 Do out-of-field teachers spend different amounts of time on teaching practices than in-field teachers?

Q4.2 Are out-of-field teachers equally likely to participate in professional activities in schools?

Q4.3 Do out-of-field teachers have more opportunities to develop their skills and knowledge on the job?

Up until now, there has been limited empirical evidence regarding the differences in teaching behavior and professional status between out-of-field and in-field teachers. Based on the assumption that out-of-field teachers lack sufficient subject matter knowledge, and consequentially pedagogical subject matter knowledge, out-of-field teachers may rely more on textbook and routinized teaching practices (Ingersoll, 1999). Therefore, one would expect out-of-field teachers to use a textbook-driven, more structured teaching approach in the classroom, compared to the hands-on teaching that emphasizes student engagement and use of different activities. In addition, if out-of-field teachers have poor training overall, we could expect to see the amount of time they spend on school activities differ from in-field teachers. For example, out-of-field teachers may spend more time controlling and managing students than teaching if they cannot control the classroom properly. Another question that is important to ask is whether out-of-field teachers are part of the school teaching community. This question builds on the notion that out-of-field teaching is a transient position in schools. Under such a scenario, we could expect out-of-field teachers to participate less in collegiate collaboration or exchange of ideas. Lastly, I was interested to see whether out-of-field teachers are offered on-the-job learning opportunities. If we presume that the out-of-field teachers do not have the same amount of extensive training of subject matter knowledge, one natural remedy is to develop such knowledge while they are on the job. So this question particularly compared learning opportunities such as feedback about teaching from the principals, participation in professional development activities, and receiving mentoring from veteran teachers, etc.

Questions one through three were answered using descriptive methods. I compared mean statistics and used graphs to present the findings. Questions two and three were also examined jointly using multivariate regression methods for each country. This technique ensured that I consider multiple sources of influences at the same time. Question four was examined through a series of regression models that take into account teachers' background and school characteristics simultaneously. Detailed model specifications are presented in Chapter 5 where I show how I formally employed these methods.

3.2 Data

In this study, I rely on the data from OECD's Teaching and Learning International Survey 2008 (TALIS 2008) data. TALIS is "the first international survey to focus on the working conditions of teachers and the learning environment in schools" (OECD, 2009, p. 18). TALIS is a cross-sectional survey database that includes lower secondary school- and teacher-level data from 24 countries, over 4,000 schools, and over 70,000 teachers. Table 3.1 lists all the countries participating in TALIS. European Union countries comprise the biggest proportion, with a total of 19 countries.[19] Two countries are from Asia (South Korea and Malaysia), one from South America (Brazil), one from North America (Mexico), and one from Oceania (Australia). Due to data quality issues, Iceland was not included in my analysis.[20]

One issue in international comparisons is the comparability problem. Since nation states structure their education systems differently, it is important for researchers to make reasonable comparisons. In TALIS, as shown in Table 3.2, the term "lower secondary" is used to described different levels of schooling cross-nationally. Although the grade level varies from country to country, it is generally believed that students began to receive departmentalized instruction at similar grades as sampled in TALIS. As discussed previously, I focus on public school teachers in the analysis, who make up the majority in TALIS sample.

[19]Iceland and Turkey are not yet part of the EU, but they are official candidates. Norway is not part of EU, though it is highly integrated into EU's economy and regulation.

[20]For reasons not disclosed to outside researchers, Iceland withdrew from the international database (OECD, 2010). Therefore I decided to exclude it from my analysis.

Table 3.1: Participatant Countries in TALIS 2008

OECD Countries	
Australia	South Korea
Austria	Mexico
Belgium (Flemish)	Norway
Denmark	Poland
Hungary	Portugal
Iceland	Slovak Republic
Ireland	Spain
Italy	Turkey
Netherlands	
Partner Countries	
Brazil	Malaysia
Bulgaria	Malta
Estonia	Slovenia
Lithuania	

Source: OECD (2010)

Table 3.2: Description of samples

Country	Grade sampled	PSU MOS Unit	Total school sample	Total teachers sample	Public schools sample	Total Math and Science teachers
Australia	7-10	S	149	2275	83	583
Austria	5-8	S	248	4265	209	989
Brazil	5-8 or 6/9	T	380	5834	257	1653
Bulgaria	5-8	T	199	3796	193	1036
Denmark	7-10	S	137	1722	76	537
Estonia	7-9	T	195	3154	189	730
Hungary	5-8	T	183	2934	163	728
Ireland	7-9	S	142	2227	55	516
Italy	lower secondary	T	298	5263	268	na
Korea	7-9	T	171	2970	110	738
Lithuania	5-10	T	206	3535	200	761
Malaysia	7-9	S	217	4248	208	987
Malta	Form I - Form V	NA	58	1142	30	265
Mexico	7-9	T	192	3368	149	930
Netherlands	ISCED 2[a]	S	39	484	33	114
Norway	8-10	T	156	2458	145	618
Poland	7-9	S	172	3184	158	794
Portugal	ISCED 2	T	173	3046	130	857
Slovak Rep	5-9	T	186	3157	158	872
Slovenia	7-9	T	184	3069	177	843
Spain	First - Fourth Compulsory Secondary	T	193	3362	138	881
Turkey	6-8	T	193	3224	140	707
Belgium (F)	First stage of secondary education	T	197	3473	83	667

a: ISCED 2 in the Netherlands consists of lower secondary education (first three years of pre-university education), the first three years of senior secondary education and all four years of pre-vocational secondary edcuation
Source: OECD (2010)

TALIS particularly focused on the role of teachers in the following aspects:

- The role and function of school leadership;
- How teachers' work is appraised and the feedback they receive;
- Teachers' professional development;
- Teachers' beliefs and attitudes about teaching and their pedagogical practices.

3.2.1 Measuring out-of-field teaching

In the TALIS teacher questionnaire, teachers were first asked in Question 34 to identify from the following list the subject they are teaching:

- Reading, writing and literature
- Mathematics
- Science
- Social Science
- Modern Foreign Language
- Technology
- Arts
- Physical education
- Religion
- Practical and vocational skills
- Others

In this project I focus only on math and science teachers. Italy dropped out of the analysis at this stage because the subject assignment variable was entirely missing for all teachers. Teachers were then asked whether the teaching of this subject was part of one's academic training (Question 36). This was a yes/no type of question. I used the answer to this question to construct my out-of-field teaching indicator. To focus on math and science teachers who work in public schools, I first linked the teacher data and the school data for each country, then used the public/private school variable provided in the school dataset to restrict my dataset. By doing so, Ireland dropped out of my analysis due to missing linking identification between teacher and school.

Using these variables, I constructed an out-of-field teaching measure. Using the method discussed in Chapter 2, I calculated the percentage of out-of-field teachers (of the total teacher population) in math and science area by schools (Equation 3.1). This measure became my dependent variable in the subsequent analysis. In the analysis, I focused on math and science teachers in particular. There are certainly limitations in the TALIS data. For instance, even though it was common for teachers to take multiple assignments at lower secondary levels, the teacher questionnaire does not differentiate between primary and secondary teaching assignments. Therefore I was not able to discern whether out-of-field teachers are teaching multiple subjects at the same time. I was also not able to differentiate out-of-field teaching by assignment types. Secondly, TALIS does not provide a measure of FTE (full-time equivalence), which has been shown in the U.S. literature to affect the estimation of out-of-field teaching (Seastrom et al., 2002). I used a proxy measure of FTE to generate alternative estimates of out-of-field teachers. These considerations made the information provided by TALIS less than ideal. Despite these limitations, TALIS data make a unique contribution to this research since this is the first time internationally comparable statistics on these issues were made available to researchers.

$$Percent\ OFT\ per\ school = \frac{Total\ number\ of\ math\ and\ science\ OFT\ per\ school}{Total\ number\ of\ math\ and\ science\ teachers\ per\ school} \quad (3.1)$$

TALIS also provided a rich set of organizational variables at the school level. The strength of the TALIS data was that it included many measures regarding teaching practices and school environment, which were not available in most administrative data. These variables included conventional school characteristics such as school size, locality, percentage of minority students, resource shortages, etc. TALIS included contextual variables such as whether or not teachers could participate in hiring decisions; how much authority teachers had in determining course content; and whether the school had a mentor teacher program. These variables were used by the TALIS team to create several composite measures of school environment, which I used in my analysis. Exploring the relationship between these variables and individual teachers' out-of-field assignment expands our understanding of the influence of school organization on teaching assignment. Table 3.3 describes the variables used in this analysis:

Table 3.3: Description of variables

Variable Name	Type	Description	Source
BTG01	categorical	gender	Teacher
BTG02	ordinal	age	Teacher
BTG03	ordinal	part/full time	Teacher
BTG06	categorical	contract teacher	Teacher
BTG07	ordinal	educational background	Teacher
BTG08A	continuous	time spent on teaching (hours)	Teacher
BTG08B	continuous	time spent on preparing lesson (hours)	Teacher
BTG08C	continuous	time spent on administrative duty (hours)	Teacher
BTG09	ordinal	years or experience	Teacher
BTG11G1	categorical	mentoring or peer observation	Teacher
BTG12	continuous	days spend on professional development	Teacher
BTG30J	ordinal	observe other teacher's class	Teacher
BTG39B	ordinal	student ability	Teacher
BTG41B	continuous	% of time spent on keeping order	Teacher
BTG41C	continuous	% of time spent on teaching and learning	Teacher
BCG08	categorical	public/private	School
BCG10	categorical	school locality	School
BCG12	continuous	school size	School
BCG15H	ordinal	principal informs teacher updating their skills and knowledge	School
TPRATIO	continuous	teacher-pupil ratio	School
AVGCLSIZ	continuous	school mean class size	School
PEDUATT3	continuous	students with at least one parent/guardian who completed ISCED 3 or higher (school mean)	School
PEDUATT5	continuous	students with at least one parent/guardian who completed ISCED 5 or higher (school mean)	School
NVREVAL	categorical	no appraisal or feedback received by the teacher	Teacher
AUTHIRE	continuous	index of autonomy of hiring teachers	School
LACKPERS	continuous	index of lack of personnel resources	School
ADMINL	continuous	index of administrative leadership	School
TSRELAT	continuous	index of teacher-student relationship	Teacher
CCLIMATE	continuous	index of classroom climate	Teacher
SELFEF	continuous	index of self efficacy	Teacher
TBTRAD	continuous	index of direct transmission beliefs about instruction	Teacher
TBCONS	continuous	index of constructivist beliefs about instruction	Teacher
TPSTRUC	continuous	index of structuring practice	Teacher
TPSTUD	continuous	index of student-oriented practices	Teacher
TPACTIV	continuous	index of enhanced activities	Teacher
TCCOLLAB	continuous	index of professional collaboration	Teacher
TCEXCHAN	continuous	index of exchange and coordination for teaching	Teacher

Chapter 4
ATTRIBUTES OF OUT-OF-FIELD TEACHERS

In the past two decades, the study of out-of-field teachers has emerged as one of the subfields of teacher quality study in the public policy circle in the United States. Researchers have used comprehensive national data to examine the characteristics of out-of-field teachers and the effect of being taught by out-of-field teachers on student achievement. The interest in this topic builds on a shift in policy focus to require teachers to display competency in subject matter knowledge. While a similar trend to use university-based teacher education as the primary means to train future teachers has also taken place internationally, little is known about whether such efforts actually improve teacher quality. In order to identify parallels to the out-of-field teacher studies in the United States, in this chapter I use the TALIS 2008 data to describe the attributes of out-of-field teachers in 21 nations.[21] The description includes teachers' demographic background, educational attainment, and working conditions. Because the TALIS sample consists of in-service teachers and provides little information about the teacher education background of these teachers, my analysis therefore primarily focused on teachers who were already on the job. Whether or not out-of-field teachers received different kinds of teacher education, and in what kinds of programs, are left for future analysis. As discussed in Chapter 3, I chose to limit my sample to math and science teachers who work in public schools in each country. Not only is the quality of math and science teachers of central interest in many policy initiatives around the world, but also are the labor market conditions faced by people who are trained in math and science fields that differ from other disciplines. In addition, the choice of public school teachers over private

[21]As previously sated, Iceland withdrew from international database after TALIS was published. Ireland does not provide a link between school and teacher, and therefore excluded in my analysis. Italy does not provide a subject matter identifier therefore I could not distinguish subject matter teachers. I exclude Italy for this reason. These exclusions lead to 21 countries in final analysis.

school teachers is because public and private institutions' recruiting patterns and potential teacher candidate pools are different in several aspects. Due to limited information regarding the operation of private schools in many countries, I chose to focus on public schools.

4.1 The distribution of out-of-field teachers across countries

Figure 4.1 shows a comparison of out-of-field teaching in math and science subjects among public school teachers in 21 TALIS countries.

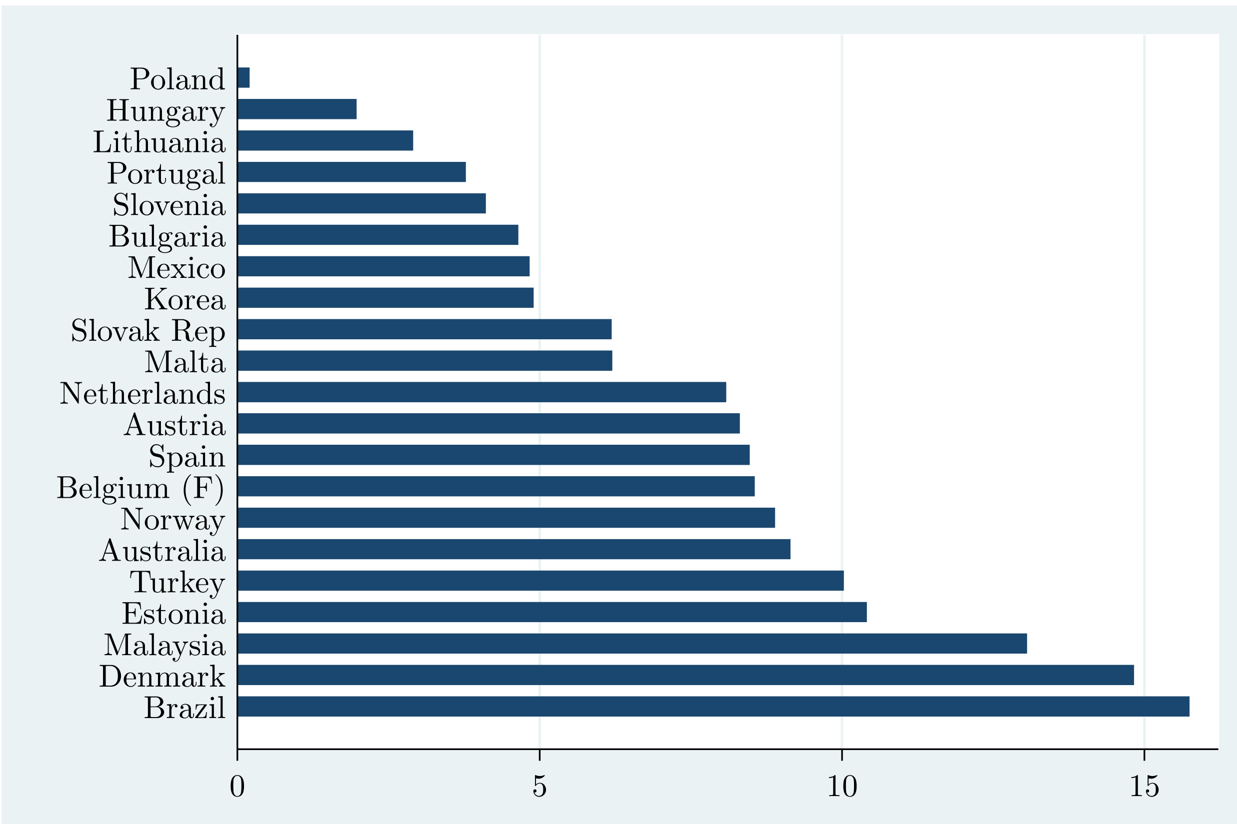

Figure 4.1: Percentage of out-of-field teachers in math and science, unweighted. For interpretation of the references to color in this and all other figures, the reader is referred to the electronic version of this dissertation

The level of out-of-field teaching ranged from 0.2 percent in Poland to 15.7 percent in Brazil. The international mean of out-of-field teaching in math and science teachers who teach in public school is 9.7 percent, which means one in ten teachers in math and science was teaching out-of-field. Figure 4.1 clearly suggests that there is cross-national variation. In Bulgaria, Hungary, Korea, Lithuania, Mexico, Poland, Portugal, and Slovenia, out-of-field teachers were less than 5 percent of the entire math and science workforce. On the other hand, Brazil, Denmark, and Malaysia had relatively large numbers of out-of-field teachers. As mentioned in Chapter 2, several EU countries allow out-of-field teaching with certain restrictions. These countries are Belgium (Flemish and German), Denmark, France, Finland, Sweden, UK (England, Wales, and Northern Ireland), Iceland, Norway, Bulgaria, Lithuania, Estonia, Luxembourg, Netherlands, Romania, Latvia, Slovenia, Czech, and Poland, according to Eurydice (2002, p. 74). Several of these countries could be found in the TALIS database. However it is difficult to tell whether these countries have a low or high percentage of out-of-field teachers in math and science due to lax regulations. For instance, though Poland allows out-of-field teaching, it has the lowest number of out-of-field teachers among TALIS countries. On the other hand it seems Denmark is taking advantage of its regulatory regime and deploys more out-of-field teachers into classrooms. Therefore there is no direction correlation between policy regulations and actual levels of out-of-field teaching across nations.

One limitation of this presentation in Figure 4.2 is that it does not take into account a teacher's full-time equivalence (FTE) status. For example, if out-of-field teachers are all part-time teachers who only have 50 percent of employment time and we ignore this in the calculation, the estimated percentage of out-of-field teachers will be inflated.[22] Unfortunately TALIS does not provide a detailed measure of FTE. Alternatively, I used one's employment time (part-/full-time status) as a proxy measure to reflect the individual teacher's FTE status. In the teacher questionnaire, every teacher answered whether they were full-time, part-time (50-90 percent of full-time hour), or part-time (less than 50 percent of full-time hours). I used this variable as an estimate of one's FTE. If a teacher worked full-time, I coded FTE as equal to 1. If one was employed at 50-90 percent of full-time status, I coded

[22]A numerical demonstration of the effect of FTE on out-of-field calculation is shown in Chapter 2, Section 2.2.1.1.

FTE as 70 percent, the center of this range; if one was employed at less than 50 percent of full-time status, I coded FTE as 25 percent. I then used this variable as a weight in the calculation. Figure 4.2 shows the weighted estimates. It is not difficult to notice that there is little difference between the estimates in Figure 4.1 and Figure 4.2. Notably the out-of-field teaching level in math and science shrinks for Brazil: now Denmark is the country with the highest level of out-of-field teachers. This suggests that many out-of-field teachers in Brazil were indeed working on a part-time basis. We will see later in this chapter that part-time teaching indeed characterizes out-of-field teachers in several countries. Since there is little discrepancy between the weighted and unweighted, for the sake of simplicity, all of the following analyses were done using the unweighted method.

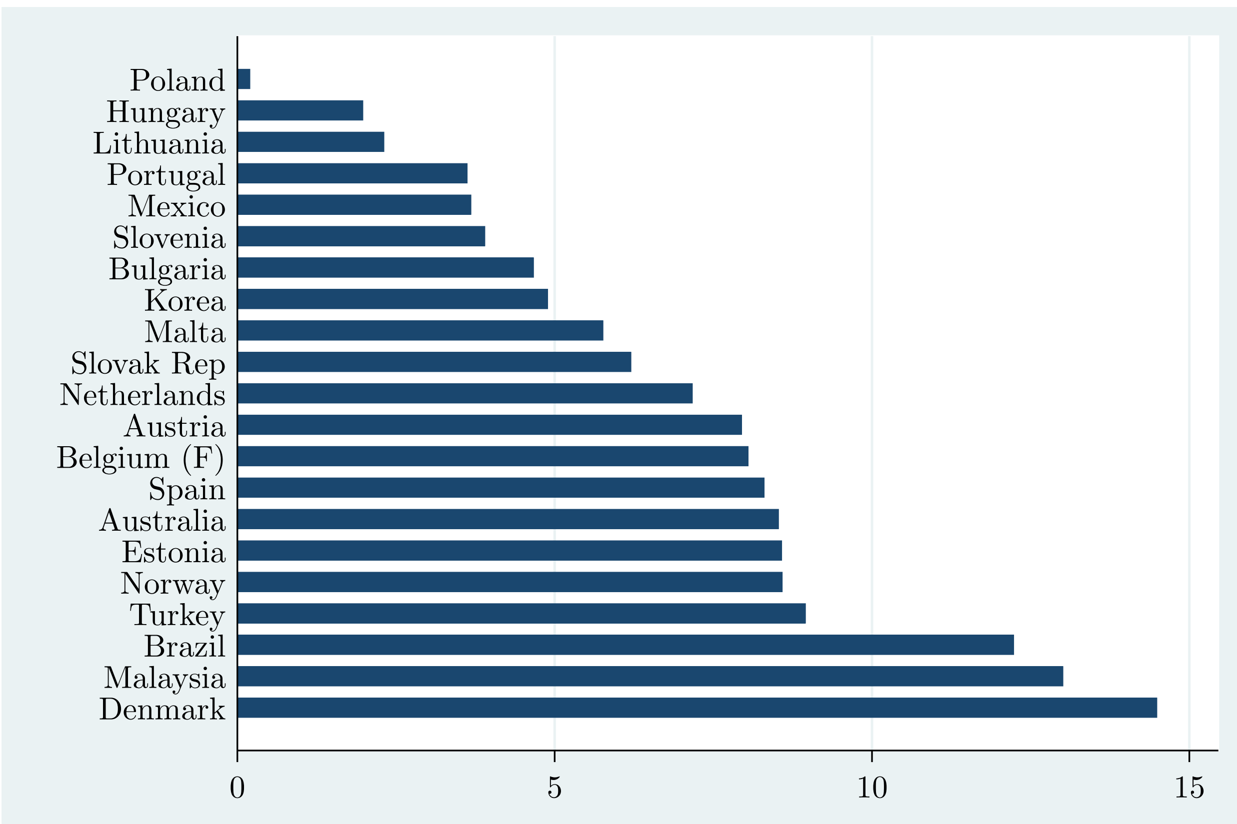

Figure 4.2: Percentage of out-of-field teachers in math and science, weighted by part-time status

In the current comparative work on teacher quality, many researchers use TIMSS as their major source of data (Akiba & LeTendre, 2009; Akiba, LeTendre, & Scribner, 2007). The appeal of TIMSS is obvious. As the largest-to-date cross-national comparative educational database, it includes more than forty countries over a wide range of levels of educational development. However, as some critics have pointed out, the TIMSS data is ill-suited to the purpose of answering teacher-related policy questions because it is designed to include nationally representative students instead of teachers (Rutkowski, Gonzalez, Joncas, & von Davier, 2010). To put it differently, the teacher data included in TIMSS can only be used to draw inferences about teachers' experience by a nationally representative sample of students rather than about a country's teaching force in general because of the way sampling is designed in TIMSS. To illustrate this point, I present a comparison of estimates using TIMSS 2007 data to generate out-of-field statistics. Since I did not intend to make any generalization, but instead compared the same estimates using two difference sources of data, I only included countries that appear in TALIS 2008 as well as in TIMSS 2007, and I used the United States for reference.

The comparison is shown in Figure 4.3. Since I only had 9 countries for comparison, it was hard to draw any definitive conclusion. If we were to make a casual judgment, estimates from TIMSS generally are higher than estimates from TALIS. In the case of Norway and Australia, the TIMSS estimates are way higher than TALIS's. It is not clear what causes the disparity between the two sets of estimates. There are several possibilities. First, the two studies used different measures of out-of-field teaching. The one used in TALIS is more generic (because TALIS targeted teachers from various fields) and the one used in TIMSS was specifically tailored to math and science education. Second, since the teacher population in TALIS was nationally representative and the one in TIMSS was not, one needs to be cautious about generalizability. Also the teacher sample from TALIS includes teachers from multiple grades, and in TIMSS only 4^{th}- and 8^{th}- grade teachers were sampled. Third, the TIMSS data does not always differentiate between public and private schools.[23] Up to this point it

[23]Countries are allowed to decide whether to include private schools in TIMSS. But there

is less clear which factor would cause the difference in estimates, and more technical work surely is needed to probe into this issue. The bottom line is, policy researchers should be advised not to use the TIMSS findings as the sole evidence against a nation's teacher quality (as is the case for Australia, Malaysia, and Norway).

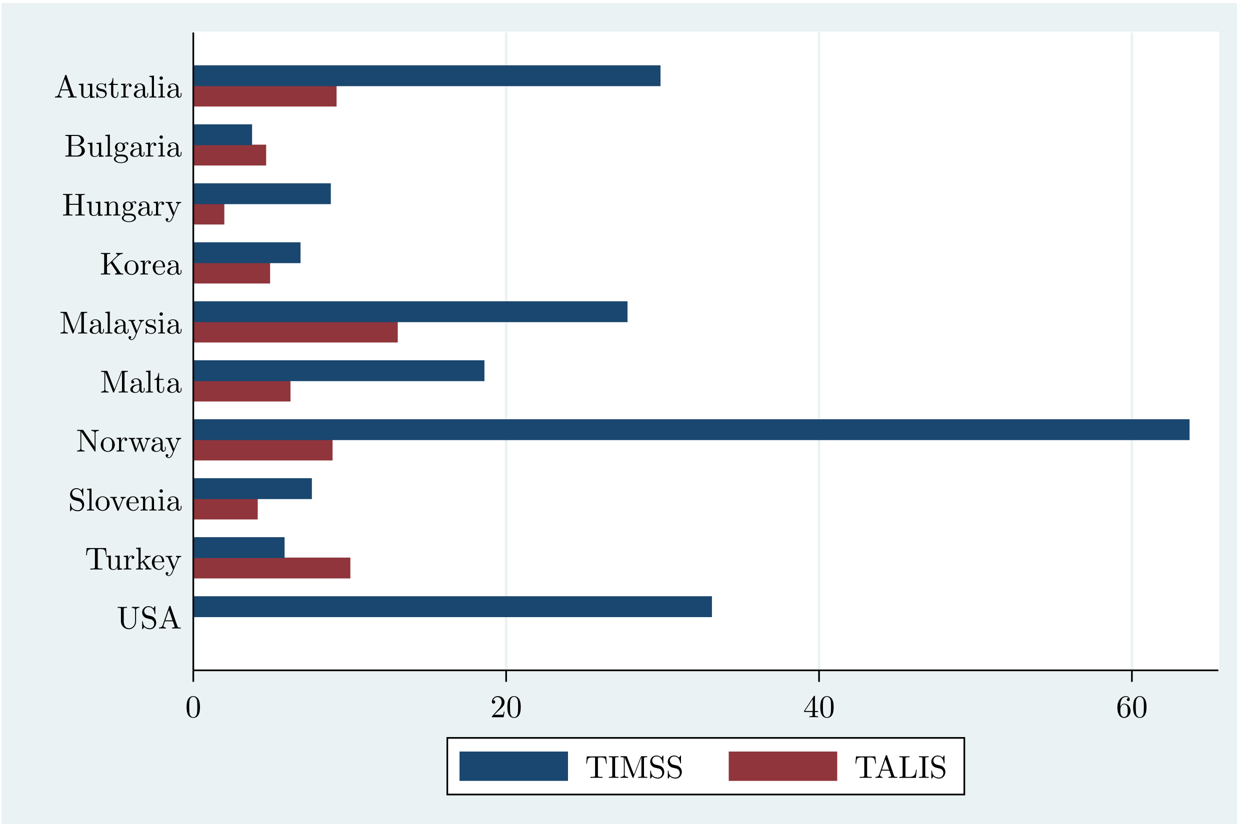

Figure 4.3: Comparison of out-of-field estimates from TALIS 2008 and TIMSS 2007 data (8^{th} grade)

If we place confidence in the estimates of out-of-field teaching, one follow-up question is how unique out-of-field teaching practices in math and science are, compared to other subject matters. In Figure 4.4 I provide a brief comparison among public school teachers from different subject fields. I categorized teachers by subject matter into three categories: math and science, humanities, and other.[24] The degree of deployment of out-of-field teach-

is no indicator for research to differentiate between these two types of schools. Since TALIS also contains private school teachers, I conducted a separate calculation between TALIS and TIMSS using the full TALIS sample; the result barely changed.

[24]The categorization followed OECD's method (OECD, 2009, p. 100). Humanities include

ers in math and science was close to those in humanities in the majority of countries.[25] In general, out-of-field teaching was more prevalent in "other" subject matters. This finding is not surprising because typically current university-based teacher training is more than likely to focus on academic subjects. Regulations on teacher assignments are more common in academic subject areas in many countries, but little evidence can be found that the same regulations apply to teachers in non-academic subject matters, such as vocational education and technology. Teacher qualifications in non-academic subjects tend not to include a specialized degree in these subject matters. This is the indication that more effort has been put into providing professional training for teachers in math and science fields so that out-of-field teaching can be kept under control.

Compared to the U.S. data that NCES compiled in the 1990s, the countries surveyed in TALIS had substantially lower levels of out-of-field teaching. For example, NCES's estimates show that in the United States, 64.7 percent of middle school math teachers do not have a major in mathematics; in science, the estimate is 49.6 percent. These numbers are higher than Brazil, the country with the highest math and science OFT in the TALIS sample. Although the U.S. data was calculated using earlier statistics, and no up-to-date nationally representative statistics exist, the substantial gap in out-of-field teaching between the U.S. and the rest of the world indicates that the U.S. is clearly not on the better side of the teacher quality spectrum. Even when we consider the estimates from TIMSS, which probably contained errors to a degree, the out-of-field level in math and science in the U.S. was about 30 percent, still substantially higher than majority of the TALIS countries. Of course there is reason to believe that, with the enforcement of the highly qualified teacher provision in the federal No Child Left Behind Act, states have geared up to reduce out-of-field teaching, yet the sheer differences suggest tremendous efforts still need to be made in the United States

reading, writing, and literature, social science, modern foreign language, arts, and religion. Other includes: physical education, vocational education, technology, and other unspecified subjects.

[25]Malaysia, Mexico, and the Slovak Republic might be exceptions.

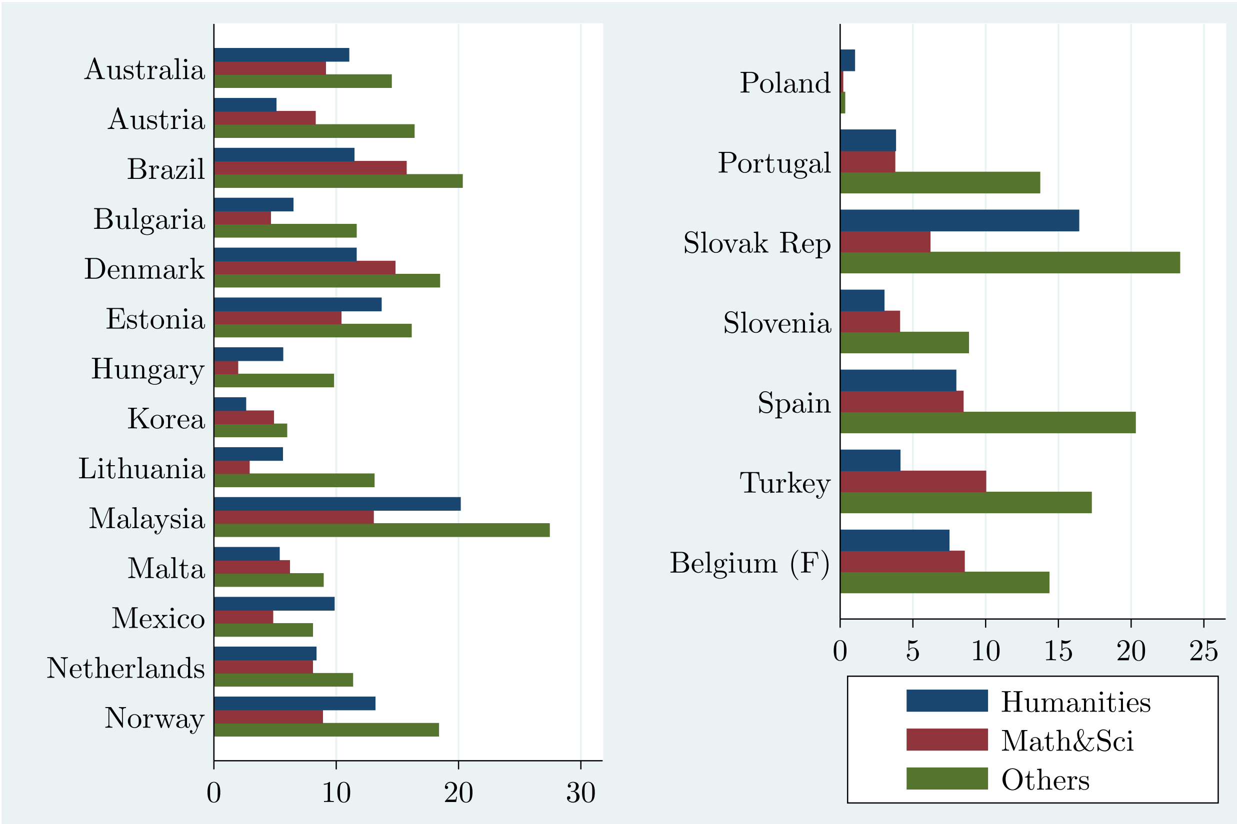

Figure 4.4: Percentage of out-of-field teachers by subject fields

in order to catch up with the rest of the world. Another caution that needs to be made when interpreting the statistics is that I focused on public school teachers in the analysis. As stated in Chapter 3, the estimates based on public school teachers are likely to understate the scale of out-of-field teaching.

4.2 Demographic background of out-of-field teachers

4.2.1 Gender

Figure 4.5 contrasts the gender composition between out-of-field and in-field teachers across nations.[26] A general observation that can be made from Figure 4.5 is that out-of-field

[26]Countries are sorted in descending order by male teachers as percentage of out-of-field teacher.

teachers' gender composition is close to their in-field colleagues' gender across countries. A simple statistical test confirms our observation: the difference in gender composition is statistically zero in 17 countries. In most countries, teaching is a feminized occupation, only a handful countries have a male-dominant teaching force (male teachers are over 50 percent), such as the Netherlands, Turkey, Denmark, Norway, Mexico, Australia, and Malta. In these countries, there tends to be more males who are out-of-field teachers. Gender compositions between out-of-field and in-field teachers were statistically different in 4 countries: Estonia, Hungary, Portugal, and Turkey, where out-of-field teachers were significantly more male than female. I should remind readers that this finding is derived from the math and science teacher population. It remains to be examined whether the same observation applies to other segments of the teacher labor force.

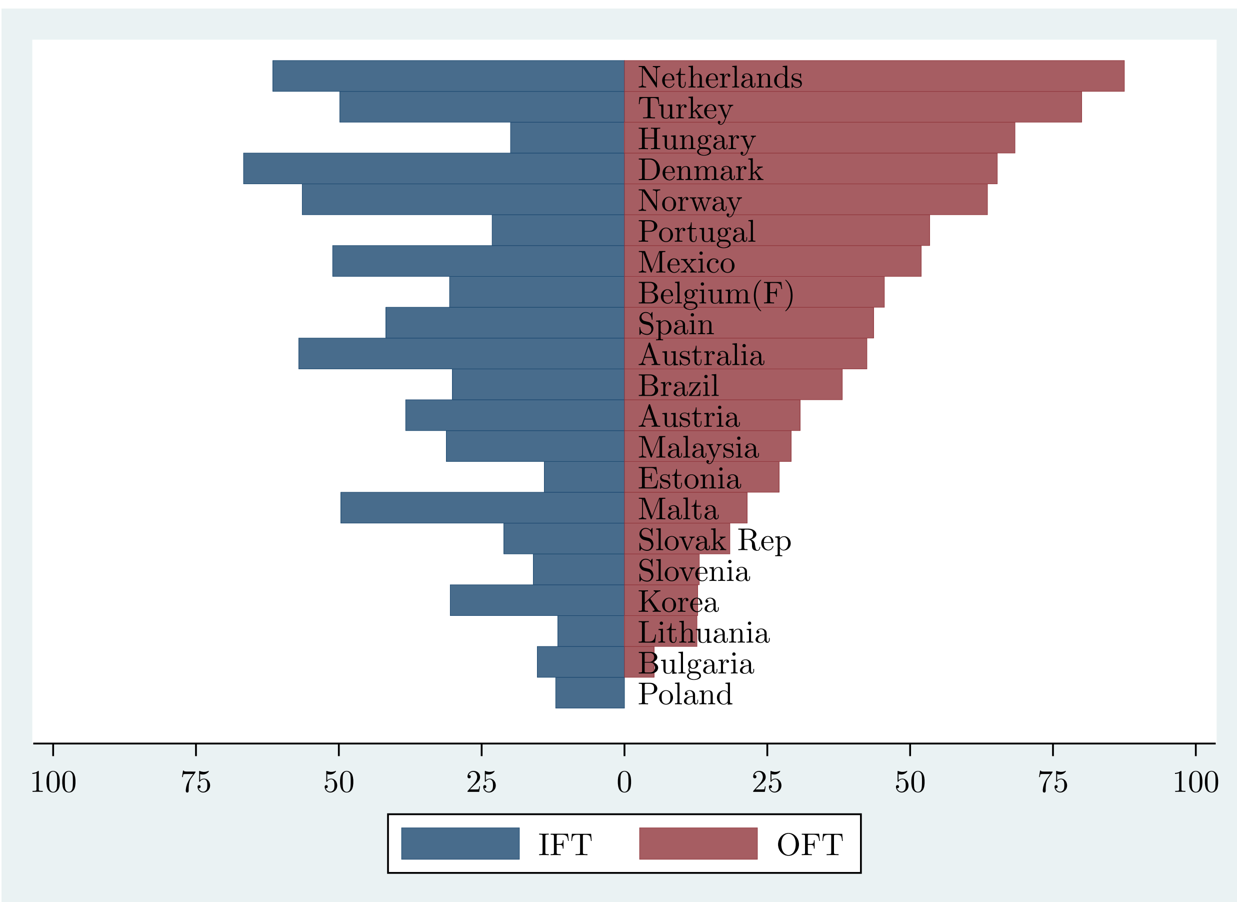

Figure 4.5: Proportion of male teachers by out-of-field status.

Male out-of-field teachers in several cases look quite different from female out-of-field teachers. In Table 4.1, for example, in Denmark male out-of-field teachers are predominantly older than female out-of-field teachers. In Turkey, male out-of-field teachers are predominantly younger than female out-of-field teachers. In Korea, male out-of-field teachers tend to be middle-aged, while female out-of-field teachers are distributed more evenly across all age groups. Does this suggest that there is a gender preference in terms of choosing out-of-field teaching as a job? Or does it reflect different opportunity structure caused by gender role in the labor market?

I further broke down age distribution by both gender and out-of-field status. As described in the three cases above, gender groups have different age characteristics in several countries. Yet we should put such dissimilarities into a broader context to compare them with the male and female distributions of in-field teachers. In Table 4.1 and Table 4.2, I calculated similar statistics for in-field teachers for comparison; I found that the age distributions are similar for male out-of-field and male in-field teachers. This means that gender composition among out-of-field teachers reflects occupation-wide gender difference.

Overall, gender composition has more between-country variation than within-country variation between out-of-field and in-field teachers. Such a pattern suggests that national contexts have clearly influenced the characteristics of the mathematics and science teacher labor market.

Table 4.1: Age distribution of male and female OFT

Country	Male OFT			Female OFT		
	<30	31-49	>50	<30	31-49	>50
Australia	21%	45%	34%	29%	57%	14%
Austria	0%	39%	61%	14%	59%	27%
Brazil	30%	53%	16%	20%	65%	15%
Bulgaria	0%	100%	0%	0%	32%	68%
Denmark	1%	51%	48%	8%	82%	9%
Estonia	31%	45%	24%	17%	47%	36%
Hungary	43%	35%	22%	0%	67%	33%
Korea	0%	86%	14%	23%	52%	25%
Lithuania	15%	22%	63%	0%	68%	32%
Malaysia	12%	85%	3%	22%	73%	5%
Malta	0%	100%	0%	17%	67%	17%
Mexico	4%	71%	25%	40%	50%	10%
Nethlands	14%	43%	43%	0%	0%	100%
Norway	5%	39%	56%	3%	51%	46%
Poland	na	na	na	0%	100%	0%
Portugal	17%	63%	21%	7%	86%	7%
Slovak Rep	0%	85%	15%	33%	52%	15%
Slovenia	0%	86%	14%	2%	98%	0%
Spain	0%	88%	12%	15%	64%	21%
Turkey	40%	48%	12%	2%	98%	0%
Belgium (F)	57%	37%	6%	48%	19%	33%

Table 4.2: Age distribution of male and female IFT

Country	Male IFT			Female IFT		
	<30	31-49	>50	<30	31-49	>50
Austria	6%	42%	52%	5%	53%	41%
Brazil	29%	56%	15%	19%	72%	10%
Bulgaria	9%	44%	47%	5%	59%	36%
Denmark	5%	44%	51%	12%	59%	29%
Estonia	11%	47%	42%	9%	44%	46%
Hungary	8%	55%	37%	4%	55%	41%
Korea	8%	74%	18%	21%	76%	3%
Lithuania	1%	44%	55%	5%	52%	43%
Malaysia	16%	70%	14%	28%	65%	7%
Malta	23%	52%	25%	35%	52%	13%
Mexico	7%	67%	25%	14%	67%	19%
Nethlands	23%	27%	50%	17%	57%	26%
Norway	7%	50%	43%	14%	52%	34%
Poland	22%	53%	26%	8%	73%	19%
Portugal	8%	80%	12%	10%	81%	9%
Slovak Rep	8%	46%	46%	13%	42%	45%
Slovenia	13%	60%	27%	12%	66%	22%
Spain	5%	46%	48%	5%	64%	30%
Turkey	50%	33%	17%	51%	47%	2%
Belgium (F)	31%	46%	23%	22%	49%	29%

4.2.2 Age

In terms of age composition, the differences between out-of-field teachers and in-field teachers are typically spotted at the two ends of the distribution. This suggests that out-of-field assignments are made for two distinctive subpopulations of teachers: those who are young or older[27] as seen in Figure 4.6 and Figure 4.7. The dots in each line represents the percentage of teachers. The blue dots indicate percentage of out-of-field teachers. The red dots indicate percentage of in-field teachers (in math and science), who are the majority in the teacher labor force. In Figure 4.6, for instance in Belgium (Flemish), fifty percent of out-of-field teachers are under age 30 and only 26 percent of in-field teachers are under age 30.

At the lower end of the spectrum, nine countries have a relatively higher proportion (>20 percent) of younger out-of-field teachers. They are Belgium (Flemish), Australia, Hungary, the Slovak Republic, Turkey, Brazil, Estonia, Mexico, and Korea. Belgium (Flemish), Australia, and Hungary's out-of-field teaching force consists of more than 30 percent of young teachers who are below the age of 30. One immediate question is whether these young out-of-field teachers are less qualified. Judging by their education attainment (Table 4.3), this does not seem to be the case. Most of them have at least a bachelor's degree. Is it possible that these young teachers are at some sort of practice teaching stage before they are eventually assigned to a particular subject category? Without an explicit variable that measures their student teaching status in the questionnaire, I only have indirect evidence about this argument.

In Table 4.4, I break down the years of teaching experience by age categories. It is clear that there are countries like Australia where all young out-of-field teachers are first-year teachers. Yet in a majority of countries, not all young teachers are novice teachers. It is common for these young teachers to have 3 years of more teaching experience, which

[27]For the ease of creating graphs for comparison, I re-categorize the age variable in the TALIS database into three categories: below 30, 30 to 50, and above 50.

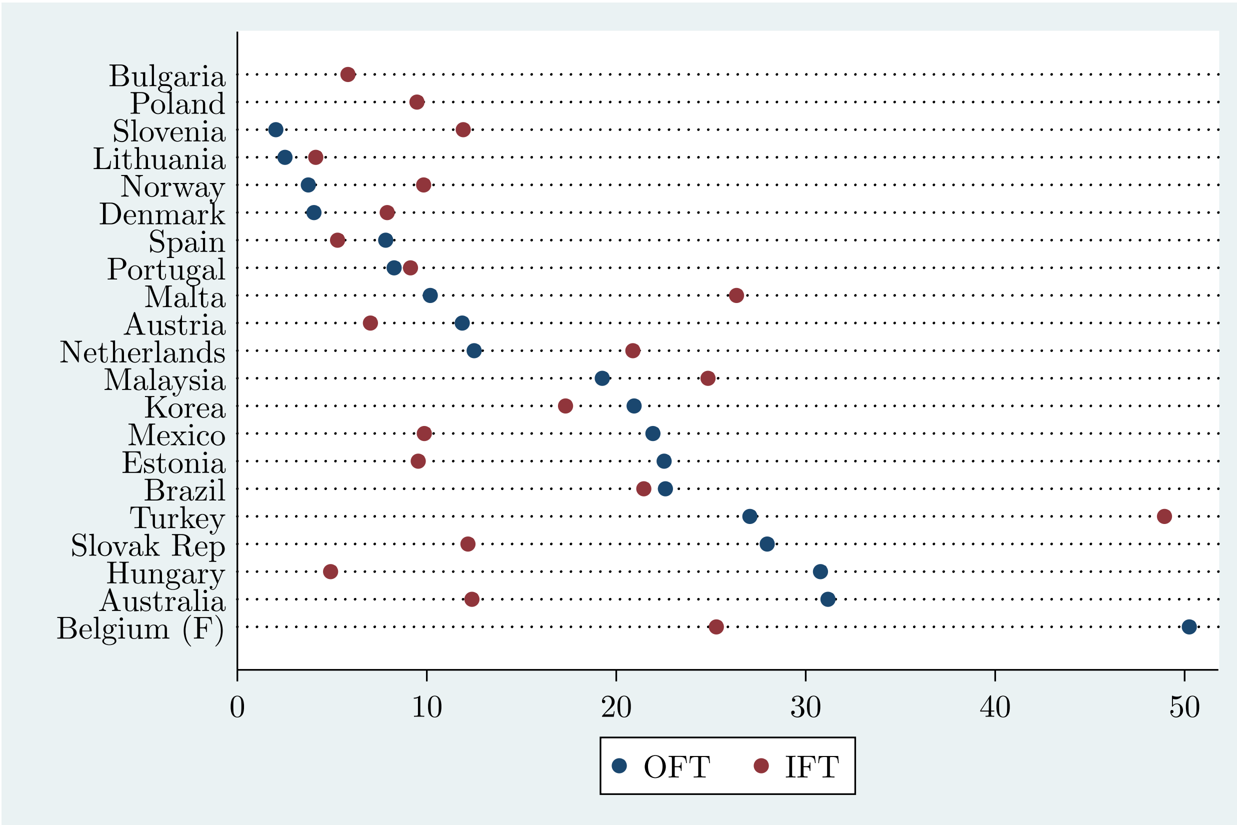

Figure 4.6: Percentage of teachers under age 30 by out-of-field status

rules out the possibility that they are indeed student teachers. At the upper end of the age distribution, not surprisingly, a majority of older out-of-field teachers also tend to be veteran teachers. There are spotty cases such as Australia, Austria, and Bulgaria where a small proportion of older out-of-field teachers also have little experience. These people are likely to treat teaching as a second career, but in general such practices are not common among TALIS countries. The data suggests that out-of-field teaching at least is not used as as a second career for old-yet-inexperienced teachers.

Previous literature has suggested that within schools (Ingersoll, 2006), veteran teachers tend to use their seniority to exert influence over teaching assignments. Following this argument, one would expect to see a smaller proportion of older and experienced out-of-field teachers and a larger proportion of younger and inexperienced out-of-field teachers. Figure 4.7 seemingly supports this argument because at the upper end of the age distribution,

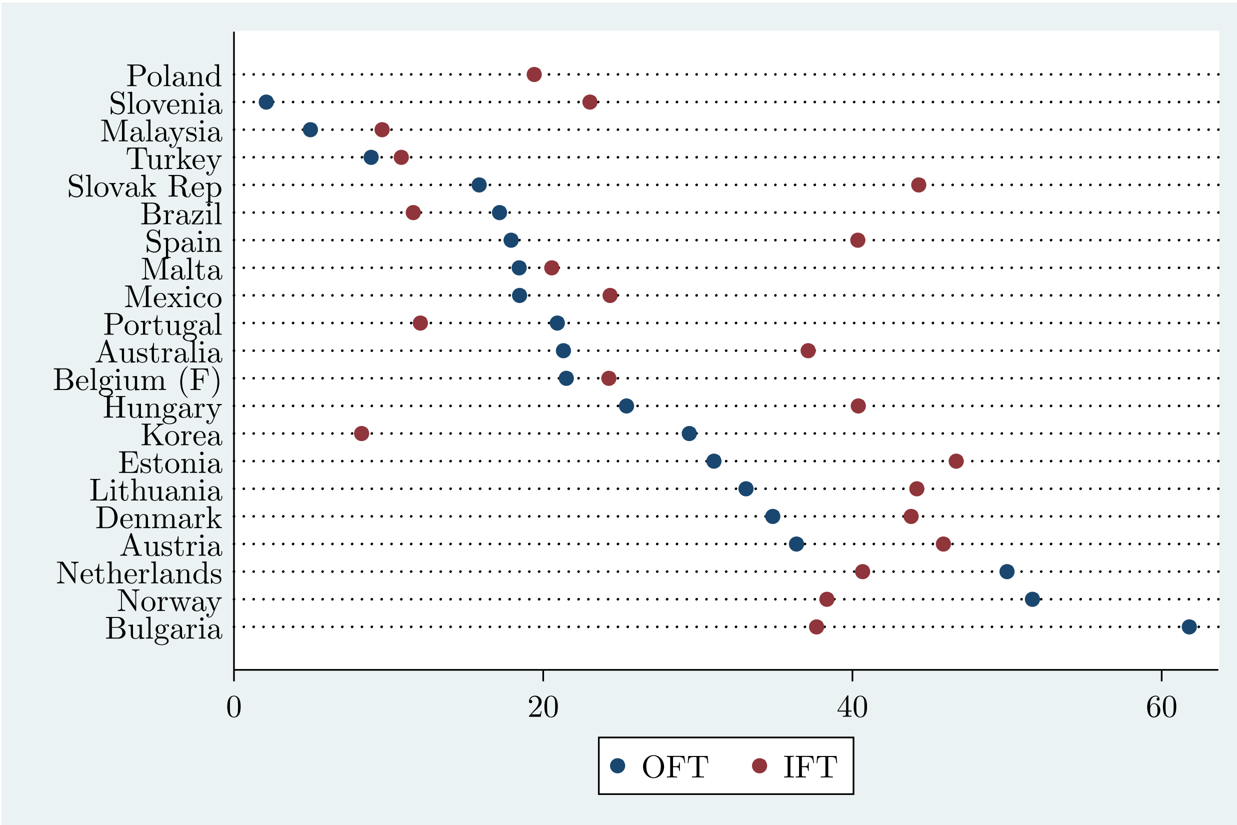

Figure 4.7: Percentage of teachers over age 50 by out-of-field status

there are clearly fewer out-of-field teachers compared to in-field teachers. At the lower end of the age distribution (Figure 4.6), at least in the case of Belgium (Flemish), Australia, Slovak Republic, Mexico, Estonia, and Hungary, many more young teachers are chosen to teach out-of-field. The hypothesis seems to hold in these countries.

However, this theory does not explain the deployment of older out-of-field teachers. Such a practice is evident in at least three countries: Bulgaria, Norway, and the Netherlands. A closer look suggests that these teachers are also experienced, and highly educated. Presumably they are not at the bottom of the school power structure. One explanation is that they are not actually part of the community. These teachers are typically hired on a part-time or short-term basis. In other words, they are not regarded as the "regular" teaching staff in the particular; instead, they are like substitute teachers who answer to short-term requests to teach something for which they do not have training, albeit they are experienced in other

Table 4.3: Distribution of educational attainment of out-of-field teachers under age 30

Country	Educational attainment		
	Below BA	BA	MA or above
Australia	0%	100%	0%
Austria	93%	0%	7%
Brazil	19%	80%	1%
Bulgaria	45%	2%	54%
Denmark	0%	100%	0%
Estonia	30%	60%	11%
Hungary	0%	100%	0%
Korea	0%	100%	0%
Lithuania	100%	0%	0%
Malaysia	0%	97%	3%
Malta	0%	100%	0%
Mexico	0%	82%	18%
Netherlands	0%	0%	100%
Norway	29%	71%	0%
Portugal	0%	100%	0%
Slovak Rep	0%	0%	100%
Slovenia	0%	100%	0%
Spain	0%	0%	100%
Turkey	0%	100%	0%
Belgium (Flemish)	48%	30%	22%

aspects. This answer could only apply to a small proportion of out-of-field teachers in these three countries; however the majority of out-of-field teachers have full-time employment and hold permanent teaching positions (Table 4.5). It could be argued that this might be the case because of their long-term general teaching expertise so that they are covering a class temporarily. Qualitative information might help to confirm these hypotheses. These three countries all allow out-of-field teaching as an emergency measure in case of teacher shortages (Eurydice, 2002).[28]

Despite special cases of Bulgaria, Norway, and the Netherlands, the pattern of age distribution is quite consistent at this end of the spectrum: out-of-field teachers are less likely

[28]More specifically, in Bulgaria and Norway, policies allow deployment of out-of-field teachers without special restrictions; in the Netherlands, out-of-field teaching has to be in "related subjects only" (Eurydice, 2002, p. 74).

to be old teachers in a majority of countries. The blue dots in Figure 4.7 always lie on the left of the red dots except for Brazil.

Table 4.4: Distribution of teacher experience by two age groups among out-of-field teachers

Country	Age <30 years old				Age >50 years old			
	0-1 year	1-2 year	3-5 year	6-10 year	0-1 year	1-2 year	3-5 year	6-10 year
Australia	100%	0%	0%	0%	25%	0%	0%	0%
Austria	20%	48%	32%	0%	0%	0%	25%	0%
Brazil	11%	14%	22%	53%	0%	0%	0%	0%
Bulgaria	25%	17%	34%	23%	0%	0%	0%	13%
Denmark	8%	0%	4%	15%	0%	0%	0%	0%
Estonia	0%	73%	27%	0%	0%	0%	6%	5%
Hungary	32%	23%	45%	0%	0%	0%	8%	4%
Korea	0%	0%	61%	39%	0%	0%	0%	0%
Lithuania	0%	19%	61%	20%	0%	0%	0%	0%
Malaysia	0%	0%	100%	0%	0%	0%	0%	26%
Malta	22%	25%	46%	6%	0%	0%	0%	0%
Mexico	0%	0%	0%	100%	0%	0%	0%	0%
Netherlands	25%	19%	46%	10%	0%	0%	0%	0%
Norway	0%	24%	51%	25%	0%	0%	0%	0%
Poland	41%	31%	28%	0%	0%	0%	0%	0%
Portugal	0%	0%	0%	0%	0%	0%	0%	0%
Slovak Rep	53%	47%	0%	0%	0%	0%	0%	0%
Slovenia	0%	62%	3%	36%	0%	0%	0%	14%
Spain	0%	0%	0%	100%	0%	0%	0%	0%
Turkey	21%	54%	24%	0%	0%	0%	0%	0%
Belgium (F)	0%	28%	67%	5%	0%	0%	0%	0%

Table 4.5: Contract type and part-time status of out-of-field teachers over age 50

Country	Contract type			Part-time status	
	Permanent position	fixed-term more than 1 year	fixed-term less than 1 year	Full-time	Part-time
Australia	78%	0%	22%	81%	19%
Austria	100%	0%	0%	88%	12%
Brazil	90%	0%	10%	47%	53%
Bulgaria	85%	2%	13%	100%	0%
Denmark	100%	0%	0%	100%	0%
Estonia	77%	6%	17%	64%	36%
Hungary	100%	0%	0%	100%	0%
Korea	100%	0%	0%	100%	0%
Lithuania	90%	6%	4%	50%	50%
Malaysia	100%	0%	0%	100%	0%
Malta	100%	0%	0%	100%	0%
Mexico	90%	0%	10%	59%	41%
Netherlands	100%	0%	0%	50%	50%
Norway	100%	0%	0%	88%	12%
Poland	na	na	na	na	na
Portugal	100%	0%	0%	100%	0%
Slovak Rep	100%	0%	0%	100%	0%
Slovenia	100%	0%	0%	100%	0%
Spain	100%	0%	0%	100%	0%
Turkey	100%	0%	0%	54%	46%
Belgium (F)	100%	0%	0%	73%	27%

4.2.3 Employment status

In Figure 4.8 I show the proportion of teachers by their part-time/full-time employment status for in-field and out-of-field teachers. Employment status is generally quite close between out-of-field and in-field teachers within each country. Graphically one could argue that there are slightly fewer out-of-field teachers who work on a full-time basis. There is no statistical difference when I formally test the difference between these two groups of teachers in most of the countries. Notably there are six countries that almost entirely prohibit part-time work among teachers. They are Bulgaria, Hungary, Korea, Malta, Poland, and the Slovak Republic.

To compare between countries, I first separated two different types of part-time teachers into a group labeled "part-time teachers." Then I subdivided the sample countries into two groups: those with larger than 20 percent of its entire teaching force in math and science working part-time, and those with smaller than 20 percent of math and science teachers working part-time (see Figure 4.9). Among countries with a high percentage of part-time teachers (those to the right of the vertical line), we also witness even more out-of-field teachers who work part-time. The differences in percentage of part-time teaching between out-of-field and in-field teachers are typically between 5-15 percent in Mexico, Brazil, Turkey, Estonia, and Lithuania.[29] This suggests that when part-time working is institutionalized in the education system, out-of-field teachers exacerbate such conditions by a large proportion. The Netherlands is the only exception in this category where the proportions of part-time teachers are virtually the same between out-of-field and in-field teachers.

Overall, out-of-field teachers are less likely to be hired on a full-time basis in the majority of the countries.

[29] Only in Estonia the difference is statistically significant at 0.05 level.

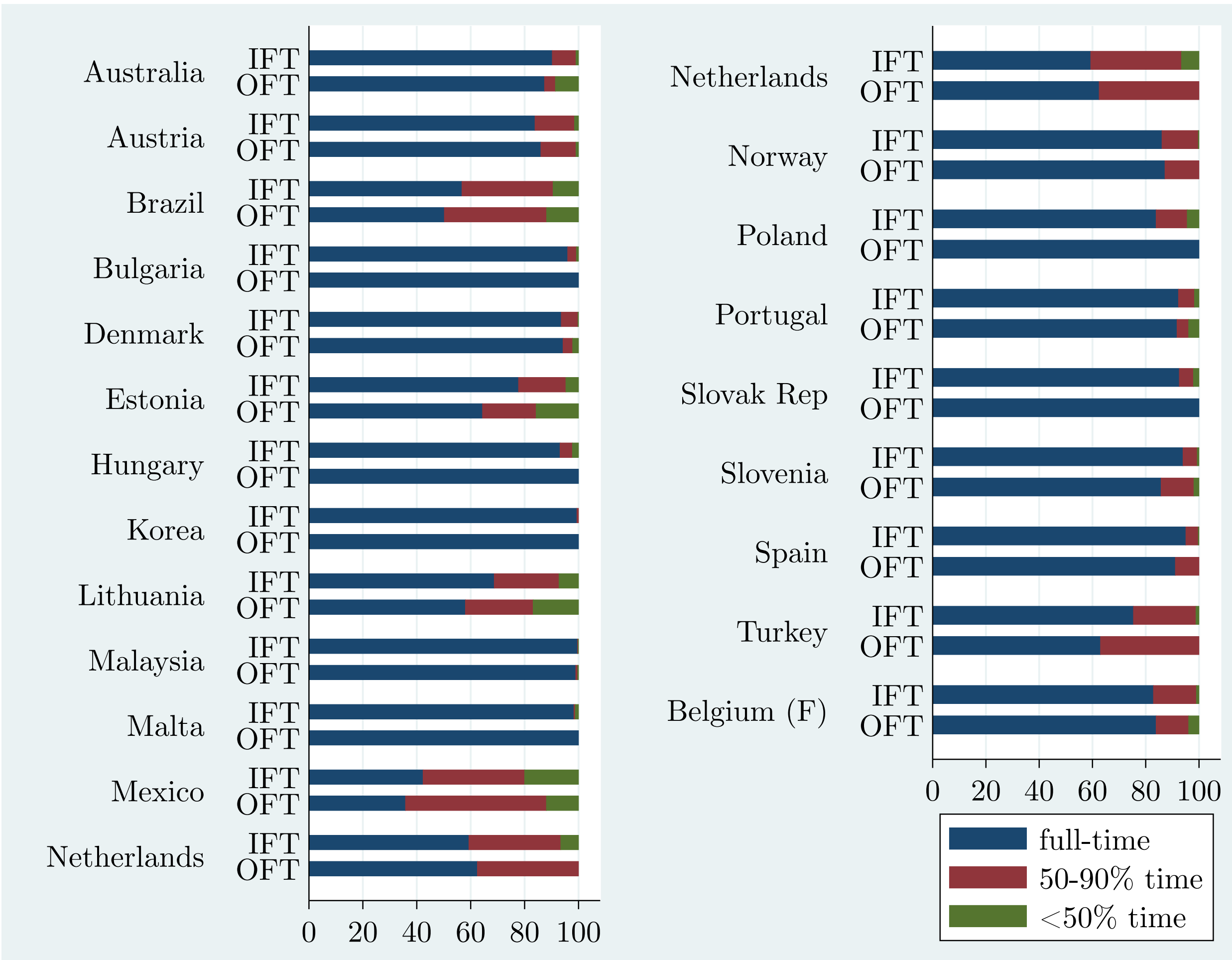

Figure 4.8: Distribution of teachers by part-time status

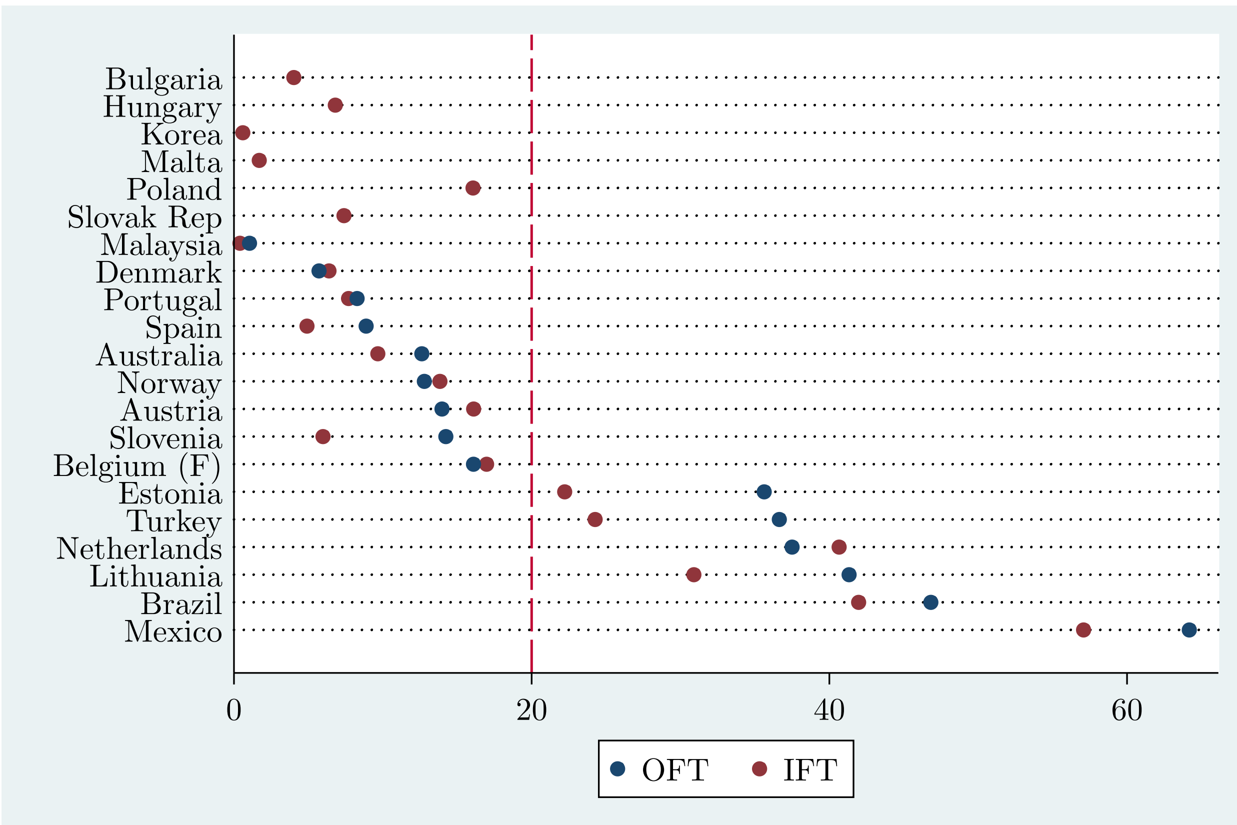

Figure 4.9: Percentage of teachers who work part-time by out-of-field status

4.2.4 Contract length

Another way to measure the working status of out-of-field teaching is to compare the type of contract they signed with the schools. The TALIS database distinguishes three types of contracts: fixed-term, for less than one school year; fixed-term, for more than one school year; and permanent positions. Here I will focus on the first and last types of contract, because the first type signifies a flexible labor deployment strategy and the last type represents the norm in teacher hiring.

In general, in-field teachers tend to have longer and more stable contracts. This statement reflects the smaller number of fixed-term contracts that are signed by in-field teachers, and the larger number of permanent contracts among in-field teachers. In 18 of the 21 countries in this analysis, less than 10 percent of in-field teachers had fixed-term contracts. The exceptions were Poland, Portugal, and Brazil. In Figure 4.10, we see that out-of-field teachers have a higher percentage of short-term contracts compared to in-field teachers in math and science fields. Graphically, this observation reflects that the blue dots, which represent out-of-field teachers, are in general to the right (therefore indicating higher percentage) of the red dots, which represent in-field teachers. One extreme case is Belgium (Flemish), where close to 50 percent of the out-of-field teachers were hired on a fixed-term short contract. Though the Belgium case is not universal, five countries have larger disparities in the proportion of teachers who signed fixed-term contracts between out-of-field and in-field teachers. They are Hungary, Australia, Spain, Estonia, and Denmark.[30] This finding indicates that out-of-field teaching deployment tends to be more flexible than in-field in these countries. In Spain and Brazil, though the short-term contract is common among out-of-field teachers, it does not distinguish them from their in-field counterparts.

At the other end, in-field teachers are easily distinguished from out-of-field colleagues by the sheer number of permanent contracts. The pattern is clear in 14 countries. In Figure 4.11, in the Slovak Republic, Austria, Turkey, and Malta, out-of-field teachers seem to have higher

[30]In Estonia, Hungary, and Belgium (Flemish), the difference is significant statistically.

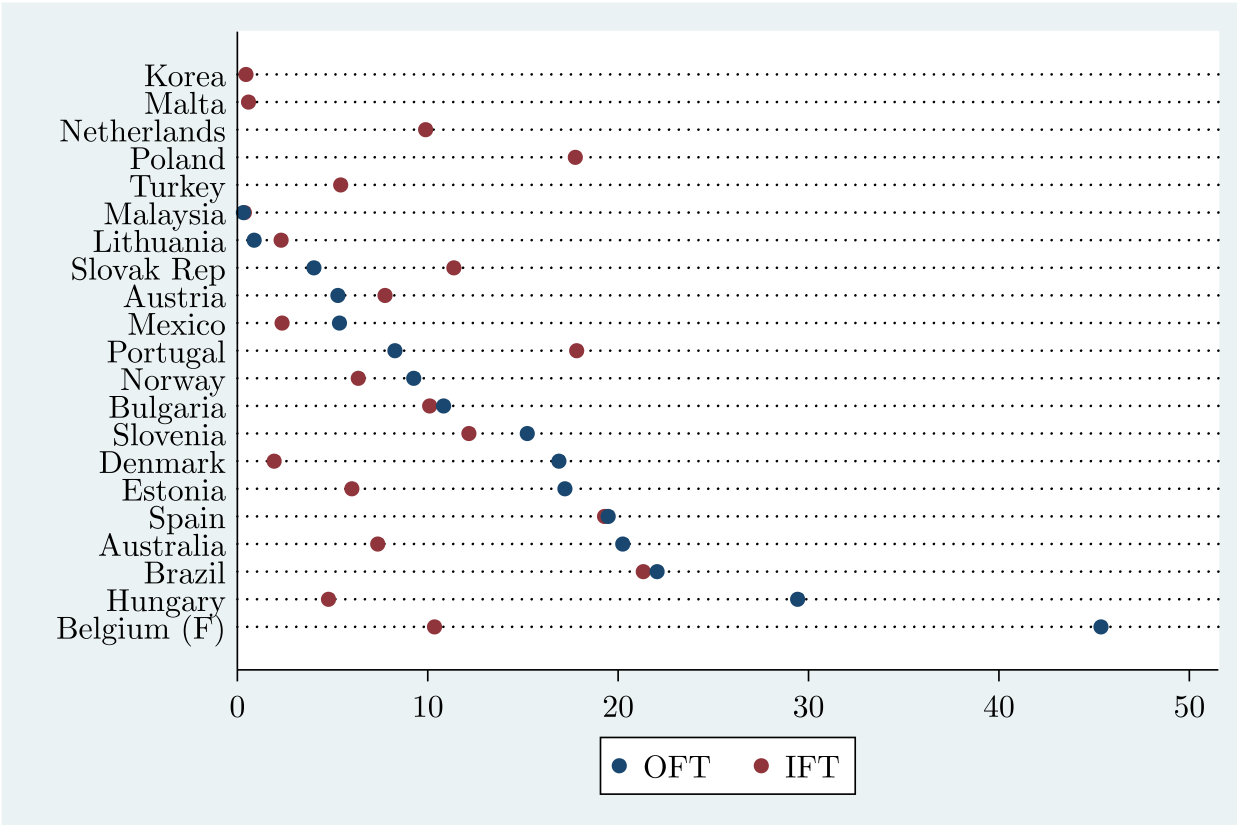

Figure 4.10: Percentage of teachers with less-than-one-year contract by out-of-field status

number with permanent positions, but there is no detectable statistical significance in this category. So we can conclude that out-of-field teachers tend to be hired on a short-term basis.

One might further ask, why is this the case? My explanation is that teachers with very short contracts probably have not established themselves within the school, or have not achieved full certification.[31] In reality, it has been commonly observed that a short contract is used to indicate probationary status among novice teachers. If we look at the experience level of these short-term teachers, no matter what their out-of-field status is, a majority of them are novice teachers, with less than five years of experience.[32] Therefore awarding new teachers a short contract may be used as a screening tool while schools evaluate the new

[31] This information is not currently available in TALIS.

[32] Several exceptions include: Bulgaria, Denmark, Korea, Lithuania, and Mexico.

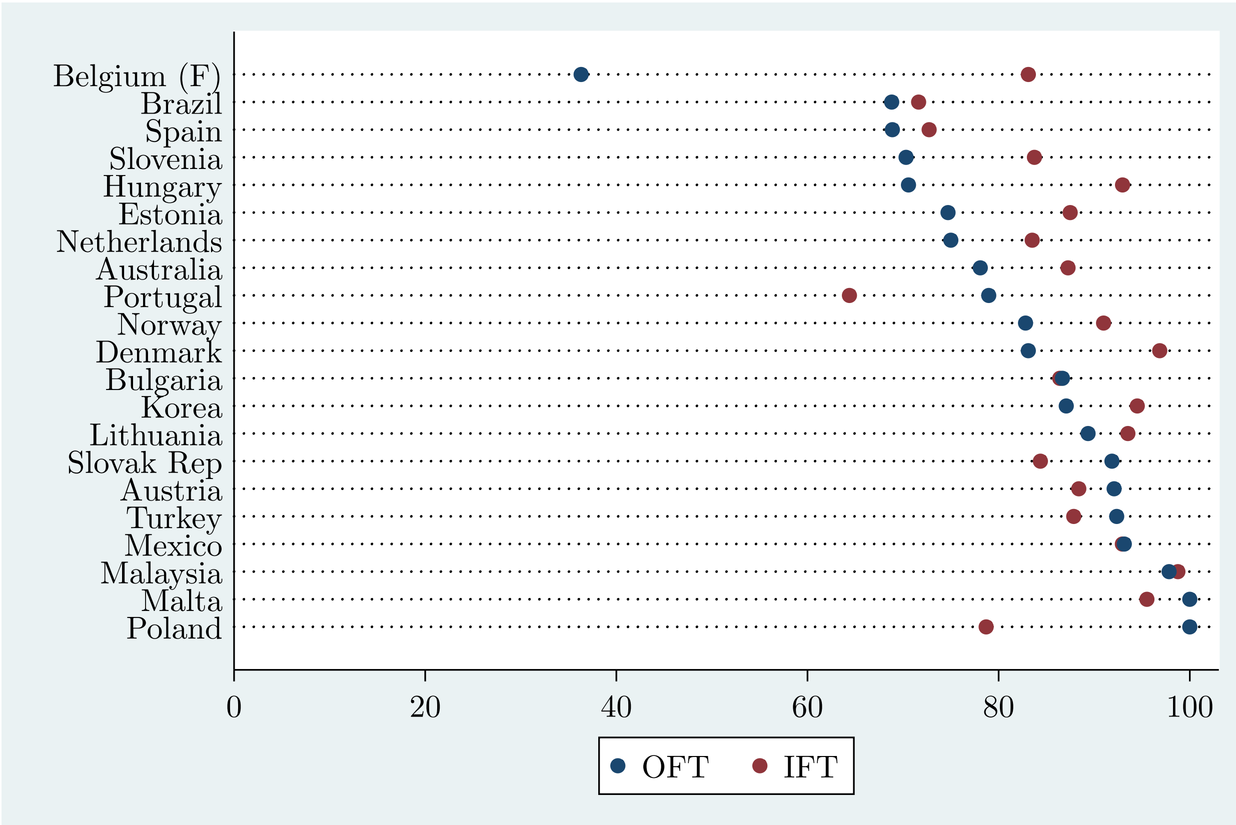

Figure 4.11: Percentage of teachers with permanent contract by out-of-field status

teachers for their competency. These teachers, who do not have a lot of job security, may welcome any opportunity to teach that is available to them. It is not a coincidence that out-of-field teachers in Australia, Estonia, Hungary, and Belgium (Flemish) also tend to be young teachers. The young and inexperienced factors combined can probably explain why these teachers who are at the bottom of school hierarchy were assigned to teach out-of-field.

4.2.5 Educational attainment

In Figure 4.12, I show the percentage of out-of-field and in-field teachers who did not have a bachelor's degree. Generally speaking, having a BA has become the norm in a majority of countries regardless of out-of-field status. In 19 countries, the percentage of in-field teachers without a BA falls below 20 percent. In 11 countries, this indicator falls below 10 percent. Malta, Slovenia, Belgium (Flemish), and Austria are exceptions in terms of their higher proportion of math and science teachers who do not have a bachelor's degree. Among these four countries, two of them have more in-field teachers without a BA; in the other two countries, out-of-field teachers outnumber in-field teachers in the proportion of non-BA degree holders.

If we look at advanced degree holders, measured by the percentage of teachers who have a master's degree or above (Figure 4.13), I found that the proportion of out-of-field teachers is similar to that of in-field teachers, if not higher, who have advanced degrees. In fact, in eight countries, there are more out-of-field teachers than in-field teachers who have advanced degrees. They are Mexico, Belgium, Malta, the Netherlands, Norway, Spain, Poland, and the Slovak Republic. Poland and the Slovak Republic are two extreme cases where almost all teachers obtain a post-bachelor degree. Spain follows the same route though to a lesser degree. This is a clear indication that out-of-field teaching is not simply a teacher supply issue in general, as portrayed by public media. There are several explanations. One possibility is that there could be a genuine teacher supply issue in the math and science fields because not enough people in these fields are willing to enter teaching. The undersupply of math and science teachers is at the same time coupled by an oversupply of non-math and non-science graduates from teacher education programs. They are hired because of their general ability to teach, as reflected in their advanced degree, not their competency in the subject matter. If that is the case, one would observe a higher level of out-of-field teaching in math and science, and a low level of out-of-field teachers in subjects such as social science, reading and writing, and foreign language. If we recall in Figure 4.4, where the levels of out-of-field teaching are even higher for teachers in humanities, the above explanation does not seem logical.

A second explanation could be that the teachers with advanced degrees could have established themselves before any kind of the subject matter competency policy is implemented; they are recruited based on their educational qualifications and are assigned out-of-field subjects. If we look at the teaching experience of these teachers in the eight countries with a higher proportion of out-of-field teachers with an advanced degree in Table 4.6, it seems to be the case for six of them. Belgium (Flemish) and the Netherlands are the exceptions, in which advanced degree holders have little experience at all.

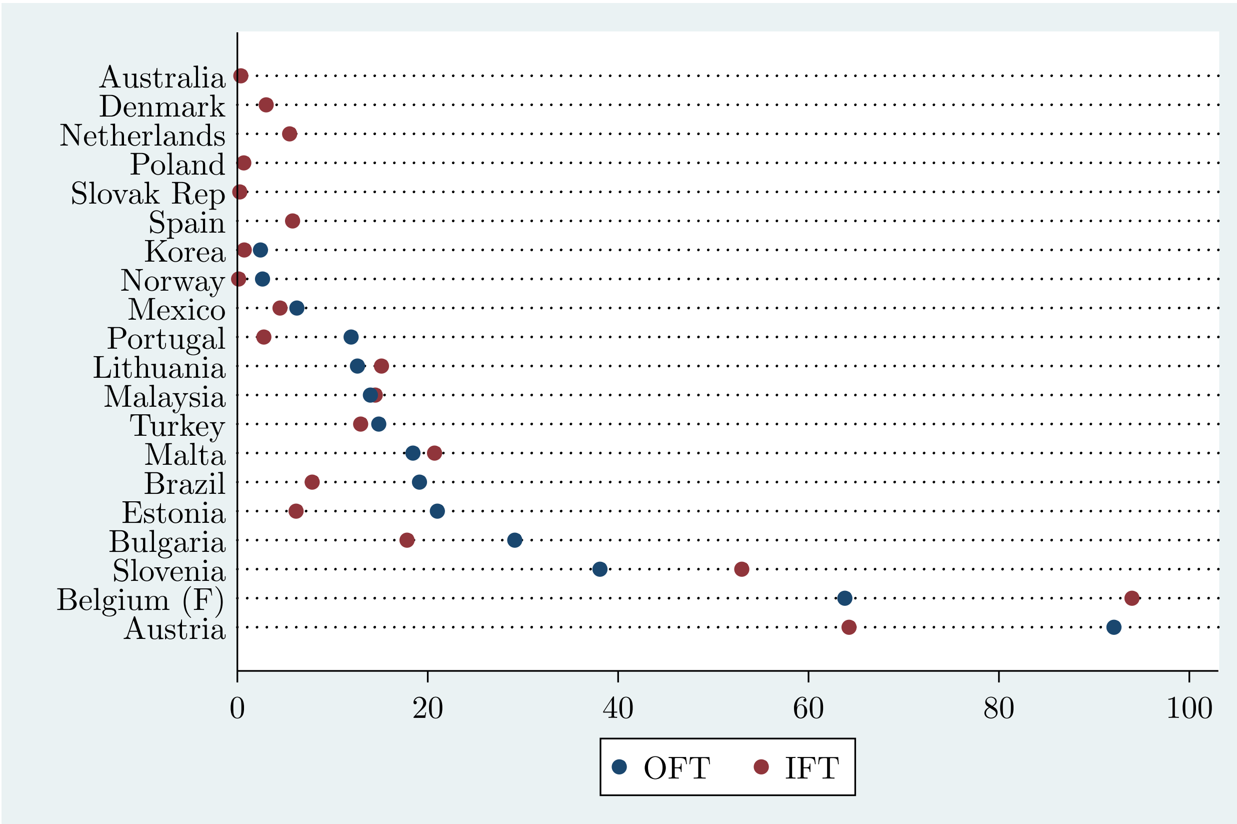

Figure 4.12: Percentage of teachers without a bachelor's degree by out-of-field status

Table 4.6: Teaching experience of advanced degree holders in selected countries

Experience	Malta	Mexico	Norway	Poland	Slovak	Spain	Belgium (F)	Netherlands
<5 years	0%	0%	0%	0%	21%	15%	51%	100%
6-20 years	100%	45%	58%	100%	43%	60%	32%	0%
>20 years	0%	55%	32%	0%	35%	26%	17%	0%

This finding has implications for policies that try to alleviate out-of-field teaching by raising qualification levels. Through the TALIS data, we see that out-of-field teachers' attainment level does not seem to be lower than in-field teachers. A majority of out-of-field teachers even have bachelor's degrees or higher. To require everyone to have a master's

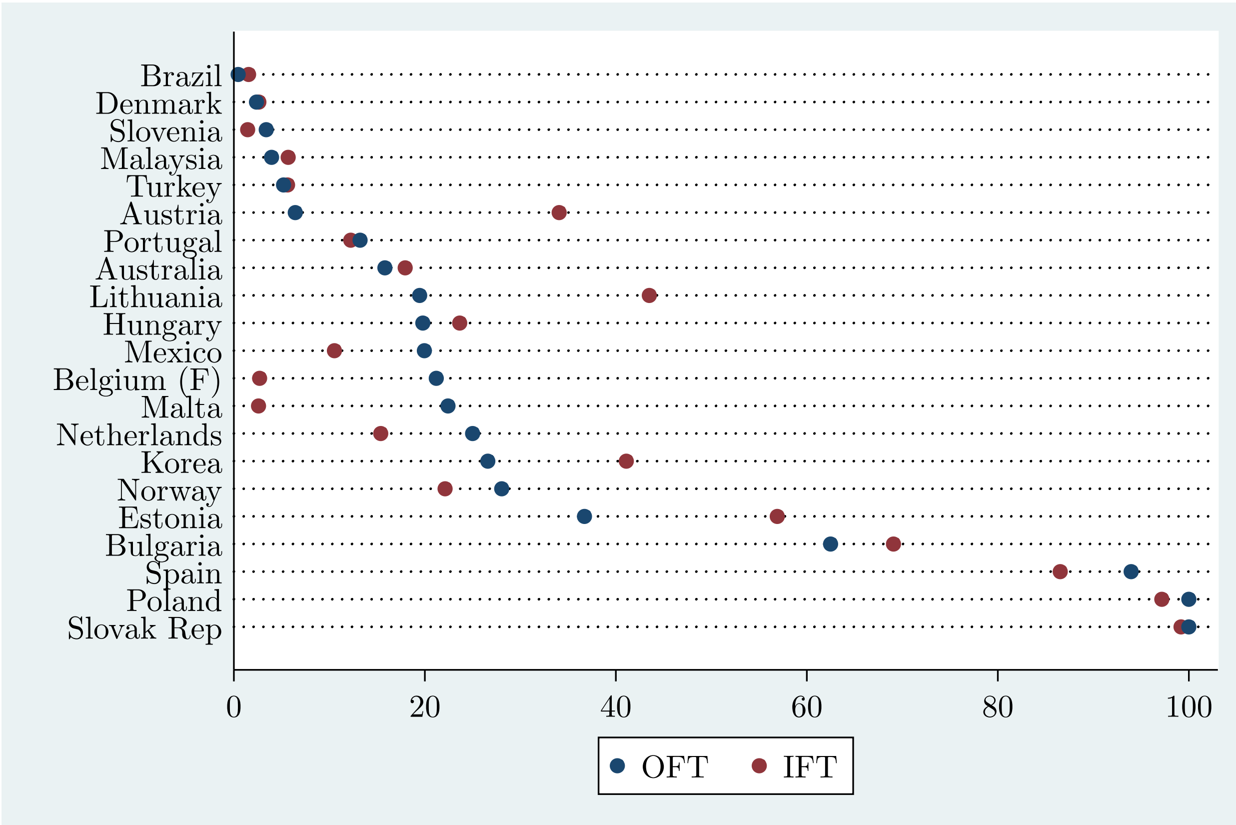

Figure 4.13: Percentage of teachers with advanced degrees by out-of-field status

degree will not solve the out-of-field teaching problem, as we observed in Poland, the Slovak Republic, and Spain, where the majority of out-of-field and in-field teachers have advanced degrees.

4.2.6 Teaching experience

To discuss the experience level of out-of-field teachers, again I focused on the two ends of the distribution where the differences are clear. Among inexperienced out-of-field teachers who have less than 5 years of experience (Figure 4.15), there is a large cross-national variation. In Bulgaria, about 5 percent of its out-of-field workforce is inexperienced compared to Belgium (Flemish), where close to 60 percent of its out-of-field teachers are inexperienced. Three examples need some discussion: the Netherlands, Australia, and Belgium (Flemish). In these countries, while the majority of their teaching force has ample experience, out-of-field teachers are overwhelmingly inexperienced. As I have shown previously, they tend to be young, and have less job security in school. Another five countries are also similar, but may be to a lesser degree. Similarly, in Estonia, Brazil, Mexico, the Slovak Republic, and Hungary, more out-of-field teachers are inexperienced than in-field teachers, though the difference is not as large. As for the composition of veteran teachers, it is quite clear from Figure 4.15 that there are fewer out-of-field teachers in the experienced category in these countries.

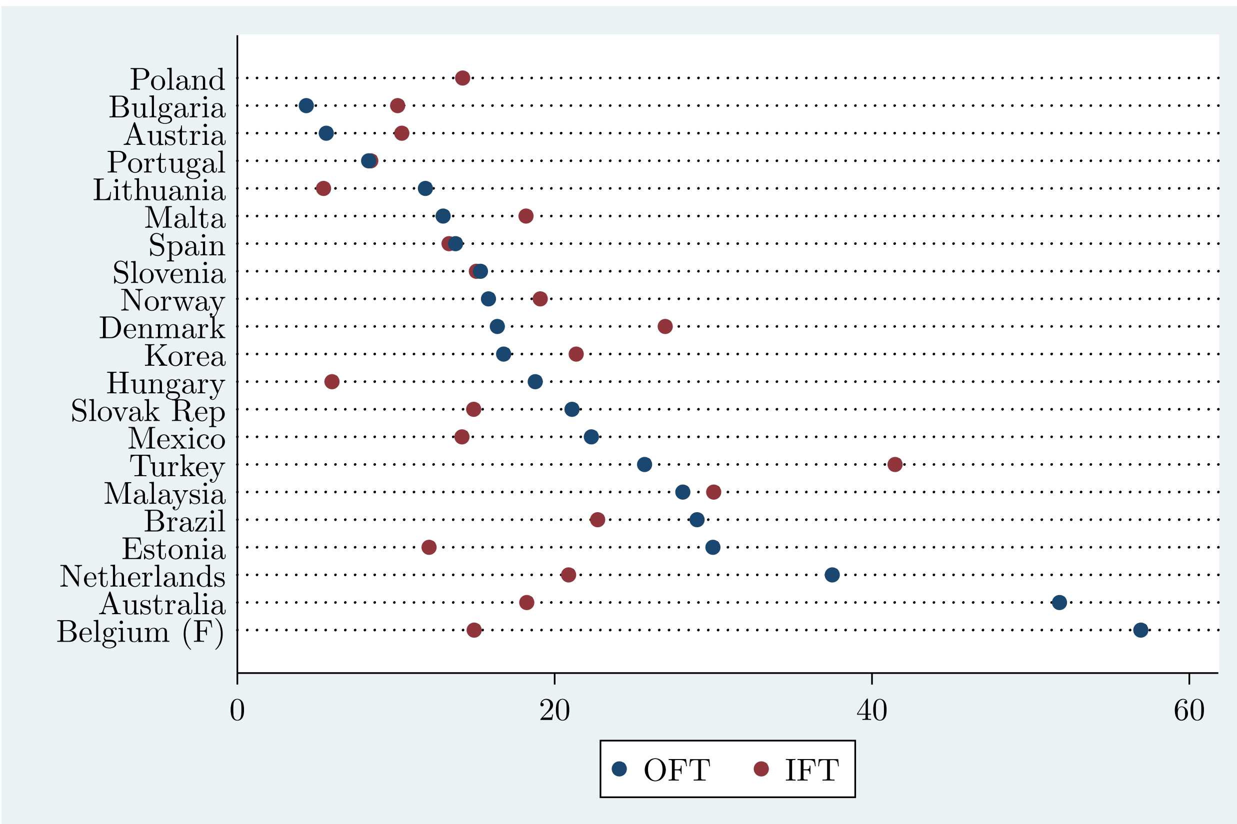

Figure 4.14: Percentage of teachers with less than 5 years working experience by out-of-field status

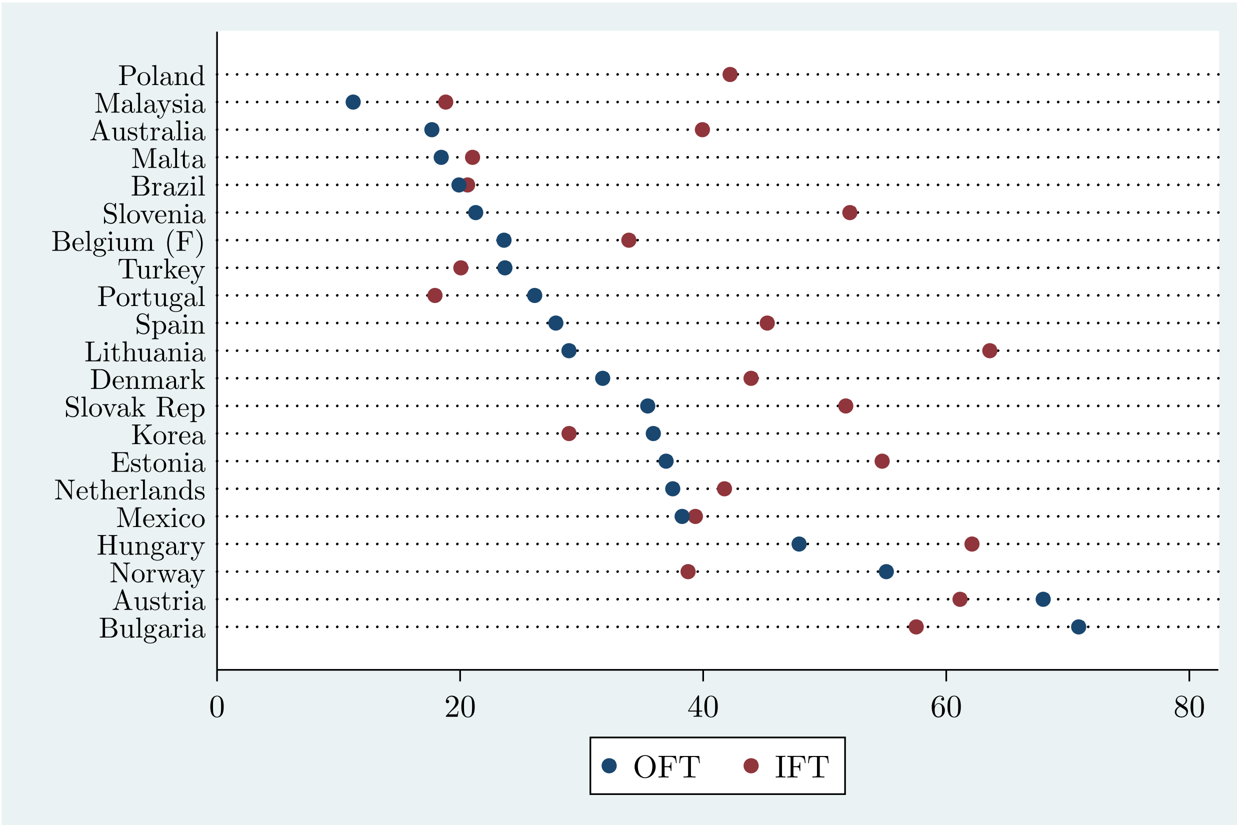

Figure 4.15: Percentage of teachers with longer than 20 years working experience by out-of-field status

4.3 Profiles of out-of-field teachers in selected countries

In the last section, I demonstrated that out-of-field teachers have different demographic backgrounds and working conditions. There are considerable cross-country variations in the combinations of these attributes among out-of-field teachers. In this section, I select several countries to explore systematically the characteristics of out-of-field teachers. The benefit of using a comprehensive dataset like TALIS is that it provides compatible statistics across a group of very diverse countries. For this section, I exploit the cross-national feature of TALIS, and I standardize my measures to generate comparable graphic presentations of the attributes of out-of-field teachers in a multivariate way. I used six variables to describe the attributes of teachers: gender, age, part-time/full-time status, highest education achieved, years of experience, and contract length. I first computed the country mean of each indicator for out-of-field and in-field teachers separately. Then I normalized each indicator across countries. In the charts below, the unit of measure has lost its interpretable meanings due to the ordinal or categorical nature of the data. Yet the directional feature of the data is preserved together with the sheer difference in the magnitude of the data that makes the findings interesting.

4.3.1 Country profile: Australia

In Australia, out-of-field teachers share similar levels of educational attainment with in-field teachers.[33] However they are relatively younger and very much inexperienced (almost all first-year teachers), which indicates that they are at the beginning of their career. This portrait fits with statistics collected through an Australian national survey, in which about 44 percent of beginning Australian teachers reported they had been asked to teach subjects outside of their area(s) of qualification/expertise (Australian Education Union, 2006). It is probably true that they were undergoing some kind of practice training stage. Australia seems to favor flexible deployment of these young out-of-field teachers, because unlike in-field teachers, the majority of out-of-field teachers have short contracts. Out-of-field teachers are more likely to work on a part-time basis compared to their in-field colleagues, and it is possible that they are undergoing a probationary period. There are also more females in out-of-field teaching than in the regular teaching force. The gender imbalance is interesting because it could be an indicator of a shortage of male math and science teachers in the profession because generally they can easily find other jobs with better monetary rewards with the same skill sets.

[33]The numerical axis was not shown on Figure 4.16 due to university regulation on dissertation formatting. The scale of each measurement is from -2 to +2. Each line on the grid represents a 0.5 increase.

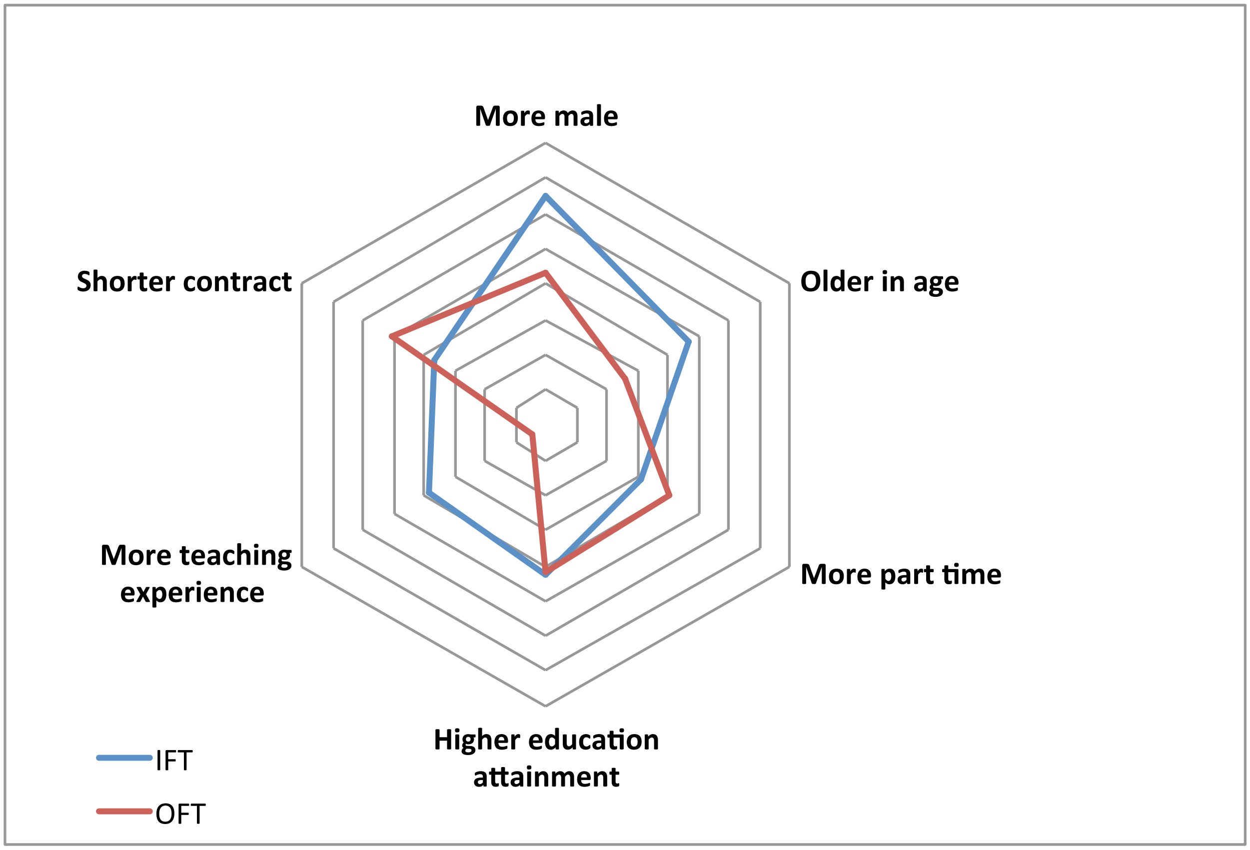

Figure 4.16: Characteristics of teachers by out-of-field status in Australia

4.3.2 Country profile: Mexico

Mexico's case is interesting because unlike Australia, where out-of-field field teachers are distinctive from in-field teachers, the overall attributes of out-of-field teachers in Mexico are similar to in-field teachers.[34] If we judge Mexico's teaching force by TALIS's standard, we find that Mexico has the most teachers working on a part-time basis independent of their out-of-field status. The part-time working situation seems to be more pervasive among out-of-field teachers, though a majority of them are working on the 50 percent to 90 percent workload of full-time teachers. Mexico's out-of-field teachers are also much younger than their in-field colleagues. The combination of younger age and part-time employment status

[34] The numerical axis was not shown on Figure 4.17 due to university regulation on dissertation formatting. The scale of each measurement is from -2 to +3. Each line on the grid represents a 0.5 increase.

raises a challenge to bring these teachers into the professional community in schools. The evidence to support such a claim is that part-time out-of-field teachers are more likely to work in multiple schools at the same time, and they do not stay very long in one particular school. This phenomenon of moving between schools also applies to part-time in-field teachers. But part-time out-of-field teachers have a much higher rate of teaching in multiple schools. This suggests the transient nature of Mexico's out-of-field teachers. They are moving from school to school, sometimes several schools at time.

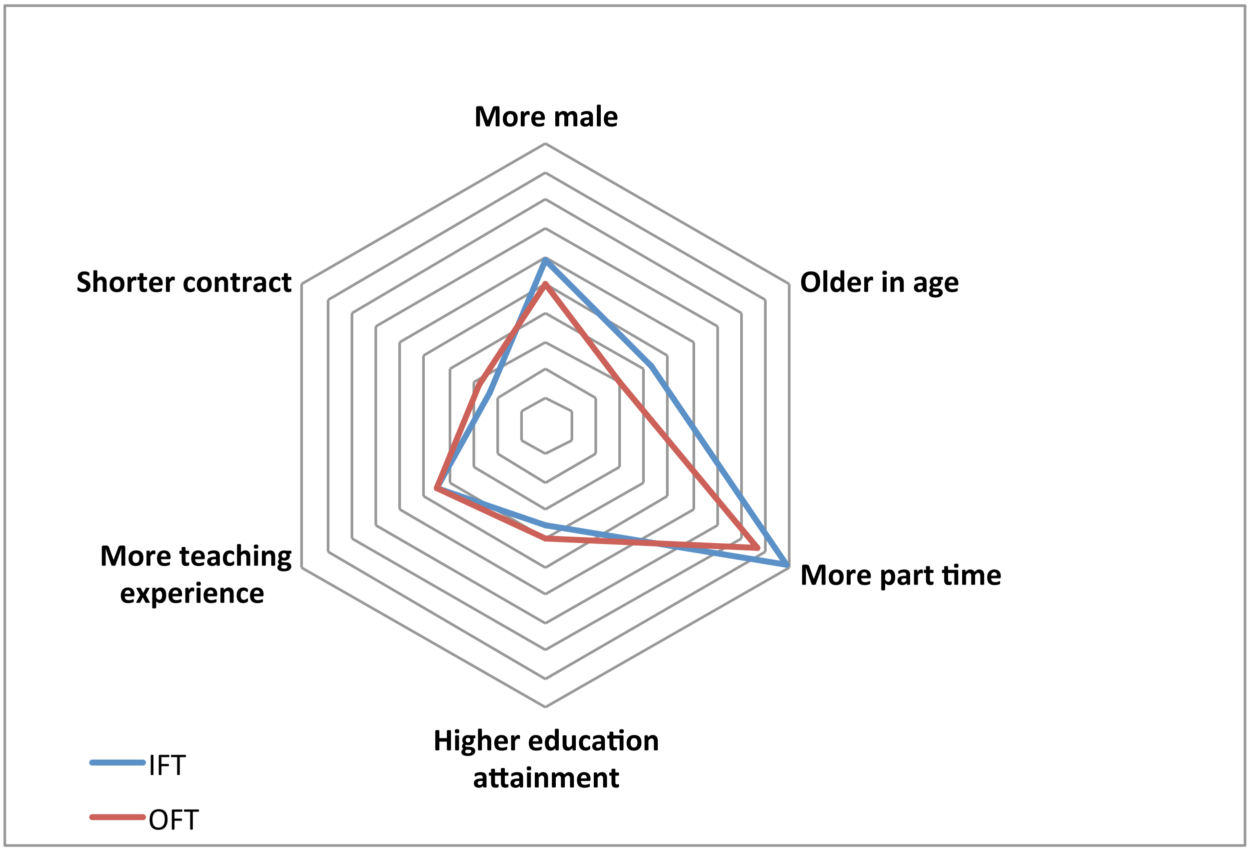

Figure 4.17: Characteristics of teachers by out-of-field status in Mexico

4.3.3 Country profile: Belgium (Flemish)

Belgium's out-of-field teachers are perhaps the most unique.[35] They are not like in-field teachers at all. They are the youngest and most inexperienced among the TALIS countries. Their educational attainment is also the lowest; most of them do not have a bachelor's degree. Considering its in-field teaching force, who are the majority, also have lower educational attainment, raises the question of whether Belgium does not require a college degree to be a prerequisite for public school teachers. It is perhaps that out-of-field teachers are recruited separately from specialized secondary teacher training institutions. Thus judging by the low proportion of teachers who had a college degree among out-of-field and in-field teachers, the former explanation might make more sense. However, although both out-of-field and in-field teachers have a low attainment level, out-of-field teachers seem to be junior faculties who are still in the probationary period because of their limited teaching experience and shorter contract. On average, they have the shortest contract, but they work on a full-time basis, just as in-field teachers do. There are also slightly more men in Belgium's out-of-field teaching force.

[35] The numerical axis was not shown on Figure 4.18 due to university regulation on dissertation formatting. The scale of each measurement is from -2 to +3. Each line on the grid represents a 0.5 increase.

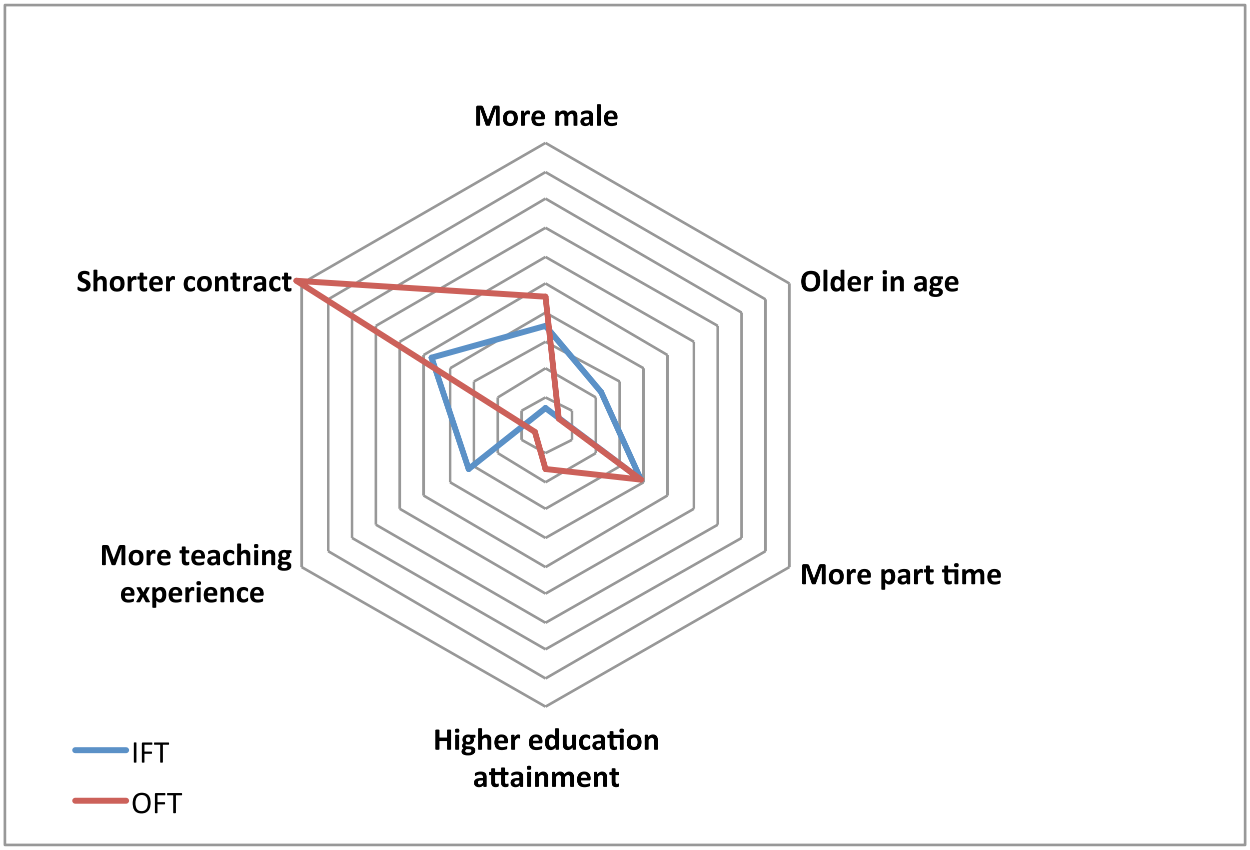

Figure 4.18: Characteristics of teachers by out-of-field status in Belgium (Flemish)

4.3.4 Country profile: Norway

Norway's out-of-field teachers are among the oldest among TALIS countries.[36] Experience is the basic criterion to select out-of-field teachers. This probably explains why they have more teaching experience than out-of-field teachers in other countries. Out-of-field teachers are also more experienced than their in-field colleagues in Norway. Older age and more experience suggests that these teachers do not use teaching as a second career, where one would expect to see older teachers with less experience. Norwegian out-of-field teachers are highly educated. Percentage-wise, more out-of-field teachers received advanced degrees compared to in-field teachers. Their employment status, including full-time equivalence and

[36] The numerical axis was not shown on Figure 4.19 due to university regulation on dissertation formatting. The scale of each measurement is from -2 to +2. Each line on the grid represents a 0.5 increase.

contract length, are close to the out-of-field teachers in other nations. This suggests their teaching engagement and job security are not different from in-field teachers. Norwegian out-of-field teachers do not work at multiple schools. In fact most of them stay in one school for a fairly long time. Thus out-of-field teachers in Norway consist of redeployed veteran teachers from other disciplines within the same school.

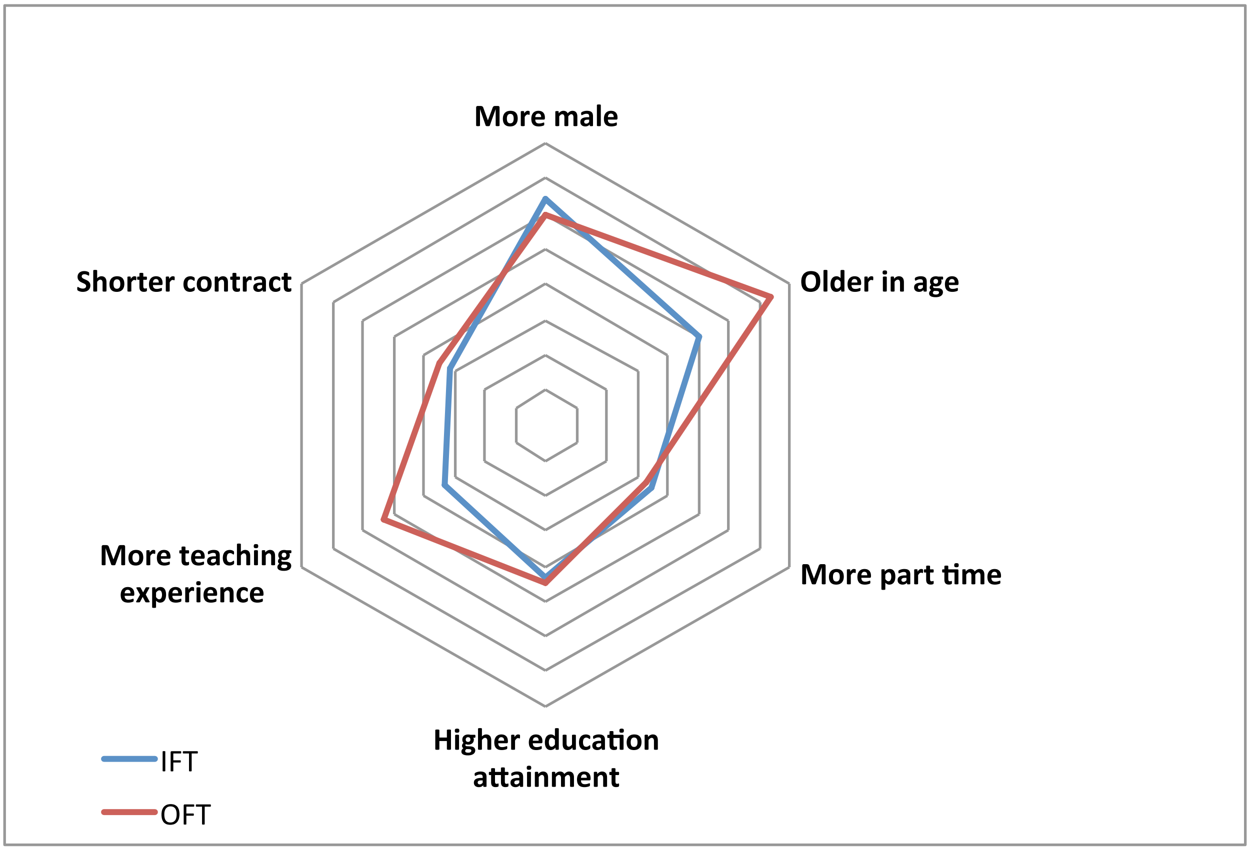

Figure 4.19: Characteristics of teachers by out-of-field status in Norway

4.3.5 Country profile: Turkey

Turkey's teaching force, both in-field and out-of-field, have more males than any other TALIS country.[37] This signifies the prestige attached to teaching jobs in the public school

[37]The numerical axis was not shown on Figure 4.20 due to university regulation on dissertation formatting. The scale of each measurement is from -2.5 to +2. Each line on the grid represents a 0.5 increase.

system. Another characteristic of Turkish teachers is their age composition: they have one of the youngest teaching forces among TALIS countries. Its in-field teaching force is young and very inexperienced. Comparatively speaking, out-of-field teachers have slightly more experience and are older. Since their employment status, educational attainment, and contract type are close to in-field teachers, I suspect that the civil servant status of the teaching job attracts more men into the profession because other job opportunities in other sectors may not be as easily found as are government provided positions. For older men with considerable skills and knowledge of teaching, a school job may be desirable, even if it means to working out of one's discipline. This could be the result of tightened qualification standards in recent years. But such employment opportunities diminish over the years because the male population is considerably smaller in the below 30-year-old category among out-of-field teachers compared to in-field teachers (33 percent vs 48 percent). A similar phenomenon is observed in the female teacher population, where there are few young female out-of-field teachers compared to an influx of younger female in-field teachers. There is a clear generation gap and change of composition in the teacher labor market in Turkey.

Table 4.7: Age distribution of Turkish teachers by gender and out-of-field status

Age	Male		Female	
	OFT	IFT	OFT	IFT
$<$30 years old	33%	48%	2%	50%
31-50 years old	56%	33%	98%	48%
$>$50 years old	11%	19%	0%	2%
Total	100%	100%	100%	100%

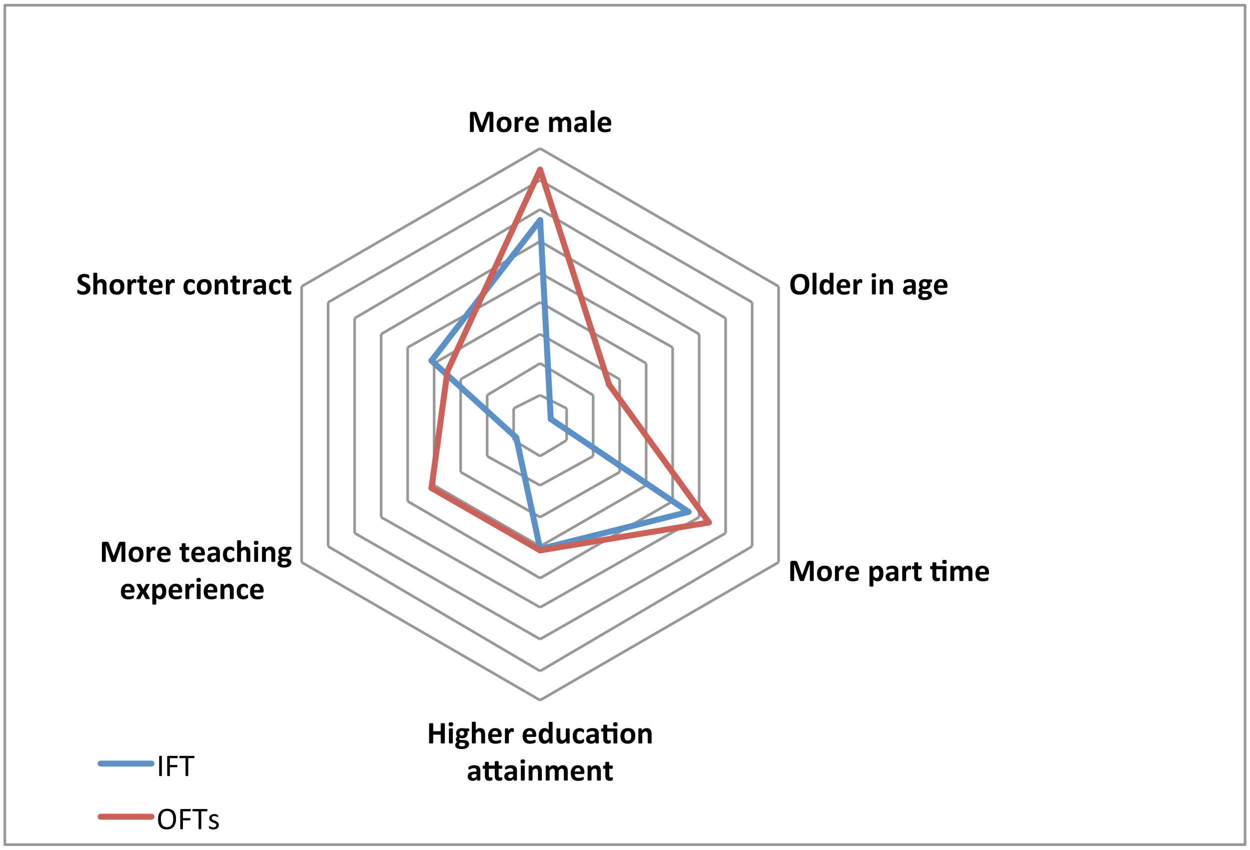

Figure 4.20: Characteristics of teachers by out-of-field status in Turkey

4.4 Characteristics of schools where out-of-field teachers work

In this section, I compare the percentage of out-of-field teachers in mathematics and science by various school characteristics. I exclude three countries from my analysis: Lithuania, Poland, and Hungary. The reason for their exclusion is because they all have minimum levels of out-of-field teachers in these two subject areas, all below 3 percent. The estimates of out-of-field teaching between different types of schools are hardly detectable. To include them in the visual presentation will not add additional information for my analysis.

Because some of the variables used in this section are constructed based on original data provided in TALIS, I first present a definition of each variable in Table 4.8:

Table 4.8: Description of school-level characteristics

Variable	Definition
School location	*Rural*: population fewer than 3,000 *Small town*: population between 3,000 and about 15,000 *Town*: population between 15,000 and 100,000 *City*: population between 100,000 and about 100,000,000 *Large city*: population over 1,000,000
School size	*Small*: less than 300 students *Medium*: 300-1,000 students *Large*: over 1,000 students
School SES	*Low*: school percentage of parents who have ISCED 5 education are below national median AND percentage of parents who have ISCED 3 education are below national median *Median*: 1) school percentage of parents who have ISCED 5 education are below national median AND percentage of parents who have ISCED 3 education are above national median; 2) school percentage of parents who have ISCED 5 education are above national median AND percentage of parents who have ISCED 3 education are below national median *High*: school percentage of parents who have ISCED 5 education are above national median AND percentage of parents who have ISCED 3 education are above national median
Classroom SES	*Low*: classroom percentage of parents who have ISCED 5 education are below national median AND percentage of parents who have ISCED 3 education are below national median *Median*: 1) classroom percentage of parents who have ISCED 5 education are below national median AND percentage of parents who have ISCED 3 education are above national median; 2) classroom percentage of parents who have ISCED 5 education are above national median AND percentage of parents who have ISCED 3 education are below national median

Table 4.8: cont'd

Variable	Definition
Classroom SES	*High*: classroom percentage of parents who have ISCED 5 education are above national median AND percentage of parents who have ISCED 3 education are above national median
Principal leadership	*Low*: principal's administrative leadership index is below the 33^{rd} percentile of national rating *Medium*: principal's administrative leadership index is between the 33^{rd} percentile and the 67^{th} percentile of national rating *High*: principal's administrative leadership index is above the 67^{th} percentile of national rating
Teacher shortage	*Low*: school's personnel shortage index is below the 33^{rd} percentile of national rating *Medium*: school's personnel shortage index is between the 33^{rd} percentile and the 67^{th} percentile of national rating *High*: school's personnel shortage index is above the 67^{th} percentile of national rating

4.4.1 School location

I first compare the distribution of out-of-field math and science teachers by school locations. Using the school locality information provided in the principal questionnaire, I calculated the percentage of teachers who were teaching out-of-field for schools located in different areas. The result is presented in Figure 4.21. It is obvious that there exist large cross national variations corresponding to the overall between-country differences in levels of out-of-field teaching. This is not surprising considering that TALIS includes countries at different levels of social and economic development, which partly explains the large between-country variations.

My interest here is to explore within-country variability. As we can see from country to country, it is evident that schools located in rural or small town areas are prone to have more out-of-field teachers. One of the most extreme cases is in Belgium (Flemish), where 50 percent[38] of math and science teachers who worked in rural schools are out-of-field, compared to less than 10 percent who worked in towns. In the rest of the countries the differences are not so dramatic, but the pattern remains the same. This finding confirms our previous discussion that rural schools' ability to attract qualified math and science talents is weaker compared to schools in more affluent suburban or metropolitan areas.

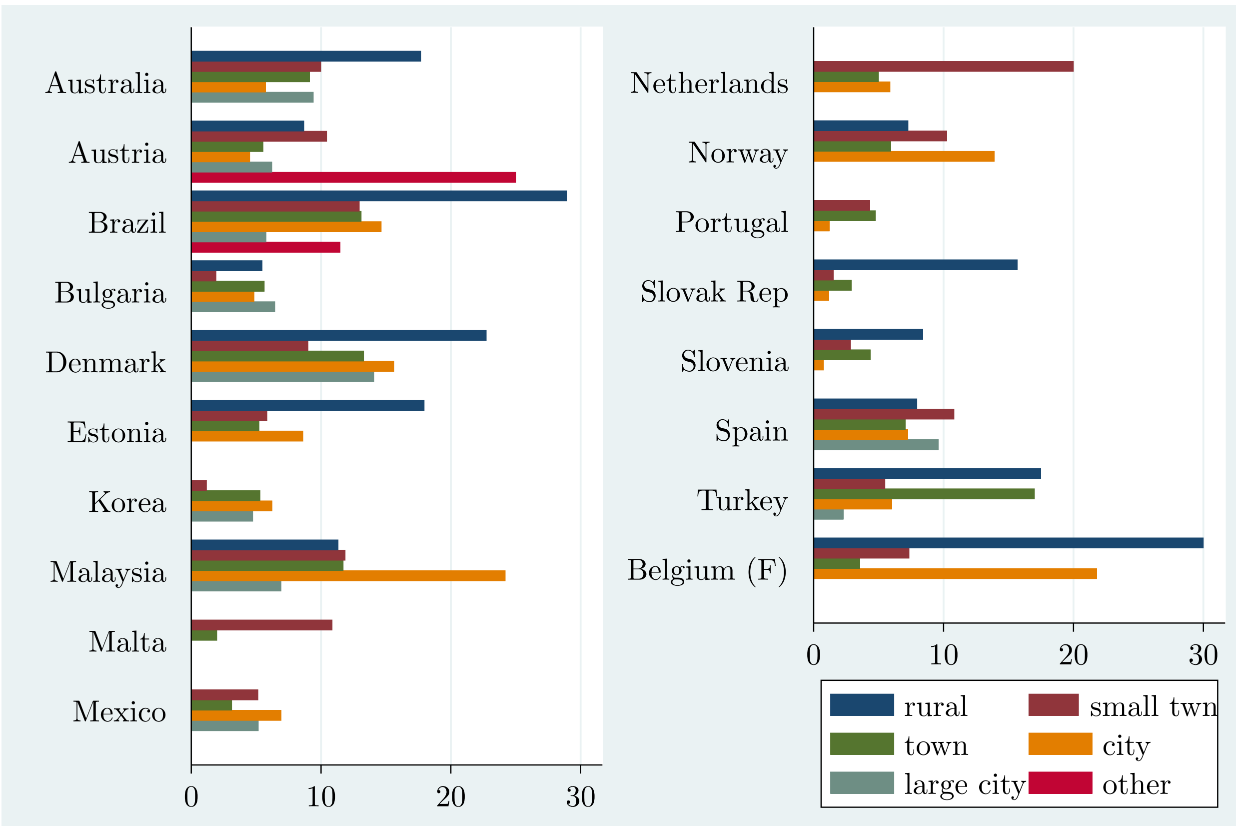

Figure 4.21: Percentage of math and science teachers who are out-of-field by school location

I should remind the reader that the mean statistics used to plot the graph do not reveal the between school variability of out-of-field teaching. Put differently, we know that out-of-field teachers are more likely to teach in rural schools, but are they evenly distributed across

[38]The figure for rural schools in Belgium (Flemish) is cropped at 30 percent in order to maintain the display aspect ratio. Percentage of teachers who are out-of-field in math and science in rural Belgium (Flemish) school is 50 percent. Hungary, Lithuania, and Poland were excluded in the analyses of this section because their levels of school-level out-of-field teaching are minimum.

rural schools, or are some schools more likely to deploy out-of-field teachers? In Table 4.9, I partition the variations of school percentage of out-of-field teaching into two sources in each country: within-school and between-schools-within-region.[39] The estimates indicate that, despite the overall higher likelihood of rural schools employing out-of-field teachers, there are greater variations between two rural schools (between-school) in their levels of out-of-field teachers than between a rural school and an urban school. This pattern holds across all TALIS countries, regardless of their level of economic or educational development. It might be easy to understand why this happens in developed and more equal nations (which a majority of TALIS countries are), since regional development is more likely to be equalized, which translates into school resource and teacher deployment decisions. The interesting part is that even for developing nations such as Brazil, Malaysia, and Turkey, the between-school variability triumphs over the between-region variability. This shows that the inequalities in teacher staffing not only permeates across regions, but also within regions.

4.4.2 School size

The size of a school is easily connected to the type of assignment it will make. In small schools, teachers are typically required to teach in multiple areas because such schools usually do not have enough resources to hire subject matter specialists who only focus on a single subject matter. The TALIS data confirms this. In Figure 4.22, I break down the percentage of teachers who are out-of-field by the size of schools into three categories: small, medium, and large.[40] Small schools are defined to have student population of less than 300; medium schools are defined with a student population between 300 to 1,000 students; large schools are those with more than 1,000 students. Figure 4.22 shows that it is very common, across

[39] I partition the variance by specifying a basic two-level fully unconditional model within each country.

[40] In addition to the Hungary, Lithuania, and Poland, that were excluded due to minimum school-level out-of-field teaching, Belgium (Flemish) is also excluded in this figure because of missing school size variable.

Table 4.9: Variance partitioning of school-level OFT in math & science

Country	Within region between-school	Between regions	Gini Coefficient[a]	2008 GDP per capita (PPP)[b]
Australia	93.55	6.45	30.5	38,223.58
Austria	98.33	1.67	26	39,875.63
Brazil	92.96	7.04	53.9	10,524.65
Bulgaria	97.86	2.14	45.3	13,187.39
Denmark	94.50	5.50	29	37,363.72
Estonia	94.72	5.28	30	20,319.87
Hungary	96.54	3.46	24.7	19,460.01
Korea	95.74	4.26	31	27,707.05
Lithuania	98.22	1.78	37.6	19,138.18
Malaysia	89.64	10.36	46.2	14,032.76
Malta	100.00	0.00	26	24,768.97
Mexico	94.19	5.81	51.7	14,506.46
Norway	94.04	5.96	25	52,839.78
Poland	92.87	7.13	34.2	17,592.49
Portugal	95.70	4.30	38.5	23,079.82
Slovak Rep	88.23	11.77	26	21,995.00
Slovenia	94.60	5.40	28.4	29,605.53
Spain	97.61	2.39	32	30,847.93
Turkey	87.68	12.32	40.2	13,107.55
Belgium (F)	87.18	12.82	28	36,249.42

Note: region is defined by school locations
a: CIA Worldfact book
b: measured in current dollar. Retrieved from International Monetary Fund, September 2011

countries, for small schools to have a higher percentage of their teachers to be out-of-field. In countries such as Korea, Malaysia, and Norway, there is little difference between small schools and medium or large schools. This suggests a further look at particular policy that might equalize teacher distribution across schools.

Another way to look the size factor is to compare the distribution of teachers across different school types by out-of-field and in-field teacher status. The rationale of such a comparison is that we know small schools are more likely to have out-of-field teachers, but due to their size, they do not necessarily deploy more out-of-field teachers in actual number. For instance, if we assume the school-level out-of-field teaching is 10 percent for a small school with 100 students and a large school with 1,000 students, then in actual number, the small school deploys 10 out-of-field teachers and the large school deploys 100. Though 100 is greater than 10, it does not necessarily mean out-of-field situation is worse in the larger school.

Because of the size of school is highly correlated with the number of teachers it employs, for a meaningful comparison we need to take the latter factor into consideration. In Figure 4.23, I contrast the proportion of teachers who work in small schools by out-of-field status. It is very clear that more out-of-field teachers, as a proportion of their total population, work in small schools compared to in-field teachers. In four countries, more than 40 percent of out-of-field teachers are teaching in small schools: Slovenia, Estonia, Austria, and the Slovak Republic. Here again, the concentration issue does not seem to affect Norway, Korea, or Malaysia.

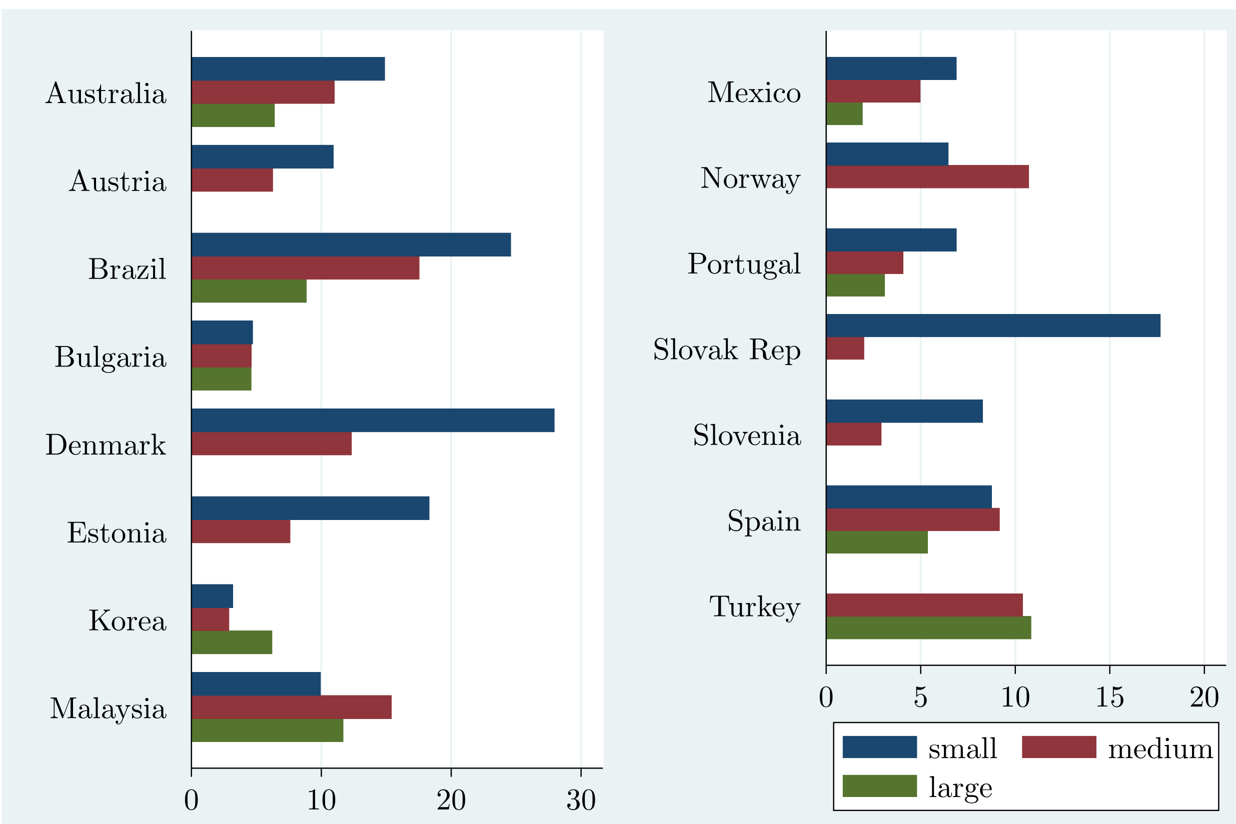

Figure 4.22: Percentage of teachers who are out-of-field by school size

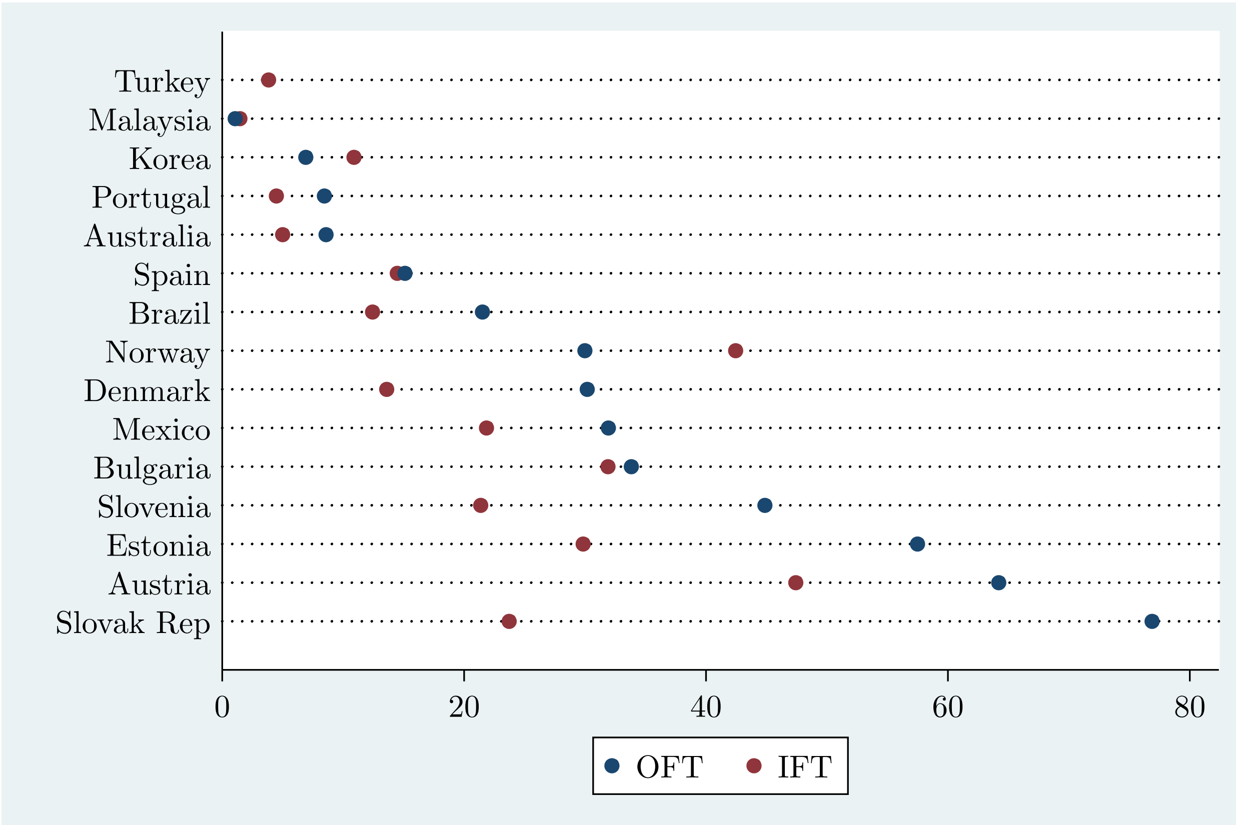

Figure 4.23: Proportion of teachers who work in small schools by out-of-field status

4.4.3 School socioeconomic (SES) status

In the teacher labor market literature, one concern has continued to plague researchers: is the teacher distribution equal among students from various socioeconomic backgrounds? Current international evidence has suggested that it is not the case in many countries (Akiba & LeTendre, 2009; Akiba et al., 2007). Students from lower social status families are consistently being assigned to teachers with less qualification and experience. For the following presentation, I conducted a similar comparison. Since the TALIS data does not provide a direct measure of student SES, I use parental educational background as a proxy measure (Table 4.8). The TALIS questionnaire asked teachers to report the percentages of students' parents who obtained ISCED 3 or ISCED 5 level of education.[41] At the teacher (classroom)

[41]ISCED 3 is equivalent to a high school diploma; ISCED 5 is equivalent to a bachelor's degree.

level, there were two items associated with this question. In item BTG40B, teachers were asked to estimate the percentage of parents who were above ISCED 3-level education; in item BTG40C, teachers were asked to estimate the percentage of parents who were above ISCED 5-level education. I first created dummy variables using these two variables to measure whether the estimated percentage was above or below the national median. Then if the class had parents with education levels higher than the national median at both the ISCED 3 and ISCED 5 level, I coded the classroom as "high SES classroom," if the parental education at the ISCED 3 and ISCED 5 level were both below national median, I coded the classroom as "low SES classroom"; those classrooms in-between were coded "medium SES classrooms." I calculated a similar measure using the school-level estimates on parental education level to reflect school SES.

I chose this coding scheme for practical reason. To illustrate my rationale, Table 4.10 shows the cross-tabulation of the two parental education dummy variables at the school level. I found that certain proportions of schools with the amount of parents who received ISCED 3-level education below national mean also have parents who have above-ISCED 5-level education (upper right corner). Similarly, there is also some proportion of schools with the amount of parents who received ISCED 5-level education below national mean but also with parents who have above-ISCED 3-level education (lower left corner). These are probably mixed-SES schools that are difficult to be simply characterized as "low" or "high" SES schools. Therefore I adopted a conservative strategy that only focuses on the extreme end of the parental education distribution.

In Figure 4.24, I first show the estimated results at school level. I contrast the percentages of teachers who were out-of-field by school SES level across countries. It is obvious that in the majority of countries, students in low-SES schools were more likely to be taught by out-of-field teachers in math and science. The extreme cases are Brazil, Denmark, the Slovak Republic, and Belgium (Flemish), where out-of-field teaching in low-SES schools almost doubled the number in high-SES schools. The highest level of out-of-field teachers in math

Table 4.10: Number of schools by parental education level

Percentage of parents with above ISCED 3 education	Percentage of parents with above ISCED 5 education		
	Below national median	Above national median	Total
Below national median	919	424	1343
Above national median	323	1363	1686
Total	1242	1787	3029

Note: missing data not shown

and science is found in Denmark, which was beyond 20 percent for low-SES schools. Low-SES schools in Brazil and Estonia come the next highest, about 15 percent, in out-of-field teaching. Interestingly for Malaysia, although the level of out-of-field teaching seemed to be high in low-SES schools, high-SES schools did not seem to be immune from this phenomenon either. There are visible disparities between high- and low-SES schools in the rest of the countries, yet the overall levels are not high. Bulgaria, Malta, the Netherlands, Spain, and Turkey actually had more out-of-field teachers in high-SES schools. These countries might have policy that equalizes teacher distribution among high-SES and low-SES schools.

If we change our view from the school-level measure to a classroom measure, it can be observed that in Figure 4.25, the basic pattern is preserved. Out-of-field teaching in general was more pervasive in low-SES classrooms than in high-SES classrooms. However in the case of Bulgaria, Spain, and Turkey, the scenario was reversed: although in general high-SES schools have more out-of-field teachers, high-SES classes tended to have fewer out-of-field teachers. This is due to the fact that there was more variation within schools (in terms of SES composition) and using a school-level mean masks such variation. A classroom viewpoint reveals that teacher sorting not only happened across schools, but also within schools.[42] In the case of these three countries, the teacher's subject matter competency is taken into consideration when assigning a teacher (or, teachers self-select) to classes. Unanimously, teachers with better qualification were assigned to teach well-off students. This finding

[42]Student ability group might also be a factor. However, I did not have a classroom composition measure of student SES.

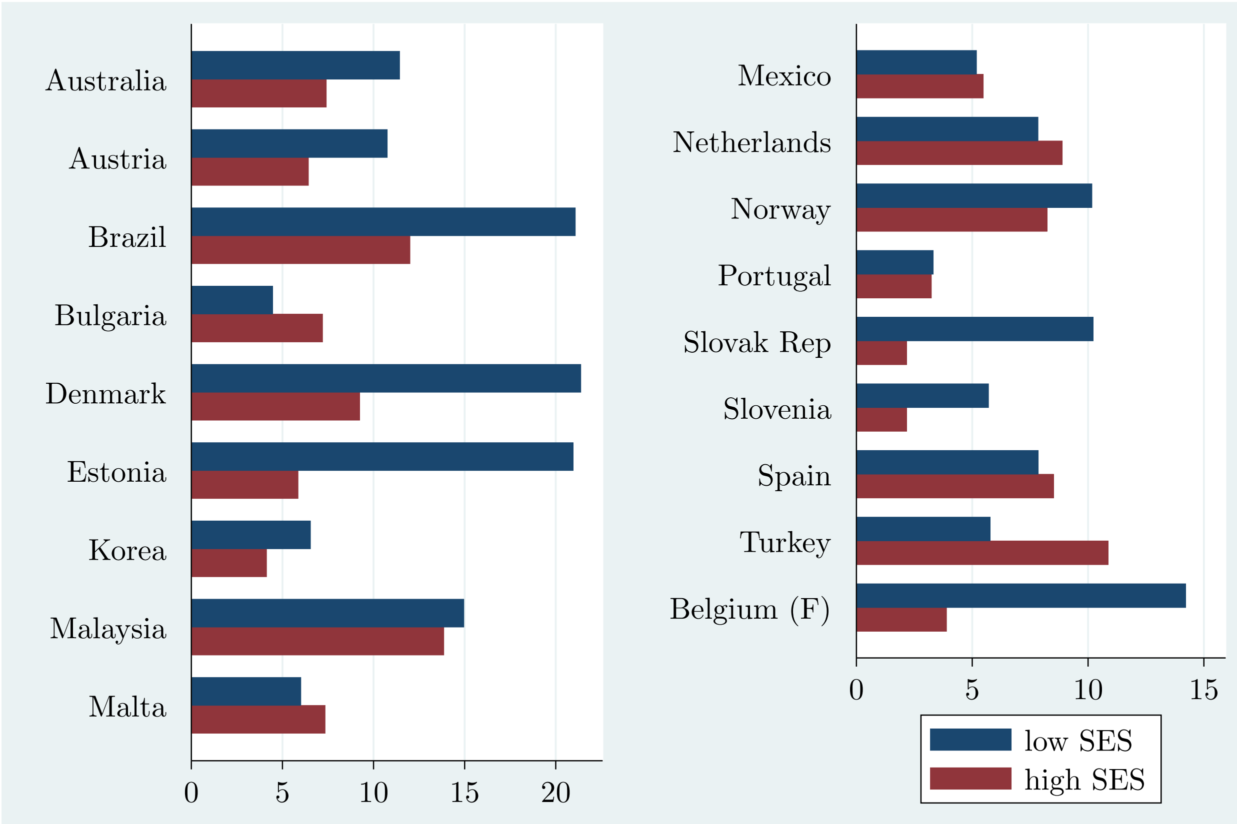

Figure 4.24: Percentage of teachers who are out-of-field by school SES

confirms the prevailing teacher sorting practice used in schools across nations.

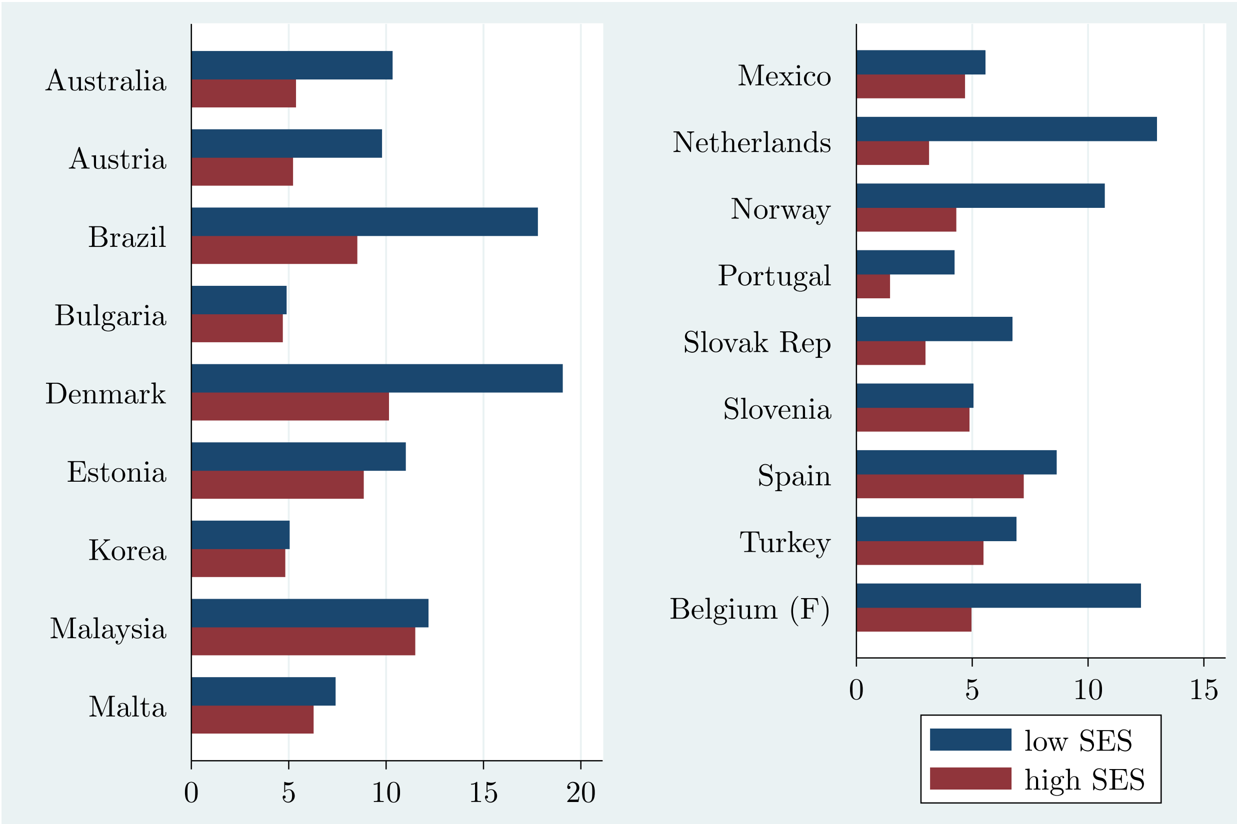

Figure 4.25: Percentage of teachers who are out-of-field by classroom SES

4.4.4 Principal leadership

The role that the school principal plays in making out-of-field assignments is crucial but under-studied. Although Ingersoll (2006) suggested that unchecked discretionary power by the school principal is a major cause of the prevalent out-of-field teaching phenomenon in the United States, the empirical evidence on this topic is very thin.

TALIS's principal questionnaire provided several measures of the principal's quality, one of which relates to the study of out-of-field teaching: a principal's administrative leadership role. In the TALIS database, this continuous variable measured two dimensions of management components. It is a combination of accountability of management and bureaucratic management. Each of these aspects is measured by a set of items from the principal questionnaire (Table 4.11). In each item, the principal rates his/her role in one of four categories: “strongly disagree,” “disagree,” “agree,” and “strongly agree.” The TALIS team first constructed a continuous index for each of the two dimensions to transform the ordinal items into a continuous scale. Then they took the simple average of the two component management indices and normalized composite score across countries to have an international metric of mean zero and standard deviation one (OECD, 2010). The indices all have high reliability and reasonable model fit. The indices “relate to school administrative tasks, enforcing rules and procedures, and accountability role of principal” (OECD, 2010, p. 146).

For each country, I categorized schools into three levels: low-, medium-, and high-leadership, based on the distribution of that variable. Low is defined as the 33^{rd} percentile, medium is the 66^{th} percentile, and high is the highest 33^{rd} percentile. I then calculated the percentage of teachers who were out-of-field based on the categorization of schools.

In Figure 4.26, I present the estimated percentage of out-of-field teaching in math and science at low- and high-leadership schools. This figure compares the level of out-of-field teaching between the top one-third of schools in the administrative rating to the bottom one-third of the school within each country. It is hard to argue whether there is any pattern according to this figure. In countries such as Australia, where school management is close to the United States’ decentralized structure, it is true that there was a higher percentage of out-of-field teachers in low-leadership schools by a large margin. Readers should be cautioned that the cross-country comparison based on leadership indices have two limitations. First, the categorization of the leadership variable is made country by country in that it does not take into account cross-country variation between schools in leadership. A “low” leadership rating (defined as if the principal is in the lowest one-third of the leadership rating) in one country does not necessarily mean low leadership in another country context. Secondly, because of the way these continuous indices are constructed, having the same average leadership rating does not necessarily reflect the same meaning across countries. It could be the case that administrative leadership means more accountability, less bureaucracy in one country, but not in others. The bottom line is that within-country comparison might be more meaningful.

Table 4.11: Description of administrative leadership variable

Variable	Indicies	Items	Item description
Administrative leadership	Accountability role of the principal	BCG16A	An important part of my job is to ensure that ministry-approved instructional approaches are explained to new teachers, and that more experienced teachers are using these approaches.
		BCG16D	A main part of my job is to ensure that the teaching skills of the staff are always improving.
		BCG16E	An important part of my job is to ensure that teachers are held accountable for the attainment of the school's goals.
		BCG16F	An important part of my job is to present new ideas to the parents in a convincing way.
	Bureaucratic rule-following	BCG16H	It is important for the school that I see to it that everyone sticks to the rules.
		BCG16I	It is important for the school that I check for mistakes and errors in administrative procedures and reports.
		BCG16J	An important part of my job is to resolve problems with the timetable and/or lesson planning.
		BCG16K	An important part of my job is to create an orderly atmosphere in the school.
		BCG16O	I stimulate a task-oriented atmosphere in this school.

Interestingly, the situation was reversed in Brazil, Malaysia, and the Slovak Republic, where high-leadership schools had a much higher level of out-of-field teachers. Mexico's school management system can also be characterized as centralized. As one would anticipate, there does not seem to be too much difference in the percentage of out-of-field teaching between these two types of schools. Does that mean that out-of-field teaching is caused by better leadership skills?

I caution readers before making any judgment on the relationship between leadership and out-of-field teaching. One limitation is that when we compare nations to nations, the sample size becomes very small. In this case, to test the relationship between school leadership and out-of-field teaching (and possible interaction between centralization and school leadership), it is almost impossible to yield any generalizable findings in a statistical sense. Thus we may characterize such relationships as illustrative at best. In addition, one might consider the possibility of some sort of remedial policy being implemented in these countries. It is perhaps *because* of the rampant level of out-of-field teachers that these high quality principals are assigned to lead the school. Of course it is very hard to verify whether this hypothesis is true based on a cross-sectional dataset. With more data across countries, we can see that a principal's influence is not the only factor that affects out-of-field teaching.

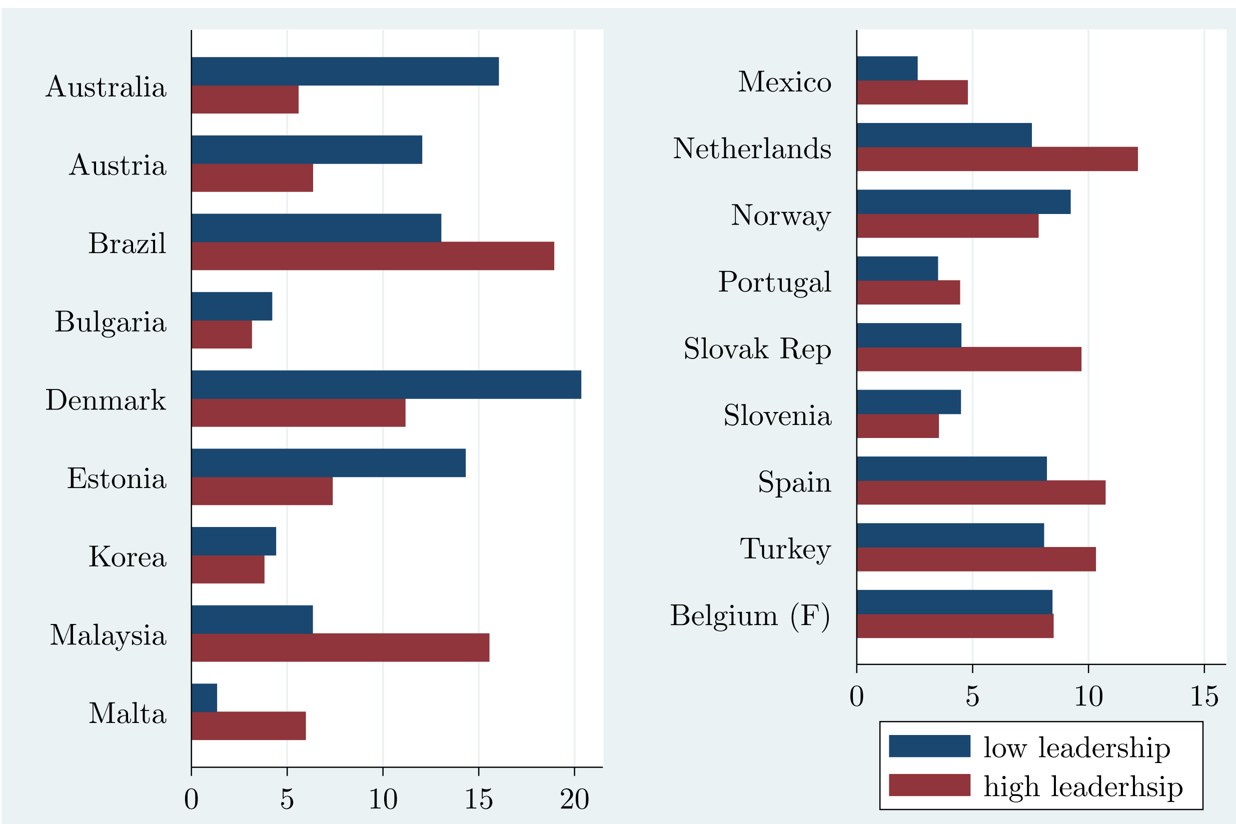

Figure 4.26: Percentage of teachers who are out-of-field by principal's administrative leadership

4.4.5 Teacher shortage

Teacher shortage is perhaps the most commonly used argument to explain the prevalence of out-of-field assignment. It has been argued that out-of-field assignments have been used to fill vacancies in fields that experience teacher shortages. Does this claim have grounds? In Figure 4.27, I present statistics based on the general personnel shortage measure in TALIS. The variable personnel shortage in schools is available at the school level. Although it will be ideal to have a direct measure of math and science teacher shortage, currently teacher shortage information is not subject-matter specific.

We can tell that the out-of-field teacher level is higher in high shortage schools in Austria, Brazil, Denmark, Mexico, the Slovak Republic, and Slovenia. Yet the difference is not large in most of these cases between high-shortage and low-shortage schools, except for Austria, Denmark, and the Slovak Republic. Brazil and Denmark are two alarming cases in which the percentage of out-of-field teachers was above 20 percent in high-shortage schools. That means one in five math and science teachers were teaching out-of-field in these countries, which is much higher than the rest of the countries. In the rest of the countries, there were barely any differences in the percentages of out-of-field teachers between low- or high-shortage schools. Teacher shortages do exist within each country to varying degrees. However, it appears that countries took different measures to alleviate the effect of teacher shortages. While out-of-field assignments might be one strategy, we only observed it being used in a handful of countries. Currently I lack sufficient information on whether countries have laws to regulate out-of-field teaching in schools under a shortage. Future research might look into that issue. Figure 4.27 explores the relationship between teacher shortages and out-of-field assignment *within* countries, where the question of whether shortage is associated with high levels of out-of-field teaching remains to be answered in the next chapter.

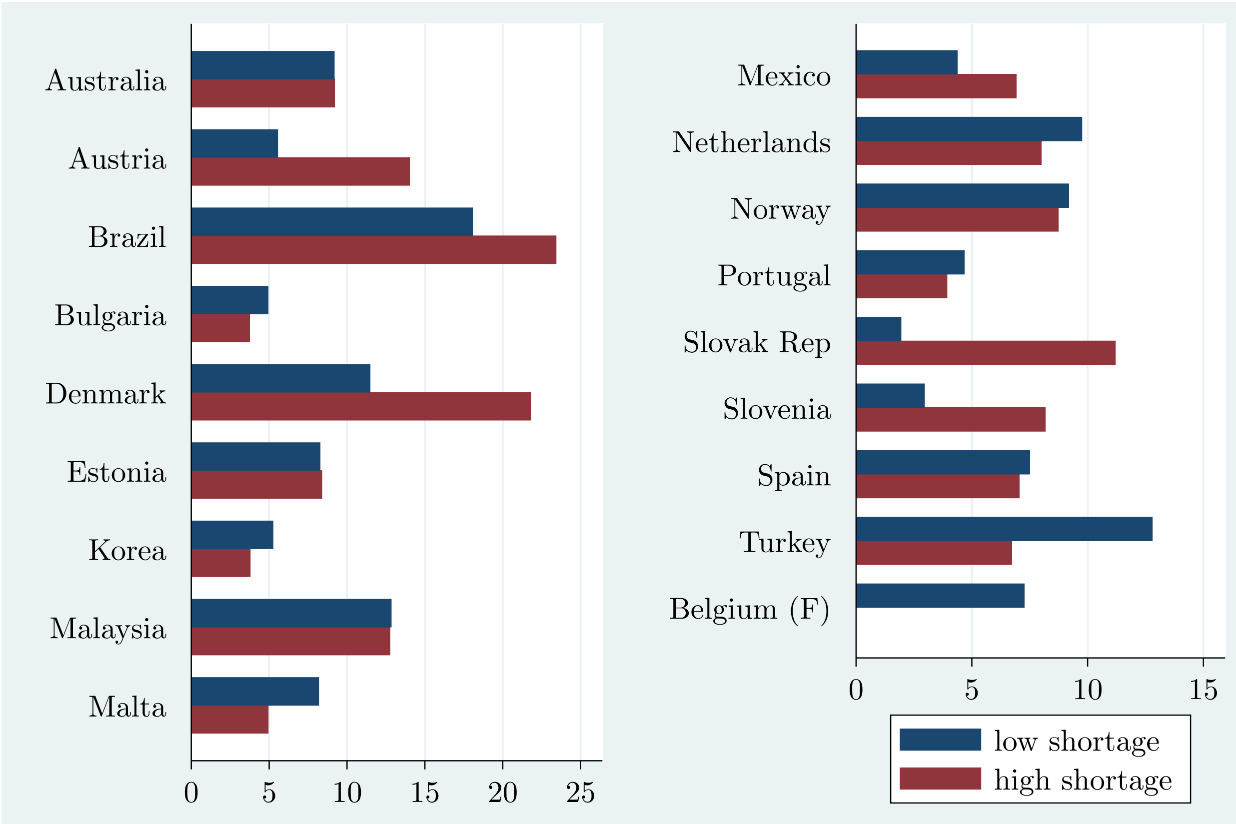

Figure 4.27: Percentage of teachers who are out-of-field by school personnel shortages level

4.5 Summary

To sum up, in this chapter I present the attributes of out-of-field math and science teachers and the schools in which they work. Cross-nationally, the overall national level of out-of-field teaching in math and science in public schools is not very high, in all cases below the 15-percent benchmark, except for Brazil. This finding suggests that nations are taking a series of measures to counter the use of out-of-field teachers in math and science. Percentages of teachers who teach out-of-field in math and science are among the lowest compared to teachers in other subject fields. Additionally, there seems little correlation between country-level regulation on out-of-field assignment with actual level of deployment in math and science fields.

In terms of teacher attributes, I found that out-of-field teachers are not a homogeneous group of teachers across nations. Out-of-field teachers within each nation do share similarities with the majority of the teaching force, in-field teachers. Comparatively speaking there are larger cross-national variations in teacher attributes, which suggests that the selection of out-of-field teachers is highly contingent on the national context. By exploring country by country, I discovered several modes of deployment of out-of-field teachers. Out-of-field teachers are likely to be younger and inexperienced teachers who just start their career. In other cases, they are older and veteran teachers with ample experience. In some cases, out-of-field teachers are employed on a part-time basis and work at several schools at a time. The varieties of out-of-field teachers reveal complex and context-dependent teacher assignment strategies. Is there anything common among out-of-field teachers? I found that small, rural and low-SES schools are most likely to deploy out-of-field teachers. This finding fits with the previous literature, which suggests that these types of schools are least able to attract qualified teachers, certainly including qualified math and science teachers (Ladd, 2007). Cross-nationally, I did not find evidence that the principal's administrative leadership might affect out-of-field assignments. Nor does teacher shortage explain cross-national variations in out-of-field teaching. These findings remind us that there is a long way to go before we fully understand the mechanisms that drive out-of-field teaching. The findings presented in this chapter only apply to a particular segment of the teacher labor force, math and science teachers who work in public school settings. Whether or not similar observations could be extended to teachers from other subject matter or private schools remains to be examined.

Chapter 5
CROSS-NATIONAL VARIATION IN OUT-OF-FIELD TEACHING ASSIGNMENTS AND THE DIFFERENCES BETWEEN OUT-OF-FIELD AND IN-FIELD TEACHERS

In Chapter 4, I described some basic attributes of out-of-field teachers in TALIS countries. The statistics shown there are mostly univariate, in the sense that each characteristic of out-of-field teachers is used one at a time. Though convenient for graphical presentation, this method does not take into account the impact of multiple factors at the same time. In addition, two key questions remain unanswered:

1. What factors explain cross-national variations in out-of-field teaching?

2. Do out-of field teachers behave differently from in-field teachers in schools?

In this chapter, I answer these two questions using regression models. This chapter is divided into two sections. In Section 5.1, I exploit cross-national variations in school level out-of-field teachers, and I examine their relationship with three policy variables. In Section 5.2, I compare out-of-field teachers with in-field teachers on several aspects. The aim is to examine whether out-of-field teachers perform differently on the job and whether or not they are given sufficient opportunity to learn.

5.1 Systemic factors explaining cross-national variation in out-of-field teaching

In this section, I examine whether three systemic-level factors explain the cross-national variations in out-of-field teaching.

Previous studies have primarily been in single-country settings (Ingersoll, 1999, 2003, 2004, 2006). The limitation of such an approach is obvious. Since there is little variation within a country regarding the institutional arrangements that could potentially affect a school's decision to make out-of-field assignments, these studies were not able to examine the relationship between country-level policy implementation and a school's out-of-field assignments simply because of insufficient variability in the policy variable. Using TALIS, which includes 21 countries, I was able to pool all these countries together in order to exploit cross-national variations in policy settings in a wide range of countries.

I was mainly concerned with three systematic variables: the principal's administrative leadership, the school's autonomy in hiring teachers, and whether or not a school is experiencing teacher shortage. These three factors illustrate related aspects of teacher policy. The principal leadership factor characterizes how schools are operated to make staffing decisions. The autonomy-of-hiring variable illustrates the amount of power designated to the school that allows them to make independent decisions in hiring staff and managing salary schedules. The teacher shortage variable characterizes each country's teacher labor market, including whether enough teachers are trained to fit into available teaching positions. Initially, these factors did seem to correlate with national average levels of out-of-field teaching to a certain degree (Figure 5.1 through Figure 5.3).

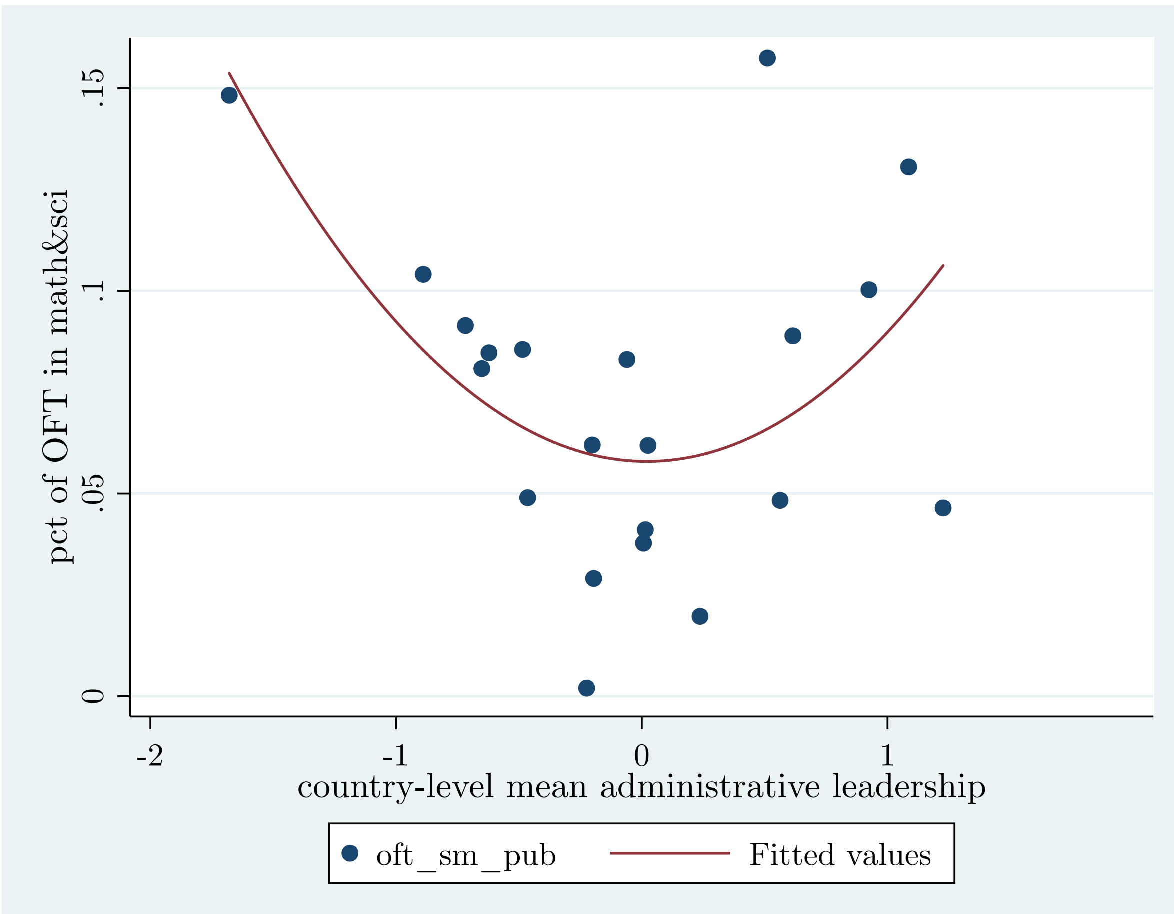

Figure 5.1: The relationship between country-level OFT with the principal's administrative leadership

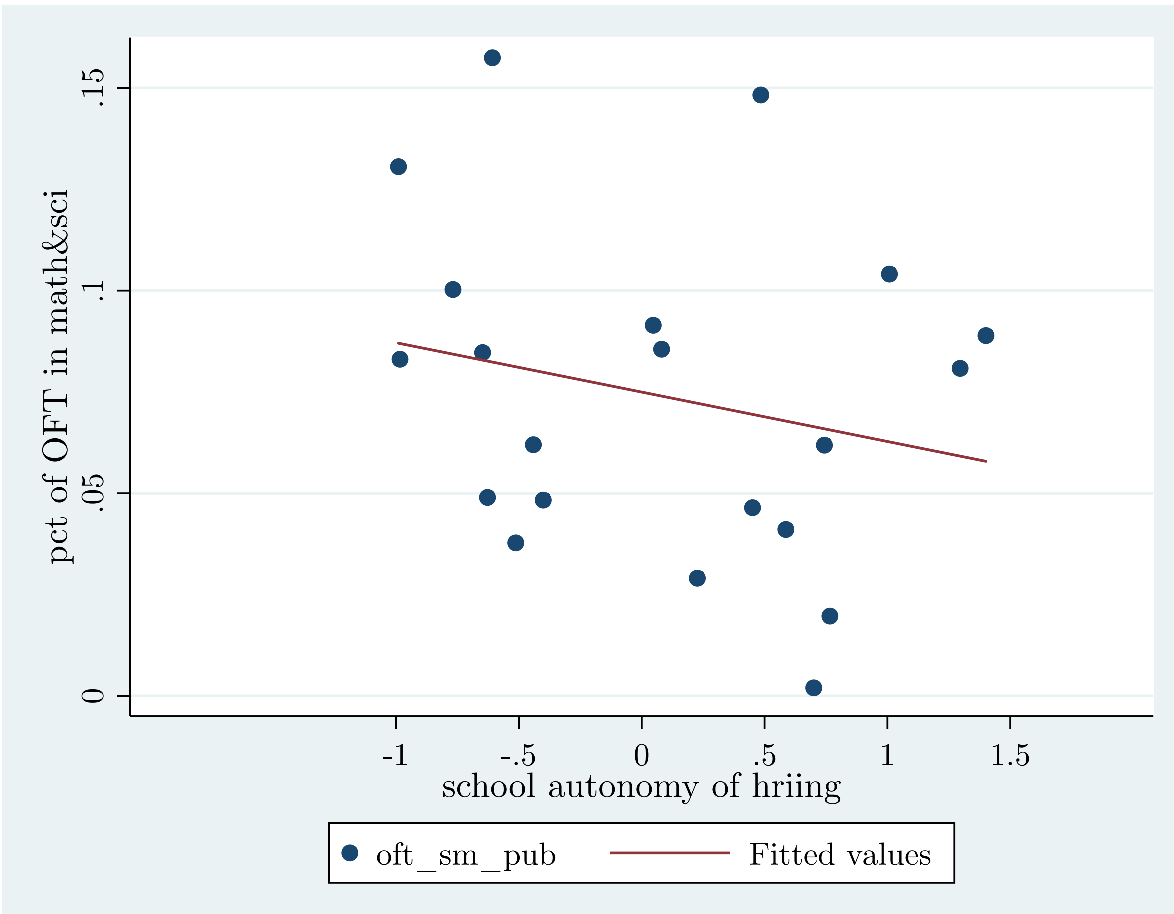

Figure 5.2: The relationship between country-level OFT with the autonomy of hiring teachers

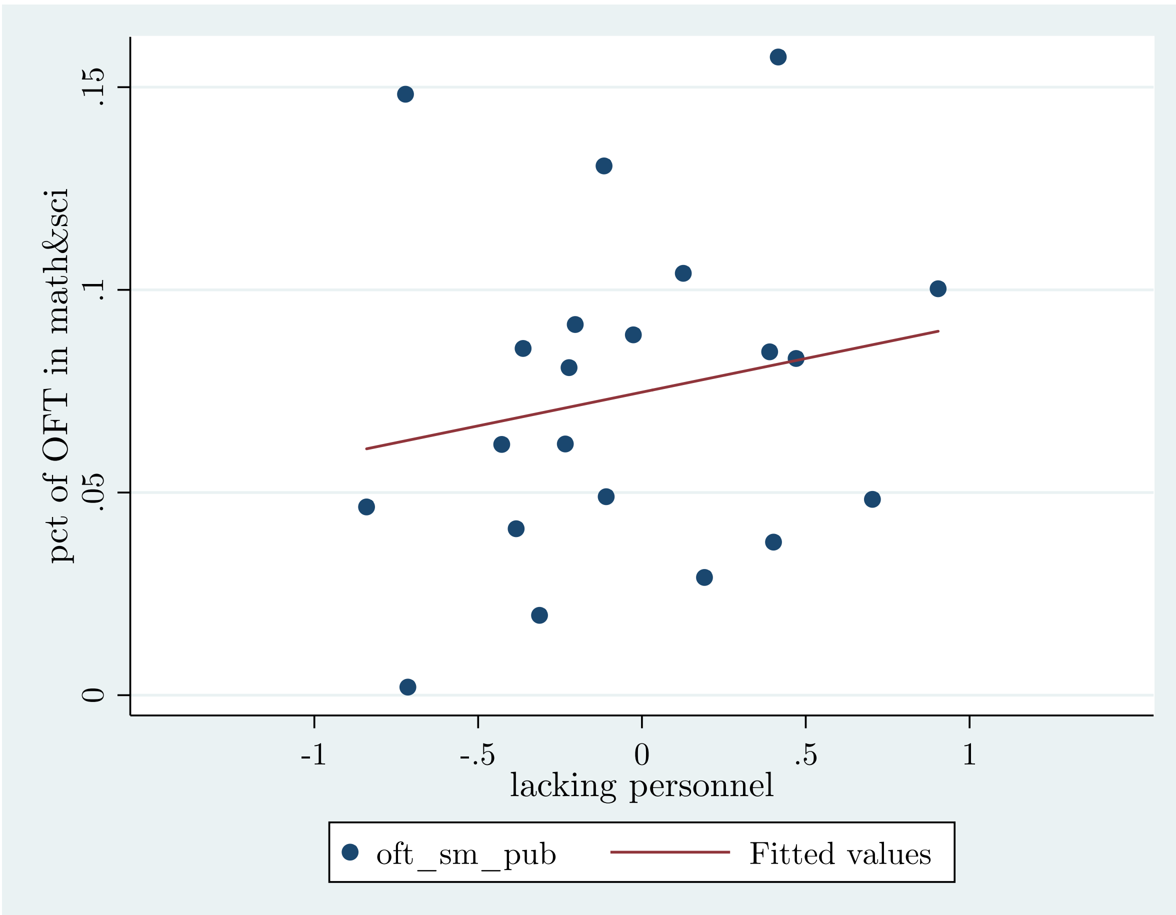

Figure 5.3: The relationship between country-level OFT with the shortages of teachers

All three of these variables were measured at the school level. Three separate continuous measures were constructed by the TALIS team using factor analysis, and were normalized across countries, so that these measures are comparable across countries.

The structure of this section is as follows: I first illustrate the model specifications in section 5.1.1; in Section 5.1.2, I discuss my data, including variable descriptions and missing data information; in section 5.1.3, I show the results and provide a discussion.

5.1.1 Empirical model specification

I specify two sets of models. The first set of models are linear models based on standard ordinary least square (OLS) assumptions. Regression models based on Equation 5.1 through Equation 5.6 are considered by pooling all the school observations across countries. The outcome variable OFT_{is} measures the percentage of teachers who teach out-of-field in math and science in schools i in country s. Only public schools are included in this model. The model controls for school-level variables listed in Section 5.1.2. In one specification, I control for country fixed effects a_s using dummy variables. This approach allows me to account for all the variation in school level out-of-field teaching due to country variables. It is commonly used in the international education literature (Ammermueller & Pischke, 2009; Hanushek & Woessmann, 2010; Ohinata & van Ours, 2011). My primary interests are the coefficients on three policy variables: $ADMINL$, $AUTHIRE$, $LACKPERS$, which are the principal's administrative leadership, the school's autonomy in hiring teachers, and the degree to which a school lacks instructional personnel, respectively. For each variable of interest, I fitted two models. The first model is fitted without country dummy variables (Equation 5.1, Equation 5.2, Equation 5.3) and the second model is fitted with country dummy variables (Equation 5.4, Equation 5.5, Equation 5.6,). The idea is to compare the change estimates to gauge how much a national context affects a school's decision to hire out-of-field teachers. I also repeat this strategy in a full specification, as described in Equation 5.7 and Equation 5.8, in which I entered all variables of interest with school controls.

Models without country fixed-effects:

$$OFT_{is} = \delta + \alpha ADMINL_{is} + \gamma SCHOOL_{is} + \epsilon_{is} \tag{5.1}$$

$$OFT_{is} = \delta + \alpha AUTHIRE_{is} + \gamma SCHOOL_{is} + \epsilon_{is} \tag{5.2}$$

$$OFT_{is} = \delta + \alpha LACKPERS_{is} + \gamma SCHOOL_{is} + \epsilon_{is} \tag{5.3}$$

Models with country fixed-effects:

$$OFT_{is} = \delta + \alpha ADMINL_{is} + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \tag{5.4}$$

$$OFT_{is} = \delta + \alpha AUTHIRE_{is} + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \tag{5.5}$$

$$OFT_{is} = \delta + \alpha LACKPERS_{is} + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \tag{5.6}$$

The full model is expressed as:

$$OFT_{is} = \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} + \gamma SCHOOL_{is} + \epsilon_{is} \tag{5.7}$$

$$OFT_{is} = \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \tag{5.8}$$

Equation 5.1 through Equation 5.8 quantify a valid relationship if the assumption holds that the relationship between variables of interest and school-level out-of-field teaching is linear. However, because the outcome measure, percentage of out-of-field teachers in school, is a fraction strictly between zero and one, the linear functional form in these models might not be appropriate, especially at the boundaries. The fact that the outcome measure is bounded suggests that the effect of the variable of interest cannot be constant throughout the range of predictors. Although it is possible to include a non-linear form of predictors to augment Equation 5.1 through Equation 5.8, there is no guarantee that the predicted values from OLS will be lying in the unit interval (Papke & Wooldridge, 1996). As an alternative, I fitted the same data to a set of fractional response models (FRM) introduced by Papke and Wooldridge (1996). Specifically, I specify three non-linear models in Equation 5.9, Equation 5.10, and Equation 5.11 without country fixed-effects:

$$logit(OFT_{is}) = \delta + \alpha AMINL_{is} + \gamma SCHOOL_{is} + \epsilon_{is} \tag{5.9}$$

$$logit(OFT_{is}) = \delta + \alpha AUTHIRE_{is} + \gamma SCHOOL_{is} + \epsilon_{is} \tag{5.10}$$

$$logit(OFT_{is}) = \delta + \alpha LACKPERS_{is} + \gamma SCHOOL_{is} + \epsilon_{is} \tag{5.11}$$

I repeat the above model controlling for country fixed-effects in Equation 5.12, Equation 5.13, and Equation 5.14:

$$logit(OFT_{is}) = \delta + \alpha AMINL_{is} + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \tag{5.12}$$

$$logit(OFT_{is}) = \delta + \alpha AUTHIRE_{is} + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \tag{5.13}$$

$$logit(OFT_{is}) = \delta + \alpha LACKPERS_{is} + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \tag{5.14}$$

The full model is expressed as:

$$logit(OFT_{is}) = \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} + \gamma SCHOOL_{is} + \epsilon_{is} \tag{5.15}$$

and

$$logit(OFT_{is}) = \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \tag{5.16}$$

Equation 5.9 through Equation 5.16 are non-linear models, therefore the estimated coefficients are not directly comparable to the OLS estimates. Here the quantity of interest is the partial effect of the three independent variables on $E(OFT|x)$. For example, the effect of administrative leadership on out-of-field teaching can be derived by $\partial E(OFT|x)/\partial ADMINL$. Papke and Wooldridge (1996) showed that Equation 5.9 through Equation 5.16 can be estimated using QMLE under standard generalized linear model (GLM) assumptions. They also showed that a fully robust sandwich form estimator is computationally easy if the GLM assumption fails.[43] The QMLE estimator has been shown to have an efficiency property if the GLM variance assumption holds. Similar to the OLS specification, I also repeat four models (each variable of interest alone and then used together) with- or without country dummy to the same data.

Additionally, I test the interaction term between the autonomy variable with leadership, and autonomy with shortage variable. The models are as follows.

OLS without country fixed-effects:

$$\begin{aligned} OFT_{is} = & \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} \\ & + \alpha_4 ADMINL * AUTHIRE + \gamma SCHOOL_{is} + \epsilon_{is} \end{aligned} \tag{5.17}$$

$$\begin{aligned} OFT_{is} = & \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} \\ & + \alpha_4 LACKPERS * AUTHIRE + \gamma SCHOOL_{is} + \epsilon_{is} \end{aligned} \tag{5.18}$$

[43] In Stata, this estimation procedure is achieved by using `glm y x1...xk, fam (bin) link (logit) robust`

OLS with country fixed-effects:

$$\begin{aligned} OFT_{is} =& \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} \\ & + \alpha_4 ADMINL * AUTHIRE + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \end{aligned} \tag{5.19}$$

$$\begin{aligned} OFT_{is} =& \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} \\ & + \alpha_4 LACKPERS * AUTHIRE + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \end{aligned} \tag{5.20}$$

FRM without country fixed-effects:

$$\begin{aligned} logit(OFT_{is}) =& \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} \\ & + \alpha_4 ADMINL * AUTHIRE + \gamma SCHOOL_{is} + \epsilon_{is} \end{aligned} \tag{5.21}$$

$$\begin{aligned} logit(OFT_{is}) =& \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} \\ & + \alpha_4 LACKPERS * AUTHIRE + \gamma SCHOOL_{is} + \epsilon_{is} \end{aligned} \tag{5.22}$$

FRM with country fixed-effects:

$$\begin{aligned} logit(OFT_{is}) =& \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} \\ & + \alpha_4 ADMINL * AUTHIRE + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \end{aligned} \tag{5.23}$$

$$\begin{aligned} logit(OFT_{is}) =& \delta + \alpha_1 ADMINL_{is} + \alpha_2 AUTHIRE_{is} + \alpha_3 LACKPERS_{is} \\ & + \alpha_4 LACKPERS * AUTHIRE + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \end{aligned} \tag{5.24}$$

All the regression analysis used proper school weights.[44]

5.1.2 Data description

The three main indicators of interest are measured at the school level. As described in Chapter 4, the administrative leadership, autonomy-of-hiring, and teacher shortage variables were constructed from the principal questionnaire. The leadership variable was measured by nine items that are on an ordinal scale. The autonomy of hiring variable was measured by five items measured that are on an ordinal scale. The general personnel shortage variable was measured by four items that are on an ordinal scale. The leadership index was developed using confirmatory factor analysis. The autonomy of hiring and the shortage variable were developed using principal component analysis. All of the three indices were normalized to have an international mean of 0 and a standard deviation of 1. The description of each variable is listed in Table 5.1.

[44] In Stata procedure, the data is set up with the `svyset` command to take into account design replication weights. Both OLS and FRM model are estimated using `svy brr` procedure. The fixed-effects approach did not use `svyset`. Instead I applied school weights (SCHWGT) directly in `areg` and `glm` routine.

Table 5.1: Description of independent variables

Indicis	Method	Items	Items description
Administrative leadership	Confirmatory factor analysis[a]	BCG16A	An important part of my job is to ensure that ministry-approved instructional approaches are explained to new teachers, and that more experienced teachers are using these approaches.
		BCG16D	A main part of my job is to ensure that the teaching skills of the staff are always improving.
		BCG16E	An important part of my job is to ensure that teachers are held accountable for the attainment of the school's goals.
		BCG16F	An important part of my job is to present new ideas to the parents in a convincing way.
		BCG16H	It is important for the school that I see to it that everyone sticks to the rules.
		BCG16I	It is important for the school that I check for mistakes and errors in administrative procedures and reports.
		BCG16J	An important part of my job is to resolve problems with the timetable and/or lesson planning.
		BCG16K	An important part of my job is to create an orderly atmosphere in the school.
		BCG16O	I stimulate a task-oriented atmosphere in this school.
Autonomy of hiring	Principal component analysis[b]	BCG31A	autonomy in selecting teachers for hire
		BCG31B	autonomy in firing teachers
		BCG31C	autonomy in establishing teachers' starting salaries
		BCG31D	autonomy in determining teachers' salary increases
		BCG31M	autonomy in allocating funds for teachers' professional development
Shortage of school personnel	Principal component analysis[b]	BCG29A	lack of teachers
		BCG29B	lack of laboratory technicians
		BCG29C	lack of instructional support personnel
		BCG29D	lack of other support personnel

a: OECD, 2010, p. 137
b: OECD, 2010, p. 135

Table 5.2: Description of missing variables

Variable	Missing	Total	Pct missing
Administrative leadership	21	3029	0.69
Autonomy of hiring	163	3029	5.38
Shortage of school personnel	122	3029	4.03
Schoolsize	168	3029	5.55
School location	14	3029	0.46
% of parents above ISCED 5	0	3029	0.00
% of parents above ISCED 3	0	3029	0.00
principal's experience	10	3029	0.33

The missing data information is described in Table 5.2. In general, the amount of missing data is mild, ranging from less than 1 percent to 5.6 percent, the highest. Since missing information is small in number, I performed list-wise deletion when fitting the models.

5.1.3 Model output

The estimates are shown in Table 5.3 through Table 5.5. First of all, the estimates between OLS and GLM (FRM) are very close, which suggests that the functional form may not be a severe issue in estimating a school's out-of-field assignments. Second, neither the administrative leadership nor the teacher shortages variables show any significance in any of the models. This is rather surprising because it suggests that across countries, the principal leadership style and the country's general teacher supply do not correlate with school's decision to deploy out-of-field teachers. The only variable that allows significant interpretation is the autonomy-of-hiring variable. The estimates suggest that if schools are given one more standard deviation autonomy in decision-making, the percentage of out-of-field teaching will reduce by a range of 3.1 to 3.8 percent. Considering that cross-nationally, the international average percentage of out-of-field teaching is 9.8 percent in math and science, a 3.1 to 3.8 percent reduction accounts for about 30 percent fewer out-of-field teachers. The effect is quite substantial. In addition to the main effect of the autonomy of hiring variable, its interaction term with the school personnel shortage variable is also significant when country fixed-effects are not used (Table 5.5). The estimates for the interaction term are positive 1.7 and 2.5 percent, respectively. This shows that when schools with a greater amount-of-autonomy (1 unit increase) in making hiring decisions experience personnel shortage (1 unit increase), they will deploy on average 1.7 to 2.5 percent more out-of-field teachers in the math and science field. Since the autonomy and shortage variables have a standard deviation of one, that means those schools who have 34 percent more autonomy and 34 percent more personnel shortage only deploy less than 3 percent more out-of-field teachers. The effects are small. Overall, giving schools more autonomy will have net effect of 1.2 to 1.4 percentage reduction in out-of-field teachers even when such schools experience moderate personnel shortage.

However I should point out that once the country fixed effects were accounted for, the effects became insignificant in both the OLS and the FRM estimates. This suggests that once the country specifics are controlled for, school autonomy of hiring teachers does not affect a school's percentage of out-of-field teaching, which one otherwise might expect because the variation of autonomy might be limited within each country, therefore reducing the association obtained cross-nationally.

Table 5.3: Estimation results from school-level pooled analysis (1)

Variable	OLS	FRM	OLS	FRM	OLS	FRM	OLS	FRM
Administrative leadership	0.013	0.014	0.007	0.007				
	(0.010)	(0.011)	(0.015)	(0.015)				
Autonomy of hiring					-0.033**	-0.038*	0.010	0.011
					(0.012)	(0.016)	(0.025)	(0.024)
Lacking personnel								
School size[a]								
Medium	0.002	-0.000	-0.039	-0.040	-0.01	-0.015	-0.045	-0.045
	(0.030)	(0.029)	(0.036)	(0.036)	(0.033)	(0.032)	(0.038)	(0.037)
Large	-0.019	-0.023	-0.077+	-0.071+	-0.044	-0.046	-0.089*	-0.081*
	(0.030)	(0.030)	(0.041)	(0.039)	(0.034)	(0.033)	(0.043)	(0.041)
School location[b]								
Small town	-0.092**	-0.085**	-0.085*	-0.076*	-0.101**	-0.092**	-0.095**	-0.085*
	(0.03)	(0.029)	(0.034)	(0.032)	(0.032)	(0.030)	(0.036)	(0.033)
Town	-0.06+	-0.057	-0.057	-0.051	-0.063+	-0.056	-0.060	-0.054
	(0.035)	(0.035)	(0.039)	(0.039)	(0.036)	(0.036)	(0.041)	(0.041)
City	-0.066+	-0.059	-0.055	-0.048	-0.068+	-0.061	-0.059	-0.0510
	(0.035)	(0.036)	(0.042)	(0.044)	(0.037)	(0.038)	(0.044)	(0.047)
Large city	-0.107***	-0.103***	-0.104**	-0.095**	-0.117***	-0.110***	-0.105**	-0.097**
	(0.031)	(0.029)	(0.038)	(0.034)	(0.032)	(0.030)	(0.039)	(0.035)

Table 5.3: cont'd

Variable	OLS	FRM	OLS	FRM	OLS	FRM	OLS	FRM
Parental Education								
20% or more above ISCED 5	0.002	-0.008	0.012	-0.010	0.010	-0.000	0.015	-0.009
	(0.017)	(0.022)	(0.019)	(0.018)	(0.017)	(0.023)	(0.019)	(0.020)
20% of more below ISCED 3	-0.050*	-0.048*	0.028	0.031	-0.036+	-0.034	0.021	0.021
	(0.019)	(0.020)	(0.024)	(0.030)	(0.021)	(0.023)	(0.024)	(0.0310)
Principal's experience[c]								
6-15 years	-0.001	0.001	0.022	0.022	0.004	0.006	0.020	0.020
	(0.025)	(0.025)	(0.027)	(0.027)	(0.026)	(0.025)	(0.028)	(0.027)
>16 years	-0.036	-0.037	0.001	0.002	-0.033	-0.034	-0.007	-0.009
	(0.029)	(0.031)	(0.028)	(0.034)	(0.031)	(0.034)	(0.029)	(0.035)
Fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
N	2793	2793	2793	2793	2656	2656	2656	2656

a: Small school as referenced group

b: Rural school as referenced group

c: Principal's experience less than 5 years as referenced group

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table 5.4: Estimation results from school-level pooled analysis (2)

Variable	OLS	FRM	OLS	FRM	OLS	FRM	OLS	FRM
Administrative leadership					0.012	0.011	0.006	0.006
					(-0.011)	(-0.012)	(-0.016)	(-0.016)
Autonomy of hiring					-0.031*	-0.036*	0.007	0.007
					(-0.013)	(-0.018)	(-0.024)	(-0.024)
Lacking personnel	0.006	0.006	-0.008	-0.009	0.000	-0.001	-0.008	-0.009
	(0.011)	(0.011)	(0.014)	(0.013)	(-0.013)	(-0.013)	(-0.015)	(-0.013)
School size[a]								
Medium	-0.003	-0.003	-0.048	-0.050	-0.02	-0.023	-0.054	-0.056
	(0.032)	(0.029)	(0.037)	(0.038)	(-0.033)	(-0.032)	(-0.039)	(0.039)
Large	-0.024	-0.027	-0.086*	-0.082*	-0.05	-0.051	-0.095*	-0.090*
	(0.031)	(0.030)	(0.043)	(0.041)	(-0.034)	(-0.033)	(0.045)	(0.044)
School location[b]								
Small town	-0.098**	-0.091**	-0.086*	-0.075*	-0.099**	-0.090**	-0.090*	-0.080*
	(0.031)	(0.030)	(0.035)	(0.032)	(0.033)	(0.031)	(0.037)	(0.034)
Town	-0.067+	-0.061+	-0.059	-0.050	-0.067+	-0.058	-0.063	-0.054
	(0.036)	(0.036)	(0.040)	(0.038)	(0.037)	(0.038)	(0.042)	(0.041)
City	-0.067+	-0.059	-0.049	-0.037	-0.070+	-0.061	-0.0560	-0.044
	(0.036)	(0.037)	(0.043)	(0.046)	(0.037)	(0.037)	(0.045)	(0.048)
Large city	-0.113***	-0.109***	-0.103**	-0.093**	-0.118***	-0.110***	-0.104**	-0.095**
	(0.032)	(0.031)	(0.038)	(0.033)	(0.034)	(0.032)	(0.039)	(0.036)

Table 5.4: cont'd

Variable	OLS	FRM	OLS	FRM	OLS	FRM	OLS	FRM
Parental Education								
20% or more above ISCED 5	0.002	-0.007	0.011	-0.013	0.016	0.006	0.015	-0.011
	(0.018)	(0.023)	(0.019)	(0.019)	(0.019)	(0.026)	(0.020)	(0.021)
20% of more below ISCED 3	-0.055**	-0.055**	0.024	0.026	-0.043+	-0.041+	0.016	0.016
	(0.020)	(0.020)	(0.025)	(0.033)	(0.022)	(0.025)	(0.026)	(0.034)
Principal's experience[c]								
6-15 years	0.003	0.004	0.023	0.022	0.005	0.007	0.020	0.020
	(0.026)	(0.025)	(0.027)	(0.026)	(0.027)	(0.026)	(0.029)	(0.028)
>16 years	-0.037	-0.037	-0.002	-0.003	-0.032	-0.032	-0.008	-0.010
	(0.030)	(0.031)	(0.029)	(0.034)	(0.033)	(0.036)	(0.030)	(0.035)
Fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
N	2699	2699	2699	2699	2559	2559	2559	2559

a: Small school as referenced group
b: Rural school as referenced group
c: Principal's experience less than 5 years as referenced group
+ $p<0.10$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 5.5: Estimation results from school-level pooled analysis with interaction terms

Variable	OLS	FRM	OLS	FRM	OLS	FRM	OLS	FRM
Administrative leadership	0.012	0.014	0.008	0.009	0.012	0.011	0.006	0.006
	(0.014)	(0.020)	(0.020)	(0.026)	(0.011)	(0.012)	(0.016)	(0.016)
Autonomy of hiring	-0.031*	-0.037*	0.006	0.005	-0.031*	-0.037*	0.005	0.005
	(0.012)	(0.015)	(0.022)	(0.022)	(0.013)	(0.017)	(0.024)	(0.024)
Lacking personnel	-0.000	-0.001	-0.008	-0.009	0.012	0.021+	-0.004	-0.001
	(0.013)	(0.013)	(0.015)	(0.013)	(0.010)	(0.011)	(0.012)	(0.014)
Leadership*Autonomy	-0.000	0.003	0.002	0.004				
	(0.013)	(0.018)	(0.014)	(0.019)				
Lacking personnel*Autonomy					0.017+	0.025*	0.005	0.008
					(0.010)	(0.010)	(0.010)	(0.012)
School size[a]								
Medium	-0.020	-0.023	-0.054	-0.055	-0.025	-0.030	-0.055	-0.058
	(0.033)	(0.032)	(0.039)	(0.039)	(0.033)	(0.032)	(0.039)	(0.040)
Large	-0.050	-0.051	-0.095*	-0.089*	-0.056+	-0.059+	-0.096*	-0.092*
	(0.034)	(0.033)	(0.045)	(0.043)	(0.033)	(0.033)	(0.045)	(0.044)
School location[b]								
Small town	-0.099**	-0.090**	-0.091*	-0.080*	-0.100**	-0.091**	-0.090*	-0.080*
	(0.033)	(0.032)	(0.037)	(0.034)	(0.033)	(0.031)	(0.037)	(0.034)
Town	-0.067+	-0.059	-0.063	-0.055	-0.064+	-0.056	-0.062	-0.052
	(0.037)	(0.038)	(0.042)	(0.041)	(0.037)	(0.038)	(0.042)	(0.041)
City	-0.070+	-0.061	-0.056	-0.044	-0.068+	-0.058	-0.055	-0.043
	(0.037)	(0.038)	(0.045)	(0.048)	(0.037)	(0.038)	(0.045)	(0.048)
Large city	-0.118***	-0.110***	-0.104**	-0.095**	-0.115***	-0.108***	-0.103**	-0.094**
	(0.034)	(0.032)	(0.040)	(0.036)	(0.033)	(0.031)	(0.039)	(0.035)

Table 5.5: cont'd

Variable	OLS	FRM	OLS	FRM	OLS	FRM	OLS	FRM
Parental Education								
20% or more above ISCED 5	0.016	0.006	0.015	-0.011	0.014	0.004	0.015	-0.011
	(0.019)	(0.026)	(0.020)	(0.021)	(0.019)	(0.026)	(0.020)	(0.021)
20% of more below ISCED 3	-0.043+	-0.041+	0.015	0.016	-0.042+	-0.039	0.016	0.015
	(0.022)	(0.024)	(0.026)	(0.034)	(0.022)	(0.024)	(0.026)	(0.033)
Principal's experience[c]								
6-15 years	0.005	0.007	0.020	0.019	0.004	0.006	0.020	0.019
	(0.027)	(0.026)	(0.029)	(0.028)	(0.027)	(0.026)	(0.029)	(0.028)
>16 years	-0.032	-0.032	-0.008	-0.010	-0.028	-0.029	-0.007	-0.007
	(0.033)	(0.036)	(0.030)	(0.035)	(0.033)	(0.037)	(0.030)	(0.035)
Country fixed-effects	No	No	Yes	Yes	No	No	Yes	Yes
N	2559	2559	2559	2559	2559	2559	2559	2559

a: Small school as referenced group
b: Rural school as referenced group
c: Principal's experience less than 5 years as referenced group
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

For the purpose of informing policymakers, it makes sense to clarify what kind of autonomy can be used as policy levers. This exercise requires us to understand how the autonomy-of-hiring variable is constructed. As described in Table 5.1, this variable is based on five aspects of information: the responsibility of selecting teachers for hire; the responsibility of firing; the responsibility of establishing teachers' starting salaries; the responsibility of determining teachers' salary increases; and the responsibility of allocating funds for teachers' professional development. In each of these aspects, the principal is asked to choose from a list of actors who is more responsible: the principal, teachers, the school governing board, the regional or local education authority, or the national education authority. Therefore each aspect consists of a series of zero-one binary choice. For instance, to identify who is responsible for selecting and hiring teachers, the principal will choose from:

- The principal is more responsible (Yes/No)
- Teachers are more responsible (Yes/No)
- The school governing board is more responsible (Yes/No)
- The regional or local educational authority is more responsible (Yes/No)
- The national education authority (Yes/No)

Of course, the principal could identify multiple actors at the same time. To simplify my analysis, I focus on each of the five actors one at time to test their relationship with school-level out-of-field teaching. To illustrate my procedure, I ran a series of models similar to the following:[45]

[45] I also replaced the administrative leadership variable and teacher shortage variables with other items. For instance, instead of using the index of general personnel shortage, I use the teacher shortage variable (BCG29A). The estimates are qualitatively similar, therefore I did not present them here.

$$OFT_{is} = \delta + \alpha_1 ADMINL_{is} + \alpha_2 BCG31A1_{is} + \alpha_3 LACKPERS_{is} + \gamma SCHOOL_{is} + a_s + \epsilon_{is} \quad (5.25)$$

in which the BCG31A1 variable indicates whether or not the principal is more responsible for selecting and hiring teachers. This approach allows me to explore some of the effects of different actors on school-level out-of-field teaching.

The findings are summarized in Table 5.6 and Table 5.7. For simplicity reasons, I show only the estimates from the country fixed-effect specification.

Although these measures are crude in themselves, they gave me a basic sense for the elements in school management that could relate to making out-of-field assignments. School level out-of-field teaching is considerably higher when either teachers or regional educational authority are given more responsibility to decide on teachers' starting salaries. In schools where the increase in teacher salary is determined by regional educational authority, levels of out-of-field teaching are also higher. Additionally, when principals are given more responsibility to determine the salary increase of teachers, levels of out-of-field teaching are somehow lower. All these findings are robust to the presence of country fixed-effects.

The challenge is how to make sense of these findings. First of all, I am rather surprised to see a significant relationship between salary schedule and school-level out-of-field teaching. Currently there is no theory that can be readily used to explain this connection. My tentative explanation is that school-level management is important. If the principal has more flexibility to determine salary increase, the school might become a more desirable place to work because it can offer more incentives to teachers. Therefore such an incentive structure could in theory attract more high-quality teachers. This is a working hypothesis that needs more data support. In addition, can the principal variable serve as a proxy for the unobserved authority he/she enjoys in school? It does not seem to be the case because letting the principal determine teachers' starting salaries does not significantly relate statistically to fewer out-of-field assignments.

In addition, It makes little sense to jump directly to a conclusion such as "giving principals more power to determine salary increases would lead to lower levels of out-of-field teaching." The items used are crude instruments that do not allow such a definitive interpretation. The analytical approach I took also excludes the possibility that several actors might jointly affect out-of-field teaching.[46] These exploratory findings suggest that different role taking by teachers, school principals, and local educational authority have a profound impact on out-of-field assignments. The interaction among these three actors to determine the salary schedule somehow leads to the decision of hiring out-of-field teachers. It implies that schools with a school-based salary-increase mechanism are associated with lower levels out-of-field teaching. This again confirms the relationship between out-of-field teaching and particular school natures.

[46]Without a sound theoretical framework about how these factors are interconnected with each other, I am reluctant to try different models based on the combination of these factors. The approach I am more inclined to, to use some indices with factor analysis, has already been undertaken by the TALIS team and the results are shown in Table 5.3.

Table 5.6: Estimation results from alternative specification (1)

Variable	OLS	FRM	OLS	FRM
Administrative leadership	0.009	0.009	0.009	0.010
	(0.016)	(0.015)	(0.016)	(0.015)
Teachers are more responsible for establishing their starting salaries	0.175*	0.154***		
	(0.074)	(0.038)		
Regional educational authority are more responsible for establishing their starting salaries			0.082**	0.112**
			(0.026)	(0.035)
Lacking personnel	-0.008	-0.009	-0.008	-0.009
	(0.014)	(0.013)	(0.014)	(0.013)
School size[a]				
Medium	-0.048	-0.050	-0.048	-0.051
	(0.038)	(0.038)	(0.037)	(0.038)
Large	-0.085*	-0.081+	-0.084+	-0.082+
	(0.043)	(0.042)	(0.043)	(0.042)
School location[b]				
Small town	-0.084*	-0.073*	-0.083*	-0.071*
	(0.035)	(0.033)	(0.035)	(0.032)
Town	-0.059	-0.051	-0.058	-0.048
	(0.040)	(0.039)	(0.040)	(0.038)
City	-0.050	-0.038	-0.052	-0.038
	(0.04)	(0.05)	(0.04)	(0.05)
Large city	-0.102**	-0.093**	-0.101**	-0.091**
	(0.039)	(0.034)	(0.038)	(0.034)

Table 5.6: cont'd

Variable	OLS	FRM	OLS	FRM
Parental Education				
20% or more above ISCED 5	0.011	-0.014	0.010	-0.015
	(0.019)	(0.019)	(0.019)	(0.018)
20% of more below ISCED 3	0.022	0.024	0.019	0.021
	(0.026)	(0.033)	(0.025)	(0.032)
Principal's experience[c]				
6-15 years	0.023	0.022	0.021	0.021
	(0.028)	(0.027)	(0.028)	(0.027)
>16 years	-0.002	-0.003	-0.000	0.003
	(0.029)	(0.034)	(0.028)	(0.034)
Country fixed-effects	Yes	Yes	Yes	Yes
N	2651	2651	2652	2652

a: Small school as referenced group

b: Rural school as referenced group

c: Principal's experience less than 5 years as referenced group

+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

Table 5.7: Estimation results from alternative specification (2)

Variable	OLS	FRM	OLS	FRM
Administrative leadership	0.01	0.01	0.01	0.01
	(0.02)	(0.02)	(0.02)	(0.02)
Principal is more responsible for	-0.043+	-0.072*		
determining teachers' salary increases	(0.022)	(0.036)		
Regional educational authority are more			0.081**	0.102**
responsible for determining teachers'			(0.029)	(0.035)
salary increases				
Lacking personnel	-0.008	-0.009	-0.008	-0.009
	(0.014)	(0.013)	(0.014)	(0.013)
School size[a]				
Medium	-0.048	-0.052	-0.049	-0.051
	(0.038)	(0.038)	(0.037)	(0.038)
Large	-0.087*	-0.085*	-0.083+	-0.079+
	(0.043)	(0.042)	(0.043)	(0.043)
School location[b]				
Small town	-0.084*	-0.072*	-0.082*	-0.071*
	(0.035)	(0.032)	(0.035)	(0.033)
Town	-0.058	-0.046	-0.061	-0.052
	(0.040)	(0.039)	(0.040)	(0.038)
City	-0.050	-0.036	-0.051	-0.037
	(0.043)	(0.045)	(0.043)	(0.046)
Large city	-0.103**	-0.092**	-0.103**	-0.093**
	(0.038)	(0.034)	(0.038)	(0.034)

Table 5.7: cont'd

Variable	OLS	FRM	OLS	FRM
Parental Education				
20% or more above ISCED 5	0.011	-0.013	0.016	-0.008
	(0.019)	(0.019)	(0.019)	(0.020)
20% of more below ISCED 3	0.024	0.026	0.017	0.017
	(0.026)	(0.033)	(0.025)	(0.032)
Principal's experience^c				
6-15 years	0.023	0.023	0.020	0.019
	(0.028)	(0.027)	(0.028)	(0.027)
>16 years	-0.001	0.001	-0.003	-0.002
	(0.028)	(0.034)	(0.027)	(0.031)
Country fixed-effects	Yes	Yes	Yes	Yes
N	2644	2644	2645	2645

a: Small school as referenced group
b: Rural school as referenced group
c: Principal's experience less than 5 years as referenced group
+ p<0.10, * p<0.05, ** p<0.01, *** p<0.001

There are several other findings worth discussion. In Table 5.3 through Table 5.7, we can see that several school characteristics are associated with prevalence of out-of-field teaching. First is school size; I found that compared to small schools, large schools are less likely to have out-of-field teaching. This effect is significant even after controlling for country-fixed effects, which suggests that the relationship is robust across countries. The difference between large schools and small schools varies from 7.1 percent to 9.5 percent. Second, the rural-urban disparity again has strong implications for a school's decision to deploy out-of-field teachers. Compared to rural village schools, schools in large cities consistently have a lower percentage of out-of-field teachers. The difference is substantial in all of the cases, ranging from 9.4 percent to 11.3 percent. Third, schools with more educated parents have fewer out-of-field teachers, although I only observed such an effect at one end of the distribution. In schools where 20 percent or more parents have ISCED 3-above[47] education, there is a lower level of out-of-field teaching. These effects are only significant cross-nationally without controlling for country fixed effects. They disappeared when country fixed-effects were introduced. Again, this suggests that the distribution of out-of-field teachers across the SES spectrum depends on the national context.

These findings suggest that the difference in levels of out-of-field teaching in math and science are substantial across different types of schools and in schools located in different regions. Small schools, rural schools, and low-SES schools are more likely to assign out-of-field math and science teachers in their classrooms. This phenomenon is consistent across an array of countries with varying degrees of educational development. The findings correspond with those which emerged in the single country analysis I discussed in Chapter 4.

[47]ISCED 3 is equivalent to high school education.

5.2 Comparing teaching behavior and professional status between out-of-field and in-field teachers

In Chapter 4, I examined the attributes of out-of-field teachers, including demographic backgrounds, working status, and school conditions. Despite the differences in these aspects between out-of-field and in-field teachers, we still do not know whether or not they perform differently on the job. Ideally one would like to use some productivity measures, such as student test scores, to examine whether there is a difference in effectiveness between out-of-field and in-field teachers in promoting student learning. However, TALIS does not include any student test scores, and I have no way to link teachers to some sort of performance benchmarks.[48]

As an alternative, I compared the teaching behaviors, classroom disciplinary climate and professional status between out-of-field and in-field teachers. The teaching behavior measures were used to measure whether out-of-field and in-field teacher status translates into different instructional practices. If I find systematic differences in these aspects between these two types of teachers, we may have reason to believe that these differences will have differential effects on student learning outcomes. In addition, because out-of-field teachers are believed to lack sufficient subject matter knowledge, one possible remedy would be to help them develop essential knowledge on the job. By comparing professional status, including access to professional development opportunities, receiving appraisals from the principal, and collaborating with other teachers in schools, I examined whether out-of-field teachers are treated differently in school compared to in-field teachers.

The structure of this section is as follows: I first describe the model used; I then describe the data structure; in the last part, I show my estimation results from multiple specifications.

[48]It has been suggested that in the next round of TALIS (2013), researchers will be able to link TALIS with student test scores from PISA 2014.

5.2.1 Empirical model specification

For each country, I fitted the following OLS model:

$$Y_{is} = \delta + \beta OFT_{is} + \pi TEACHER_{is} + a_s + \epsilon_{is} \tag{5.26}$$

In this model, each teacher's out-of-field status is used as an independent variable to compare the difference between out-of-field and in-field teachers on a set of outcome measures (represented by the generic term Y_{is}) as described in Section 5.2.2. Subscript i indexed teacher and subscript s indexed school. The quantity of interest is the coefficient β associated with the OFT variable. I controlled for a set of teacher background characteristics, including gender, age, part-time status, contract type, education attainment, and teaching experience. I also introduced school fixed effects a_s to control for the endogeneity problem. The purpose of using school fixed effects (dummy variable) is to compare teachers within schools rather than across diverse schools; because teachers' time allocation and teaching practices are likely to differ across schools. The use of fixed effects addresses any unobserved school factors that may cause systemic difference in these practices across schools. It is commonly used in the economics literature (Ammermueller & Pischke, 2009; Hanushek & Woessmann, 2010; Ohinata & van Ours, 2011).

For binary outcomes, a similar logit model with school fixed-effects is specified as follows:

$$logit(Y_{is}) = \delta + \beta OFT_{is} + \pi TEACHER_{is} + a_s + \epsilon_{is} \tag{5.27}$$

One concern over the fixed-effect approach is whether there are enough numbers of teachers per school to provide variation among teachers. I provide a description of numbers of teachers per school by each country in Table B.1. The majority of schools sampled in TALIS have at least 3 to 4 faculties in math and science, which guarantees enough variation per school. Alternatively, I ran a series of two-level hierarchical linear models (Raudenbush & Bryk, 2001) to conduct similar exercise. For each country, the model is specified as follows:

$$
\begin{aligned}
Level-1: Y_{is} = & \delta_{0s} + \beta OFT_{is} + \pi_1 GENDER_{is} + \pi_2 AGE_{is} + \\
& \pi_3 EDLV_{is} + \pi_4 CONTRACT_{is} + \pi_5 CONTRACT_{is} + \\
& \pi_6 YREXP_{is} + \epsilon_{is}
\end{aligned}
$$

$$
\begin{aligned}
Level-2: \delta_{0s} = & \gamma_{00} + \gamma_{01} LOCATION_{1s} + \gamma_{02} SSIZE_{2s} + \\
& \gamma_{03} SSES_{3s} + \gamma_{04} PAEXP_{4s} + \gamma_{05} ADMINL_{5s} + \\
& \gamma_{06} AUTHIRE_{6s} + \gamma_{07} LACKPERS_{7s} + u_{0s}
\end{aligned} \tag{5.28}
$$

where the teacher controls are exactly the same as in Equation 5.26. School controls include location, size, SES, principal's experience, administrative leadership, autonomy of hiring, and whether or not school lacks personnel.[49] Proper weights are used at both teacher level and school level.[50]

5.2.2 Data description

As stated in Section 5.2.1, the out-of-field status variable was used as the main independent variable. I used several outcome variables to measure various aspects of teachers' classroom practices and their professional status. Most outcome measures are composite indices on a continuous scale, constructed by multiple items.[51] The outcome measures are

[49] It is preferable to specify a hierarchical generalized linear model (HGLM) for binary outcomes. However, it is a challenge to incorporate multiple sampling weights in HGLM computationally. Right now in Stata, in which I ran all the analyses for this dissertation, only the `gllamm` package is capable of handling HGLM with more than one weighting variable. In my analysis `gllamm` is sensitive to missing variables which results in dropping several key variables of interest in estimation (even when the degree of missing is mild). Therefore for operational reasons, I use only a linear probability model for binary outcomes. Also note that all the models for Belgium (Flemish) exclude school size variable due to missing data.

[50] The weights are calculated in Stata using method introduced by Pfeffermann, Skinner, Holmes, Goldstein, and Rasbash (1998). I used the `pwigls` package to rescale the weights. For technical detail, see Chantala, Blanchette, and Suchindran (2011).

[51] Only two outcome measures are binary variables. I fit a similar logistic regression to these two variables, as decribed in Equation 5.28.

described in Table 5.8 and Table 5.9. For a full treatment of the continuous composite indices, I refer readers to *TALIS 2008 Technical Report* (OECD, 2010). Similar to the last section, I include a description of missing data information in Table 5.10. The missing data issue is mild. I performed list-wise deletion of missing cases when running the models.

Table 5.8: Description of variables used as outcomes

Variable name	Item	Variable description
TTEACHH	BTG08A	Number of hours on teaching students in school (either whole class, in groups or individually) in a typical week
TPLANH	BTG08B	Number of hours planning or preparation of lessons either in school or out of school (including marking of student work) in a typical week
TORDERP	BTG41B	Percentage of time typically spent on keeping order in classroom (maintaining discipline) for this target class
TTEACHP	BTG41C	Percentage of time typically spent on actual teaching and learning for this target class
CCLIMATE	BTG43A, BTG43B, BTG43C, BTG43B	Classroom disciplinary climate index
TSRELAT	BTG31G, BTG31H, BTG31I, BTG31J	Teacher-student relations
SELFEF	BTG31B, BTG31C, BTG31D, BTG31E	Teacher self-efficacy index
TPSTRUC	BTG42B, BTG43C, BTG42H, BTG42I, BTG42M	Classroom teaching practice index - structuring
TPSTUD	BTG42D, BTG42E, BTG42F, BTG42N	Classroom teaching practice index - student-oriented
TPACTIV	BTG42J, BTG42O, BTG42Q, BTG42S	Classroom teaching practice index - enhanced activity
MENTOR	BTG11H1	During the past 18 months, did you receive mentoring and/or peer observation and coaching, as part of a formal school arrangement?
NEVERAF	BTG21A, BTG21C	No appraisal or feedback received by the teacher
PDDAYS	BTG12	In all, how many days of professional development did you attend during the last 18 months?

Table 5.9: Description of index variables

Variable name	Method of construction	Items	Item description
CCLIMATE	Confirmatory factor analysis	BTG43A	When the lesson begins, I have to wait quite a long time for students to quieten down.
		BTG43B	Students in this class take care to create a pleasant learning atmosphere.
		BTG43C	I lost quite a lot of time because of students interrupting the lesson.
		BTG43D	There is much noise in this classroom
TSRELAT	Confirmatory factor analysis	BTG31G	In this school, teachers and students usually get on well with each other.
		BTG31H	Most teachers in this school believe that students' well-being is important.
		BTG31I	Most teachers in this school are interested in what students have to say.
		BTG31J	If a student from this school needs extra assistance, the school provides it.
SELFEF	Confirmatory factor analysis	BTG31B	I feel that I am making a significant educational difference in the lives of my students.
		BTG31C	If I try really hard, I can make progress with even the most difficult and unmotivated students.
		BTG31D	I am successful with the students in my class.
		BTG31E	I usually know how to get through to students.
TPSTRUC	Confirmatory factor analysis	BTG42B	I explicitly state learning goals.
		BTG42C	I review with the students the homework they have prepared.
		BTG42H	I ask my students to remember every step in a procedure.
		BTG42I	At the beginning of the lesson I present a short summary of the previous lesson.
		BTG42M	Students evaluate and reflect upon their own work.

Table 5.9: cont'd

Variable name	Method of construction	Items	Item description
TPSTUD	Confirmatory factor analysis	BTG42D	Students work in small groups to come up with a joint solution to a problem or task.
		BTG42E	I give different work to the students that have difficulties learning and/or to those who can advance faster.
		BTG42F	I ask my students to suggest or to help plan classroom activities or topics.
		BTG42N	Students work in groups based upon their abilities.
TPACTIV	Confirmatory factor analysis	BTG42J	Students work on projects that require at least one week to complete.
		BTG42O	Students make a product that will be used by someone else.
		BTG42Q	I ask my students to write an essay in which they are expected to explain their thinking or reasoning at some length.
		BTG42S	Students hold a debate and argue for a particular point of view which may not be their own.
NEVERAF	Addition	BTG21A	How often have you received appraisal and/or feedback from the school principal?
		BTG21C	How often have you received appraisal and/or feedback from an external individual or body (e.g. external inspector)?

Table 5.10: Description of missing variables

Variable name	Number of missing data	Total cases	Percent missing
TTEACH	558	13172	4.24
TPLANH	575	13172	4.37
TORDERP	387	13172	2.94
TTEACHP	387	13172	2.94
CCLIMATE	125	13172	0.95
TERELAT	56	13172	0.43
TPSTRUC	114	13172	0.87
TPSTUD	114	13172	0.87
TPACTIV	114	13172	0.87
TCEXCHAN	60	13172	0.46
TCCOLLAB	60	13172	0.46
SELFEF	63	13172	0.48
TBTRAD	52	13172	0.39
TBCONS	52	13172	0.39
PDDAYS	543	13172	4.12
STUAB	255	13172	1.94
MENTOR	114	13172	0.87
NEVERAF	222	13172	1.69

5.2.3 Model output

I structured this section into four parts according to different outcome variables. In Section 5.2.3.1, I compare whether out-of-field teachers allocate different amounts of time on various tasks compared to in-field teachers. In Section 5.2.3.2, I compare the classroom climate and teachers' self-efficacy between out-of and in-field teachers. In Section 5.2.3.3, I compare whether out-of-field teachers use different teaching practices in class. In Section 5.2.3.4, I compare the amount of professional help received by out-out-field teaching compared to in-field teachers.

In each section, I ran six regression models using different outcome measures for each country. The first three models use fixed-effects approach. Model specification is summarized in Equation 5.26 and Equation 5.27.[52] The next three models use HLM approach for comparison. Model specification is summarized in Equation 5.28.[53] For simplicity reasons, the tables shown in this section only summarize the estimates of the β coefficient and its standard error by country and by outcome measure. Estimates for control variables are omitted.

5.2.3.1 Time on task

In Table 5.11, I first compare the time that out-of-field and in-field teachers spent on different tasks using the fixed-effects approach. There are no obvious patterns across countries. The estimates are not always significant. In Denmark, Lithuania, Slovenia, and Turkey, out-of-field teachers spend 2.3 to 7.3 hours less per week teaching students. There is little difference in hours spent on preparing lessons. The only cases are Austria and Slovenia, where out-of-field teachers spend 1.4 and 2 hours less per week. Percentage-wise, out-of-field teachers in Brazil and Lithuania spend more time on keeping classroom orders; Hungary is one exception where out-of-field teachers spend less time on keeping classroom order. For the rest of the countries, there is essentially no statistical difference in time allocation of various tasks between out-of-field and in-field teachers. For out-of-field teachers in Denmark, Lithuania, Slovenia, and Turkey, the general pattern is that out-of-field teachers spend less time on learning activities and preparing for lessons, but more time on keeping classroom order.

Table 5.12 shows estimation results from HLM models. The results are qualitatively similar. The signs of the estimates are consistent with those of fixed-effects estimates. Out-of-field teachers spent less time on teaching activities and preparing lessons. It is less clear whether there is a systematic difference in keeping classroom orders across countries.

[52]The Netherlands is excluded in this analysis because the sample size is too small.

[53]Malta and the Netherlands are excluded in the HLM analysis because of insufficient sample size.

Table 5.11: Comparing time spent on various tasks between out-of-field and in-field teachers, school fixed-effects approach

Country	Number of hours on teaching students in school		Number of hours planning or preparing of lesson		For this particular class, % of time on keeping order	
	Coeff	Std Error	Coeff	Std Error	Coeff	Std Error
Australia	0.449	(1.360)	-1.330	(1.915)	1.920	(4.502)
Austria	0.300	(0.525)	-1.401+	(0.785)	1.176	(1.764)
Brazil	-1.593	(1.323)	1.591	(1.715)	3.072+	(1.690)
Bulgaria	-0.223	(0.794)	-0.078	(0.994)	-1.506	(1.106)
Denmark	-2.236+	(1.164)	-1.099	(1.169)	-0.224	(2.168)
Estonia	-0.346	(1.306)	-1.581	(1.138)	-0.340	(1.728)
Hungary	0.615	(2.605)	1.166	(2.127)	-4.068+	(2.261)
Korea	0.129	(1.497)	1.408	(1.367)	-2.103	(2.698)
Lithuania	-3.935+	(2.296)	-1.516	(1.455)	8.862+	(4.924)
Malaysia	0.465	(0.649)	-0.124	(0.712)	1.920	(1.567)
Malta	5.325	(3.236)	3.069	(2.785)	12.396	(8.813)
Mexico	0.718	(1.912)	0.717	(0.953)	0.397	(1.629)
Norway	-0.716	(0.803)	0.506	(0.989)	-1.189	(1.794)
Poland	0.129	(9.109)	1.921	(3.244)	3.558	(3.120)
Portugal	0.381	(2.120)	0.300	(1.406)	-1.412	(4.079)
Slovak Rep	-1.278	(1.406)	0.565	(1.393)	-0.431	(2.451)
Slovenia	-2.452+	(1.356)	-2.071*	(0.989)	1.357	(1.804)
Spain	-0.566	(0.525)	-0.997	(0.810)	1.106	(2.284)
Turkey	-7.349**	(2.689)	-3.435	(2.679)	5.796**	(2.002)
Belgium (F)	0.675	(0.802)	2.277	(1.873)	5.224	(3.843)

Note: Controlled for gender, age, part-time status, contract type, education attainment, and teaching experience

Table 5.12: Comparing time spent on various tasks between out-of-field and in-field teachers, HLM approach

Country	Number of hours on teaching students in school		Number of hours planning or preparing of lesson		For this particular class, % of time on keeping order	
	Coeff	Std Error	Coeff	Std Error	Coeff	Std Error
Australia	0.592	(0.958)	-0.274	(1.849)	3.084	(4.186)
Austria	0.570	(0.546)	-1.503+	(0.863)	-0.273	(1.539)
Brazil	-1.368	(1.345)	2.182+	(1.154)	0.806	(1.538)
Bulgaria	0.002	(1.117)	-0.046	(0.948)	0.334	(0.839)
Denmark	-1.845*	(0.836)	-0.838	(0.926)	4.213+	(2.435)
Estonia	-0.304	(1.105)	-2.479**	(0.927)	-0.160	(1.226)
Hungary	-0.360	(1.477)	-0.520	(1.338)	-2.167	(2.361)
Korea	0.612	(1.455)	2.382*	(1.088)	-2.422	(2.068)
Lithuania	-3.776+	(2.081)	-2.208+	(1.202)	8.141	(6.056)
Malaysia	0.732	(0.653)	0.065	(0.712)	2.071	(1.497)
Mexico	-1.227	(2.152)	0.590	(1.017)	-0.570	(1.656)
Norway	-0.379	(0.717)	0.453	(0.821)	-1.256	(1.545)
Poland	-5.084***	(1.151)	-4.223***	(0.954)	-6.052***	(1.163)
Portugal	1.533	(1.618)	-1.338	(1.434)	1.016	(3.967)
Slovak Rep	-1.548	(1.050)	-1.017	(1.257)	-1.004	(1.763)
Slovenia	-2.207+	(1.155)	-2.524**	(0.914)	1.589	(1.924)
Spain	-0.603	(0.634)	-1.277	(0.827)	-2.600	(1.859)
Turkey	-3.168*	(1.608)	0.532	(1.969)	3.025	(2.663)
Belgium (F)	0.100	(0.655)	1.392	(1.158)	3.172	(3.826)

Note: Controlled for gender, age, part-time status, contract type, education attainment, teaching experience, school location, sizes, SES, administrative leadership, personnel shortage, autonomy of hiring, and principal's years of experience.

5.2.3.2 Disciplinary climate

One explanation of the differences in time spent is that out-of-field teachers are assigned to tough classrooms and their limited ability to control in classrooms. There seems to be some grounds for this hypothesis. The estimates are listed in Table 5.13 and Table 5.14. In Austria, Brazil, Lithuania, Malaysia, Poland, and Turkey, the classroom disciplinary climate is consistently worse for out-of-field teachers. The outcome measure, classroom disciplinary climate, is standardized to have a zero mean and a standard deviation of one. We can thus interpret the outcome in terms of standard deviation. This finding suggests that out-of-field teachers' classroom climate is 0.24 to 0.55 standard deviation lower than in-field teachers'. The difference in classroom climate also translates into the teacher-student relationship. In Brazil, Denmark, Mexico, Poland, Portugal, the Slovak Republic, Spain, and Turkey, out-of-field teachers are likely to have worse relationships with their students compared to in-field teachers. The difference is still in the range of 0.18 to 0.55 standard deviation. The estimates from HLM analysis are relatively smaller and insignificant.

It is less clear about what causes such a difference in classroom climate between out-of-field and in-field teachers. It could be that out-of-field teachers have worse classroom management skills so that they cannot control the classroom and students. On the other hand, although school fixed-effects guarantee that cross-school sorting is taken into account, it is still possible that out-of-field teachers are assigned to teach in tougher classrooms. As seen in Chapter 4, I found some partial evidence for this claim because we have seen that out-of-field teachers are more likely to be assigned to low-SES classrooms in each school and students' SES status could affect teachers' perception of classroom discipline.

Although some out-of-field teachers teach in less-disciplined classrooms, this does not seem to affect the way out-of-field teachers feel about themselves. They feel the same about their role in changing student learning outcomes in most cases. There are only three cases, Mexico, Spain, and Belgium (Flemish), where out-of-field teachers felt much worse about their job situation, in the range of 0.32 to 0.69 standard deviation, compared to in-field teachers.

Table 5.13: Comparing classroom management between out-of-field and in-field teachers, school fixed-effects approach

Country	Classroom disciplinary climate index		Teacher-student relationship index		Teacher's self efficacy index	
	Coeff	Std Error	Coeff	Std Error	Coeff	Std Error
Australia	0.123	(0.302)	0.030	(0.196)	0.211	(0.358)
Austria	-0.261+	(0.148)	-0.015	(0.147)	0.088	(0.130)
Brazil	-0.277*	(0.120)	-0.231+	(0.132)	-0.175	(0.157)
Bulgaria	0.071	(0.118)	-0.260	(0.181)	0.166	(0.186)
Denmark	0.191	(0.191)	-0.442*	(0.211)	0.040	(0.184)
Estonia	-0.146	(0.186)	-0.054	(0.151)	0.046	(0.093)
Hungary	0.160	(0.374)	0.255	(0.341)	0.689*	(0.323)
Korea	0.248	(0.217)	-0.021	(0.169)	0.126	(0.138)
Lithuania	-0.555*	(0.220)	-0.174	(0.226)	-0.354	(0.255)
Malaysia	-0.227+	(0.118)	0.016	(0.092)	0.009	(0.110)
Malta	-0.542	(0.460)	-0.052	(0.431)	-0.155	(0.382)
Mexico	0.118	(0.128)	-0.292+	(0.170)	-0.439**	(0.165)
Norway	0.172	(0.230)	0.077	(0.144)	0.034	(0.165)
Poland	-0.531*	(0.226)	-0.176+	(0.096)	0.067	(0.101)
Portugal	-0.102	(0.242)	-0.285+	(0.154)	-0.294	(0.188)
Slovak Rep	0.174	(0.285)	-0.470**	(0.154)	-0.322	(0.277)
Slovenia	0.147	(0.284)	-0.013	(0.107)	-0.160	(0.134)
Spain	-0.050	(0.190)	-0.257*	(0.124)	-0.322+	(0.173)
Turkey	-0.526*	(0.215)	-0.546+	(0.302)	-0.409	(0.412)
Belgium (F)	-0.075	(0.326)	0.107	(0.208)	-0.687+	(0.372)

Note: Controlled for gender, age, part-time status, contract type, education attainment, and teaching experience

Table 5.14: Comparing classroom management between out-of-field and in-field teachers, HLM approach

Country	Classroom disciplinary climate index		Teacher-student relationship index		Teacher's self efficacy index	
	Coeff	Std Error	Coeff	Std Error	Coeff	Std Error
Australia	-0.044	(0.252)	0.038	(0.229)	-0.186	(0.220)
Austria	-0.162	(0.166)	-0.168	(0.132)	0.027	(0.134)
Brazil	-0.130	(0.089)	-0.135	(0.090)	-0.138	(0.121)
Bulgaria	-0.016	(0.108)	-0.136	(0.120)	0.225	(0.168)
Denmark	-0.015	(0.154)	-0.061	(0.169)	0.032	(0.176)
Estonia	-0.134	(0.158)	-0.013	(0.128)	-0.056	(0.089)
Hungary	-0.210	(0.392)	0.347	(0.364)	0.471	(0.304)
Korea	0.038	(0.170)	-0.121	(0.122)	0.122	(0.104)
Lithuania	-0.287	(0.262)	-0.249	(0.210)	-0.241	(0.252)
Malaysia	-0.268*	(0.116)	-0.051	(0.094)	0.029	(0.110)
Mexico	-0.003	(0.119)	-0.269	(0.174)	-0.466**	(0.165)
Norway	0.115	(0.223)	-0.016	(0.122)	-0.103	(0.123)
Poland	-0.038	(0.137)	-0.231+	(0.130)	-0.131	(0.118)
Portugal	-0.237	(0.181)	-0.271	(0.167)	-0.157	(0.219)
Slovak Rep	0.421+	(0.237)	-0.222*	(0.105)	-0.178	(0.178)
Slovenia	-0.014	(0.234)	0.021	(0.090)	-0.113	(0.110)
Spain	0.179	(0.173)	-0.182	(0.122)	-0.093	(0.176)
Turkey	-0.423*	(0.214)	-0.382+	(0.212)	-0.283	(0.243)
Belgium (F)	0.252	(0.238)	-0.152	(0.204)	-0.705*	(0.301)

Note: Controlled for gender, age, part-time status, contract type, education attainment, teaching experience, school location, sizes, SES, administrative leadership, personnel shortage, autonomy of hiring, and principal's years of experience.

5.2.3.3 Teaching practice

Ingersoll (1999) suggested that out-of-field teachers are more likely to use structured and routine practices because they do not have sufficient pedagogical content knowledge to tailor their teaching to students with different needs. Is this true for out-of-field teachers in TALIS countries? The estimates are listed in Table 5.15 and Table 5.16. From the results of the fixed-effects approach, it does not appear to be the case. In fact, out-of-field teachers almost unanimously used less-structured practice in classroom (though the difference not always significant). There is only one case, Hungary, where out-of-field teachers did use more structured lecturing. Similarly, out-of-field teachers used less student-oriented teaching practices and enhanced activities. There are exceptions, though. In Malta and Slovenia, out-of-field teachers reported using more student-oriented practices and enhanced activities in the classroom.

Estimates from the multi-level approach generally shows no difference in structuring practices between out-of-field and in-field teachers except for two countries. Out-of-field teachers in Estonia use less structured teaching practices. Out-of-field teachers in Poland use more structured teaching practice. There is hardly any differences in student-oriented practices between out-of-field and in-field teachers. In terms of using enhanced activities, though out-of-field teachers in 12 countries appear to use less structured teaching practices, only two are artistically significant. Surprisingly, out-of-field teachers in Australia and Denmark use more enhanced activities, which are not consistent with the results from the fixed-effects approach.

Table 5.15: Comparing teaching practices between out-of-field and in-field teachers, school fixed-effects approach

Country	Teaching practice: Structuring		Teaching practice: Student-oriented		Teaching practice: Enhanced activities	
	Coeff	Std Error	Coeff	Std Error	Coeff	Std Error
Australia	-0.125	(0.185)	-0.269	(0.190)	-0.290*	(0.137)
Austria	0.013	(0.132)	0.154	(0.105)	0.069	(0.062)
Brazil	-0.048	(0.169)	-0.254+	(0.148)	-0.239	(0.150)
Bulgaria	-0.236*	(0.109)	-0.204	(0.165)	-0.117	(0.128)
Denmark	-0.247*	(0.114)	-0.299**	(0.114)	-0.259*	(0.109)
Estonia	0.044	(0.116)	0.061	(0.112)	-0.026	(0.079)
Hungary	0.459+	(0.261)	0.088	(0.232)	0.175	(0.177)
Korea	-0.248	(0.261)	-0.099	(0.218)	-0.029	(0.256)
Lithuania	-0.288	(0.337)	0.135	(0.244)	0.190	(0.174)
Malaysia	0.011	(0.125)	0.099	(0.114)	0.067	(0.115)
Malta	0.441	(0.274)	0.726+	(0.369)	0.300+	(0.176)
Mexico	-0.300+	(0.173)	-0.417**	(0.132)	-0.492***	(0.148)
Norway	-0.125	(0.111)	0.047	(0.077)	0.056	(0.077)
Poland	0.537	(0.497)	0.507***	(0.104)	-0.025	(0.411)
Portugal	-0.247	(0.243)	-0.149	(0.214)	-0.208	(0.148)
Slovak Rep	-0.137	(0.217)	-0.112	(0.208)	-0.042	(0.117)
Slovenia	0.108	(0.177)	0.054	(0.122)	0.101+	(0.053)
Spain	-0.011	(0.130)	0.046	(0.094)	0.032	(0.087)
Turkey	-0.440	(0.351)	-0.485*	(0.232)	-0.476+	(0.267)
Belgium (F)	-0.368	(0.239)	0.063	(0.261)	0.021	(0.228)

Note: Controlled for gender, age, part-time status, contract type, education attainment, and teaching experience

Table 5.16: Comparing teaching practices between out-of-field and in-field teachers, HLM approach

Country	Teaching practice: Structuring		Teaching practice: Student-oriented		Teaching practice: Enhanced activities	
	Coeff	Std Error	Coeff	Std Error	Coeff	Std Error
Australia	-0.338*	(0.153)	-0.495***	(0.116)	-0.405***	(0.086)
Austria	-0.084	(0.121)	0.175+	(0.092)	0.058	(0.048)
Brazil	-0.105	(0.112)	-0.075	(0.119)	-0.060	(0.122)
Bulgaria	-0.018	(0.095)	-0.057	(0.135)	0.022	(0.105)
Denmark	-0.313**	(0.104)	-0.202+	(0.110)	-0.146	(0.109)
Estonia	0.048	(0.086)	0.040	(0.090)	-0.021	(0.063)
Hungary	0.211	(0.229)	0.183	(0.173)	0.211	(0.187)
Korea	-0.021	(0.224)	-0.079	(0.149)	-0.021	(0.177)
Lithuania	-0.282	(0.352)	-0.032	(0.291)	0.113	(0.201)
Malaysia	0.030	(0.135)	0.144	(0.105)	0.087	(0.100)
Mexico	-0.254	(0.171)	-0.470**	(0.160)	-0.568***	(0.166)
Norway	-0.156	(0.095)	-0.002	(0.069)	0.003	(0.065)
Poland	-0.368*	(0.152)	0.224*	(0.111)	-0.079	(0.125)
Portugal	-0.189	(0.205)	-0.093	(0.195)	-0.129	(0.123)
Slovak Rep	-0.047	(0.218)	0.103	(0.191)	0.029	(0.112)
Slovenia	-0.147	(0.136)	-0.063	(0.118)	0.014	(0.056)
Spain	0.015	(0.129)	0.074	(0.105)	0.059	(0.100)
Turkey	0.009	(0.193)	-0.112	(0.187)	-0.089	(0.194)
Belgium (F)	-0.360	(0.221)	0.031	(0.264)	0.059	(0.211)

Note: Controlled for gender, age, part-time status, contract type, education attainment, teaching experience, school location, sizes, SES, administrative leadership, personnel shortage, autonomy of hiring, and principal's years of experience.

5.2.3.4 Professionl status

Regarding out-of-field teacher's professional status, the estimates are listed in Table 5.17 and Table 5.18. Under the school fixed-effects approach, I use logistic regression to fit the mentoring and appraisal models. The professional development model is fitted using OLS. Therefore the point estimates for the second and fourth columns in Table 5.17 are exponentiated coefficients for logistic regression models. In the HLM approach, I only use linear probability models to fit the mentoring and appraisal models. Therefore the estimates in Table 5.18 should be interpreted in probability terms.

In Estonia and Slovenia, they appear to receive a little bit more mentoring and peer observation than in-field teachers from the fixed-effects estimates. However the effects are not consistent with the HLM estimates. In the latter case, out-of-field teachers in Estonia receive less mentoring and peer observation compared to in-field teachers. There is no statistical difference in the amount of mentoring and peer observation between Slovenian teachers from HLM estimates.

The estimates from the fixed-effects approach show that in Australia, Brazil, and Bulgaria, out-of-field teachers are less likely to receive feedback about their work from their principal or external inspector. For Australian out-of-field teachers, the situation is especially worse. They are nearly 10 times less likely to receive any feedback compared to their in-field peers. In Lithuania, out-of-field teachers spend less time (4.8 days) on professional development. Again, the HLM estimates are smaller and the significant estimates did not always line up with those from the fixed-effects approach. Yet even after taken these difference into consideration, it is easy to find that the statistically significant estimates are special cases. All the other non-significant findings paint a picture that out-of-field teachers are not treated differently in school compared to their in-field peers.

Is it a good thing or bad thing? It is hard to say. On the one hand, it might be good that these out-of-field teachers are not being singled out from their peers. Yet one might argue that they in fact need more help to develop because they lacked certain knowledge when they first started. If there is no remedial policy targeting them, how can we expect that they will just learn by themselves?

Though not all the findings are statistically significant across TALIS countries, they illuminate a not-so-rosy picture of out-of-field teachers in certain countries. For instance, the Brazilian out-of-field teachers spend about 3 percent more time on maintaining classroom order. Their classroom climate is about 0.3 standard deviation worse than in-field teachers. They are also less likely to use student-oriented practices and yet they are twice as likely to not receive any appraisals. Out-of-field teachers in Lithuania also spend considerably less time on teaching (4 hours) and more on keeping classroom order (8.9%). Their classroom climate is half-a-standard-deviation worse than in-field teachers'. They spend 4.8 days less on professional activities than in-field teachers do. Turkish out-of-field teachers spend the 7 hours less on teaching and 5.8 percent more on keeping order. Yet their classroom climate is half-a-standard-deviation worse than in-field teachers, and that teacher-student relationships are similar. They are less inclined to use a student-oriented approach or enhanced activity in teaching (0.49 and 0.48 standard deviation, respectively).

Table 5.17: Comparing professional status between out-of-field and in-field teachers, school fixed-effects approach

Country	Receiving mentoring or peer observation (probability)		Never received appraisal or feedback (probability)		Days spent on professional development	
	Coeff	Std Error	Coeff	Std Error	Coeff	Std Error
Australia	0.040	(0.150)	0.075	(0.077)	0.963	(1.223)
Austria	-0.029	(0.052)	0.024	(0.051)	-0.922	(0.919)
Brazil	-0.049	(0.060)	0.056	(0.054)	-0.629	(3.548)
Bulgaria	0.066	(0.075)	0.017	(0.026)	-33.105	(30.284)
Denmark	-0.024	(0.067)	0.133+	(0.070)	3.059	(3.338)
Estonia	-0.193**	(0.064)	-0.048+	(0.025)	0.291	(2.155)
Hungary	0.146	(0.173)	0.011	(0.122)	0.769	(5.113)
Korea	-0.079	(0.109)	0.059	(0.072)	1.127	(5.963)
Lithuania	-0.117	(0.144)	0.044	(0.055)	-4.831+	(2.855)
Malaysia	-0.005	(0.055)	-0.020	(0.015)	-0.610	(1.706)
Malta	0.331*	(0.133)	0.501**	(0.172)	8.375	(7.015)
Mexico	-0.135	(0.083)	-0.044	(0.031)	1.080	(15.580)
Norway	-0.081	(0.067)	-0.015	(0.051)	-0.532	(2.404)
Poland	-0.031	(0.063)	-0.418	(0.340)	-7.573	(7.727)
Portugal	-0.024	(0.107)	-0.003	(0.133)	-26.589	(16.390)
Slovak Rep	-0.083	(0.139)	0.044	(0.047)	-1.258	(1.846)
Slovenia	-0.147+	(0.078)	0.053	(0.050)	0.483	(1.909)
Spain	-0.025	(0.058)	-0.047	(0.084)	-5.755	(3.768)
Turkey	-0.142	(0.202)	-0.085	(0.072)	-5.650	(3.664)
Belgium (F)	-0.136	(0.116)	0.073	(0.088)	1.395	(5.566)

Note: Controlled for gender, age, part-time status, contract type, education attainment, and teaching experience.

Table 5.18: Comparing professional status between out-of-field and in-field teachers, HLM approach

Country	Receiving mentoring or peer observation (probability)		Never received appraisal or feedback (probability)		Days spent on professional development	
	Coeff	Std Error	Coeff	Std Error	Coeff	Std Error
Australia	-0.149	(0.099)	0.070	(0.088)	2.180+	(1.278)
Austria	0.008	(0.065)	-0.053	(0.041)	-1.297	(1.041)
Brazil	-0.003	(0.049)	0.036	(0.042)	-0.782	(2.727)
Bulgaria	0.102	(0.077)	0.053	(0.046)	1.110	(9.075)
Denmark	-0.043	(0.057)	-0.009	(0.039)	7.592*	(3.022)
Estonia	-0.109*	(0.054)	-0.020	(0.021)	-0.581	(1.666)
Hungary	-0.101	(0.120)	0.021	(0.060)	2.257	(3.692)
Korea	-0.026	(0.107)	0.063	(0.067)	4.523	(5.622)
Lithuania	0.005	(0.151)	0.096	(0.081)	-1.918	(1.695)
Malaysia	-0.036	(0.043)	-0.016	(0.013)	1.340	(1.468)
Mexico	-0.065	(0.077)	-0.057**	(0.021)	-0.330	(12.814)
Norway	-0.059	(0.057)	-0.031	(0.048)	-1.013	(1.103)
Poland	0.209**	(0.070)	-0.012	(0.040)	-13.668+	(7.203)
Portugal	-0.034	(0.081)	-0.035	(0.119)	-14.185	(9.451)
Slovak Rep	-0.098	(0.112)	0.019	(0.035)	-1.033	(1.328)
Slovenia	-0.065	(0.084)	0.054	(0.055)	-0.347	(1.785)
Spain	0.002	(0.064)	-0.120	(0.091)	-7.024*	(3.049)
Turkey	-0.121	(0.087)	0.039	(0.072)	1.591	(2.802)
Belgium(F)	-0.125	(0.081)	0.052	(0.060)	-1.98	(3.838)

Note: Controlled for gender, age, part-time status, contract type, education attainment, teaching experience, school location, sizes, SES, administrative leadership, personnel shortage, autonomy of hiring, and principal's years of experience.

5.3 Summary

For the results presented in this chapter, I used regression methods to study two questions: 1) What factors are associated with cross-national variations in school-level out-of-field teaching? 2) On what aspects do out-of-field teachers differ from in-field teachers?

Regarding the first question, I find that school autonomy in hiring teachers is correlated with school-level out-of-field teaching in math and science. Schools with higher autonomy generally have lower level out-of-field teaching in math and science. The relationship is highly contingent upon national context. Once the country fixed-effects are controlled for, the significance disappear. Additionally, other school characteristics such as location, size, and SES, also significantly correlated with levels of out-of-field teaching. Rural schools and small schools consistently deploy more out-of-field teachers. Low-SES schools also tend to have more out-of-field teachers, but the effects are only significant cross-nationally. These findings are consistent with previous literature on the teacher labor market which concludes that these types of schools have a disadvantage in hiring high-quality teachers.

The picture of the performance of out-of-field teachers is mixed. In a small number of countries, out-of-field teachers spend less time in teaching and preparing lessons, and more time in keeping classroom order. For the majority of countries, the difference is not significant after accounting for teacher attributes and school factors. There is also some evidence that out-of-field teachers are assigned to classrooms with worse climates and out-of-field teacher's self-reported relationship with students therefore are worse. However out-of-field teachers do not have lower self-efficacy. Contrary to previous studies, out-of-field teachers used less structured teaching practices in the classroom. They are also slightly less likely to use student-oriented practices and enhanced activities in teaching.

Lastly, out-of-field math and science teachers are not given extra attention on the job. They do not receive more opportunities for teacher collaboration, and they do not receive more feedback on their work. Their time spent on professional development activity is also close to that of in-field teachers. In the next chapter I will discuss the implications of these findings for policy and administration.

However these findings should be interpreted with caution. Regression estimates from two different approaches do not always yield the same conclusion. The fixed-effects approach could suffer from insufficient variation within schools thus leading to inflated standard errors. The HLM multilevel approach, although not limited by number of teachers per school, suffers from potential omitted variable bias. School-level information such as curriculum arrangement, length of school day, and resources devoted to professional development is not directly observed and therefore is not explicitly controlled in HLM models. These factors could potentially cause bias in HLM estimates.

Chapter 6
DISCUSSION AND CONCLUSION

6.1 Summary of findings

The primary goal of this study is to provide a basic understanding of the nature of out-of-field assignments in today's classrooms. Unlike previous studies which built upon nationally representative teacher data, this is the first study that utilize such information from a comparative perspective. Though researchers and practitioners have long realized that out-of-field teaching is commonly used in the classroom, this is the first empirical study that provides comprehensive statistics on this issue. This study focuses on math and science teachers who work in public schools. I tried multiple ways to provide a detailed portrait of mathematics and science teachers who are not trained in the subjects they are training.

The findings are multifaceted. First of all, for most TALIS countries, out-of-field teaching is a commonly used strategy in classrooms in math and science subjects. The overall degree of out-of-field teaching is moderate, compared to what has already been found in the United States. On average, about one in ten teachers in public math and science classrooms is teaching out-of-field. There are large between-country variations in out-of-field teaching. In countries such as Hungary, Lithuania, and Poland, the out-of-field teacher is extremely rare, consisting of fewer than 3 percent of the entire teaching force; on the other hand, countries such as Brazil, Estonia, and Turkey deploy larger numbers of out-of-field teachers, with over 10 percent of their teaching force being out-of-field. I should note that even the country with the most severe out-of-field teaching in TALIS fell well below the estimates for the United States. Moderate levels of out-of-field teaching among TALIS countries show that out-of-field teaching has been effectively limited in many countries around the world. The commitment to building a high quality math and science teaching force by ensuring every teacher has sufficient qualification is reflected in these statistics.

So who are these out-of-field teachers? I spent considerable effort trying to investigate the attributes of out-of-field teachers, hoping to find certain patterns that could characterize the whole out-of-field teaching force. Yet my analysis shows that out-of-field teachers are not a homogenous group of teachers. It makes little sense to conclude with one image of out-of-field teachers. For one thing, I found that out-of-field teachers are much like their in-field colleagues in each country. There is more similarity between out-of-field and in-field teachers within each country than out-of-field teachers shared with each other across borders. This suggests that just like the attributes of the teacher workforce around the world that differ from country to country, out-of-field teachers are largely determined by national policies and regulations. This finding corresponds to the earlier statement that national context plays an important role in shaping the teacher labor force.

Though the characteristics of out-of-field teachers vary across nations, there are certain patterns of similarities among out-of-field teachers; notably the combination of demographic and occupational factors. For example, younger out-of-field teachers are also likely to be inexperienced teachers with less job security. Older out-of-field teachers also have ample teaching experience and a lot of job security. There are more countries deploying young and inexperienced out-of-field teachers than older and experienced out-of-field teachers. Across countries, out-of-field teachers have equal amounts of education compared to their in-field colleagues. They are more likely to work on a part-time basis.

In terms of types of schools in which they work, math and science out-of-field teachers across countries find strikingly more similarities in their working place. I found that out-of-field teachers of these two subjects are more likely to work in rural schools, small schools, and low-SES schools. This pattern is consistent across countries and also holds within most countries. The concentration of out-of-field teachers in these types of schools reflects the unequal distribution of teachers in several countries. This finding reveals the complex nature of teacher distribution across schools. The national average level of out-of-field teaching is likely to mask the within-country between-school variations. For instance, in addition to the high overall level of out-of-field teaching in Denmark (about 15 percent nationally), small schools have almost 30 percent out-of-field teachers. Variations between schools should also not be overlooked. There are also rare cases where the teacher distribution is more equal between schools. For example in Bulgaria, Korea, Lithuania, Mexico, Norway, Portugal and Spain, the regional differences in levels of out-of-field teaching are much smaller. Across schools of different sizes, the levels of out-of-field teaching are more equal in Bulgaria, Korea, and Turkey. At the classroom level, Bulgaria, Korea, Mexico, and Slovenia also ensure that out-of-field teacher distribution is equal among high and low SES classrooms.

I also found that an increase a school's autonomy in hiring and staffing teachers could reduce out-of-field teaching in math and science across countries. Two other factors, a school's administrative leadership and teacher shortage experienced by the school do not seem to explain the variation in out-of-field teaching.

Among all the TALIS countries, Poland has the lowest level of out-of-field teaching in math and science, and Brazil and Denmark have the highest level. Distribution-wise, Bulgaria, Korea, and Mexico have a more equal distribution of out-of-field teachers among schools with different characteristics. Levels of out-of-field teaching in math and science are also low in these three countries. In Australia, Brazil, Denmark, and Estonia, not only are the levels of out-of-field teaching in math and science higher, but the distribution is highly unequal. Disadvantaged schools consistently deploy more out-of-field teachers.

6.2 Implication of policy and administration

There are several policy implications that can be derived from this study. First of all, out-of-field teaching is not just a general undersupply issue.[54] I found that out-of-field teaching

[54]There is a nuanced difference between the conventional use of shortages and shortages in the broad sense in economics. Any imbalance between labor demand and supply can be labeled as a shortage in the supply and demand framework. In conventional connotation, shortage typically refers to an insufficient supply. I adhere to this definition in my discussion here. A detailed discussion of the confusion caused by terminology can be found in Ingersoll

is actually higher in areas such as reading and writing, foreign language, and social science, where the teacher supply is supposedly abundant. This is the case for Australia, Bulgaria, Estonia, Hungary, Lithuania, Malaysia, Mexico, Norway, Poland, and the Slovak Republic. If teacher shortage is the main driver of out-of-field teaching, one would expect to see higher levels out-of-field teaching in math and science compared to these subject areas, because the labor demand in math and science is much higher than in other fields in general. One caveat is that in certain developing countries, because of lack of industrial development, employment opportunities in manufacturing and the service sector do not generate sufficient demand. In such cases, maybe teaching is a better job for people who have a college degree, regardless of their field of training. This scenario is certainly plausible, and a country-by-country analysis is highly needed to investigate labor demand in particular settings; yet in the above cases, there is at least a handful of countries which have a highly developed economy (i.e. Australia and Norway) and I still observed higher levels of out-of-field teaching in the humanities than math and science.

Furthermore, in the cross-national regression analysis, teacher shortages did not correlate well with school-level out-of-of-field teaching. This finding holds in the pooled regression analysis with or without country fixed effects. Certainly there is a role for teacher shortages in causing out-of-field teaching, but it is not as direct and robust as we have thought before. More recent empirical evidence from the United States also suggests that we expand our line of thinking beyond just the teacher preparation pipeline; factors such as a high attrition rate among math and science teachers causes short-term fluctuation in supply of teachers even if the pipeline is full (Ingersoll & Perda, 2010).

Second, out-of-field teaching is not a qualification issue. In the past, proposals have been made to raise the bar of teacher qualification in order to eliminate out-of-field teaching. Some commentators believe that if every teacher has a college degree, the out-of-field teaching practice would be effectively curbed. However, empirical evidence does not support this

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and Perda (2010).

view. In several countries where a bachelor's degree is almost universal, I still observed higher levels of out-of-field teaching. More interestingly, out-of-field teaching is even more prevalent among those who hold a master's degree in certain countries. This finding suggests that even if we raise the qualification standard to require teachers to have at least a university level degree, out-of-field teaching will likely still persist in the classroom. On the other hand, one could argue that if making out-of-field assignments is inevitable, having someone with higher levels of education is better than those with lower levels of education. I do not think we have sufficient information to differentiate between the effectiveness among out-of-field teachers at this point of time.

These findings lead me to draw the third policy implication: out-of-field teaching is a school issue. In the cross-country analysis, I showed that giving schools more autonomy to make decisions, in terms of staffing, deciding the salary schedule, and allocating the budget for professional development, is correlated with lower levels of out-of-field teaching. The effect is not trivial. On average, one standard deviation increase in school autonomy will lead to 30 percent less out-of-field teaching from the baseline. Thus, by giving schools more freedom in making staffing decisions, and deciding on teachers' salary increases in particular, might be a feasible way to address out-of-field teaching. Yet because school autonomy is most likely endogenous within a particular country setting, the effect is highly dependent on national context. Further analysis is needed to figure out the specific policy lever that can be used alongside giving schools more autonomy.

Another line of thinking is to look beyond the pure number of out-of-field teachers, because it is also a distributional issue. The exercise of variance partitioning shows large between-school variations in the levels of out-of-field teaching across countries. What are the policy options left to contain it? One thing this analysis confirmed is that out-of-field teaching is closely related to other forms of teacher sorting mechanisms across schools. In many countries, out-of-field teachers are more likely to teach in rural schools, small schools, and low-SES schools. Policymakers should look beyond their national average and closely study disparities between different types of schools. Typically these types of schools' ability to attract and retain high quality teachers are much weaker than large city schools, where not only is the living standard higher, these schools are also close to a large labor market, hence job opportunities are better. The negative effect of being a small school is perhaps innate to its nature. To maintain certain economies of scale, teachers are typically required to teach multiple subjects at the same time. Of course, one simple (and naive) solution is to limit the number of small schools and mandate a certain minimum size. Yet policymakers should be cautious of additional costs such as increased student transportation and safety concerns, because rural and village schools are often located in sparse populated areas as well.[55] In general, the playing field is not equal in terms of teacher staffing. A closer study of those countries which can ensure a more equal distribution of teachers, such as Bulgaria and Korea, is essential.

Another implication can be drawn from the close relationship between school SES and levels of out-of-field teaching. On the one hand, school SES certainly correlates with other factors such as financial resources and school location. So the correlation between school SES and out-of-field teaching reflects the previously stated relationship between various forms of teacher sorting and school types. Without longitudinal data, it is difficult to isolate the true causal effect of high school SES. On the other hand, qualitative studies have shown that parental involvement in high-SES schools is much higher (Lareau, 2000). Not only do highly educated parents choose schools with better teachers, they will also not hesitate to voice their concern about teachers once their children get in. Parental pressure may play a role in affecting a school's staffing decisions. There is emerging international evidence suggesting that parental involvement and choice are likely to affect schools on a series of organizational issues, including teacher assignment (Duflo, Dupas, & Kremer, 2011; Pop-Eleches & Urquiola, 2011). Based on the difference in levels of out-of-field teaching between

[55] Also considering these "hard costs" such as school buses, dormitories, dealing with out-of-field teaching is a financially more acceptable issue and I will not be surprised that it gets sidelined on the policy agenda.

high-SES and low-SES classrooms, we can assume that the notion of out-of-field teachers may signal a certain degree of teacher quality to parents. Of course there are could be other confounding factors that I did not observe in the TALIS data but that also played a role that is associated with within-school teacher sorting. For example, within-school sorting of students based on their achievement level may well lead to sorting of teachers, with better qualified techers being assigned to high-achieving classrooms. The dynamics on which these choices are made is not clear at this time.

From a teacher's perspective, there is also a role for policy intervention. As I showed earlier, in several countries younger and inexperienced teachers are more likely to teach out-of-field. We know that they are at the lower end of the school power hierarchy. They do not have a lot of say in the teaching assignment process because they are junior, and the data also suggests that they do not have long contracts to secure their position in schools. This poses a big challenge from a teacher development perspective, because the first couple of years of a teacher's career are vital, both intellectually and professionally (Jensen, Sandoval-Hernandez, Knoll, & Gonzalez, 2012; Johnson, Kardos, Kauffman, & Liu, 2004). If they cannot get a good opportunity to teach something for which they have training, how can we expect them to develop sufficient teaching skills? Actions must be taken to stop assigning out-of-field positions to these junior faculties.

Another aspect for possible policy innovation is on-the-job development for out-of-field teachers. Surprisingly, almost no country provides additional support for out-of-field teachers. If we assume that out-of-field teachers lack certain abilities or skills prior to joining the teaching force, what kind of remedial policies can be in place to help them grow? Literature suggests that providing mentors and creating a supportive induction program can have a positive effect on teaching skills and teachers' retention rate (Rockoff, 2008; Smith & Ingersoll, 2004). Using various forms of professional development is also a good way to help these teachers learn. Unfortunately, I did not observe any quantitative difference in professional development opportunity, appraisal, or collegial collaboration received by out-of-field and in-field teachers. That is to say, they are treated just like any other teachers. Of course, not to stigmatize out-of-field teachers is in itself a good thing, yet if out-of-field teachers do not receive extra vital help, it is not reasonable to expect them to perform as well as in-field teachers. One certainly can argue that if out-of-field teaching is mostly a temporary job, then all these additional sources of support can be deemed unnecessary. There is certain value in this argument. If out-of-field teachers are just regular teachers who are assigned to cover up short-term vacancies, such practice is more justifiable. However the data suggests that in several countries many of out-of-field teachers are working on part-time or short term basis. It is unsound if these personnel are just used in a disposable fashion without providing any professional opportunities (including skills development) to them. Up to this point, I do not have any data to investigate whether out-of-field teaching indeed does just occur in the short run. This is an important direction for future research.

With regard to this latter matter, currently there is no productivity measure of teachers available to me. It may seem subjective to evaluate whether out-of-field teachers are less effective teachers. Indirect evidence suggests that out-of-field teachers spend less time on teaching activities, although their approach does not seem to be any different. This is a future area of research, to use a meaningful measure to compare the effectiveness of out-of-field teachers.

6.3 Limitation of this study

6.3.1 Limitation in conceptualization of out-of-field teaching

Conceptually, the study of out-of-field teachers offers a narrowly defined policy question: to what degree does teachers' subject matter training related to the content he/she is teaching? The fidelity of this research focus is based on the reforms that took place in colleges or schools of education around world. There are growing contentions and dissatisfaction toward teacher education since the 1960s (Conant, 1963; Koerner, 1963). The dissatisfaction is based on the fact that teacher education at that time was considered generally weak in preparing teachers' subject matter competency. These critique led to a series of reforms in teacher education programs and teacher certification systems (Sedlak, 2008). In developed countries such as the United States and Britain, this change occurred in the second half of the 20th century (Sedlak, 2008; Judge et al., 1994). Yet for a vast majority of developing nations, this is an ongoing process. With the aid of international development agencies, university-based teacher education programs mushroomed in a wide range of countries (Luschei & Chudgar, 2011).

Today the idea that a properly trained teacher should have at least a college major in the subject matter has been largely accepted by the public and research community. However, we should remember that obtaining a major in specific subject matter is only a crude instrument to measure competency. For instance, in the United States, there are about 1,300 teacher education programs that offer basic training for future teachers. The quality of these future teachers, who will all get a major in subject area, varies dramatically. The United States may be an extreme example of a highly decentralized teacher education system, but it is not hard to agree that a major or degree in the subject matter offers a minimum competency measure at best.

The limitation of the out-of-field measure reflects the current challenge to reach a consensus on teacher quality. One promising approach is to use teacher knowledge as a measure of teacher quality. There are growing efforts that try to measure teacher knowledge based on Lee Shulman's (1986; 1988) characterization of the knowledge of teaching. However, at current stage such study either focuses on a single subject matter or is too small in scale to be generalized to the national level. There are also challenging measurement issues to be resolved in developing such a measure. With the development of measurement and statistical technology, we might soon be able to use that measure to replace the out-of-field measure. The change in research focus may also help us to focus on the substantive skills of teachers rather than look at teacher quality at the instrumental level.

Lastly, the theoretical foundation of teacher labor markets has not reached a comprehensive stage, especially under international settings. In this dissertation, I explore some plausible mechanisms that might drive out-of-field teaching. However, as described earlier, national context largely determines the composition and characteristics of teacher labor force. We are yet to understand what factors can explain out-of-field teacher compositions across nations. Other unobservable factors such as country-level regulation and administrative regimes are part of the national context factor. The fixed-effects approach I used accounted for these unobservables. However I was unable to *explain* why nations differ from one another in terms of out-of-field teacher attributes and distribution. To answer the why question lies beyond the scope of analyzing the TALIS dataset. It requires a deep understanding of the contextual knowledge such as the political economy and other social forces. The lack of country-specific knowledge on teacher labor markets also limits the policy recommendation I can make. As keen readers will find, several of the explanations offered are based on extrapolation rather than evidence grounded in solid theoretical foundation. I see this as a major limitation of this current study. Some of these limitations could be overcome by detailed country-by-country analysis. I leave this task for the next project.

6.3.2 Limitation of data

At the operational level, there are several issues related to TALIS 2008 data. First of all, as described in Table 3.2, in at least seven countries, the primary sampling unit (school) is chosen according to the size of student body per school instead of number of teachers per school. Ideally in order to ensure that first stage of sampling is truly nationally representative, schools should be sorted based on number of teachers and a systemic random sampling should be conducted.[56] Because not all the countries collect information on the number of teachers at each school but usually the number of students are readily available,

[56]For detailed procedure of systematic random sampling, please refer to OECD (2010, p. 59)

it then became a practical choice to use number of students as measurement of size (MOS). Yet the consequences of using the number of students as MOS is not clear. If in one country the student-teacher ratio is uniform across schools, then it makes no difference which MOS measure is used to sample the primary sampling unit (school). However, such a scenario is certainly not realistic in most countries where the student-teacher ratio could vary from school to school. Then the probability of how schools are sampled might differ depending which MOS is used, and consequently affect the representativeness of the final teacher sample. In the current international education literature, there is no empirical work that examines the implications of using different MOS measures, which casts some doubts on the generalizability of the findings using international database such as TALIS 2008.

Second, the out-of-field definition used by TALIS 2008 is not directly comparable with the ones used in previous literature as described in Section 2.2.1. The out-of-field measure in TALIS 2008 is close to the main assignment measure. However due to the wording of the survey item, individuals could have different interpretations of the out-of-field question. For instance, someone with high school-level academic training could justify him/herself as having sufficient "academic training." By using this measure, the out-of-field estimates probably reflects a under-estimated out-of-field teaching level because of a relaxed definition of academic training. The true levels of out-of-field teaching might be higher, as suggested by estimates from other international databases such as TIMSS.

Third, this study used cross-sectional data. The benefit of this dataset is to allow researchers to look across a diverse group of countries. The limitation is that there is no easy way to establish a causal link between the factors I described in previous chapters and out-of-field assignment. At best the findings in this dissertation is associational instead of causal. To gauge the casual effect, one would need to rely either on experimental study or on longitudinal data. These types of studies are more often found in a single-nation setting. There are many things I would like to have done in this study but could not.

Fourth, since TALIS is not specifically designed for the purpose of finding attributes of out-of-field teachers, the actual sample of out-of-field teachers used in the analysis was small, averaging 50 teachers per country. This is not a satisfactory sample size by any means if one thinks about generalizing to all the math and science teachers in the entire country. This sample size essentially limited the statistical techniques I eventually employed.

Fifth, since this study only uses the mathematics and science teacher sub-samples, whether or not the findings derived in this study could be applied to other segments of the teacher labor force and teachers who work in private schools remain to be examined.

Lastly, I also would like to point out that the grade sample varies substantially across nations depending on how each nation defines "lower secondary education" (Table 3.2). Currently in the TALIS sample, teachers from various grades are pooled together and there is no way to differentiate cross-grade variation in out-of-field teaching. Thus it is not clear whether the out-of-field teaching phenomenon happens across several grades or only applies to certain levels in schools.

6.4 Recommendation for future TALIS studies

At the time of writing, the next round of TALIS (2013) is well underway. As an important component in today's international education data collection efforts, TALIS makes a unique contribution to our understanding of teachers' work. As demonstrated in this dissertation, TALIS has much potential to provide scientifically valid evidence for researcher and policymakers. In this section, I make several recommendations for future waves of TALIS based on my understanding of TALIS data.

First of all, the current TALIS adopts a design that collects information from all the teachers within each school. Such a design is beneficial in the sense that it sketches a big picture of teachers across subject matter areas. Yet the limitation of such an approach is that it does not allow researchers to look specifically at teachers in a particular subject field, which might be of substantive interest to researchers. For instance, research on mathematics teachers has generated much interest. In many countries, math teachers could either have a math major, an education major, or an education minor in his/her teacher preparation. It would be of substantive interest for researchers to grasp a deep understanding of how math teachers are prepared across countries. To obtain such information, we will need subject-specific questions for math teachers. Such survey questions are not implemented in a general survey protocol that covers all teachers. I recommend that TALIS synchronize its subject matter coverage with the PISA assessment. For example, in PISA 2012, mathematics will be the major domain of assessment, and TALIS 2013 could also focus on math teachers to provide supplemental information. Under this scenario, TALIS should over-sample math teachers in each school and design separate math teacher survey items. Each future wave of TALIS could focus on teachers from one or more particular subject fields. Such survey items could be implemented alongside general questionnaires targeting teachers from other subject fields. This strategy will have two benefits. It would certainly give researchers who design the teacher questionnaire more flexibility because they are not limited by sampling teachers from all the subject matters. Additionally, subject matter focus could substantially improve the sample size issue I raise in the previous section. With more subject-specific teachers sampled, the precision of estimates could be greatly improved.

Secondly, TALIS could be a good route to gauge information about teacher education. It would be ideal to obtain more information on how teachers are trained. Right now the measure of this kind is crude at best; researchers would benefit from knowing the type of certificate one received and the type of courses one took in teacher training institutions. For example, instead of asking teachers about their academic training in general, it would be beneficial if researchers could gather information about the major and minor each teacher had previously received and the type of teacher education program they attended. Alternatively, in recent years assessments of teacher knowledge have emerged in several subject fields. It is a very effective way to directly evaluate the degree to which teachers master different types of knowledge at various stages of their career.

Thirdly, TALIS could incorporate more administrative information on teachers. Because this round of TALIS specifically targeted teachers' professional development opportunities, many other aspects of teachers' lives and careers were not included in the data. Such information would include the number of assignments in each school, duration of each assignment, number of classes taught in one semester, grade taught, and previous number of schools worked. This information could help to understand teachers' career choices and sustainability, which is vital for teacher labor market research. In the future, I would like to see how long teachers stay in the profession and for what reasons they might leave it. Other features, such as their feeling of inclusion in the professional community in school, would also be good. We are yet unaware of the motivations and reactions of out-of-field teachers. To be able to obtain more detailed information in that regard would be beneficial.

Lastly, TALIS could learn from other single country teacher databases such as the US's SASS. As a matured data collection program, SASS has accumulated much experience in designing survey items and sampling strategies. For instance, SASS has four different types of out-of-field measures that TALIS is currently lacking. To learn from other successful data collection programs not only improves the overall data quality, it also helps to link the potential research outcome with previous research findings by using the same indicators. Because TALIS is conducted every five years, it will thus accumulate longitudinally comparable statistics to other single-country findings. Of course doing so is not without challenge. Single-country survey projects are often derived within the particular country context. Some of the survey items might make sense in one country but not for others. An international project like TALIS is not an extension of single-country study, but it has to stay relevant to the participating countries to serve their educational needs. This is no easy task by any means.

Despite these challenges, as a newcomer in the international education assessments, TALIS is an ideal source of information to provide researchers with well-rounded evidence about teachers' life and work. With growing interests in improving teacher quality and understanding teacher labor markets, TALIS will continue to grow and evolve. I hope my recommendations will help to improve this new venture.

APPENDIX

Appendix A
TECHNICAL NOTES

A.1 Statistical computation

The analytical work of this dissertation is conducted in Stata 12. To account for sampling weights, the mean statistics are estimated under the `svy brr` environment. I also used `areg` and `glm` procedure to estimate fixed-effects models.

For multilevel models, I first calculate sampling weights for each teacher within school.[57] Then I rescaled the weights using the `pwigls` command written by Chantala et al. (2011). Although Stata offers increasing flexibility in estimating multilevel mixed models in its `xtmixed` command, there are still some restrictions. For binary data with multiple sampling weights, I used the `gllamm` procedure developed by Rabe-Hesketh and Skrondal (2008). The estimates are extracted and formatted using the `esttab` procedure developed by Jann (2007).

During the process of writing, I benefited much from Long's (2008) method of organizing and automating the analysis process. The charts and graphs used in this dissertation are mostly generated using Stata 12. The methods are described in Mitchell (2008).

A.2 Typesetting

This dissertation is first written in Microsoft Word and then ported to LaTeXfor typesetting. I used the `MSU Thesis class`[58] designed by Prof. Alan Munn from MSU. Another package of his, `csv2Latex`, is also used to convert tables from estimation results generated in Stata by `esttab`. The texts used the default *Computer Modern* font family. Most figures used All the figures used *Computer Modern* font family with the except of those country profiles. I used *Calibri* font for these graphs.

[57] This is achieved by dividing the SCHWGT from TCHWGT.
[58] See https://www.msu.edu/~amunn/latex/msu-thesis.zip for detail.

Appendix B
ADDITIONAL TABLES

Table B.1: Number of schools by the size of teaching force in math and science in the TALIS sample

Country	Number of teachers per school												Total schools
	1	2	3	4	5	6	7	8	9	10	11	12	
Australia	6	7	16	24	17	5	6	0	0	0	0	0	81
Austria	5	29	31	58	41	22	15	3	1	1	0	0	206
Brazil	20	31	35	45	42	41	22	9	3	5	1	0	254
Bulgaria	9	15	17	28	32	34	26	17	9	5	0	0	192
Denmark	6	11	16	11	11	6	10	2	3	0	0	0	76
Estonia	15	30	42	36	30	23	6	4	1	0	0	0	187
Hungary	6	29	26	37	28	21	6	7	0	1	0	0	161
Korea	4	11	6	30	44	13	1	1	0	0	0	0	110
Lithuania	9	26	50	66	37	10	2	0	0	0	0	0	200
Malaysia	3	5	33	53	63	42	8	0	1	0	0	0	208
Malta	0	1	1	16	10	1	1	0	0	0	0	0	30
Mexico	4	14	19	20	27	30	22	7	2	3	0	0	148
Netherlands	2	6	6	8	7	0	0	0	0	0	0	0	29
Norway	15	24	19	14	13	21	10	3	4	5	2	2	132
Poland	2	5	25	44	38	28	13	2	1	0	0	0	158
Portugal	1	4	9	23	40	28	20	4	0	0	0	0	129
Slovak Rep	3	18	23	26	34	16	23	8	4	1	1	0	157
Slovenia	4	21	27	38	30	30	12	5	8	1	0	0	176
Spain	6	6	20	30	29	36	9	1	0	0	0	0	137
Turkey	11	25	19	42	23	16	2	1	0	0	0	0	139
Belgium (F)	9	19	21	19	12	2	0	0	0	0	0	0	82

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