The Pennsylvania State University

The Graduate School

Department of Education Policy Studies

NON-COGNITIVE SKILLS AND ACHIEVEMENT:

A CROSS-NATIONAL ANALYSIS OF THE ASSOCIATION BETWEEN ACADEMIC PERSEVERANCE AND ACHIEVEMENT

A Dissertation in

Educational Theory and Policy

and

Comparative and International Education

by

HyoJung Jang

Submitted in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

May 2018

The dissertation of HyoJung Jang was reviewed and approved* by the following:

Dana L. Mitra
Professor of Educational Theory and Policy
Dissertation Co-Advisor
Co-Chair of Committee

Gerald K. LeTendre
Harry Lawrence Batschelet II Chair of Educational Administration
Dissertation Co-Advisor
Co-Chair of Committee

David P. Baker
Professor of Educational Theory and Policy

John D. McCarthy
Distinguished Professor of Sociology

Liang Zhang
Professor of Higher Education at New York University
Special Member

Kevin Kinser
Professor of Higher Education.
Head of the Department of Education Policy Studies

*Signatures are on file in the Graduate School

ABSTRACT

This dissertation examines the association between academic perseverance—a non-cognitive skill—and academic achievement in a cross-national perspective. Large and well-established bodies of research have documented empirical evidence for the importance of intelligence or cognitive ability on academic achievement. Research on non-cognitive skills, in comparison, remains sparse and nascent. The extant non-cognitive skills literature from economics, psychology, sociology, and the broad field of education have recently provided evidence for the salience of several non-cognitive skills, particularly grit, which is defined by Angela Duckworth and colleagues (2007) as perseverance and passion for long-term goals. However, findings on grit are mixed, with some studies highlighting a significant role of the perseverance component of grit but not the passion component. Moreover, the lack of empirical evidence from cross-national studies indicates that no universal theoretical explanation about grit and achievement can be inferred yet.

To fill this important void in the literature, this dissertation builds on and extends the recent research on grit within the larger non-cognitive skills literature and focuses on the perseverance component to introduce the concept of academic perseverance, which is more narrowly defined and domain-specific than grit. Thus, this dissertation provides some of the first cross-national evidence on the association between academic perseverance and academic achievement. Findings from regression analyses with fixed effects show that academic perseverance is positively and significantly associated with achievement across countries, net of between-country differences, as well as within all countries, above and beyond student demographics and between-school differences.

These cross-national findings give support to the grit theory and buttress recent findings from a meta-analytic study of grit research highlighting the salience of the perseverance component of grit on academic achievement outcomes. Although there is much room for future

studies to further examine the association between the full construct of grit and academic achievement outcomes when internationally valid measurement tools become available, this dissertation makes important theoretical and empirical contributions to the non-cognitive skills literature across multiple academic disciplines and the field of comparative and international education, which in turn would help inform education policy around the world.

Keywords: non-cognitive skills, grit, academic perseverance, achievement, cross-national comparisons, PISA

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

First and foremost, I thank God for the inspiration, wisdom, and will to finish my dissertation project. I am also grateful for many individuals who helped make my dissertation writing process a more enjoyable one. While I prefer—and plan—to write to them individually to express my gratitude for the unique ways in which they played a positive role, I briefly acknowledge their contributions here also.

I thank my co-advisors and co-chairs of my dissertation committee, Prof. Gerald (Gerry) LeTendre and Prof. Dana Mitra, for their guidance and support for my dissertation research. I feel very fortunate to have been a student of both Gerry and Dana, both of whom set an outstanding example of an effective scholar, teacher, and academic advisor. Gerry and Dana have guided and supported me to develop and pursue my own research agenda. I deeply appreciate Gerry's generosity in making time to meet to discuss ideas, reading and providing detailed and helpful feedback on my drafts even during a break, encouraging me to pursue my goals, and celebrating my achievements. I am grateful for all the ways in which he has guided and supported me throughout my dissertation stage and PhD journey at Penn State. Along with Gerry, Dana has provided much guidance and support throughout the dissertation writing process and beyond. I thank her for supporting my decision to pursue my dissertation topic, writing notes during both my proposal and final defenses, and celebrating my achievements. I truly appreciate her passion for high quality research that informs educational policy, and I thank her for encouraging me to highlight my contributions more confidently in my work. I am grateful for the time, guidance, and support that Gerry and Dana have provided me over the years.

I thank my wonderful dissertation committee members, including Prof. David Baker, Prof. Liang Zhang, and Prof. John McCarthy, all of whom always made time to meet and discuss

ideas with me. I really appreciate Dave's clear ways of providing feedback and suggestions, along with his wealth of knowledge, from which I learned a lot. I am grateful for Liang's feedback and guidance especially on the methods section, and it was in Liang's data analysis course during my first semester at Penn State that I decided to pursue my passion for quantitative research. John has always provided timely and detailed feedback when I was developing my dissertation idea and writing the initial draft of my research proposal for his course and beyond. I am so grateful for John's encouragement and his astute scholarly advice. I thank my committee again for their wonderful guidance and support for my dissertation.

I am also grateful for all the administrative assistance I received from Linda Oishi, who helped with navigating through the bureaucratic mazes at Penn State. I thank her for taking care of all the paperwork, especially for scheduling and reserving rooms for my comprehensive exam and dissertation defense.

I also thank many wonderful professors, teachers, and mentors prior to and during my PhD journey at Penn State for their support and continued encouragement over the years. Among the many, I thank Prof. John Meyer at Stanford for introducing me to neo-institutional theory, inspiring me to pursue a line of research in education, and sharing his research with me and providing timely feedback whenever I asked questions. I thank Prof. Gi-Wook Shin at Stanford for always encouraging me to pursue my goals and celebrating my achievements. I thank Dr. Gary Mukai at the Stanford Program on International and Cross-cultural Education for inspiring me to pursue a PhD in comparative and international education, providing constant encouragement prior to and throughout my PhD journey, and celebrating my professional and personal milestones. I thank Dr. Randy Frieling for his enthusiastic encouragement over the years for whatever I set out to do.

I am grateful for my friends and colleagues—all over the country and around the world—who have played a significant role in making my dissertation writing process a more fun one. I

will thank them individually for their love, prayers, encouragement, celebrations, and all the fun memories.

I thank my amazing family (Mom, Dad, and Jun), for whom I am so tremendously thankful to God, for their unconditional love, prayers, support, encouragement, and care for me over the years, including my dissertation writing period. Mom and Dad, I am so blessed and proud to be your daughter. Your strong and godly character always inspires me to be a better person, and your work in the education sector has had a profound impact on my decision to study education. I admire your passion for serving and loving the underserved in a foreign country, foregoing of your comfortable life in your home country. I will always remember the example you have set. I was able to finish writing my dissertation, largely because of your constant prayers for me, absolute belief and confidence in me, and your joy and sense of humor you shared with me throughout this journey made all the difference. And, Jun, my one and only brother, thank you for love, prayers, encouragement, and the chats transcending multiple time zones. You make me so proud by setting an inspiring example of the best math/physics teacher and mentor for your students.

Last but not least, I thank Tim, for going through the dissertation stage with me with much love, patience, and grace. Tim, thank you for your unwavering encouragement and support for me always. I am excited to continue our journey together, celebrating all of our achievements along the way!

Chapter 1

Introduction

Although the notion that hard work and perseverance matter for academic achievement outcomes is a widely-shared belief around the world, cross-national research evidence to support or validate this claim remains thin at best. Only recently, research evidence based on small select samples of highly successful individuals in the United States gives credence to such a taken-for-granted idea. Grit—defined as perseverance and passion for long-term goals (Duckworth, Peterson, Matthews, & Kelly, 2007)—has been identified as a key non-cognitive skill1 that is highly predictive of individual success above and beyond other predictors, such as cognitive ability, in multiple domains including education (Duckworth et al., 2007; Heckman & Kautz, 2015).

However, mixed findings on grit to date question the universal validity of grit as a non-cognitive skill theorized to be significantly associated with academic achievement scores. A recent meta-analytic study reports the significant predictive power of the perseverance component of grit but finds no significance for the passion for long-term goals component (Credé, Tynan, & Harms, 2016). And the lack of cross-national evidence renders the current theoretical argument on grit under-substantiated. This study contributes to the ongoing debate by examining the perseverance component of grit and its association with academic achievement scores in a cross-national perspective.

Although the research on grit is relatively nascent, the study of non-cognitive skills more broadly is not new. For decades, economists, psychologists, and sociologists have studied the role of various non-cognitive skills on educational, labor market, and life outcomes, often drawing on

1 See "A note on the definition of non-cognitive skills" on page 8.

relatively small, non-nationally representative samples in single-country settings (Bowles & Gintis, 1976, 2002; Borghans, Duckworth, Heckman, & ter Weel, 2008; Jencks, 1979). Yet, little is known about the role of specific non-cognitive skills, such as grit or perseverance, on academic achievement in a cross-national perspective, leaving a large void in the multi-disciplinary non-cognitive skills literature as well as in comparative and international education research. The inquiry into the association between the perseverance component of grit and academic achievement, as well as how that association might vary across nations, merits close attention for several reasons.

First, there is no clear theoretical or empirical consensus on the specific non-cognitive skills that matter universally for academic achievement test scores, despite extant research across economics, psychology, sociology, and the broad field of education on non-cognitive skills. Studies employ a wide range of non-cognitive skills measures, often constructed based on the available data. This creates issues with regards to reliability and validity of the constructs, replicability of those studies, and applicability of the findings to larger or other populations. Standardized measures of non-cognitive skills, such as the Big Five, perhaps alleviate these concerns, but the association between such standardized measures of non-cognitive skills and achievement scores of students of the same age across a diverse set of countries is not yet documented. Such a dearth in research evidence underscores the need for a cross-national study on the association between non-cognitive skills, such as grit and perseverance, and achievement scores.

Second, although research on grit has been proliferating in recent years, results are mixed and cross-national evidence on the association between grit and achievement scores remains extremely sparse. Recent research shows that grit is one non-cognitive skill that predicts academic outcomes, including achievement test scores, above and beyond other predictors (Borghans & Duckworth, 2008; Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014). However,

a recent meta-analysis revealed results that the perseverance component of grit was found to be significantly associated with outcomes, but not necessarily the passion for long-term goals component, questioning the validity of grit as a single construct or two separate ones (Credé et al., 2016).

Perhaps not too surprisingly, even less is known about the role of grit or perseverance on standardized achievement scores, other than course grades or GPAs, in a cross-national comparative framework. While much of the existing research documents the relationship between grit and academic outcomes, such as course grades or GPA, a much smaller body of research has examined the association between grit and standardized achievement test scores. (Almlund, Duckworth, Heckman, & Kautz, 2011a). Given the significance of academic achievement, which is closely linked to educational attainment, labor market outcomes, and social mobility, as the sociological theories of status attainment (Sewell, Haller, & Ohlendorf, 1970; Sewell & Hauser, 1975; Woelfel & Haller, 1971) and human capital theories (Becker, 1964, 1975) would argue, it is important to consider the role of grit and perseverance on standardized achievement scores as a key academic outcome across nations. The findings have policy implications.

Third, the role of students, namely the degree to which they persevere in their learning efforts, on their academic achievement has been under-theorized in comparative education literature and in the sociology of education. This deficit in the literature markedly contrasts the copious sets of studies focusing on family background or school context effects on academic achievement since the publication of the "Coleman Report" (Coleman, 1966) in the 1960s. Despite these well-established studies, the under-developed literature on students' own input and initiative that they bring to their own learning and achievement have largely been under-addressed in education research, particularly in the field of comparative and cross-national education. This is a substantial gap, given that students are at the intersection of three major institutions that shape them, namely family, school, and society at large, all of which play a role

to influence students' non-cognitive skills and academic achievement. In this view, comparing the association between perseverance and achievement cross-nationally lends a unique opportunity to indirectly analyze the degree to which perseverance is rewarded in different educational systems.

For instance, cultural theories such as Stevenson et al.'s (1990) idea of Confucian culture strongly emphasizes hard work and perseverance, which allows for an inference that students living in nations heavily influenced by Confucian cultural norms are more likely to value hard work and perseverance in school and have higher levels of perseverance than students elsewhere without the influence of Confucian culture. In turn, students' hard work and perseverance may be more highly rewarded in Confucian culture, and the positive feedback look may continue. Alternatively, it is also possible to imagine that students living in Confucian cultures may be more perseverant than their peers in other nations such that the "returns" or "rewards" to perseverance may not be as high since it is almost expected of students to be perseverant and work hard in their academic pursuits.

Institutionalized culture of schooling and the homogenization of school effects

On top of such cultural differences of primordial roots across nations, the institutionalization of mass schooling around the world since the end of World War II has established the importance of education as a central institution, a human right, and a major path of social mobility. It is widely believed that education is central to one's life success and well-being in most nations, if not all. The conventional wisdom that hard work and perseverance matter largely reflects the degree to which meritocratic ideals are shared by many societies worldwide through the institution of education—all consistent with the themes of excellence (progress) and

equity (justice) associated with shared visions for education globally (Meyer, Ramirez, Frank, & Schofer, 2005).

Schooling has become more similar across nations in terms of its organization, curricula, and quality around the world (Meyer, Ramirez, & Soysal, 1992). As a result, school effects on student achievement has more or less homogenized across nations, and they have diminished relative to the effects of individual differences. In other words, individual input, such as perseverance, or other between-student differences may matter more now for academic achievement than any between-school differences from a global perspective as evidenced in a prior study by Baker, Goesling, and LeTendre (2002). This perspective stems from a neo-institutional school of thought in sociology.

A macro-sociological argument based on neo-institutional theory asserts that schooling has become more similar across nations due to the intense institutionalization of mass schooling globally since the World War II (Meyer et al., 1992), and highlights the increased importance of family socioeconomic status (SES) on academic achievement (Baker et al., 2002). Research shows that between-student differences, namely family backgrounds, account for a significantly more proportion of variation in academic achievement than school effects across nations, which again can be explained by the expansion and homogenization of the "grammar" of schooling and school quality worldwide over the past decades (Baker et al., 2002). Theoretically, high SES families are assumed to have the ability to provide additional educational opportunities and extra lessons outside of school for their children, thus enlarging the achievement gap.

Numerous studies have examined the role of family SES or school effects on achievement—separately to assess their independent effects or together to estimate the relative contribution of the combination of the two. However, whether or not and the degree to which students' personal efforts—measured in the level of perseverance as a key component of grit—influence their learning and achievement have largely been under-documented in cross-national

comparative research. To date, cross-national research on the role of students' perseverance—or any other non-cognitive skills—on achievement remains highly scarce. It is timely to explore the role of students themselves, especially as mass schooling is assumed to have played a role in empowering students to become purposive actors (Meyer et al., 2010) who can take action in terms of investing efforts in their own learning and achievement.

Perseverance as a malleable key non-cognitive skill

Perseverance is one such key input that students can bring to their learning and schooling. It is malleable to individual effort, among other factors, and one that distinguishes students in their academic achievement outcomes, given the homogenization of school effects. Extant research suggests that non-cognitive skills, such as perseverance and grit, are malleable and can be developed (Borghans, Duckworth, Heckman et al., 2008; Cunha, Heckman, Lochner, & Masterov, 2006; Duckworth, 2016; Heckman & Kautz, 2012, 2015; Walsh, 2004), often highlighting the salience of the educational system and school environments in influencing students' non-cognitive skills, which are linked to their academic achievement.

Even with the homogenization of school effects on a macro level, societies or school systems within societies may emphasize different types of non-cognitive skills and intelligence. For instance, Raymond Cattell (1963) and later his student John Horn developed the theory of fluid and crystal intelligence (Cattell, 1963; Bempechat, 2004; Horn & Cattell, 1966). While fluid intelligence, or the ability to use logic in new situations to solve new problems, is fixed at an early age, crystalized intelligence is not as it is the ability to use learned knowledge and experience. Like crystalized intelligence, perseverance can grow with individual effort over time.

Thus, in addition to examining the direct association between perseverance and achievement across nations, it is important to consider whether that association varies across different national educational systems, and if so, to what extent.

Fourth, although an extensive body of research has sought to explain significant variations in students' achievement scores on standardized tests, which also vary cross-nationally, the remaining unexplained variance invites more research. The Program for International Student Achievement (PISA) reports significant variations in student mean academic achievement levels across countries in mathematics, reading, and science domains (OECD, 2014). However, despite much efforts by researchers to explain the unexplained variance in achievement scores, no predictor or a set of predictors has explained all of the variance in achievement scores. These findings, combined with past research documenting different levels of non-cognitive skills across countries (Heckman & Kautz, 2012) and the research evidence showing the heterogeneity of effects of non-cognitive skills on academic and educational achievement outcomes (Borghans & Duckworth, 2008; Heckman, 2008), suggest that the association between perseverance and achievement is likely to vary across different national educational systems. Establishing an empirical evidence base for cross-national variations benchmarks directions for future research.

Significance of this study

I build on prior research on grit within the non-cognitive skills literature to introduce academic perseverance as a key non-cognitive skill and contribute cross-national evidence on the association between academic perseverance and achievement, as well as a new way to explain differences in student achievement across nations, drawing on data from PISA 2012. Specifically,

I ask: (1) Is academic perseverance associated with achievement in a cross-national perspective? (2) What is the association between academic perseverance and achievement, net of student demographics and between-school differences?

By documenting the association between perseverance and achievement cross-nationally, this study links the recent research on grit within the larger non-cognitive skills literature with cross-national comparative research on achievement scores. Although the dataset used for this study is cross-sectional and thus cannot model later achievement outcomes, this study nonetheless provides some of the first cross-national evidence to show whether or not perseverance is significantly associated with achievement scores above and beyond student- and school-differences, thereby extending the recent theories and research on grit and perseverance within the non-cognitive skills literature. Moreover, this study links the non-cognitive skills literature with comparative education research to examine the way in and the degree to which individual effort captured by academic perseverance is linked with achievement scores in modern, mass-schooled societies. By focusing on the association between a specific non-cognitive skill—academic perseverance—and achievement, this study sheds light on whether or not and the extent to which the association varies across national educational systems and speculates what may explain that variation in the massively schooled society, where the idea of meritocracy is assumed to be a dominant narrative.

A note on defining non-cognitive skills

As mentioned above, grit and perseverance are non-cognitive skills. Non-cognitive skills have multiple names and are defined in a variety of ways. The varying terminology and

definitions for non-cognitive skills across academic disciplines reflects the complex and variegated facets of and underlying assumptions for non-cognitive skills. Economists use the terms "non-cognitive skills," "soft skills," or "character skills" (Cunha, Heckman, Lochner, & Masterov, 2005; Heckman & Kautz, 2012; Heckman & Rubinstein, 2001) to define them as skills, which by definition can be learned and developed as a form of human capital that can create value. Psychologists refer to non-cognitive skills as personality traits, which are "the relatively enduring patterns of thoughts, feelings, and behaviors that reflect the tendency to respond in certain ways under certain circumstances" (Roberts, 2009, p. 140). Some traits are considered to be relatively stable or fixed, while others are more malleable across the life cycle, as suggested by research evidence from neuroscience showing the malleability of the prefrontal cortex into the early 20s, although there may be more sensitive periods for the formation of non-cognitive skills (Walsh, 2004). Sociologists use multiple names, including non-cognitive skills, soft skills, socio-emotional skills, social and behavioral skills (Arum, 2005; DiPrete & Jennings, 2012; Farkas, 2003; Jencks & Others, 1979), and, sometimes even cultural capital (Lareau, 2006), though too far-fetched, to denote any skill that falls out of the purview of the conventional conception of measurable cognitive skills.

The term "non-cognitive" may be a misnomer in that the processes involved in acquiring, developing, and even utilizing these skills involves cognitive processes. The current literature—with the lack of consensus on a single universal definition of non-cognitive skills and measurement tools—tacitly implies that non-cognitive skills can refer to anything that falls out of the purview of what are traditionally considered as cognitive skills or intelligence. However, the lack of conceptual clarity can even sometimes muddy the distinction between non-cognitive skills and cognitive skills, given the possibility of overlaps between psychological processes involved in enacting "non-cognitive skills" and cognitive skills or processes.

A case in point is the discussion around what are referred to as "cognitive executive functions" that deal with "planning, organization, working memory, integration of experience, spatial reasoning, unique problem-solving and skills for goal-directed behavior related to reasoning ability as applied in novel contexts" (Baker, Eslinger, Benavides, Peters, Dieckmann, & Leon, 2015). Intelligence—or cognitive skills—includes crystallized intelligence and fluid intelligence, latter of which controls the effective use of "cognitive executive functions" (Baker et al., 2015). One could argue that "skills for goal-directed behavior related to reasoning ability as applied in novel contexts" somewhat overlaps with perseverance or grit. However, it is important to note the key condition, that is, "as applied in novel contexts," which differs from the long-term nature of perseverance or grit. Likewise, individuals who have the ability to plan and organize do not necessarily carry out their plans may lack non-cognitive skills such as perseverance and grit. In this sense, an individual's intelligence becomes less salient and non-cognitive skills can potentially make a difference on the outcome.

Even if some facets or psychological processes involved in cognitive skills and non-cognitive skills are thought to be related, it is important to acknowledge that they are conceptually distinct and separable constructs and measures. Cognitive skills are conceptually distinct from non-cognitive skills in that they refer to more or less innate "talent" that distinguishes the rate at which an individual learns something, while non-cognitive skills refer to the effort that an individual invests (Duckworth, Eichstaedt, & Ungar, 2015). Prior studies support this conceptual distinction by providing evidence that non-cognitive skills predict success in academic achievement above and beyond intelligence (Duckworth et al., 2007; Heckman & Kautz, 2012). The formation of cognitive and non-cognitive skills has also been examined both theoretically and empirically as a way to compare the skills development and how those skills relate to each other (Cunha, Heckman, & Schennach, 2010).

Acknowledging these debates, the term "non-cognitive skills" will be used throughout this study to account for the extent to which these skills can be distinguished from conventional measures of cognitive skills, in that they are much more malleable to be cultivated and influenced by environmental factors and improved with personal efforts (Borghans, Duckworth, et al., 2008; Borghans, Meijers, & Ter Weel, 2008; Cunha et al., 2005; Duckworth, 2016; Heckman & Kautz, 2012). Thus, building on the definitions from across various academic disciplines and following previous research, this study defines non-cognitive skills as "the relatively enduring patterns of thoughts, feelings, and behaviors that reflect the tendency to respond in certain ways under certain circumstances" (Roberts, 2009, p. 140), which, as skills, can be learned and shaped by external environments and improved with efforts. This definition also takes into consideration that non-cognitive skills are relatively stable—but not completely fixed—across ages.

Non-cognitive skills—under multiple names—have been recognized as important skills for individuals' success in many domains and studied across multiple academic fields for decades. Yet, the research field is still in its infancy in that researchers only "have established the quantitative importance of non-cognitive skills without identifying any specific non-cognitive skill" (Heckman & Rubinstein, 2001). In addition to the limited knowledge about specific non-cognitive skills that matter for individual outcomes, it is worthwhile to note that "too little is understood about the formation of these skills or about the separate effects of all of these diverse traits currently subsumed under the rubric of non-cognitive skills" (Heckman & Rubinstein, 2001).

The inherent difficulty in identifying and measuring non-cognitive skills has in part been responsible for the relatively sparse empirical evidence and theorization. Non-cognitive skills vary and one cannot assume that there is a finite number of non-cognitive skills that are associated with certain outcomes. Based on theory and much rigorous empirical testing and

validation, psychologists have identified several non-cognitive skills and tools (i.e., scales) to measure them, including perseverance, the Big Five scale, and more recently the construct of grit.

There is a divide in the literature about the measurement of non-cognitive skills. Unlike cognitive skills that are measured directly through standardized tests, non-cognitive skills are latent constructs that are indirectly measured. Measurement takes place in the form of psychological scales or behavioral measures. Some argue that it is tautological to measure behavior to predict later behavior, although evidence shows that behavioral measures are at least as good (Pratt & Cullen, 2000) or better (Benda, 2005) at predicting later behaviors as psychological scales used in self-reported questionnaire answers. This makes sense in that psychological scales often ask questions about behavioral tendencies of the respondents, and thus they are related to behavioral measures. There may be advantages and disadvantages for using either measurement tool, but both psychological scales specifically developed to measure specific non-cognitive skills/personality traits and behavioral measures thought to be related are used as predictors of later behaviors in the literature.

As such, there is no consensus in the literature about the absolute efficacy regarding ways to measure non-cognitive skills, although administering self-reported surveys is a more realistic option given the costs and time associated with measuring actual behaviors and reliability issues when using past behaviors as proxies. Often times, non-cognitive skills are measured through self-reported questionnaires, which is still less than ideal because the answers may or may not accurately reflect respondents' actual behavior due to incentives (or the lack thereof), emotional state at the time of answering the survey questions, various environmental factors, and reference bias, to name a few. Although self-reported scales cannot be assumed to be more reliable than behavioral measures or measures based on tasks or behaviors, it is more implementable in practice and defendable in terms of its theory and standardized measurement schemes.

In the next chapter, I briefly review the theoretical perspectives on non-cognitive skills from economics, psychology, and sociology to highlight how they intersect and deviate from each other. Prior to the theoretical discussion, I provide a brief outline of this dissertation.

Dissertation outline

The outline of this dissertation is as follows. Chapter One identifies and situates the main problem and the specific research questions that this dissertation addresses within a larger academic discussion cutting across various academic disciplines to provide a rationale for this study. It is the introduction chapter that provides the background, purposes, significance, and the organization of the dissertation.

Chapter Two begins with reviewing the larger non-cognitive skills literature across economics, psychology, sociology, and the broad field of education. Identifying the gaps and potential linkages within this larger non-cognitive skills literature, this chapter presents how comparative and international education research can help fill in and bridge some of the gaps by examining the association between non-cognitive skills and academic achievement from a cross-national perspective. Focusing on one specific non-cognitive skill of grit, this chapter provides an in-depth theoretical and empirical background on grit and its association with academic outcomes, and introduces a more narrowly defined and domain specific concept of academic perseverance. It examines the grit scale developed by Angela Duckworth and colleagues (2007) and the perseverance index measured by PISA to provide a detailed comparison of what they measure and how they converge and diverge. This analytic discussion on conceptual underpinnings sets the background and theoretical anchor for the current study. The chapter

concludes with a summary that includes remaining issues in the study of non-cognitive skills using large-scale and cross-national datasets.

Chapter Three begins by describing the research questions and hypotheses deriving from the theoretical framework introduced in Chapter Two, followed by a detailed description of the PISA 2012 data, analytic sample, measures, and methods. It explains and justifies the use of ordinary least square (OLS) regression approaches with fixed effects to examine the association between academic perseverance and achievement across and within countries, net of student demographics and between-school differences. The use of fixed-country and fixed-school effects allows for the estimation of the association between academic perseverance and achievement at the student level, net of any observed and unobserved heterogeneity at the country or school level. Thus, the regression estimates are more conservative and less biased. The chapter concludes with a summary that includes limitations of the methodology and data.

Chapter Four describes the results of the empirical analyses, beginning with descriptive statistics and trends across nations. Then it provides detailed findings from the regression analyses for all countries in the analytic sample. It begins with the results from the pooled regression country-fixed effects models to show a global trend in the association between academic perseverance and achievement, controlling for between-country differences and student demographics. Then, the results from the school-fixed effects regression models for each of the 57 countries are detailed, along with tables and figures. The chapter closes with a summary which speculates potential explanations for cross-national variation in the association between academic perseverance and achievement.

Finally, Chapter Five provides a discussion and conclusion of the main findings and how they support or fail to support the hypotheses. It begins with a brief recap of the grit theory and the importance of non-cognitive skills, particularly focusing on the perseverance component of grit, and connects the non-cognitive skills literature with comparative education research. Then it

discusses this study's contributions and innovations, followed by a summary of main findings to draw main inferences and implications. Moreover, implications for educational policy and limitations and directions for future research are discussed.

Chapter 2

Literature Review

This chapter reviews the literature on non-cognitive skills, particularly grit, by connecting extant research from economics, psychology, and sociology—and more recently, research from the field of education. Situated within the larger non-cognitive skills literature cutting across multiple disciplines and fields, the theoretical discussion on grit highlights a core component of perseverance and introduces the concept of academic perseverance along with its theorized salience on academic achievement. The chapter then presents an analytic comparison between the perseverance of effort subscale of the grit scale developed by Duckworth et al. (2007) and the (academic) perseverance scale from PISA to show the ways in which they converge and diverge. Finally, the chapter briefly discusses some of the challenges researchers have faced thus far when studying non-cognitive skills, followed by a short summary of the chapter.

Non-cognitive skills research

Although a substantial body of research has documented the role of cognitive skills on various outcomes such as education, labor market, and life outcomes across multiple academic disciplines, a much smaller and disparate body of research focuses on the role of non-cognitive skills. Economists, psychologists, and sociologists—often motivated by disparate theoretical perspectives—have all studied the role of various non-cognitive skills for decades. More recently, education researchers have undertaken similar lines of research, often drawing on theoretical

frameworks from one or more disciplines to examine their relationship with student academic outcomes. While the theoretical perspectives and empirical foci may vary, the consensus on the existing bodies of research converges to establish the importance of non-cognitive skills on a broad array of individual outcomes, including academic achievement. This section presents some of the theoretical views of non-cognitive skills and empirical findings on the association between non-cognitive skills and several outcomes. This discussion sets up the context for the theoretical discussion of grit and academic perseverance—both non-cognitive skills—and their salience on academic achievement.

For decades, economists, psychologist, and sociologists have studied non-cognitive skills to estimate their impact on various outcomes, including educational and labor market outcomes. Economists' human capital framework to consider non-cognitive skills as an independent predictor of outcomes, psychologists' concern on identifying valid and reliable constructs to measure non-cognitive skills that potentially matter for academic and educational outcomes, and sociologists' endeavor to look for ways to explain group differences in outcomes along the lines of class, gender, and race/ethnicity all contribute to exploring a direct association between non-cognitive skills and outcomes. Education researchers often draw on theories and research from multiple academic disciplines to estimate the association between non-cognitive skills and various academic and educational outcomes. This section briefly surveys relevant literature in each of the three disciplines as a way to identify remaining gaps in the literature and how this project fills some of these existing gaps.

Economics

Economists drawing on human capital theory (Becker, 1975; Mincer, 1958, 1974; Schultz, 1961) identify non-cognitive (or "character" or "soft") skills as a separate component of human capital distinct from cognitive skills (Heckman, 2005). Cognitive skills and education attainment (e.g., years of schooling or diplomas/degrees) have been considered as major components of human capital, which is broadly defined as a sum of individual assets that can create value such that they make individuals competitive in the labor market (Becker, 1975; Schultz, 1961). While a large and abundant body of research has documented the role of cognitive skills and education on various outcomes within this theoretical tradition alone, a much smaller body of research focuses on the role of non-cognitive skills to date.

Within this relatively smaller but rapidly burgeoning literature, one of the most important and consistent findings is that non-cognitive skills are as strong predictors of later-life outcomes as cognitive skills, if not stronger (Bowles, Gintis, & Osborne, 2001; Heckman & Kautz, 2015). Evidence shows that non-cognitive skills predict a broad range of outcomes, including academic achievement, educational attainment, labor market, and life outcomes, including health (Almlund, Duckworth, Heckman, & Kautz, 2011; Heckman & Kautz, 2015; Heckman et al., 2014, p. 358). Thus, these studies document the independent "returns" to non-cognitive skills, which constitute an important dimension of human capital.

Drawing on this human-capital framework, Bowles and Gintis (1976, 2002) and Edwards (1976)—Marxist economists who provided some of the first evidence on the role of non-cognitive skills on labor market outcomes—have shown that students' non-cognitive skills are rewarded by teachers in high schools in the form of grades, much akin to the ways in which employees' non-cognitive skills are rewarded by employers in low-skill markets in the form of wages. They observe that non-cognitive skills rewarded in both places are essentially the same.

The most important student traits rewarded by teachers in the form of school grades were perseverance, dependability, and consistency, while employers were found to favor perseverance, dependability, and docility over cognitive ability of their employees (Bowles & Gintis, 1976, 2002).

Although Bowles and Gintis (1976, 2002) liken the returns to non-cognitive skills in the low-skilled labor market to the individual student traits rewarded by teachers in high school in the form of their grades, a key difference exists. It is that various non-cognitive skills are consistently predictive of grades in school across grade levels (K-12 and beyond) and time (see DiPrete & Jennings, 2012; Duckworth & Seligman, 2006; Farkas, 2003), while they were rewarded more favorably by employers only in low-skill martkets—at the time of writing—such that individual differences in non-cognitive skills explained the variance in wages. Evidence is limited on the returns to non-cognitive skills in the other types of (mid- and high-skill) markets.

Furthermore, recent evidence shows that even a perceived lack of non-cognitive skills negatively impacts wages. A more recent work by Heckman et al. (2012) on GED recipients has shown that although GED recipients are as intelligent as high school graduates, they are perceived by employers as lacking non-cognitive skills, such as ability to look ahead and plan, perseverance, and so forth. Such a perception associated with GED was found to negatively influence wages. These findings highlight the importance of non-cognitive skills on wages in low-skilled labor markets, and suggest that even a perceived lack of non-cognitive skills is negatively associated with wages.

Aside from the association between non-cognitive skills and labor market outcomes, recent research evidence shows the role of non-cognitive skills on student achievement. Economists interested in the educational production function have also been concerned with the main effects of non-cognitive skills—such as the Big Five, grit, perseverance, and so forth—on academic achievement or educational attainment. (Almlund et al., 2011; Heckman, Stixrud, &

Urzua, 2006). Although results remain inconclusive depending on the non-cognitive skills studied, recent empirical evidence shows that non-cognitive skills not only predict success in many domains, especially in education, but they also "causally produce that success, and that programs that enhance soft skills have an important place in an effective portfolio of public policies" (Heckman & Kautz, 2012).

For instance, Heckman and Kautz (2012) provide examples (e.g., the Perry Preschool program) that demonstrate the causal effects of various non-cognitive skills measures on later educational outcomes. Likewise, Cunha, Heckman, and Schennach (2010) show that "non-cognitive skills promote the formation of cognitive skills" and they do not find evidence for a reverse causality. In an experiment study conducted with Dutch university students as subjects, Borghans, Meijers, and Ter Weel (2008) estimate the direct causal effects of non-cognitive skills—including the Big Five and a battery of other non-cognitive skills such as resilience, internal locus of control and so forth—on cognitive test scores. The results from these studies, although limited in number and scope, nonetheless provide strong evidence for the positive effects of non-cognitive skills on academic and cognitive outcomes, and suggest how their effects can vary across contexts and individuals.

Psychology

In line with the economics literature on the "returns" to non-cognitive skills, psychologists have studied personality traits—another name for non-cognitive skills—and their predictive power on various outcomes. Along with economists, psychologists have examined the association between non-cognitive skills and educational, labor market, and life outcomes

(Almlund, Duckworth, Heckman, & Kautz, 2011; Duckworth, Kirby, Tsukayama, Berstein, & Ericsson, 2011; Duckworth & Seligman, 2006; Heckman et al., 2006).

The task of identifying and measuring new non-cognitive skills that predict success has been a main focus of many positive psychologists, including Angela Duckworth and her colleagues (2007) in their research on grit, defined as perseverance and passion for long-term goals. Yet, they recognize that the search for a specific non-cognitive skill that determines success began at least as early as the beginning of 1900s, when William James (1907) sought to address one of his questions on the reasons why "some individuals accomplish more than others of equal intelligence" (Duckworth et al., 2007). More recently, positive psychologists have revived interest in the study of trait-level personality/non-cognitive skills more broadly (Peterson & Seligman, 2004).

A rapidly growing research on grit is a case in point. The focus has been on verifying the validity of constructs of trait-level personality characteristics and testing their predictability of individual outcomes, such as academic, educational, labor market, and life outcomes. In this case, grit is measured and studied as a predictor variable, not as the outcome variable, as it often used to be the case in personality psychology (Duckworth & Quinn, 2009).

For instance, personality traits, such as perseverance, have often examined as dependent variable rather than an independent variable in earlier studies. Scholars have often examined perseverance as a dependent variable in research on “optimistic attribution style, self-efficacy, goal orientation, and depletion of self-control resources (see Duckworth & Quinn, 2009a), although research on perseverance as a trait-level predictor was of interest to psychologists as early as in the first half of 20th century (Duckworth & Quinn, 2009). Such an interest is reflected in the following quote from a psychologist in the 1930s: “The existence of a general trait of persistence, which permeates all behavior of the organism, has not been established, though evidence both for and against such an assumption has been revealed” (Ryans, 1939, p. 737).

Psychologists have been concerned about the theoretical and empirical soundness of new constructs to reliably measure non-cognitive skills, in addition to their predictive power on later-life outcomes. Studies often show the construct validity and reliability of constructs when reporting results, especially when introducing new constructs. The empirical fit indices of the factor structure of latent constructs based on the self-reported measurement of non-cognitive skills in turn inform theoretical justification for the constructs. The iterative process and testing hypotheses based on the theoretical concept of non-cognitive skills establish validity and reliability across samples. Thus, psychologists identify new non-cognitive skills that are theorized to be highly correlated with individual success in many domains, which then can be tested by other scholars across academic disciplines.

The search for universally reliable and valid measures of non-cognitive skills has motivated many psychologists to pursue this line of research. And scholars across disciplinary boundaries have adopted the theoretically informed and temporally validated constructs and measures of non-cognitive skills to show their impact on key outcomes in their fields.

Sociology

Parallel to economists and psychologists, sociologists have produced a large body of research on the role of non-cognitive skills on academic, educational, and labor market outcomes (e.g., occupation attainment and wages) (Jencks, 1979). Many of these studies are motivated by the theme of reproduction of social classes, as were Marxist economists, to explain the stratification in outcomes (e.g., educational achievement and attainment, labor market outcomes, etc.) of individuals across social classes. For instance, Bowles and Gintis (1976), focusing on high-school students, showed that the most important student traits rewarded by teachers in terms

of school grades were perseverance, dependability, and consistency. A similar line of thinking appears in sociological research drawing on cultural capital theory (Bourdieu, 1984).

Some sociologists loosely consider an array of what are usually defined as non-cognitive skills as cultural capital and study their role on student course grades in school. For instance, Farkas, Grobe, Sheehan, and Shuan (1990), studying middle-school students, found that "work habits exert a larger effect than cognitive performance (coursework mastery) in determining teacher's grades." Similarly, Rosenbaum (2001, ch. 8) also found that both test scores and non-cognitive behaviors predicted course grades assigned by teachers. They argue that differences in course grades of students along the lines of gender, ethnicity, and class is almost entirely accounted for by the cognitive and non-cognitive performance variables.

Sociologists often examine group differences in academic outcomes, often by gender, race/ethnicity, and socioeconomic groups. They have studied whether or not non-cognitive skills account for those group differences in grades, for instance. Again, many of the existing studies draw on cultural capital theory to explain the role of non-cognitive skills as a form of cultural capital (e.g., work habits, other non-cognitive behaviors) that is rewarded based on teachers' subjective judgements reflected on course grades (Farkas et al., 1990; Rosenbaum, 2001). The loose use of the concept of cultural capital has been criticized (see Kingston, 2001), while some have argued otherwise (see Lareau, 2006; Swidler, 1986).

The main limitation in this theoretical framework is that cultural capital theory cannot explain the role of non-cognitive skills on achievement scores on standardized tests, which are not dictated by teachers' subjective evaluation of students' academic performance based on a variety of factors, including students' cognitive and non-cognitive skills. Based on this theory, teacher academic evaluations would be more strongly affected by students' non-cognitive skills. Thus, unless the focus of the inquiry is on testing hypotheses based on cultural capital theory and how teachers reward non-cognitive skills (as a form of cultural capital) differentially in their

subjective grading, this theory is largely irrelevant to the study of the association between non-cognitive skills and academic achievement measured by standardized test scores.

Standardized test scores have increasingly garnered a central place in students' success in school, and they have been used to assess the effectiveness of schools and national educational systems. As such, chool systems around the world have increasingly adopted standardized testing—both national and international—to assess their students' learning and performance as a way to measure the effectiveness of the teachers and schooling in their respective countries. Comparative and international education research shows that the quality of schooling has become more similar across national boundaries than decades ago due to the institutionalization of mass schooling around the world (Meyer et al., 1992; Baker et al., 2002).

What remains less known is whether or not non-cognitive skills matter for students' academic achievement measured by standardized test scores regardless of students' social origin, and whether the association between non-cognitive skills and achievement varies across nations. Thus, even before studying group differences in academic outcomes, addressing the main association between non-cognitive skills and academic achievement measured by standardized test scores will shed light on understanding the role of non-cognitive skills on students' achievement cross-nationally.

Still, other than cultural theorists' interpretation of the association between non-cognitive skills and course grades given by teachers to students, alternative theoretical explanation for the role of non-cognitive skills on standardized test scores seems to be missing or thin at best. In fact, the theorizing part is largely underdeveloped. One main issue has been the broad criteria applied for non-cognitive skills. Although there has been a steady stream of research on non-cognitive skills, there is no clear consensus on the bounded definition of non-cognitive skills, with some studies equating habits as non-cognitive skills to differentiate anything other than what are typically measured and considered as cognitive skills.

Remaining gaps in the larger non-cognitive skills literature

The chief focus of the non-cognitive skills literature across academic fields has been to examine the main or independent effects of non-cognitive skills on later individual outcomes, including academic achievement captured by GPA. Studies drawing on human capital theory in economics, personality theory in psychology, and cultural capital theory in the sociology of education all have often employed an assortment of loosely defined non-cognitive skills measures. As a result, it has not been easy to theorize the association between specific non-cognitive skills and academic achievement in a systemic manner, due in part to the lack of clearly defined and bounded definition of non-cognitive skills and standardized tools to measure them across large samples. Efforts to use standardized scales and inventories (e.g., the Big Five, grit**,** etc.) to measure non-cognitive skills have provided some evidence to help further theorize their association with academic achievement. Yet, no cross-national research has documented the association between non-cognitive skills and academic achievement measured by standardized test scores to date.

Some studies have examined the differential effects—or heterogeneity of effects—of non-cognitive skills on individual outcomes by different groups, often by class, gender, and race/ethnicity. Economists and sociologists have more propensity to pursue these lines of research. Among the three theoretical perspectives surveyed, the cultural capital argument seems the weakest. First, it is hard to make a case for conceptualizing non-cognitive skills to be the same as cultural capital, shaped exclusively by family's class-based cultural norms. It largely ignores the role of schools—and other key institutions, student's own dispositions and will, and other environments—to shape non-cognitive skills or cultural capital, however loosely and

broadly defined. Second, cultural capital argument cannot explain the association between any non-cognitive skills and academic achievement measured by standardized test scores, which are different from course grades subjectively assigned by teachers who may or may not take into consideration and reward the seemingly assumed class-based norms expressed in the form of cultural capital, which they equate with non-cognitive skills. This is a stretch.

Despite decades of research on non-cognitive skills across academic fields, more systemic approach to document and theorize the association between specific non-cognitive skills and academic achievement measured by standardized test scores merits much attention to fill in some remaining gaps. Given the present dearth of research in the area of non-cognitive skills and achievement in particular, the comparative and international education research has much to offer to this inquiry. This study builds on extant research on non-cognitive skills from across academic disciplines as well as research from comparative and international education to shed light on the association between academic perseverance and achievement in a cross-national perspective, thereby providing some of the first cross-national evidence necessary for further theory building. In the next section, I briefly introduce the education literature to set the context.

Comparative and international education literature on achievement

A classic concern in education research since the "Coleman report" in 1966 has centered on estimating the effects of schools, family socioeconomic background, or the relative contribution of the two, on students' academic achievement. Cross-national comparative education research has followed suit and focused on the role of the broader national-level institutions and the ways in which they interact with school and family effects. For instance, a large body of literature focuses on the role of national educational institutions (e.g., the

organization of schooling into academic and vocational streams) on inequality of academic achievement across social class backgrounds (Bol, Witschge, Van de Werfhorst, & Dronkers, 2014; Brunello & Checchi, 2007; Chmielewski, 2014; Marks, 2006; Schutz, Ursprung, & Woessmann, 2008; Van de Werfhorst & Mijs, 2010). Another formidable body of research focuses on other national institutional characteristics, such as the level of national economic development, and its variable impact through school resources and family background on student achievement outcomes across nations and time at the macro level (Baker et al., 2002; Heyneman & Loxley, 1983). The latter, particularly research by Baker, Goesling, and LeTendre (2002), builds on neo-institutional theory in sociology to show how institutions shape student achievement outcomes across nations.

Despite the findings that student background differences (i.e., family SES differences) account for more variation in achievement relative to between-school differences (Baker et al., 2002), the role of students, namely, their effort and input in their own learning and achievement, has been under addressed, particularly in cross-national comparative education research. According to a neo-institutional perspective, students are "purposive actors," (Meyer, Bromely, & Ramirez, 2010) who play a significant role in their own learning and achievement. The expansion of mass education worldwide since the post WWII-era (Meyer et al., 1992) has created a massively schooled society (Baker, 2014), and educational credential has become one of the most important credentials for attaining social mobility. The meritocratic ideals and the globally shared visions for education on the themes of excellence (progress) and equity (justice) (Meyer et al., 2005) have produced empowered, right-bearing, and proactive students (Meyer et al., 2010), who invest in their learning and achievement, given the centrality of education for many reasons, including labor market outcomes, socioeconomic mobility, and personal achievement. Yet, the number of studies that examine the role of students pales in comparison with the studies focusing on the roles of schools or families.

According to a neo-institutional perspective, education—with the liberal democratic values it carries—itself has transformed students to develop both cognitive and non-cognitive skills. As educational credentials and the skills and knowledge one obtains become more important in the labor market, students recognize the importance of their education and academic achievement to attain higher education. The meritocratic ideals pervade many schooling systems around the world, if not most. Given this, students recognize the importance of perseverance to work hard for their academic achievement.

A cross-national analysis of the association between students' academic perseverance and achievement lends a unique opportunity to examine the degree to which it varies across nations. It would be difficult to find national educational systems that do not highlight the importance of education and achievement-based merit for their students. Students from around the world are encouraged to work hard to realize their fullest potential, and this has become a dominant normative view of schooling and the institutionalized role of students. In this sense, the national educational system (macro-level institution) influences students' perseverance (micro-level input) as well as achievement. Yet, we do not know how the direction or the magnitude of the association between academic perseverance and achievement might vary cross-nationally.

Alongside the non-cognitive skills research, research from psychology and sociology support for the logic of this macro-micro process. Research in psychology shows that students who believe that they can improve their learning and achievement with efforts have better achievement outcomes in the future than those who do not (Dweck, 1999). The idea that one has control over his/her future performance or achievement is referred to as a growth mindset (Dweck, 1999, 2006), which closely relates to and motivates grit and perseverance, and one that is likely to be shaped by the broader educational system, among others. The sociology of education research has been concerned about the role of school environment in shaping students' academic performance and educational expectations and aspirations (Parsons, 1959; Turner,

1960), all of which have also been shown to be affected by the level of educational differentiation (e.g., academic and vocational streams) (Buchmann & Dalton, 2002; Buchmann & Park, 2009). The macro institution of national educational system, which shapes school settings, educational policy, and expectations, influences students' beliefs about the role of their abilities and efforts on achievement.

Recognizing these complex processes, the main objective of this study is not to examine the ways in which the institution of schooling influences non-cognitive skills development or academic achievement, but to test the validity of theoretical claims of non-cognitive skills with regards to academic achievement cross-nationally, net of school context and family SES, as a first step. Numerous studies continue to document significant impact of family socioeconomic status on students' achievement or achievement gaps, but the results consistently show that it does not explain all of the variance in student achievement. This study offers a new way of thinking about factors that matter for achievement above and beyond class background and other well-documented factors. Therefore, this study offers a broader purview of the varying associations between a particular non-cognitive skill and student achievement, net of family, school, and national differences. Building on the work by Baker et al. (2002) that documented the increased importance of the role of family SES relative to between-school differences, this study provides new evidence on the role of another key between-student difference, namely academic perseverance, from a cross-national perspective.

Grit, academic perseverance, and achievement

Grit literature

A relatively nascent and rapidly growing line of research on grit has captured much attention from scholars, policy-makers, educators, and the general public in recent years, so much so that the U.S. Department of Education had rolled out plans to measure grit since 2017 (U.S. Department of Education, 2016). Grit is defined as "perseverance and passion for long-term goals" (Duckworth et al., 2007). By definition, it combines the properties of perseverance—a non-cognitive skill in its own right—and the concept of passion for long-term goals (Duckworth, 2016). Duckworth and colleagues (2007) characterize gritty individuals as those with propensity to maintain "effort and interest over years despite failure, adversity, and plateaus in progress" (Duckworth et al., 2007). In contrast, less gritty individuals are characterized as those who are "more easily discouraged, prone to take 'naps' mid-course, and frequently led off track by new passions" (Duckworth & Eskreis-Winkler, 2013). In short, grit entails "stamina for long-term goals" in addition to perseverance of efforts (Duckworth, 2016).

The theoretical basis for grit stems from within the boundaries of personality theory. Duckworth and colleagues identify grit as a personality trait on par with the Big Five personality traits consisting of agreeableness, conscientiousness, extroversion, openness, and neuroticism. Although the grit research may seem recent, it builds on a long line of research from psychology, tracing back to William James (1907), recasting one of his questions on the reasons why "some individuals accomplish more than others of equal intelligence" (Duckworth et al., 2007). The search for traits that matter for individual success regardless of the domain has motivated Duckworth and colleagues, and they have shown that grit is one such non-cognitive skill that is essential to achieving success in every field. This relates to and is compatible with the human

capital framework, where the exogenous input of grit or perseverance as a non-cognitive skill enhances the outcome.

One of the core assumptions in theorizing grit is that individuals have varying levels of grit. Given that the construct of grit combines perseverance and passion for long-term goals, it is useful to dissect the construct and examine the two components that comprise grit. First, Merriam-Webster Dictionary defines perseverance as "continued effort to do or achieve something despite difficulties, failure, or opposition," and its etymological root traces back to a Latin word *perseverare* where per- means through and *severus* means severe. Perseverance by definition contains an unspecified temporal dimension, that is "continued efforts" exerted over time until goals are achieved despite challenges and setbacks along the way. This conventional definition of perseverance does specify the duration of continued effort; it could be short-, medium-, or long-term. Duckworth and colleagues (2007) highlight this temporal dimension by adding an extra focus on staying on course toward "long-term" goals. The added emphasis on persevering to achieve long-term goals is one of the two defining characteristics of grit, namely, passion.

Passion—or consistency of interest—for long-term goals is another key component of grit. Duckworth and colleagues (2007) argue that it is possible to persevere through difficulties to achieve one's goals. However, without passion, it becomes drudgery such that the effects of persevering may not be the same as persevering with a clear long-term goal. By adding the component of passion—or the consistency of interest—for long-term goals, Duckworth and colleagues distinguish between grit from drudgery, which may or may not be effective in achieving success. Moreover, it is possible for perseverant individuals to change their goals rather frequently such that their hard work is distributed to multiple non-long-term goals and its effect is diluted rather than focused on single long-term goal (Duckworth et al., 2007).

Combining the properties of both perseverance and consistency of interest for long-term goals, grit is a powerful non-cognitive skill that is theorized to predict success in all domains (Duckworth et al., 2007), including academics. This is not to say that innate talent or even luck does not play any role in one's success, but that grit plays a more significant role above and beyond the traditionally accepted predictors of one's academic achievement or success, such as intelligence or family socioeconomic background. Therefore, it is conceptualized as a powerful non-cognitive skill that can determine or explain one's success when other things are equal between individuals. If grit is indeed that one such factor that can make or break someone's success over and above other factors and even make up for deficits in some areas, it is important to establish a sound theoretical and empirical base to show its association with outcomes across large samples in various contexts through rigorous research.

Indeed, a body of research has shown the strong predictive power of grit on various educational and academic outcomes (Duckworth et al., 2007). For example, grit has been identified as a key predictor of retention among first-year West Point cadets (Duckworth et al., 2007; Maddi, Matthews, Kelly, Villarreal, & White, 2012). Other studies have shown the predictive power of grit on retention and graduation among high school students "over and beyond established context-specific predictors" such as IQ, physical aptitude, Big Five personality traits, and demographic characteristics (Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014; Robertson-Kraft & Duckworth, 2014), and on lifetime educational attainment (Duckworth & Quinn, 2009). These studies characterize gritty people as "working strenuously toward challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress" (Duckworth et al., 2007) and identify grit as a key predictor of longer-term academic success.

Likewise, prior studies show that grit is positively related to academic outcomes, such as GPAs. Grit has been found to be a stronger predictor of GPAs—an important academic outcome

for subsequent educational attainment—than IQ among high school students (Duckworth & Carlson, 2013) and a stronger predictor of GPAs than SAT scores among undergraduates (Duckworth et al., 2007; Strayhorn, 2014). For example, in a recent study (Duckworth et al., 2007) that examined the relationship between grit and the GPAs of undergraduate students at the University of Pennsylvania, grit was found to be positively associated with college GPAs ($r = .34$), when controlling for SAT scores. Although the sample size is small ($n = 139$) and it consists of a relatively homogeneous group of students at an elite university, it is interesting to note that the association is similar to that between GPA and SAT scores ($r = .30$). The findings also show that the grittier students tended to have higher GPAs but lower SAT scores than their less gritty students, indicating perhaps that having higher levels of grit compensated for the relatively lower SAT scores in higher GPAs. This suggests the possibility that grit can be negatively associated with one-off test scores among high-performing students.

A smaller but growing body of research has examined the relationship between grit—along with several other non-cognitive skills—and academic achievement measured by standardized test scores (Alexander, Entwisle, & Dauber, 2003; Duckworth et al., 2007; Normandeau & Guay, 1998; Trzesniewski, Moffitt, Caspi, Taylor, & Maughan, 2006; West, Kraft, Finn, Martin, & Duckworth, 2016). These studies show that grit predicts achievement test scores above and beyond IQ. For instance, Borghans, Golsteyn, Heckman, and Humphries (2011) show that grit and the Big Five personality traits explain the variance in the Armed Forces Qualification Test and Differential Aptitudes Test, a standardized achievement test often used to measure adults' pure intelligence in the economics literature, above and beyond the variance that IQ explains when both IQ and non-cognitive skills are included as predictors in a regression.

Similarly, studies that used the Big Five personality inventory found that Openness to Experience was associated with standardized achievement test scores of middle school students from three New York City middle schools (Martin, 1989) and Conscientiousness was associated

with standardized achievement test scores in kindergarten, controlling for IQ (Blair & Razza, 2007). Likewise, a study drawing on six large, longitudinal datasets showed that non-cognitive skills measured by task and questionnaires on attention skills at school-entry, predicted achievement test scores, controlling for school-entry academic skills (Duncan et al., 2007). These studies demonstrate that non-cognitive skills predict achievement test scores above and beyond cognitive ability or IQ, all in the case of non-nationally representative samples drawn in the United States.

A more recent study by West and colleagues (2016) has focused on comparing the role of grit along with a set of other non-cognitive skills on scores gains on achievement tests between fourth and eighth grades of students attending over-subscribed charter schools and public schools in Boston. West and colleagues show that grit is positively and significantly related to test-score gains of eighth graders between their fourth and eighth grade years at the individual level among students at both types of schools (West et al., 2016). However, they also report a paradoxical finding, which is that grit is not positively associated with score gains at the school level, which they attribute to reference bias. The authors explain that students attending different schools might assess their own level of grit differently depending on their reference group. For instance, compared with students attending public schools, students attending an over-subscribed charter school may self-report lower levels of grit because their reference group consists of more or less equally gritty peers attending the same over-subscribed charter school. The between-student differences in grit may vary more at public schools than at over-subscribed charter schools, where students are likely more similar in their levels of girt, among other academic characteristics.

While the findings provide meaningful evidence for the positive relationship between grit and achievement gains among middle school students in Boston, the inference from the results cannot be directly generalized to larger populations of students attending other schools elsewhere or students in other countries. Research on grit is in its infancy but rapidly growing. While many

of the existing studies within this young literature document a positive association between grit and academic achievement, these studies draw on relatively small samples, often select groups of high-performers. Thus, the results of these studies cannot be generalized to larger populations, much less cross-nationally.

Despite the rapidly growing literature on the predictive value of grit on various academic success and performance outcomes, empirical results remain mixed, often calling into question the construct validity and reliability of the grit scale. For instance, a recent meta-analytic synthesis of the grit literature has shown a moderate correlation between grit and academic performance (Credé et al., 2016), which contrasts previous findings (see Duckworth, 2013a; Duckworth et al., 2007; and Duckworth & Quinn, 2009). A particularly important finding to note is the discussion regarding the structure of grit construct, which is originally conceptualized as a higher-order construct with two lower-order facets of "perseverance of effort" and "consistency of interest" (Credé et al., 2016; Duckworth et al., 2007).

Credé et al. (2016) problematize the use of the single construct of grit, since the identification of the grit construct is not fully supported by an adequate model fit. That is, Credé et al. (2016) find that the model fit for grit as a single construct is not any better than the model fit for perseverance and consistency as two separate constructs. Pointing out that most research on grit focuses on the grit construct, rather than the two constructs that consist grit, they argue that it is important to examine the two components of grit—perseverance and consistency (or passion)—separately and together and compare the model fit with that of grit as a single construct. Doing so provides insights into which part of the grit construct matters more than the other, and whether grit merits to be a valid predictor of academic achievement over perseverance or consistency as separate constructs.

The perseverance of effort (perseverance) component of the grit construct proves to be more salient to the purposes of this project. First, as discussed earlier, the findings from a recent

meta-analysis inform that perseverance is a more reliable and significant predictor of outcomes, while consistency of interest is less so (Credé et al., 2016). Given the findings of the meta-analysis, this study further contributes to the literature by further illuminating the association between a separate construct of perseverance and academic achievement. Second, the structure and characteristics of the available cross-national data allow for the measurement of perseverance but not passion for long-term goals. Even if passion or consistency of interest for long-term goals is measured, the cross-sectional nature of the data does not allow for analyses of later outcomes.

The primary purpose of this project is not to further validate the construct of grit or perseverance as many psychologists are doing, but to build on extant research on grit and other non-cognitive skills to examine whether or not there is a significant association between academic perseverance and achievement in a cross-national framework and how it may vary across nations. I hypothesize that academic perseverance as defined, validated, and measured by PISA is significantly associated with achievement, although the strength or the magnitude of the association may vary cross-nationally. Doing so establishes, first, a clear case that shows that there is or isn't a significant association between academic perseverance as a key non-cognitive skill and achievement. Secondly, addressing these questions as a way to probe broader questions about what may be accountable for potential cross-national differences, for instance, the reasons why the association between perseverance and achievement is stronger in some countries/school systems, where non-cognitive skills are rewarded differently.

The broad definition of grit theoretically allows the construct to be generally applicable to multiple domains. Given the findings that personality traits like grit do not have the same effects in every domain, I problematize the lack of specificity of the construct. I make a case to define and measure the construct more narrowly for a specific domain, such as academic achievement in terms of standardized test scores. As mentioned previously, a recent meta-analysis of the grit literature reports that "the perseverance of effort facet has significantly stronger

criterion validities than the consistency of interest facet and that perseverance of effort explains variance in academic performance even after controlling for conscientiousness" (Credé et al., 2016).

Given this finding and the limitations and future research directions identified in Duckworth & Quinn (2009), I focus on the perseverance subscale of the grit scale to conceptualize academic perseverance as a domain-specific aspect of grit and detail how the grit scale and the academic perseverance scale converge and diverge. Before proceeding to do that, it is important to define academic perseverance first. In the next section, I introduce the concept of academic perseverance as a special case of grit as it builds on its perseverance of effort component.

Academic perseverance

Academic perseverance is a key non-cognitive skill that is theorized to be closely associated with academic achievement. Academic perseverance has been defined by other scholars as a broad, overarching term covering many non-cognitive skills. According to Farrington et al. (2012) in their valuable synthesis of literature on non-cognitive skills and academic achievement, "academic perseverance is a concept that, in its most basic form, addresses student effort and the resulting quality of academic behavior. By quality we refer to the intensity, direction, and duration of a student's academic behavior" (2012). While Farrington et al. categorize grit as a measure of academic perseverance, thus subsumed under the broader conceptual umbrella of academic perseverance, it is important to distinguish that academic perseverance is more specialized and narrowly focused than grit and does not necessarily pertain to the passion part of the grit scale. Thus, I conceptualize academic perseverance more narrowly as a special case of grit and treat it as such in this project. I first briefly discuss existing literature

on academic perseverance as a non-cognitive skill to set the context for a discussion of academic perseverance and academic achievement.

Academic perseverance is identified as one of the five categories of non-cognitive factors related to academic performance by Farrington et al. (2012), with the other four categories being academic behaviors, academic mindsets, learning strategies, and social skills. Academic perseverance boils down to "persistent effort in school" (Farrington et al., 2012), although various kinds of persistence is documented in the psychological literature. In this conceptual framework by Farrington et al (2012), academic perseverance subsumes grit and self-control.

The concept of academic perseverance closely builds on and extends the recent research on grit, which is defined as passion and perseverance for long-term goals. Academic perseverance is conceptually distinguished from the definition of grit in that its temporal component is not specified, whereas grit entails consistency of efforts for long-term goals. Building on Duckworth's grit theory and informed by Farrington et al.'s (2012) framework based on a synthesis of recent literature on grit, I conceptualize academic perseverance as a non-cognitive skill that can be learned and define it as *sustained conscious effort to achieve learning despite difficulties, failure, or a lack of instant gratification*. I argue that academic perseverance is a key non-cognitive skill associated with academic achievement for students around the world. In the next section, I discuss recent developments on research on grit and describe how the concept of grit and academic perseverance converge and diverge.

The grit scale

Both the original 12-item Grit Scale (or Grit-O) developed by Duckworth, Peterson, Matthews, and Kelly (2007) and the Short Grit Scale (Grit-S) (Duckworth & Quinn, 2009) have a

2-factor structure consisting of trait-level perseverance ("Perseverance of Effort") and passion ("Consistency of Interest") for long-term goals. Grit-S, which has four less items than Grit-O, is an improvement of the original Grit Scale in that it has improved psychometric properties (Duckworth & Quinn, 2009). Grit-S is correlated with educational attainment and fewer career changes among adults, and with later GPAs among adolescents.

Duckworth and Quinn (2009) acknowledge the domain-general nature of Grit-S rather than domain-specific, and call for further studies to explore the differences between in domain-general and domain-specific aspects of grit. While such a task is beyond the focus of this dissertation, the examination of domain-specific perseverance is achieved with the utilization of the academic perseverance scale from PISA 2012. In the next section, I provide a detailed comparison between the Grit-S scale and the academic perseverance scale.

Comparison between the perseverance component of grit and academic perseverance

In this section, I compare the perseverance of effort subscale of the S-Grit developed by Duckworth and colleagues and PISA's perseverance scale to analyze the ways in which they converge and diverge. The 8-item S-Grit scale consists of two subscales, one containing four questions for measuring consistency of effort (passion) and another containing four items for perseverance of effort. Given the focus on the perseverance component of grit, the comparison between the perseverance of effort subscale of the S-Grit scale and PISA's five-item perseverance scale is meaningful and appropriate. Both the perseverance of effort subscale of the S-Grit scale and PISA's perseverance scale do not concern future-looking or long-term goals that the consistency of interest subscale concerns.

For both scales, respondents rate their responses on a 5-point scale, where 1: *very much like* me to 5: *not at all like me*. Several questions on both scales are (questions 2, 4, 7, and 8 on the S-Grit scale and questions 3-5 on academic perseverance scale) are reverse-coded, meaning that 1: *not at all like me* and 5: *very much like me*. For both scales, the maximum score is 5 meaning the respondent is extremely gritty or extremely perseverant (See Table 2-1 for a comparison of the two scales).

The 8-item S-Grit scale contains four items that measure perseverance of effort: "I finish whatever I begin;" "Setbacks don't discourage me;" I am diligent;" and "I am a hard worker." These statements denote general tendencies rather than specific tendencies, meaning that they apply to any domains, including academic and occupational/labor market domains. These general statements are open to interpretation on the part of the respondent who self-rates on each of these items.

In comparison, PISA's perseverance scale contains five statements that are more specific to academic behavioral tendencies. The five statements are: "When confronted with a problem, I give up easily;" "I put off difficult problems;" "I remain interested in the tasks that I start;" "I continue working on tasks until everything is perfect;"; and "When confronted with a problem, I do more than what is expected of me." These statements focus on (academic) problem solving and task completion behavioral patterns, when faced with difficulties/setbacks, as evinced in the usage of terms, such as "problem(s)" and "tasks" prefaced by "when confronted with a problem." These are more situational and context-specific compared with the wording found in the perseverance subscale of grit.

Given the difference in general versus situational specific orientation of the two scales, the S-grit scale and PISA's perseverance scale share similarities in the wording of items that pertain to the concept of perseverance of efforts. All items are related to each other and there are overlaps between items from both scales, meaning that there are one-to-multiple correspondences

between the two scales. For instance, the statement “Setbacks don’t discourage me” from the S-grit scale corresponds to “When confronted with a problem, I give up easily” from PISA’s perseverance scale. They are the reverse of each other in terms of wording—one using double negatives and the other not—and so reverse-coded. But both of these statements refer to the tendency to persevere despite setbacks and difficulties. Put another way, they describe the pattern of response when faced with a problem or setback.

Another item from PISA’s perseverance scale “I put off difficult problems” also pertains to the reverse of the idea of pushing through setbacks or difficult problems. However, this statement is more closely related to the reverse of “I am diligent” from the S-Grit scale in that it denotes delaying working on difficult problems without a guarantee of returning to face/solve them. The respondent can put off difficult problems forever and may never return to face and solve them. Thus, this characterizes the lack of diligence.

Multiple items from PISA’s perseverance scale correspond to more than just one item on the S-Grit scale. For instance, “When confronted with a problem, I do more than what is expected of me” and “I continue working on tasks until everything is perfect” both pertain to the idea of “I am a hard worker,” “I am diligent,” and “I finish whatever I begin” from the S-Grit scale. Moreover, “I remain interested in the tasks that I start” from PISA’s perseverance corresponds to “I finish whatever I begin” from the S-Grit scale. (See Table 2-1).

*Table **2-1**: Comparison between the grit scale and the academic perseverance scale.*

Grit: Perseverance of effort (Duckworth & Quinn, 2009)	Academic perseverance (PISA 2012)
I finish whatever I begin.	(d) I continue working on tasks until everything is perfect. (c) I remain interested in the tasks that I start.
Setbacks don't discourage me.	(a) When confronted with a problem, I give up easily. (Reverse-coded) (e) When confronted with a problem, I do more than what is expected of me.
I am diligent.	(b) I put off difficult problems. (Reverse-coded) (d) I continue working on tasks until everything is perfect.
I am a hard worker.	(d) I continue working on tasks until everything is perfect. (e) When confronted with a problem, I do more than what is expected of me.

Notes: The perseverance of effort subscale, which consists of four items, of the Grit-S scale is reported here, but not the passion subscale. There are five items on the academic perseverance scale from PISA 2012, and more than one item is matched to each item on the perseverance of effort subscale of grit.

Challenges in studying non-cognitive skills in a cross-national framework

Self-reported measures in surveys have long been a topic of concern in terms of their construct validity and comparability within and across groups. Cross-national surveys face greater threats to construct validity given the various national and cultural contexts that may convey different interpretations of questions and responses, thus rendering comparability across nations less meaningful. Recognizing these issues, for instance, PISA has used psychometric techniques to consider the national and cultural contexts, in addition to carefully monitoring the process of translating survey questions and response choices into local languages (OECD, 2012).

Reference bias is another challenge in studying non-cognitive skills measured by self-reports (see Heckman & Kautz, 2014; Kyllonen & Bertling, 2013; West et al., 2016). Basically, the idea is that depending on the constituents of the reference group against which students rate

their non-cognitive skills (by answering a series of questions on a scale), the results may be biased in both directions. Relatedly, a significant association found at the student level may not be found at the classroom (Trautwein, Lüdtke, Schnyder, & Niggli, 2006), school (West et al., 2016), or even at country levels (Kyllonen & Bertling, 2013), partly due to reference bias at those levels.

Summary

This chapter reviews extant literature on non-cognitive skills across academic disciplines, focusing particularly on the nascent but rapidly growing research on grit. Evidence shows that grit is positively and significantly associated with many outcomes, including academic achievement, although the scope and number of the studies remain limited. Recent research findings from a meta analytic study of grit research show that the perseverance component of grit is much more significantly associated with academic achievement outcomes, while the passion component is often not. Duckworth and colleagues (2007, 2009) also have called for more domain-specific aspects of grit to be further explored in future studies. Building on both the recent research on grit within the larger non-cognitive skills literature, this study introduces a more narrowly defined concept of academic perseverance by focusing on the perseverance component of grit.

This study links the non-cognitive skills research with comparative and international education research to provide some of the first evidence on the association between academic perseverance and achievement in a cross-national perspective. Cross-national studies on grit and other non-cognitive skills remain extremely limited, despite increasing interests in the

measurement and study of non-cognitive skills in recent years. This study makes both empirical and theoretical contributions to the non-cognitive skills literature.

In addition, this study also contributes to the comparative and international education research. From a cross-national perspective with a neo-institutional lens, schooling itself empowers and develops various skills of students around the world (Meyer et al., 2010), and the institutionalization of mass schooling has subsequently homogenized school effects on achievement across nations, rendering between-student differences more salient than school effects on a global level (Baker et al., 2002), but not necessarily within countries. We do not have much evidence on the between-country variations, which are subsumed under global-level analyses that mask within-country variations. Thus, it is also important to examine the role that students play in their own learning and achievement within each country. Variation in the association between academic perseverance and achievement is likely to be present across nations, which will be tested and speculated in subsequent chapters.

In short, academic perseverance is a key non-cognitive skill that is theorized to be associated with achievement. This study makes both theoretical and empirical contribution by focusing on the perseverance component of grit to introduce a domain specific academic perseverance, and examines its association with academic achievement in a cross-national and comparative perspective, providing some of the first cross-national evidence.

Chapter 3

Data, Measures, and Methodology

This chapter provides a detailed description of the data, measurements of key explanatory variables, and the methodology employed in this dissertation. The chapter begins with the research questions and hypotheses deriving from the literature discussed in Chapter 2. This chapter then describes the PISA 2012 survey data utilized in this study, including details about the characteristics of the data, sampling frame, and unique strengths. The chapter provides a detailed justification for the analytic sample, all variables included in the analyses, analytic decisions made with regards to missing data, the empirical strategy with the use of ordinary least square (OLS) regression framework with fixed-effects, and model specification. This chapter ends with a brief note on innovations and main analytic limitations discussed in a summary.

Research Questions

Research on grit, though rapidly growing, remains nascent. More systematic studies using large samples need to be conducted to establish a convincing and consistent evidence base to support the theory of grit. Given the present dearth of large-scale and cross-national research on the association between grit and academic achievement, as well as the recent meta-analytic findings showing the significant role of the perseverance component—but not necessarily the passion component—of grit, this study examines and provides some of the first cross-national evidence on the role of perseverance on achievement scores. In other words, building on the concept and theory of grit within the larger non-cognitive skills literature, this study introduces a

more narrowly defined concept of academic perseverance and examines whether it is significantly associated with math achievement test scores among 15-year-olds in a cross-national perspective. In short, this dissertation examines whether or not there is a significant association between academic perseverance and achievement worldwide, and how the association might vary across nations, when controlling for student and school characteristics. Thus, I ask two interrelated questions:

1. Is academic perseverance significantly associated with achievement in a cross-national perspective?

2. What is the association between academic perseverance and achievement, net of student demographics and between-school differences, within countries?

Hypotheses

Extant literature on non-cognitive skills across various academic disciplines and fields documents significant associations between a diverse set of non-cognitive skills and academic achievement. However, the specific non-cognitive skills that matter for academic achievement and the extent to which they matter are not clear. Recent research on grit has shown that grit is a non-cognitive skill that is significantly linked to academic achievement at the student level (Duckworth et al., 2007; West et al., 2016). In short, the main findings of extant grit literature drawing on relatively small samples of mostly high-performing students suggest that grit is positively and significantly associated with academic achievement, often measured by course grades or GPAs. This means that gritty students earn better grades (Duckworth et al., 2007; Duckworth & Carlson, 2013; Strayhorn, 2014), score higher on standardized tests (Borghans et

al., 2011), and are more likely to graduate from high school (Eskreis-Winkler et al., 2014; Kautz & Research, 2015; Robertson-Kraft & Duckworth, 2014) than their less gritty peers.

However, a recent meta-analysis of studies on grit has highlighted that the perseverant component of grit is a strong and significant predictor while the passion component of grit often isn't (Credé et al., 2016; See also Datu, Valdez, & King, 2016). Focusing on the perseverance component of grit and introducing a more narrowly defined measure of academic perseverance, I hypothesize that academic perseverance is positively and significantly associated with academic achievement cross-nationally. In other words, I hypothesize that the association between academic perseverance and achievement is positive and significant among students around the world.

Extant research evidence shows that grit predicts academic outcomes at the individual level, including student achievement test scores, above and beyond other predictors, such as luck and talent (Borghans & Duckworth, 2008; Eskreis-Winkler, Shulman, Beal, & Duckworth, 2014). However, aggregated at the classroom or school level, the association may vary as reported by recent studies drawing on large datasets. For instance, recent studies on grit and other non-cognitive skills (West et al., 2016) highlight the issue of reference bias in survey data (See Chapter 2 and the summary in this chapter for a more detailed discussion on reference bias). West et al. (2016) show that the significant association found between grit and achievement at the individual level does not hold at the school level (See also Trautwein et al., 2006 in the case of the association between predictors and homework effort at the student and classroom levels). Given this, one assumption is that the association between academic perseverance and achievement likely varies across nations, net of student demographics and between-school differences.

The notion of "luck" and "talent" often refer to factors that are out of students' control, for instance, students' family socioeconomic status (SES) and school characteristics—both

observed and unobserved—which have been shown to be associated with students' achievement by an extensive body in the education literature. Research in the field of comparative and international education has investigated the relative contribution of the two—family SES and school characteristics or "quality," often broadly and variously defined—on student achievement across nations (Baker et al., 2002; Heyneman & Loxley, 1983). Yet, other than family SES, evidence on the role of between-student differences, including students' non-cognitive skills, on achievement remains scarce. This study focuses on a particular between-student difference, namely, academic perseverance, building on the theory of grit to test the efficacy of perseverance on achievement scores cross-nationally.

The grit argument would state that, when holding constant students' demographics including family SES, students who persevere in their learning despite setbacks and difficulties, would achieve higher than those who do not. In their analytic discussion of grit, Duckworth and colleagues (2007, 2009) do not distinguish between efficacious perseverance and less efficacious perseverance. Instead, they emphasize the long-term goal element in the consistency of interest (or passion) component of grit to distinguish grit from simple drudgery that may or may not be as effective. By implication, then, goal-oriented academic perseverance is considered effective as it is purposeful, although it is not clear whether or not there is a threshold above which academic perseverance or grit is negatively linked with outcomes.

Thus, I hypothesize that academic perseverance will be positively and significantly associated with achievement within each country, net of student demographics and between-school differences, albeit the magnitude of the association may vary across nations. In other words, this is to say that although the association between academic perseverance and achievement is hypothesized to be positive and significant for each country in the sample, the magnitude or size of the association is likely to vary across nations, given that the dominant national cultural attitudes may support perseverance over fluid intelligence or what is considered

a type of innate and fixed intelligence—or vice versa. Just as those dominant national cultural attitudes valuing perseverance result in learning cultures that promote student engagement with learning more effectively than those that don't, the association between academic perseverance and achievement may vary as a function of that, which is beyond the scope of this study but crucial to examine in future research.

In summary, I hypothesize the following:

Hypothesis 1: Academic perseverance will be positively and significantly associated with achievement.

Hypothesis 2: Academic perseverance will be positively and significantly associated with achievement, net of student demographics and between-school differences, within each country.

Data

I draw on data from the PISA 2012 survey, which is a cross-national survey that measures the skills and knowledge of nationally representative samples of 15-year-old students in mathematics, reading, and science every three years as a way to evaluate education systems around the world since 2000. There are other cross-national surveys that measure students' knowledge in mathematics and other academic domains. For instance, the Trends in International Mathematics and Science Study (TIMSS) assesses students' curricular-based knowledge in mathematics and science at the fourth and eighth grades across countries in a four-year cycle. For the TIMSS 2011 assessment, 52 educational systems for the fourth grade and 45 for the eighth grade participated. Unfortunately, TIMSS and other existing cross-national assessments of students' knowledge in math as well as other academic domains do not measure non-cognitive skills like PISA 2012 does.

In fact, PISA 2012 is one of the very few, if not the only, existing large-scale, standardized, and cross-national surveys that measure students' academic perseverance and achievement, along with a rich set of student and school characteristics for a nationally representative sample of students from a large set of countries. More countries (more than 60 countries) participate in PISA surveys than in TIMSS, thus utilizing PISA surveys provides a larger sample of nationally representative student samples from a larger set of countries. Furthermore, the target population for PISA surveys consists of 15-year-olds, who most often tend to be high school students in most countries. It is assumed that older students will have further developed and stabilized non-cognitive skills than their younger counterparts, such that the findings may have more currency. These characteristics make PISA 2012 the most appropriate and efficacious source of data for this study. Each PISA survey has a particular focus on one of the three test domains. For instance, PISA 2012 focuses on mathematics.

PISA uses a two-stage stratified sampling design, in which individual schools (first-stage or primary sampling units) that have 15-year-old students were sampled first, followed by a sampling of students (second-stage sampling units) within sampled schools. This multi-stage sampling design produces a nationally representative sample of students for each country. Data are collected from student assessments as well as questionnaires for students, school principals, and parents. In the 2012 survey, around 510,000 students between the ages of 15 years 3 months and 16 years 2 months participated, representing about 28 million 15-year-olds in the schools of the 65 participating countries and economies (OECD, 2014). All 34 OECD member countries as well as 31 non-member countries and economies participated in the 2012 survey.

I restrict my analytic sample to students in nations and exclude sub-national economies (e.g., Hong Kong, Macao, Shanghai, Taipei) due to the lack of national representativeness of the student data. I also exclude Albania and Lithuania due to low observations on key variables. The OECD's rotated PISA context questionnaire scheme that creates missing values at random further

restricts my sample. Given the context questionnaires containing the main independent variable of interest for this study reaching every 2 out of every 3 students randomly by design, I only include students who were randomly given questionnaires that contained questions about academic perseverance, which is a practice consistent with past research (Mijs, 2016). The final analytic sample for this study includes 57 nations in which more than 280,000 students are nested in more than 16,000 schools.

*Table **3-1**: Frequency table of the analytic sample.*

Country code 3-character	Students Freq.	Percent	Cumulative Percent
1. ARE	7,094	2.52	2.52
2. ARG	3,586	1.27	3.79
3. AUS	8,939	3.17	6.96
4. AUT	3,088	1.1	8.06
5. BEL	5,316	1.89	9.94
6. BGR	3,242	1.15	11.09
7. BRA	11,671	4.14	15.24
8. CAN	13,729	4.87	20.11
9. CHE	7,202	2.56	22.66
10. CHL	4,466	1.58	24.25
11. COL	5,406	1.92	26.17
12. CRI	2,835	1.01	27.17
13. CZE	3,435	1.22	28.39
14. DEU	2,575	0.91	29.31
15. DNK	4,690	1.66	30.97
16. ESP	16,315	5.79	36.76
17. EST	3,086	1.1	37.86
18. FIN	5,655	2.01	39.86
19. FRA	2,898	1.03	40.89
20. GBR	8,075	2.87	43.76
21. GRC	3,307	1.17	44.93
22. HRV	3,265	1.16	46.09

23. HUN	3,134	1.11	47.2
24. IDN	3,590	1.27	48.47
25. IRL	3,238	1.15	49.62
26. ISL	2,162	0.77	50.39
27. ISR	3,079	1.09	51.48
28. ITA	20,010	7.1	58.58
29. JOR	4,281	1.52	60.1
30. JPN	4,105	1.46	61.56
31. KAZ	3,789	1.34	62.9
32. KOR	3,337	1.18	64.09
33. LTU	2,943	1.04	65.13
34. LUX	3,286	1.17	66.3
35. LVA	2,774	0.98	67.28
36. MEX	21,643	7.68	74.96
37. MYS	3,290	1.17	76.13
38. NLD	2,826	1	77.13
39. NOR	2,995	1.06	78.2
40. NZL	2,694	0.96	79.15
41. PER	3,545	1.26	80.41
42. POL	3,008	1.07	81.48
43. PRT	3,340	1.19	82.66
44. QAT	6,267	2.22	84.89
45. ROU	3,303	1.17	86.06
46. RUS	3,386	1.2	87.26
47. SGP	3,632	1.29	88.55
48. SRB	2,919	1.04	89.59
49. SVK	2,975	1.06	90.64
50. SVN	3,673	1.3	91.95
51. SWE	2,999	1.06	93.01
52. THA	4,305	1.53	94.54
53. TUN	2,750	0.98	95.51
54. TUR	3,122	1.11	96.62
55. URY	3,274	1.16	97.78
56. USA	3,143	1.12	98.9
57. VNM	3,105	1.1	100
Total	281,797	100	

Notes: Nationally representative samples of 15-year-old students.

Measurement of variables

Math achievement

The dependent variable is mathematics achievement test scores (hereafter, math achievement or achievement). Math achievement is an important educational outcome as it has been shown to predict academic success in other academic subjects as well as educational attainment and labor market outcomes (Adelman, 2006; Duncan et al., 2007; Rose & Betts, 2004). Moreover, compared to reading or science achievement test scores, mathematics achievement has been shown to be less sensitive to students' socioeconomic status (Bol et al., 2014; Driessen, Sleegers, & Smit, 2008). PISA reports five plausible values for each student's math achievement scores. All test scores are standardized to a mean of 500 and a standard deviation of 100 across all nations. The cross-national mean of math achievement scores is about 500 and the mean score for each country varies significantly, ranging from 400-600s. All analyses in this project use all five plausible values for math achievement scores and appropriate weights as recommended by PISA (OECD, 2014).

Academic perseverance

The main independent variable of interest is academic perseverance (hereafter, perseverance), which is a latent construct measured through self-reported questionnaires in the PISA 2012 survey. The perseverance variable is a composite index term that is created based on five items about the student's perseverance in the context of academics, thus it has a narrower scope than perseverance that is usually defined in a dictionary or in personality psychology, for instance. Each of these five items, which are also available as separate individual variables, is

constructed based on student responses to a question: "How well does each of the following statements below describe you?" and students rate their responses for each of the following five items on a 5-point scale (1: *very much like* me to 5: *not at all like me*): (1) "When confronted with a problem, I give up easily"; (2) "I put off difficult problems"; (3) "I remain interested in the tasks that I start"; (4) "I continue working on tasks until everything is perfect"; and (5) "When confronted with a problem, I do more than what is expected of me." The last three items are reverse-coded. The perseverance index is standardized to a mean of 0 with a standard deviation of 1. The higher the score on the perseverance scale, more perseverant a student is.

*Table **3-2**: Program for International Student Assessment's scale of perseverance.*

Question	"How well does each of the following statements below describe you?"
Response category	1-5, where 1: *very much like* me to 5: *not at all like me*
ST93Q01	"When confronted with a problem, I give up easily."
ST93Q03	"I put off difficult problems."
ST93Q04	"I remain interested in the tasks I start."
ST93Q06	"I continue working on tasks until everything is perfect."
ST93Q07	"When confronted with a problem, I do more than what is expected of me."

Source: OECD. (2014). *PISA 2012 technical report*. Paris: OECD Publishing.
Note: The last three questions are reverse-coded such that a higher score indicates a higher level of perseverance.

Given PISA's major goal of developing cross-nationally comparable measures, cross-country validity of the perseverance variable has been of particular importance. Toward this goal, the OECD has thoroughly and closely monitored the process of questionnaire translation into different languages and applied psychometric techniques to assess the degree of consistency in construct validity within and across participating nations (Oecd, 2012, 2014). This entailed checking internal consistency of each scaled index within countries, assessing the reliability of

the scales across individual countries, estimating correlations for some scales that are thought to be related, and checking for consistency in such correlations across countries (Oecd, 2012, 2014). The perseverance variable is an index that has "a high degree of internal consistency for both OECD and partner countries" and the scale reliability is .80 (OECD median) and .79 (partner countries' median) (Oecd, 2012, 2014). These high degrees of internal consistency and reliability of the perseverance scale allows for meaningful cross-national analyses that compare the role of students' academic perseverance on achievement within and across countries, which can inform policy and practice.

The highly consistent and reliable scale of academic perseverance compares well with the perseverance of effort subscale of the grit scale. As shown in Table 3-3, academic perseverance is more narrowly defined and domain-specific, which relates to students' academic learning and task behavior, while the perseverance of effort subscale is broader (in scope and themes) and more general in nature as reflected in the item wording. As shown in Table 3-3, more than one item from the academic perseverance scale matches with each of the four items on the perseverance of effort subscale, which is an evidence of their compatibility. The overlaps between and within each scale also indicate that all items are correlated, as reported separately in previous studies (Duckworth & Quinn, 2009) and technical reports (Oecd, 2012, 2014).

*Table **3-3**: Comparison between the grit scale and the academic perseverance scale.*

Grit: Perseverance of effort (Duckworth & Quinn, 2009)	Academic perseverance (PISA 2012)
I finish whatever I begin.	(d) I continue working on tasks until everything is perfect. (c) I remain interested in the tasks that I start.
Setbacks don't discourage me.	(a) When confronted with a problem, I give up easily. (Reverse-co (e) When confronted with a problem, I do more than what is expec of me.
I am diligent.	(b) I put off difficult problems. (Reverse-coded) (d) I continue working on tasks until everything is perfect.
I am a hard worker.	(d) I continue working on tasks until everything is perfect. (e) When confronted with a problem, I do more than what is expec of me.

Notes: The perseverance of effort subscale, which consists of four items, of the Grit-S scale is reported here, but not the passion subscale. There are five items on the academic perseverance scale from PISA 2012, and more than one item is matched to each item on the perseverance of effort subscale of grit.

Control variables

This study includes a set of student characteristics in the models to control for key student demographic characteristics. Student-level control variables that past research has documented as being correlated with students' academic achievement include students' age, gender, grade, family SES, and immigration status. Consistent with literature, observations of the data indicate that older students, boys, and students in a higher grade than a in lower grade tend to score higher on math achievement tests. Thus, I control for age, grade, and gender (dummy indicating female=1, male=0). Furthermore, an extensive body of research has shown that students from high-SES families perform better than students from low-SES families and that immigrant students underperform relative to native students. Thus, I control for family SES (PISA's index of economic, social, and cultural status) and the immigrant status of students

(dummy indicating 1=immigrant, 0=native). The missing cases on these control variables were less than 2 percent (i.e., age <.03 percent, grade <.2 percent, family SES <1.5 percent, immigration status <1.79 percent missing) of the data and they were removed from the analytic sample using a list-wise deletion method.

For the global-level preliminary analysis, country dummies are created and included in the models to control for unobserved heterogeneity at the country level. The inclusion of country dummy variables allows for an estimation of a country-effect, controlling for student-level control variables, that may be correlated with variation in students' math achievement scores. For within-country analyses, school dummies are created and included in the models to control for any observed and unobserved between-school differences that maybe correlated with student-level math achievement. In both cases of country dummies and school dummies, one dummy is always excluded from the model to serve as the reference group.

Empirical Strategy

I examine the association between students' academic perseverance and math achievement scores in a cross-national and comparative framework. Specifically, I explore whether there is a significant association between academic perseverance and achievement, both globally and within individual countries. The primary focus of this project does not entail identifying or modeling specific country-level characteristics that may predict students' math achievement or interact with the effect of students' academic perseverance differently on math achievement. Instead, the primary focus of this project is to first establish a strong empirical evidence base for the theorized association between students' academic perseverance and achievement worldwide and how that association might vary cross-nationally. This section briefly

describes the main empirical strategy to address the two research questions followed by a more detailed discussion of the steps taken in the analyses.

I employ an OLS regression framework to address the two interrelated research questions. For the first research question, I use two approaches. First, as a preliminary analysis, I estimate an OLS regression model with country-fixed effects to explore the association between academic perseverance and achievement at the world level, using a pooled sample of 57 countries. The use of country-fixed effects approach removes an omitted variable bias at the country level and the estimated regression coefficient of academic perseverance is less biased. Then, I include student-level control variables to examine whether the association between academic perseverance and achievement changes at the world level. For the second research question, I examine the association between perseverance and achievement, net of student demographics and between-school differences, in each country. For this, I estimate OLS regression models with school-fixed effects for each country in the sample to examine the association between academic perseverance and achievement within each country, which would allow me to compare the association cross-nationally. In other words, I specify OLS regression models with school-fixed effects for each country to control for observed and unobserved between-school differences and include student's age, grade, gender, family SES, and immigrant status as control variables.

Prior to conducting the main regression analyses, I begin with exploring descriptive statistics, including the means, standard deviations, and ranges of all variables to examine how the key variables, such as academic perseverance and achievement, vary across countries. This is important because statistically significant variation among the key variables would allow for a meaningful regression estimation. Data are weighted to give equal weight to each student and country in the sample. All appropriate student weights are used as recommended by PISA.

The analytic approach proceeds in three steps to address the research questions. The first stage concerns the first research question (RQ 1) on the association between academic perseverance and achievement. Model 0 includes no predictor but country dummies only to estimate the proportion of variance in math achievement that is attributable to between-country differences. This sets a baseline from which to estimate the additional variance explained by including academic perseverance in subsequent models. Model 1 estimates an OLS regression with country-fixed effects where the outcome variable is student-level math achievement and the independent variable is student-level academic perseverance, using the pooled sample of 57 countries. I include country dummies to control for unobserved heterogeneity at the country level. In other words, Model 1 examines the association between academic perseverance and achievement worldwide, controlling for the variation in math achievement that is associated with between-country differences. In Model 2, I add student-level control variables, including age, gender, grade, immigration status, and family SES to examine whether the association between academic perseverance and achievement changes in significance, direction, and magnitude.

While the regression results from the pooled sample are useful in providing a worldwide pattern in the association between academic perseverance and achievement, net of between-country differences, they mask cross-national variation that may exist in terms of the direction, significance, and the magnitude of strength in the academic perseverance-achievement association. Thus, I examine cross-national variations (RQ2) in the association between academic perseverance and achievement. Since there are no school-level (level 2) independent variables of interest, I employ OLS regression models with school fixed effects rather than hierarchical linear models. I adopt school-fixed effects approach to control for both observed and unobserved between-school differences that may influence student math achievement. The school-fixed effects approach removes between-school differences from the model, thereby removing any school factors that may be associated with math achievement scores.

In Model 3, I only include school dummies to estimate the proportion of total variance in math achievement that is explained by between-school differences in each country. This model establishes a baseline before assessing the additional variance in math achievement scores explained by academic perseverance. In all subsequent models, between-school differences are controlled.

In Model 4, I estimate the association between academic perseverance and achievement for each country in the sample by specifying an OLS regression that includes students' academic perseverance as the sole independent variable and achievement as the outcome variable, while fixing between-school differences. In Model 5, student-level controls are added to examine if and how much the association changes in its significance, direction, and magnitude.

The models for estimating the association between academic perseverance and achievement in this study are specified as the following:

Pooled sample of all countries (estimates are weighted averages across all countries)

$$Y_i = \beta 0_i + \sum_{k=k-1} \beta x Dk + e_i \quad \text{[EQ 3.0]}$$

$$Y_i = \beta 0_i + \beta 1 \text{perseverance}_i + \sum_{k=k-1} \beta x Dk + e_i \quad \text{[EQ 3.1]}$$

$$Y_i = \beta 0_i + \beta 1 \text{female}_i + \beta 2 \text{age}_i + \beta 3 \text{grade}_j + \beta 4 \text{immig}_i + \beta 5 \text{SES}_i + \beta 6 \text{perseverance}_i + \sum_{k=k-1} \beta x Dk + e_i \quad \text{[EQ 3.2]}$$

Within-country models

$$Y_i = \beta 0_i + \sum_{s=s-1} \beta x Ds + e_i \quad \text{[EQ 3.3]}$$

$$Y_i = \beta 0_i + \beta 1 \text{perseverance}_i + \sum_{s=s-1} \beta x Ds + e_i \quad \text{[EQ 3.4]}$$

$$Y_i = \beta 0_i + \beta 1 \text{female}_i + \beta 2 \text{age}_i + \beta 3 \text{grade}_j + \beta 4 \text{immig}_i + \beta 5 \text{SES}_i + \beta 6 \text{perseverance}_i + \sum_{s=s-1} \beta x Ds + e_i \quad \text{[EQ 3.5]}$$

In the above equations, Y_i is the score on the mathematics achievement test for individual *i*; $\beta 1_i$ to $\beta 5_i$ are all the estimates for the individual-level covariates (gender, age, grade, immigration status, and family SES, respectively); β_6 is the estimate of the effect of the main independent variable of interest *perseverance* on *math achievement scores*; β_x estimates the fixed effects for countries by adding dummies (dummy D for country *k* or school *s*); and e_i is the error term at the student level.

Summary

This chapter provides a detailed description of the empirical analyses undertaken in this dissertation, beginning with research questions, hypotheses, data, analytic sample, measurement of variables, the methodology employed, and regression model specifications with fixed-effects. In terms of data, PISA 2012 is utilized given that it is the one of the very few large-scale datasets measuring non-cognitive skills of students of the same age around the world. The analytic sample consists of 57 countries, excluding sub-national economies, for comparisons between nationally-representative samples of students. Moreover, Albania and Lithuania are excluded from the sample due to low observations on key variables. In total, the analytic sample consists of 57 countries in which more than 16,000 schools and 281,797 students are nested. All variables included—as well as the treatment of missing data—in the analyses are described along with justifications. In addition to the description of the academic perseverance index scale from PISA 2012, a comparison between the perseverance of efforts subscale of the grit scale and the academic perseverance scale is provided. The method of OLS regression with fixed effects is detailed along with equations and the ways in which it addresses omitted variable bias or unobserved heterogeneity that is a chronic issue in studies with survey data. For instance, the

school-fixed effects approach controls for any between-school differences within a country, thereby removing an omitted variable bias at the school level. As a result, the regression coefficients of academic perseverance are less biased.

Still, some analytical limitations and potential sources of bias remain, mainly due to the nature of the data utilized. First, given the nature of cross-sectional data without prior achievement scores to be used as controls (baseline), only associations are elucidated. Therefore, this study makes no causal inferences or claims. Relatedly, the regression estimates are likely to be upward biased given the lack of prior achievement scores or IQ scores to serve as controls, although regression with fixed effects modeling removes the omitted variable bias at the school and country levels, respectively.

Second, the data on the measurement of academic perseverance is not immune from the potential issue of reference bias. Past studies have shown that significant associations found at the individual level does not always hold at the classroom (e.g., Trautweins et al.' (2006) work on homework) or school levels (e.g., West et al., 2016), and it is plausible that the association may or may not hold at the country level. For instance, West et al.'s study (2016) shows that while grit is positively and significantly associated with student achievement score gains between 4^{th} and 8^{th} grade years, the association loses its significance when aggregated at the school level, meaning that grit and score gains are found to be not related at the school level. The authors point to the issue of reference bias that may influence students to self-report their level of grit relative to their reference group at each school, with students attending over-subscribed charter schools, where the mean level of grit is likely higher, scoring lower on the grit scale than their peers attending public schools.

Likewise, a reference bias may exist in the PISA 2012 data, especially across countries. As mentioned previously in this chapter, some countries may place a higher premium on perseverance while others value fluid intelligence more, thus creating divergent learning cultures

and attitudes that may influence students' perseverance levels, real or self-perceived. For instance, students living in nations where perseverance is highly regarded and most students are academically perseverant and studying hard may perceive that they need to do study harder, because of their perception of their equally hard working and academically persevering peers—their reference group. The large number of countries in the sample helps to test and extrapolate whether there are significant differences in academic perseverance among students living in different countries. In fact, cross-national comparisons of the mean levels of academic perseverance will provide evidence for variations across nations. Theoretically, the theory of grit should hold at both the individual- and the country-level, although country-level evidence remains unsubstantial to date to draw any solid inference. While it is possible that the theory of grit holds at the individual level but not at the national level, it may also be the case that the magnitude of the association varies across nations. The scope of this dissertation covers up to that much, and what would explain those between-country differences must be addressed in a future study.

In summary, this chapter introduces a more narrowly defined concept of academic perseverance based on the theory of grit. The empirical analyses conducted in this study, which are based on the theory of grit within the larger non-cognitive skills literature as well as comparative and international education research, shed light on the role of academic perseverance as a key non-cognitive skill theorized to be associated with academic achievement measured by standardized test scores, within a cross-national framework. The results presented in the following chapter (Chapter Four) constitute some of the first cross-national evidence on the association between academic perseverance and achievement and how it may vary across nations.

Chapter 4

Empirical Results

This chapter describes the results of the empirical analyses detailed in Chapter Three. Beginning with reviewing descriptive statistics, this chapter presents results from OLS regression models to address the two interrelated research questions: (1) Is academic perseverance associated with achievement in a cross-national perspective? (2) What is the association between academic perseverance and achievement, net of student demographics and between-school differences, within countries?

Following a discussion of the descriptive statistics for the analytic sample consisting of 57 countries pooled together, results from a world-level regression with country-fixed effects on the association between academic perseverance and achievement are presented as part of a preliminary analysis to explore a general global trend. To examine cross-national variations, regression results with and without school-fixed effects for each country, are presented in graphical representations and in tables for cross-national comparisons. Full regression models with school-fixed effects and student-level control variables for each country are reported to show how the association between academic perseverance and achievement might change when controlling for student demographics and any between-school difference within each country. Finally, all models are estimated using STATA. Key results are presented in tables and figures, along with detailed explanations. For all analyses, statistical significance is set at $p<.05$. Additional tables and figures are presented in the Appendix as indicated.

Descriptive statistics

Table 4-1 provides descriptive statistics for all variables employed for this study. It presents the mean, standard deviation, and the minimum and maximum values for each variable used in this study. The analytic sample consists of 281,797 students attending more than 1,600 schools in 57 countries.

Table **4-1**: Descriptive statistics of all variables

Variable	Mean	Std. Dev.	Min	Max
Perseverance	0.134	0.999	-4.053	3.529
Age	15.784	0.290	15.17	16.33
Female	0.512	0.500	0	1
Grade	-0.137	0.632	-3	3
Family SES	-0.242	1.134	-5.63	3.69
Immigrant	0.054	0.226	0	1
PV1math	470.801	98.864	41.915	896.799
PV2math	470.844	98.906	80.472	902.952
PV3math	470.832	98.926	95.973	911.598
PV4math	470.824	98.942	108.436	912.377
PV5math	470.846	98.962	60.921	885.893

Source: This study's analytic sample of the PISA 2012 (*N*=281,797).
Notes: This table reports the descriptive statistics of all 57 countries pooled together. Data are weighted to give equal weight to each country.

The mean math achievement score across all countries in the sample is approximately 471, with a standard deviation of about 100. The mean level of perseverance across all countries in the sample is .134, which ranges from a minimum value of -4.053, and a maximum value of 3.529, with a standard deviation of 1. The correlation between all variables is reported in Appendix A. The correlation between academic perseverance and achievement is positive in each of all 57 countries, as reported in Appendix B.

Figure 4-1 below presents the mean math achievement scores for each of the 57 countries in the sample. Singapore has the highest mean math achievement score of nearly 570 points, followed by South Korea (555 points), Japan (534 points), Switzerland (533 points), the Netherlands (531 points), and Germany (527 points). At the other end of the spectrum, Peru has the lowest mean math achievement score (377 points), along with Indonesia (378 points), Columbia (384 points), Qatar (386 points), Tunisia (393 points), Argentina (394 points), Jordan (395 points), and Brazil (396 points), all of which have a mean score below 400 points. The United States (U.S.) ranks about in the middle, with a mean math achievement score of 483, which is slightly below the international average of 500, but slightly above the analytic sample mean score of 471 points. Sweden closely follows the U.S. and is followed by countries including Israel (475 points), Turkey (448), and Kazakhstan (433 points).

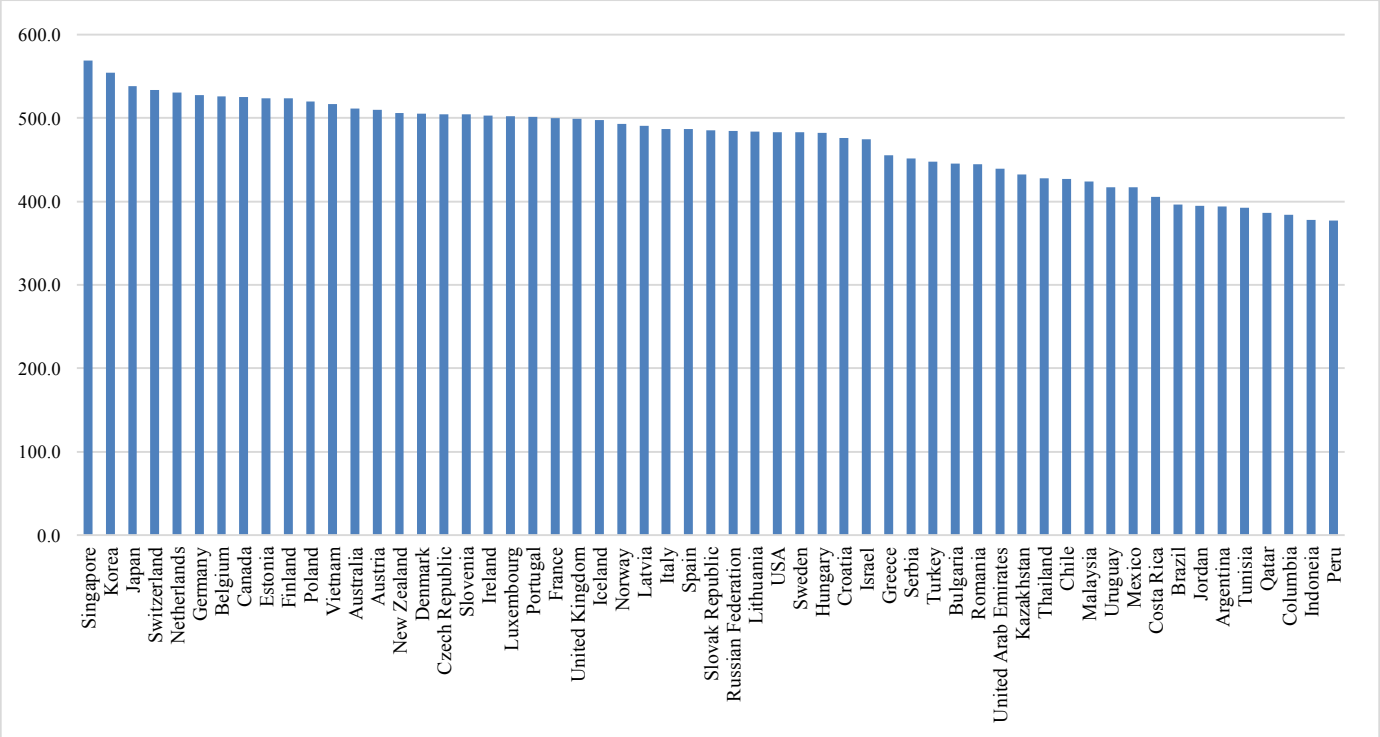

Figure 4-1: Mean of math achievement score for each of the 57 countries in the analytic sample.

In terms of standardized means of academic perseverance, one of the most interesting trends to note is that many of the mid- to low-performing nations in math achievement rank high in the mean level of academic perseverance, as shown in Figure 4-2. Kazakhstan takes the top spot, with a mean perseverance level of nearly .8 (or .788), which is well above the sample mean of .136. Bulgaria and Russia follow Kazakhstan's lead in students' level of academic perseverance, with .590 and .499, respectively, followed by Costa Rica, Vietnam, Turkey, United Arab Emirates, Columbia, and Portugal. Interestingly, Jordan and Peru, two of the lowest-performing countries in math achievement, rank at 10th and 12th spots for the mean academic perseverance level, with .383 and .363, respectively. The United States, ranking at 11th, has a mean perseverance level of .383.

On the other hand, some of the highest-performing nations in math achievement seem to have the lowest levels of academic perseverance, compared with their peers in other countries. For instance, Japan, which ranks third in math achievement score, has an academic perseverance mean of -.597, which is the lowest in the empirical sample. Similarly, high-performing nations such as Switzerland (-.151), the Netherlands (-.137), and Korea (-.093) all have negative values on the standardized scale of students' self-ratings of academic perseverance, meaning that students in these countries rate themselves lower on the academic perseverance scale than their peers in other countries, despite their strong performance in math achievement.

While the majority of countries have positive mean levels of academic perseverance, in several countries, the mean level of academic perseverance is not significantly different from zero. For instance, Romania, Argentina, and Austria have means not significantly different from zero. Germany, Hungary, Finland, and New Zealand all have means close to zero as well. These countries have mean levels close to the international mean level of academic perseverance, which is the standardized mean of zero. The analytic sample mean, as expected, is close to that, which is .134, with a standard deviation of 1. See below Figure 4-2.

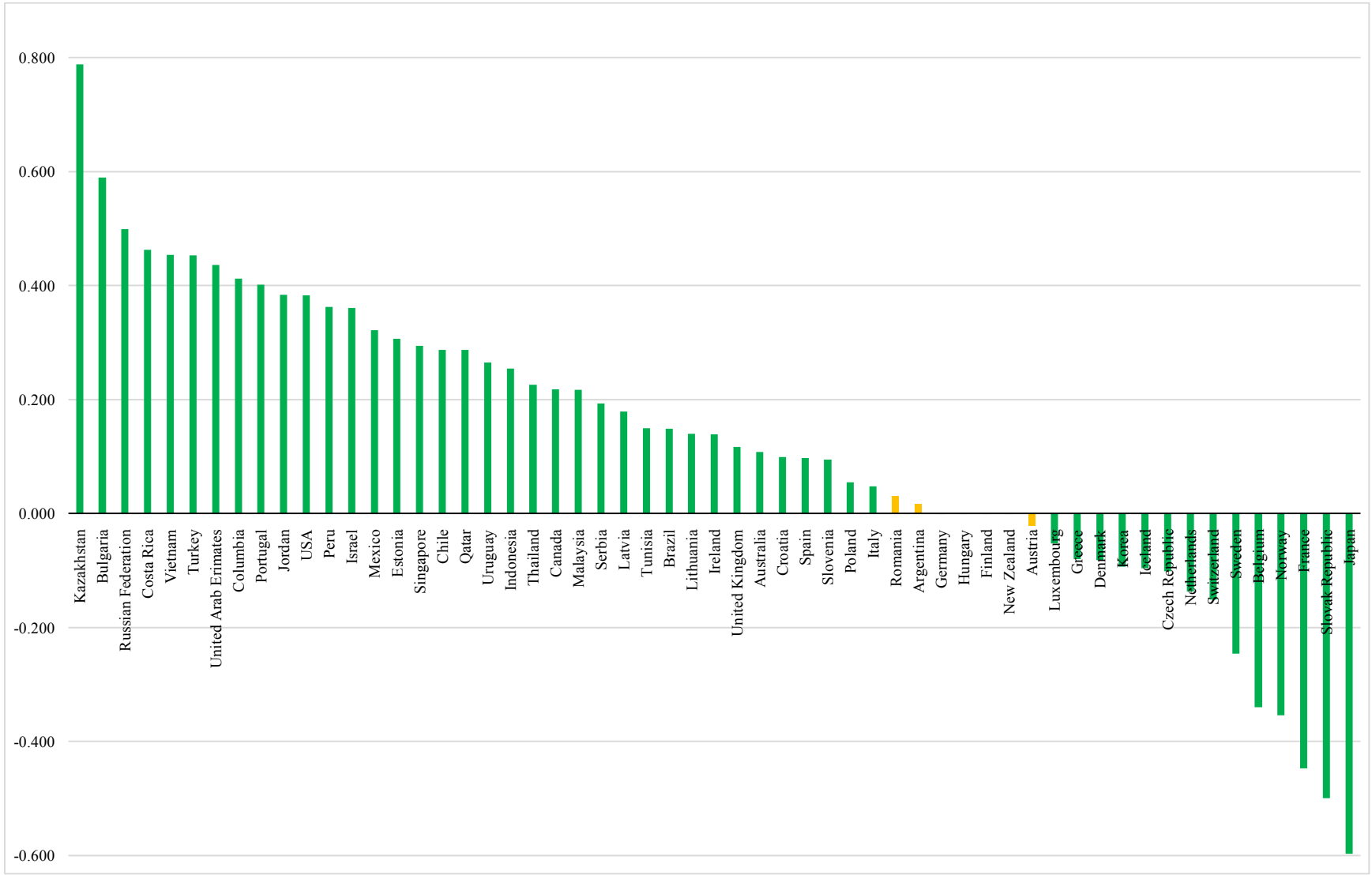

Figure 4-2: Mean level of academic perseverance for each country in the sample.

Main findings

Findings from preliminary analyses using a pooled sample of 57 countries

I begin with a set of preliminary analyses using the pooled sample of all 57 countries. Model 0 has no predictor but only country dummies to estimate the proportion of total variance explained by observed and unobserved between-country differences. The proportion of total variance in math achievement attributable to between-country differences, while itself is not central to the main purposes of this study, is calculated to control for them, in the preliminary analyses. Results reported in Table 4-2 indicate that about 30 percent of the total variance in math achievement is attributable to between-country differences (Note: a null model using a hierarchical linear modeling approach produces a very similar result.).

Results from Model 1, which includes academic perseverance as the sole independent variable of interest, with country dummies to control for country differences, suggest that there is a positive and significant association between academic perseverance and achievement. The regression coefficient of academic perseverance represents a weighted average for all 57 countries pooled together. This means that on average, each unit increase in mean perseverance is associated with a nearly 16-point increase in mean math achievement scores for students around the world. About 32.6 percent of the total variance in math achievement is explained by Model 1, of which about 2.3 percent is explained by academic perseverance.

In Model 2, the association between perseverance and achievement remains significant and positive even after controlling for student background characteristics, all of which have been documented to be significantly and strongly associated with achievement in the education literature. Results shows that one unit increase in mean perseverance would be associated with an increase of nearly 12 points in mean math achievement scores of students across all 57 countries,

net of key student characteristics as well as observed and unobserved country differences (See Table 4-2). Model 2, which includes perseverance and student control variables, explains about 45.1 percent of the total variance in math achievement among students around the world.

These results from the pooled sample of 57 countries do not inform about each country's unique case, given the country-fixed effects approach that controls for any between-country differences. Rather, they provide a general global trend in the association between academic perseverance and achievement. The next section reports within-country analyses to provide a more detailed understanding of the academic perseverance-achievement association for each country in the sample, which allows for cross-national comparisons.

Table 4-2: Pooled regression with country-fixed effects.

VARIABLES	Model 0	Model 1	Model 2
Perseverance		15.87***	11.89***
		(0.496)	(0.452)
Age			-4.640***
			(1.090)
Grade			32.73***
			(0.948)
Female			-13.52***
			(0.788)
Family SES			25.09***
			(0.592)
Immigrant			-8.152***
			(3.106)
Observations	281,797	281,797	281,797
R-squared	0.303	0.326	0.451

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
Regression results based on the pooled sample of 57 countries.

Within-country analyses for each of the 57 countries

Given the positive and significant association between academic perseverance and achievement found from the pooled sample of 57 countries, I explore how the association might vary across countries in terms of the direction, significance, and the magnitude of strength of the association. (Note: The results of a correlation analysis show that academic perseverance and achievement are positively correlated for each county in the empirical sample, as presented in Appendix B.) Estimating regression models for each country provides a more in-depth look into the academic perseverance-achievement association within each country and allows for a cross-national comparison. I use OLS regression modeling with school-fixed effects in an attempt to control for any between-school differences that may influence students' math achievement.

Prior to estimating regression models with school-fixed effects, I estimate a bivariate association between academic perseverance and achievement for each country to explore cross-national patterns in general (See Figure 4-3). The bivariate association is positive and significant in all 57 countries in the sample, except in Israel, where the association is positive but not significant. The size of the association is the largest in Korea, Finland, Norway, New Zealand, Iceland, and Sweden, respectively. For instance, one unit increase in academic perseverance is associated with an increase of 35 points on math achievement scores in both Korea and Finland, and an increase of about 30 points on math achievement scores in Sweden. On the other hand, the size of the association is the smallest in Estonia and Israel, where less than 4 and less than 2 points, respectively, are expected to increase for every one unit increase in academic perseverance. Only in Israel, the positive association is not statistically significant, suggesting that there is no significant association between academic perseverance and achievement.

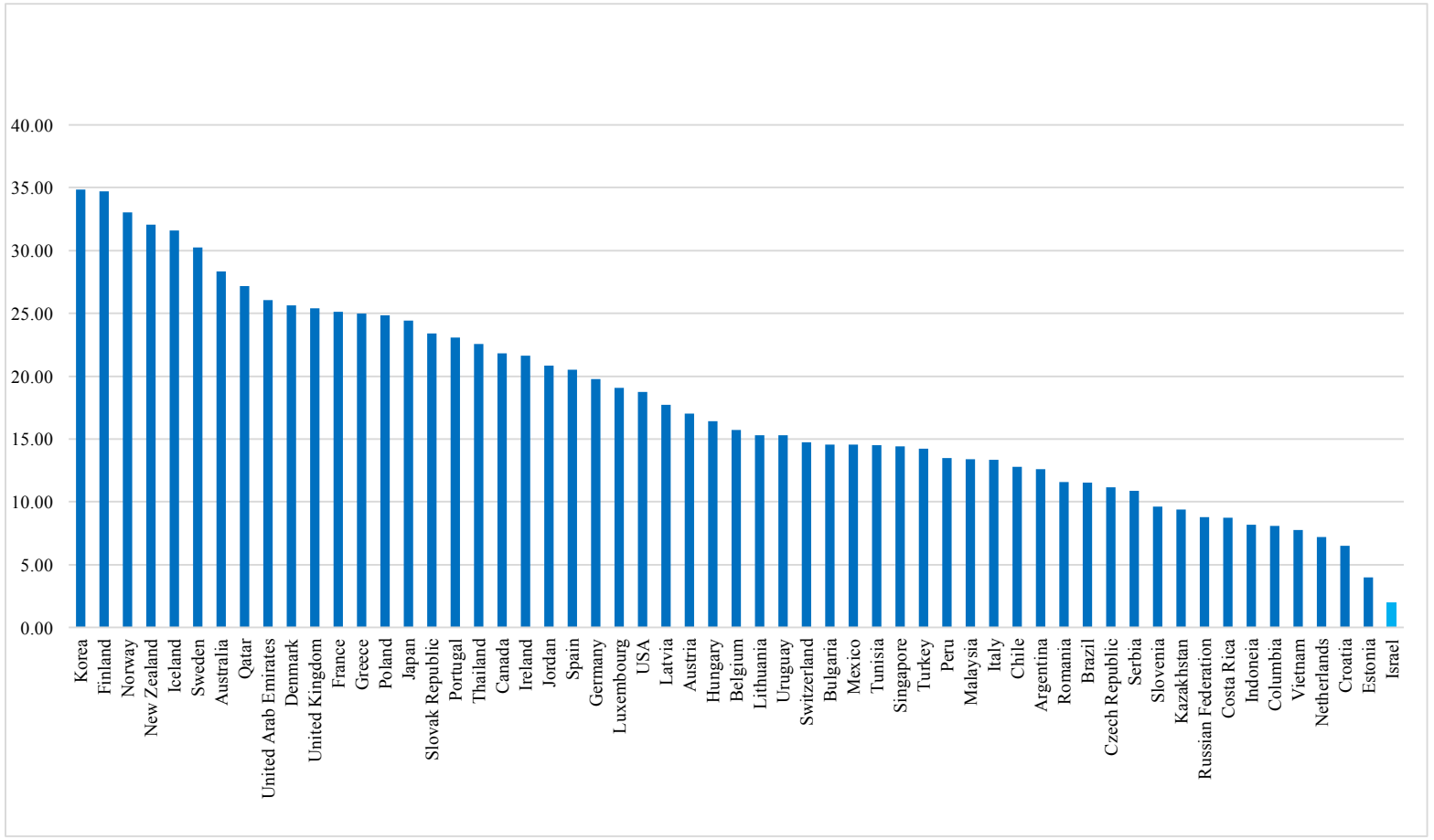

Figure 4-3: Bivariate association between academic perseverance and achievement.

Model 3 estimates the proportion of total variance in math achievement explained by school-level factors within each of the 57 countries, and thus has no predictors. The R-squared value indicates the proportion of total variance in math achievement attributable to between-school differences in each country. This model serves to establish a baseline to assess the degree to which perseverance further explains the variance in students' math achievement in each country, regardless of school differences.

Model 4, which adds perseverance as a sole independent variable while fixing between-school differences, shows that perseverance is positively and highly significantly associated with math achievement in all countries in the sample (See Table 4-3 and Figure 4-4). An expected increase in math achievement for each unit of increase in academic perseverance ranges from just under 6 points (5.57 in Indonesia) to about 35 points (34.58 in Finland). The top five countries where the size of the perseverance-achievement association is the largest are Finland, Norway, Iceland, New Zealand, and Sweden. For instance, for Finnish students, being academically perseverant really pays off for their math achievement, as one unit increase in perseverance is associated with a 34.6-point increase in math achievement on average. Similarly, a unit increase in academic perseverance is associated with a 31.6-point increase in Norway, a nearly 30-point increase in Iceland and New Zealand, and a 28-point increase in Sweden, on average. Denmark, Australia, the United Kingdom, Korea, and Poland follow suit in the top 10 countries with the largest expected increase in achievement for every unit increase in perseverance. With the exception of Korea, many of the top ten countries where the size of the association is the largest are Scandinavian countries (Finland, Norway, Iceland, Sweden, and Denmark) and what are usually referred to as "Western" countries, including Nez Zealand, Australia, the United Kingdom, and Poland.

Table 4-3: Association between academic perseverance and achievement, net of between-school differences (in descending order).

Country	Perseverance	SE	Observations	R-squared
1. Finland	34.58***	(1.297)	5,655	0.246
2. Norway	31.57***	(1.470)	2,995	0.321
3. Iceland	29.85***	(1.889)	2,162	0.261
4. New Zealand	29.70***	(1.808)	2,694	0.366
5. Sweden	28.16***	(1.761)	2,999	0.278
6. Denmark	26.12***	(1.547)	4,690	0.298
7. Australia	24.42***	(1.199)	8,939	0.395
8. United Kingdom	22.27***	(1.610)	8,075	0.365
9. Korea	22.02***	(1.962)	3,337	0.449
10. Poland	21.91***	(1.619)	3,008	0.313
11. Germany	21.63***	(1.650)	2,575	0.562
12. Canada	20.93***	(1.050)	13,729	0.305
13. Spain	20.82***	(1.164)	16,315	0.285
14. Qatar	20.33***	(1.166)	6,267	0.526
15. Ireland	19.11***	(1.618)	3,238	0.265
16. Greece	19.03***	(1.440)	3,307	0.408
17. United Arab Emirates	19.02***	(1.032)	7,094	0.519
18. Slovakia	18.35***	(1.634)	2,975	0.544
19. Portugal	18.06***	(1.449)	3,340	0.353
20. Jordan	16.99***	(1.363)	4,281	0.431
21. France	16.95***	(1.546)	2,898	0.628
22. United States	16.77***	(1.499)	3,143	0.311
23. Switzerland	15.45***	(1.451)	7,202	0.417
24. Luxembourg	14.98***	(1.621)	3,286	0.347
25. Austria	14.05***	(1.730)	3,088	0.512
26. Thailand	13.78***	(1.861)	4,305	0.470
27. Belgium	13.45***	(1.510)	5,316	0.505
28. Latvia	13.44***	(2.226)	2,774	0.363
29. Japan	12.62***	(1.580)	4,105	0.567
30. Uruguay	12.21***	(1.318)	3,274	0.462
31. Italy	12.05***	(0.700)	20,010	0.566
32. Argentina	11.92***	(1.361)	3,586	0.479
33. Malaysia	11.86***	(1.524)	3,290	0.366
34. Lithuania	11.07***	(2.073)	2,943	0.361
35. Peru	11.02***	(1.331)	3,545	0.503
36. Singapore	10.74***	(1.904)	3,632	0.407

37. Mexico	10.70***	(0.699)	21,643	0.413
38. Brazil	10.33***	(0.972)	11,671	0.494
39. Czech Republic	9.81***	(1.737)	3,435	0.519
40. Hungary	8.81***	(1.315)	3,134	0.659
41. Serbia	8.61***	(1.390)	2,919	0.502
42. Chile	8.48***	(1.174)	4,466	0.484
43. Israel	8.19***	(1.244)	3,079	0.424
44. Turkey	7.85***	(1.328)	3,122	0.646
45. Tunisia	7.82***	(1.176)	2,750	0.531
46. Costa Rica	7.55***	(1.556)	2,835	0.461
47. Russia	7.24***	(1.559)	3,386	0.349
48. Slovenia	7.01***	(1.452)	3,673	0.619
49. Kazakhstan	6.74***	(1.134)	3,789	0.427
50. Bulgaria	6.37***	(1.014)	3,242	0.553
51. Columbia	6.30***	(1.160)	5,406	0.403
52. Croatia	6.30***	(1.212)	3,265	0.474
53. Netherlands	6.28***	(1.361)	2,826	0.652
54. Estonia	6.05***	(1.777)	3,086	0.250
55. Romania	5.97***	(1.279)	3,303	0.485
56. Vietnam	5.58***	(1.486)	3,105	0.520
57. Indonesia	5.57***	(1.282)	3,590	0.550

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

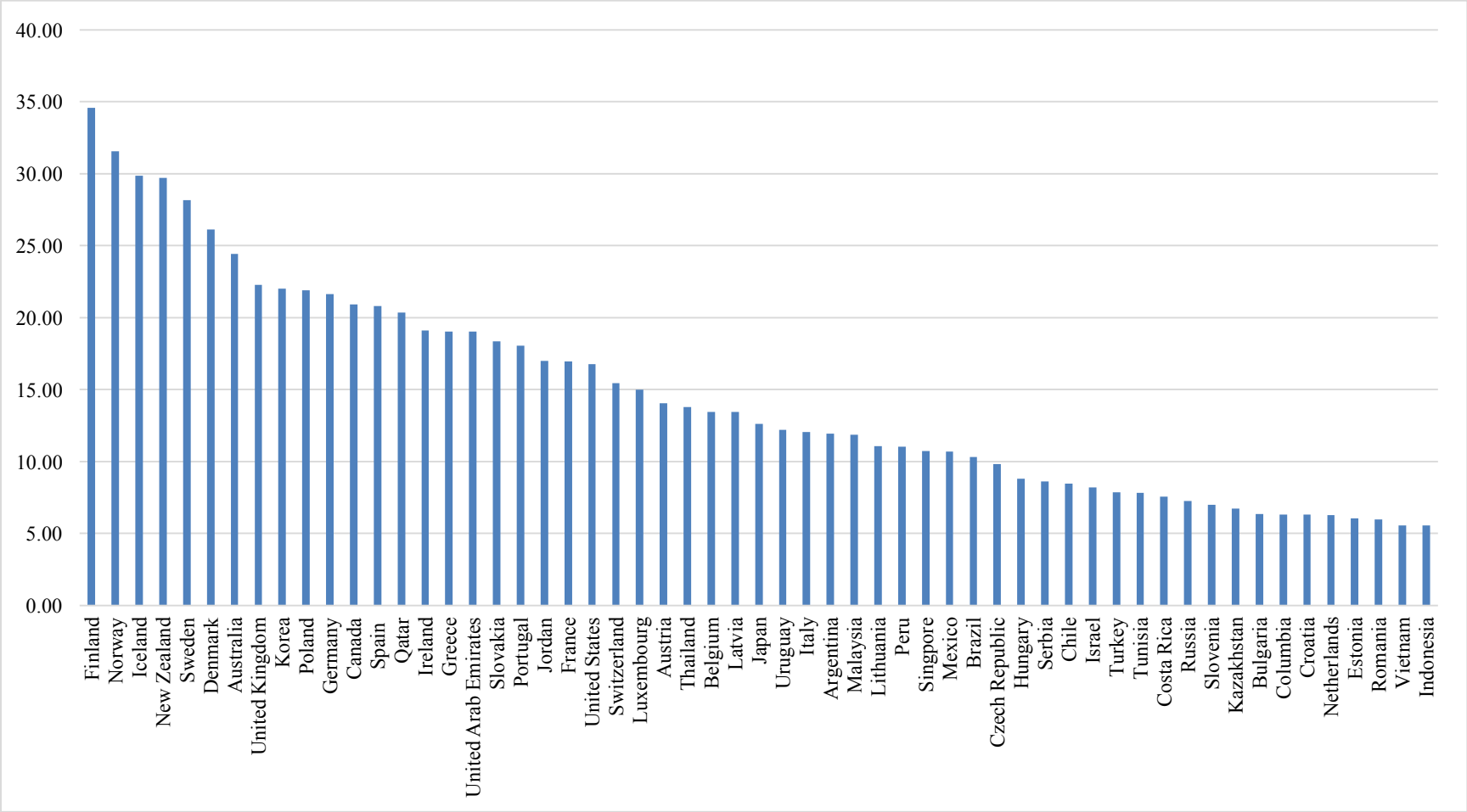

Figure 4-4: Association between academic perseverance and achievement, net of between-school differences.

Interestingly, results from Model 4 reported in Table 4-3 (and depicted in Figure 4-4) also show that the size of the association between perseverance and achievement tends to be larger in countries that have some of the lowest mean levels of academic perseverance. For instance, Norway, Sweden, Iceland, Korea, and Denmark all have negative values on the standardized scale of academic perseverance. Yet, regression results show some of the largest sizes of the association between academic perseverance and achievement in these countries. Yet, this pattern is not uniform across all countries. For instance, a nearly 17-point increase for each unit of academic perseverance is expected for both France and the U. S., although France (third from the bottom or 56th) has a negative mean level of academic perseverance and the U.S. has a positive and one of the highest mean levels (11^{th}) in man perseverance.

On the other hand, countries whose mean perseverance was the highest, including Kazakhstan, Bulgaria, Russia, Costa Rica, Vietnam, and Turkey, showed the smallest size of the association between academic perseverance and achievement. For instance, the mean academic perseverance in Kazakhstan was nearly .8, the highest mean level in the sample. However, Kazakhstan was 9^{th} from the bottom when it comes to the size of the association between academic perseverance and achievement. That is, one unit increase in academic perseverance is associated with an increase of about 6.74 points in Kazakhstan. Moreover, Vietnam and Indonesia are the bottom when it comes to the size of the association between academic perseverance and achievement (just under a 6-point increase associated with every unit increase in academic perseverance), although these two countries had higher mean levels of academic perseverance than many other countries in the empirical sample.

These results seem rather paradoxical. There may be several explanations, including theoretical (e.g., reference bias) and statistical (e.g., restriction of range), among others. In the case of reference bias, it is possible that some high-income countries have a highly competitive educational system where students have to perform and endure long hours of study both in and outside of school throughout their schooling years ultimately for their high-stakes college

entrance exam, for instance. In such systems, including Japan and Korea, the average student may rate herself/himself relatively lower on the academic perseverance self-assessment because the bar has already been set high by their own peers, although in fact they are just as or even more academically perseverant than peers in other countries. Thus, countries like Japan and Korea have a lower mean of academic perseverance. At the same time, it may be the case that these countries offer an effective educational system that help students to learn and perform better on standardized tests than their peers in other (perhaps less effective) educational systems in other countries, such that the mean achievement score is still relatively higher than that of other countries despite the lower mean of academic perseverance. In such educational systems, just a small increase in academic perseverance is associated with a bigger increase in test scores.

Another explanation can be due to the potential of reverse causality. High-performing students may already have a high level of academic perseverance, or their academic perseverance can increase as a result of their high academic performance. The highest performing students are most academically perseverant, while all others are less perseverant. Yet, most perform fairly well on the standardized tests, hence the results. It is possible that the high performing students drive up the size of the association, although a majority of students rate themselves lower on the academic perseverance scale.

Besides the possibility for high performers to have self-reported higher academic perseverance, thereby pulling the regression results upward, other statistical explanations may explain these results. For instance, it could be due to varying dispersion of both academic perseverance and achievement. It could be the case that in some countries there is less variance in achievement to explain (i.e., a case of restriction of range, ceiling effect), thus even a high mean of academic perseverance can explain the variance in achievement only so much. Conversely, if there is more variance in achievement within a country, it is possible that even a low mean of perseverance can explain a larger proportion of variance in achievement. The standard deviation of academic perseverance and the standard deviation of achievement for each country, along with

the slightly negative correlation between the two (-0.173) that can explain the paradoxical results, are reported in Appendix C.

Yet, there may be some other sources of explanations at the national level. Perhaps it is also plausible that students in countries like Kazakhstan, Bulgaria, Russia, and Vietnam—all of which happen to be former or present (in the case of Vietnam) communist/socialist countries—believe that they have high academic perseverance or they really do, but it could be that the educational system is not as effective as those in other countries perhaps. It is as though the academic perseverance of students is not matched with the quality of their schooling that these countries can provide. In other words, much akin to a ceiling effect perhaps, there is only so much being academically perseverant can impact the average student's achievement on standardized tests, when the education system of a country produces a certain level of educational quality. Potential explanations will be further speculated in the next chapter.

These positive and significant associations between academic perseverance and achievement remain in all countries even after controlling for key student characteristics in addition to holding constant between-school differences in Model 5, thus supporting Hypothesis 2. Results from Model 5, which is the full model that includes all previously discussed measures and students' age, grade, gender, family SES, and immigrant status, show that perseverance remains significantly and positively associated with achievement in all countries in the analytic sample, giving strong support to Hypothesis 2. Table 4-4 reports the regression coefficients for perseverance, which range from approximately 4 to 30. Results are quite similar to the those found in Model 4, except that the top two countries in the size of the academic perseverance-achievement association swapped places. By just a difference of .14 points, Norway (30.41) comes at the top, closely followed by Finland (30.27). Iceland (28.52), Sweden (27.19), New Zealand (27.13), Denmark (22.25), Australia (22.12), Korea (20.61), United Kingdom (19.90), Poland (18.65), Qatar (18.51), and Germany (17.47) follow suit. At the bottom of the list where the size of the academic perseverance and achievement is the smallest are the Netherlands (5.61),

Columbia (5.43), Russia (5.31), Kazakhstan (5.30), Romania (5.28), Vietnam (4.99), Indonesia (4.88), and Estonia (4.47). Aside from Korea, countries that show strong performance on math achievement, such as Singapore (8.280) and Japan (12.04), have a small to moderate size of an increase in math achievement for every unit increase in academic perseverance. Results are also depicted in Figure 4-5, from the largest size of the academic perseverance-achievement association to the smallest.

Table 4-4: Association between perseverance and achievement, net of student characteristics and between-school differences.

Country	Perseverance	SE	Female	SE	Family SES	SE	Observations	R-squared
1. Norway	30.41***	(1.445)	3.270	(2.746)	16.76***	(2.515)	2,995	0.352
2. Finland	30.27***	(1.380)	-0.849	(2.723)	19.55***	(1.664)	5,655	0.335
3. Iceland	28.52***	(1.879)	6.545*	(3.878)	18.39***	(2.688)	2,162	0.288
4. Sweden	27.19***	(1.695)	5.278	(3.278)	21.52***	(2.288)	2,999	0.348
5. New Zealand	27.13***	(1.850)	-18.37***	(3.807)	28.61***	(2.220)	2,694	0.430
6. Denmark	22.25***	(1.420)	-14.08***	(2.469)	21.57***	(1.920)	4,690	0.384
7. Australia	22.12***	(1.164)	-12.64***	(2.080)	17.49***	(1.384)	8,939	0.438
8. Korea	20.61***	(2.036)	-6.354	(4.493)	10.28***	(2.433)	3,337	0.455
9. United Kingdom	19.90***	(1.680)	-10.09***	(3.161)	17.44***	(1.700)	8,075	0.389
10. Poland	18.65***	(1.455)	-11.31***	(3.039)	25.36***	(2.104)	3,008	0.402
11. Qatar	18.51***	(1.152)	-3.634	(3.063)	4.326***	(1.543)	6,267	0.557
12. Canada	18.09***	(1.011)	-14.47***	(1.956)	19.62***	(1.583)	13,729	0.381
13. Germany	17.47***	(1.734)	-28.39***	(2.847)	4.957***	(1.581)	2,575	0.639
14. United Arab Emirates	17.23***	(0.999)	-26.34***	(8.887)	6.934***	(1.216)	7,094	0.569
15. Greece	17.10***	(1.372)	-19.46***	(2.746)	15.12***	(1.614)	3,307	0.444
16. Slovakia	16.09***	(1.460)	-26.11***	(3.058)	15.75***	(2.196)	2,975	0.604
17. Ireland	15.97***	(1.527)	-18.61***	(3.976)	23.14***	(1.777)	3,238	0.332
18. Jordan	15.59***	(1.308)	-26.86*	(13.76)	9.566***	(1.287)	4,281	0.457
19. France	15.36***	(1.426)	-18.69***	(2.679)	14.80***	(2.500)	2,898	0.673
20. Spain	14.59***	(1.210)	-25.41***	(2.164)	13.14***	(1.100)	16,315	0.531
21. Switzerland	13.95***	(1.511)	-19.38***	(2.465)	18.12***	(1.963)	7,202	0.522
22. United States	12.98***	(1.437)	-14.20***	(2.789)	20.77***	(2.209)	3,143	0.413
23. Portugal	12.82***	(1.350)	-25.85***	(2.432)	13.26***	(1.492)	3,340	0.535
24. Thailand	12.81***	(1.833)	-5.879**	(2.443)	7.732***	(1.468)	4,305	0.486
25. Austria	12.49***	(1.668)	-28.36***	(3.304)	11.54***	(1.828)	3,088	0.573
26. Japan	12.04***	(1.552)	-14.79***	(2.615)	4.305**	(1.973)	4,105	0.573
27. Italy	11.39***	(0.641)	-26.94***	(1.536)	3.617***	(0.756)	20,010	0.606
28. Mexico	10.55***	(0.684)	-17.31***	(1.173)	2.967***	(0.701)	21,643	0.443
29. Belgium	10.37***	(1.332)	-21.83***	(2.075)	10.38***	(1.477)	5,316	0.626
30. Luxembourg	10.35***	(1.427)	-28.73***	(2.945)	11.21***	(1.508)	3,286	0.506

31. Latvia	9.935***	(2.095)	-7.184**	(3.573)	16.29***	(1.799)	2,774	0.457
32. Peru	9.646***	(1.379)	-30.53***	(3.076)	5.930***	(1.310)	3,545	0.591
33. Argentina	9.326***	(1.313)	-20.22***	(2.777)	6.880***	(1.580)	3,586	0.555
34. Uruguay	9.287***	(1.163)	-21.72***	(2.801)	10.38***	(1.554)	3,274	0.563
35. Malaysia	9.141***	(1.449)	1.154	(2.550)	13.66***	(1.794)	3,290	0.413
36. Lithuania	9.051***	(2.004)	-13.43***	(2.913)	18.49***	(1.811)	2,943	0.418
37. Brazil	8.846***	(0.856)	-27.17***	(1.683)	5.137***	(0.769)	11,671	0.589
38. Czech Republic	8.751***	(1.588)	-30.14***	(3.452)	11.70***	(2.342)	3,435	0.584
39. Singapore	8.280***	(1.845)	-0.773	(3.017)	20.44***	(1.940)	3,632	0.456
40. Serbia	7.829***	(1.368)	-23.22***	(2.816)	7.554***	(1.481)	2,919	0.524
41. Chile	7.709***	(1.042)	-30.20***	(2.121)	6.892***	(1.285)	4,466	0.563
42. Hungary	7.599***	(1.329)	-29.45***	(2.561)	5.695***	(1.652)	3,134	0.698
43. Israel	7.481***	(1.154)	-26.63***	(3.330)	19.58***	(2.306)	3,079	0.479
44. Slovenia	7.175***	(1.443)	-27.51***	(3.435)	-0.519	(1.811)	3,673	0.644
45. Turkey	7.126***	(1.239)	-24.64***	(2.759)	4.047***	(1.162)	3,122	0.700
46. Tunisia	6.917***	(1.087)	-28.07***	(2.119)	3.844***	(1.100)	2,750	0.607
47. Costa Rica	6.838***	(1.424)	-28.55***	(2.716)	6.696***	(1.118)	2,835	0.582
48. Croatia	6.457***	(1.181)	-25.98***	(2.922)	9.557***	(1.841)	3,265	0.505
49. Bulgaria	6.021***	(1.037)	-15.01***	(2.757)	9.208***	(2.018)	3,242	0.571
50. Netherlands	5.605***	(1.197)	-21.41***	(2.200)	6.095***	(1.821)	2,826	0.715
51. Columbia	5.426***	(1.062)	-29.38***	(2.496)	6.015***	(1.275)	5,406	0.546
52. Russia	5.310***	(1.501)	-2.792	(3.182)	19.66***	(2.537)	3,386	0.412
53. Kazakhstan	5.303***	(1.151)	-4.623*	(2.443)	12.91***	(1.765)	3,789	0.461
54. Romania	5.280***	(1.238)	-13.34***	(2.979)	16.09***	(1.741)	3,303	0.515
55. Vietnam	4.986***	(1.398)	-27.25***	(2.353)	6.559***	(1.542)	3,105	0.554
56. Indonesia	4.875***	(1.258)	-7.646***	(1.857)	5.529***	(1.394)	3,590	0.563
57. Estonia	4.474***	(1.638)	-11.66***	(2.612)	17.49***	(1.974)	3,086	0.335

Notes: *** p<0.01, ** p<0.05, * p<0.1. Results are presented in a descending order. Only two student-level control variables are presented here due to space limitations.

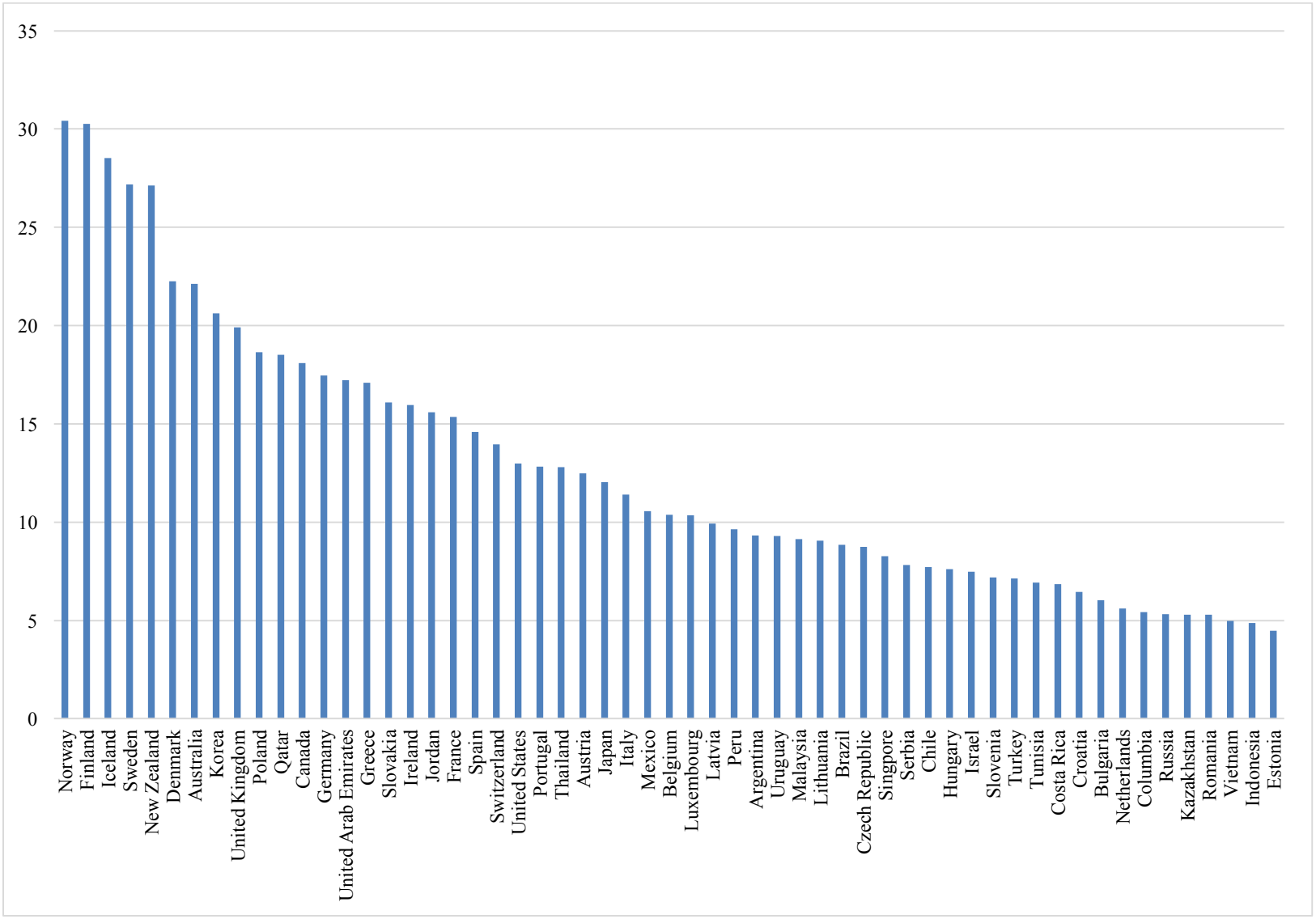

Figure 4-5: Association between academic perseverance and achievement, net of student characteristics and between-school differences.

Summary

The present lack of systematic and cross-national evidence on a specific non-cognitive skill and its association with academic achievement within the multidisciplinary non-cognitive skills literature as well as comparative and international education literature calls for empirical evidence based on large-scale and cross-national samples of students. The present study and the results from the analyses conducted in this chapter fill this important void in by testing hypotheses about the role of academic perseverance as a non-cognitive skill that is theorized to be significantly and positively associated with achievement across and within countries. Specifically, all analyses are carried out to address the two research questions: (1) Is academic perseverance associated with achievement in a cross-national perspective? (2) What is the association between academic perseverance and achievement, net of student demographics and between-school differences, within countries?

Results from the OLS regression models with country-fixed effects, which remove unobserved heterogeneity at the country level, show a statistically significant and positive association between academic perseverance and achievement at the world level (all 57 countries pooled together), where the regression coefficients indicate the weighted average for an expected change in mean achievement scores (achievement) associated with each unit increase in mean academic perseverance for students from the 57 countries. On average, one unit increase in academic perseverance is associated with an increase of about nearly 16 points in mean math achievement scores for all students in the sample, and a nearly 12-point increase in mean achievement scores when controlling for student demographics, including age, grade, gender, family SES, and immigrant status. These results indicate that academic perseverance is positively

and significantly associated with achievement around the world as a whole, giving preliminary support to Hypothesis 1.

Recognizing that these results mask variations that may exist within each of those 57 nations, separate regression models are estimated for each country with a school-fixed effects modeling approach. By removing between-school differences—both observed and unobserved—that may be correlated with students' math achievement scores, the regression estimates of academic perseverance are less biased. The association between academic perseverance and achievement is positive and significant in all countries in the sample, giving support to Hypothesis 1, and it remains positive and significant even after controlling for student demographics, providing strong evidence to support Hypothesis 2. The regression coefficient for academic perseverance ranges from 4.5 (Estonia) to 30.4 (Norway) in the final model, indicating that every unit increase in mean academic perseverance is associated with a mean achievement score increase of about 4.5 in Estonia and 30.4 in Norway on average.

Interestingly, for some countries that have the highest mean levels of academic perseverance (e.g., Kazakhstan and Vietnam), the size of the association between academic perseverance and achievement is the smallest, with about a 5-point increase in mean math achievement score associated with each unit increase in mean academic perseverance for both Kazakhstan and Vietnam. On the other hand, the size of the association between academic perseverance and achievement is the largest for countries that report some of the lowest mean levels of academic perseverance (e.g., Korea, Japan, France, etc.). For instance, each unit increase in mean academic perseverance is associated with a nearly 21-point increase in mean achievement in Korea, a 12-point increase in Japan, and a 15-point increase in France.

Overall, the results from all regression models employed in this study show that the association between perseverance and achievement is positive and highly significant in all 57 countries in the sample. The regression model with school-fixed effects that controls for both

observed and unobserved between-school differences produces more conservative estimates for perseverance. Results show that the academic perseverance-achievement association is positive and significant, above and beyond key student demographic differences and all of between-school differences, providing strong support for both Hypotheses 1 and 2.

Results show that there is large variation in the size of the association between academic perseverance and achievement between countries in the empirical sample. While there may be multiple potential explanations, including theoretical, statistical, and otherwise, for these seemingly paradoxical results, several are speculated. Among those, explanations pertaining to potential reference bias, restriction of range and ceiling effect, reverse causality, cross-national differences in the structure and quality of educational systems, and the distribution of academic perseverance and achievement within each country are briefly discussed. A plausible explanation might be that in countries with a larger variation in school quality, student variation in academic perseverance might matter more for achievement that it would in countries with a similar school quality between schools.

While this important finding will need to be further examined by future research, it noteworthy to also speculate national cultural differences, among others. Broader societal cultural attitudes and norms, as conjectured and theorized by Stevenson et al. (1990), might be at play contributing to such differences between countries. For instance, the association between academic perseverance and achievement is the largest in Norway, Finland, Iceland, Sweden, and Denmark. It may be that these Scandinavian countries may share cultural heritages, attitudes, and norms that emphasize and reward perseverance.

Duckworth (2016) specifically highlights a Finnish cultural concept and construct of *sisu*, which captures the perseverance component of grit. *Sisu*, according to Finlandia University, resembles the meaning of "will, determination, perseverance, and acting rationally in the face of adversity" when roughly translated into English and is referred to as "an inherent characteristic of

the Finnish people" that is "a measure of integrity that surpasses the hardship and sees through to the end" and thus it is "not momentary courage, but the ability to sustain that courage" ("Our Finnish Heritage - Finlandia University : Finlandia University," n.d.). The culture of *sisu* and valuing it highly as an important individual characteristic to have may explain the large, positive, and significant association between academic perseverance and achievement in Finland. The sources of variation in the academic perseverance-achievement association within and between countries, though a topic for future studies, are further speculated in Chapter 5.

Moreover, though modest in size, academic perseverance further explains remaining variance in achievement scores. For instance, as much as about 14 percent of variance in achievement is further explained by academic achievement in Norway and 13 percent in Finland, while about 3.8 percent in the United States and an almost negligible amount (less than 1 percent) of variance is explained by academic perseverance in many countries. Across all 57 countries, about 2.7 percent of additional variance in achievement on average is explained by academic perseverance.

Chapter 5

Discussion & Conclusion

Although the salience of non-cognitive skills (also known as character skills, soft skills, socio-emotional skills, etc.) has been studied and documented by many researchers across academic disciplines and fields for decades, large-scale and cross-national research on non-cognitive skills has particularly been scarce. In particular, cross-national evidence on a particular non-cognitive skill that matters for academic achievement remains thin and under-substantiated. Grit, defined as perseverance and passion for long-term goals (Duckworth et al., 2007), is one of the non-cognitive skills theorized to be positively and significantly associated with various outcomes, including academic achievement. This dissertation builds on the recent theory of grit and previous research within the larger non-cognitive skills to introduce a more narrowly defined concept of academic perseverance and examines its theorized association with academic achievement in a cross-national framework. In doing so, it links the multidisciplinary non-cognitive skills literature with comparative and cross-national education literature to contribute new knowledge based on some of the first cross-national evidence on the association between academic perseverance and achievement and its variation across countries.

This chapter begins with a brief discussion of the importance of non-cognitive skills, particularly grit and its perseverance component, and details some of the major contributions of this study to the non-cognitive skills literature cutting across multiple academic disciplines and the broad field of education. The chapter then discusses the major findings of this study and assess the ways in which they support the hypotheses that are derived from existing theories.

Then the chapter concludes by laying out policy recommendations based on the findings of this study, followed by limitations and directions for future research.

Importance of non-cognitive skills: grit and its perseverance component

Although the age-old conventional wisdom that hard work and perseverance pays off is widely accepted around the world, systematic research evidence to support this idea for academic achievement measured by standardized test scores remains sparse. The putative role of perseverance on almost any outcome, including academic achievement, has become an almost taken-for-granted belief, especially with the global institutionalization of mass schooling as a central institution (Meyer et al., 2010) that helped spread what are often considered as the Western version of meritocratic ideals along with other liberal democratic ideas and norms. Economists, psychologists, and sociologists have studied various non-cognitive skills, including a loosely-defined concept of perseverance, to explain their independent impact on education (e.g., attainment/graduation, GPAs, course grades, etc.) and labor market (e.g., employment, wages, retention, etc.) outcomes. Yet, a systematic study of a specific type of a non-cognitive skill and its role on academic achievement scores has been largely under-explored and under-theorized.

Recently, research on grit—defined as perseverance and passion for long-term goals by Duckworth and colleagues (2007)—that is rooted in personality theory in psychology has shown that grit is a significant predictor of academic achievement, above and beyond talent and luck. Although research on grit is rapidly growing, cross-national evidence remains deficient, and recent studies (Crede et al., 2016; Datu et al., 2016) show the salience of the perseverance of effort component of grit but not necessarily the passion component, questioning the usefulness of combining the two components into one construct of grit. Building on the theory of grit and past

research on perseverance, this dissertation has introduced a more narrowly defined and domain specific measure of academic perseverance and examined its association with academic achievement measured by standardized test scores, drawing on PISA 2012 data for nationally representatives samples of students from 57 countries.

Contributions and innovations

This study makes several important contributions, both theoretical and empirical. First, it introduces a more narrowly defined measure of a key non-cognitive skill—academic perseverance—that is theorized to be associated with academic achievement. Currently available measures of non-cognitive skills are broad in nature, and they may or may not be narrow enough to argue for their direct association with educational outcomes, such as academic achievement. Moreover, currently available measures of non-cognitive skills vary significantly in terms of their definition, scope, and measurement. Past studies often use a wide assortment of non-cognitive skills—often constructed by the researchers based on available data—such that it is often difficult to infer appropriate conclusions that may apply to larger populations, much less cross-national populations.

Relatedly, second, this study is one of the first to draw on a large-scale and cross-national dataset to examine the association between a non-cognitive skill and achievement scores. One of the main challenges for the inquiry on non-cognitive skills has been the availability of nationally and cross-nationally validated measures. As a result, large-scale, cross-national research on non-cognitive skills has particularly been scarce. This study fills this important gap by taking advantage of a recent cross-national dataset capturing a key non-cognitive skill that is theorized to

be associated with achievement, namely, academic perseverance. The comparison between the perseverance of effort subscale of the grit scale and the academic perseverance scale from PISA 2012 show that they are compatible, where items on the PISA's academic perseverance scale matching with the items on the grit scale that is broader in scope.

Third, this study provides some of the first cross-national evidence on the association between academic perseverance and achievement measured by standardized test scores, not GPAs or course grades, thereby eliminating some of the competing hypotheses. In previous studies, GPAs, course grades, and other educational outcomes (e.g., retention and graduation rate) have been more frequently documented thus far. By focusing on standardized test scores, this study eliminates some of the competing hypotheses regarding the role of teachers' subjective grading and gives more support to the main hypotheses tested in this study, which is the role of students' academic perseverance on their achievement on standardized tests. It is important to note that standardized test scores from PISA are reliable and comparable cross-nationally, which makes cross-national comparisons on the association between academic perseverance and achievement more meaningful.

Fourth, this study links the multidisciplinary non-cognitive skills research with comparative and international education research to contribute to multiple literatures as well as establish a linkage between them. In the broad field of education, recent and growing attention on non-cognitive skills has not been matched with the same level (quantity) of research evidence (both theoretical and empirical) on the role of non-cognitive skills on academic outcomes. Thus, this study contributes to the education field at large, as well as several academic disciplines where research on non-cognitive skills has historically been lively, including economics, psychology, and sociology.

In terms of this study's contribution to the comparative education literature in particular, this study identifies and provides cross-national evidence for a key between-student difference

that is associated with variations in achievement, namely academic perseverance. This study draws on the neo-institutional argument about the institutionalization of mass schooling around the world (Meyer et al., 1994) and its subsequent impact on homogenizing school effects around the world, highlighting the salience of between-student differences as the main source of variation on achievement scores (Baker et al., 2002), which contrasts previous research findings on the role of school quality relative to between-student differences (Heyneman & Loxley, 1983). This study assesses the degree to which academic perseverance—a key between-student difference other than family SES—is associated with achievement, net of key student demographics and school effects, in each country and how that association varies across countries. The results of this study thus contribute to both the grit research within the non-cognitive skills literature as well as the comparative and cross-national education literature, and bridges these two large important literatures.

Fifth, the findings of this study can inform national and international education policy dialogue and policy-making regarding skills development, particularly that of non-cognitive skills. The lack of proper measures for non-cognitive skills has historically been a main challenge in the study of non-cognitive skills, both nationally and cross-nationally. Despite the national and international efforts to measure non-cognitive skills, the availability of data remains scarce and more systematic studies need to provide evidence that can be used for furthering educational policy dialogue and policy-making. This study provides evidence that establishes a baseline by showing that academic perseverance, as a key non-cognitive skill, is linked with achievement, above and beyond family socioeconomic background or school differences, nationally and cross-nationally. This finding has policy implications as educational systems around the world seek to improve their students' achievement, above and beyond their background and schools, and to develop non-cognitive skills, which are increasingly regarded as key skills for one's life outcomes. Moreover, these findings serve as talking points and tools with which policy makers

can discuss, design, implement, and measure other non-cognitive skills and study their role in achievement, all of which will inform further policy dialogue.

Lastly, in addition to both theoretical and empirical contributions that inform policy, this study also makes a methodological contribution by employing school-fixed effects regression models for within-country analyses. Unobserved heterogeneity, or omitted variable bias, is an inevitable issue for all researchers working with survey data. The proportion of variance explained by between-school differences is quite substantial within countries—although it is not on a global scale relative to the proportion explained by between-country or between-student differences—and previous studies often included various school-level control variables in an attempt to alleviate the issue of unobserved heterogeneity at the school level. However, the issue of unobserved heterogeneity still remains even with a large set of control variables. This study uses a school-fixed effects regression model approach to circumvent this issue. In other words, by fixing all—observed and unobserved—between-school differences, this study removes potential school-level confounders that may influence both the outcome variable and the main predictor variable of interest. Thus, the regression estimates are more conservative, which allow room for more confidence in the interpretation of the association between academic perseverance and achievement.

Summary of main findings

The main findings of this study ascertain the importance of non-cognitive skills, particularly that of academic perseverance on achievement measured by standardized test scores by providing some of the first cross-national empirical evidence. Results of this study show that

academic perseverance is positively and significantly associated with achievement worldwide and in each of the 57 countries in the sample, giving strong support for Hypothesis 1. The association remains positive and significant even after controlling for between-school differences and student demographics in each country, which supports Hypothesis 2. This evidence proves consistent with previous findings on the perseverance component of grit (Credé et al., 2016; Datu et al., 2016), partially supports the grit research and theory, and gives credence to the widespread belief about the positive role of hard work marked by perseverance on academic achievement. This section briefly recaps the broad findings in a detailed discussion of the main findings.

It is important to clarify that this dissertation makes no causal claims in the interpretation of the findings. Thus, the findings do not by any way implicate that academic perseverance should be interpreted as a panacea for improving student achievement scores. On the contrary, the evidence from this dissertation cautions that there is much variation across countries on the association between academic perseverance and achievement, which will need to be further examined in a careful manner in future research. More detailed findings are presented in the following sections.

Worldwide trend in the association between academic perseverance and achievement

The world-level analysis, for which all 57 countries in the empirical sample are pooled, shows strong evidence that support the grit theory and recent findings on the perseverance component of grit. Results show that academic perseverance is positively and significantly associated with achievement, above and beyond country differences and student demographics,

including age, grade, gender, family SES, and immigrant status. Results suggest that each unit increase in academic perseverance is associated with an increase of nearly 12 points on average in mean math achievement scores, controlling for students' age, grade, gender, family SES, and immigrant status. Academic perseverance explains about 2.3 percent of the variance in achievement.

These results indicate that there is a case to be made for the grit theory at the world level, regardless of a particular country setting. Given the focus on a student-level predictor and the relatively small variance explained by school-level predictors (less than 8 percent), the world model focuses on removing the larger between-country differences (about 30 percent variance in achievement attributable to between-country differences) and controlled for student demographics. Future research examining the influence of national-level factors as well as school-level factors should take into account the relative contribution of country-, school-, and student-level factors in explaining variance in achievement and to further mitigate the issue of omitted variable bias.

Taken together, results from the country fixed effects regression models show that national differences—cultural and otherwise—are significant sources of variation in academic achievement along with between-student differences. On the other hand, from a cross-national perspective, between-school differences are much smaller as indicated in the small proportion of variance explained by school factors. This is consistent with the neo-institutional argument about the homogenization of school effects on achievement worldwide, which highlights the need to examine more of between-student differences that account for the largest proportion of variance in achievement. This dissertation goes beyond the traditional student-level variables associated with achievement, particularly family SES, and introduces a new measure of non-cognitive skill as a key between-student difference to examine the degree to which it is associated above and

beyond other factors, including family SES—one of the strongest predictors of achievement documented in education research.

It is also possible that national differences may play a role in the association between academic perseverance and achievement. As the descriptive statistics show, mean levels of academic perseverance vary greatly across the 57 countries in the empirical sample. Yet, the association between academic perseverance and achievement is positive and significant in all countries. Although much beyond the scope of this project, results of this study underscore the need for future research to examine the role of the national cultural differences on the association between academic perseverance and achievement.

Within-country association between academic perseverance and achievement

Underneath the world-level trend, results from regression models for each of the 57 countries show that much cross-national variation exists in terms of the size of the association between academic perseverance and achievement. Although the positive and significant association holds within each of the 57 countries, academic perseverance is variably associated with an expected achievement score gain ranging from 5.57 to 34.58 when controlling for between-school difference only and just below 5 points to just above 30 points, net of between-school differences and student demographics. Again, these results are associations, which do not warrant causal interpretations whatsoever.

It is interesting to note that the size of the academic perseverance-achievement association does not change drastically even after controlling for between-student differences, particularly family SES, which has been documented to be strongly associated with achievement.

The correlation between academic perseverance and family SES is about .035, which is low and thus it satisfies the exogeneity and orthogonality assumption in OLS regression and the regression results do not suffer from multicollinearity (See a correlation matrix between all variables used in this study in Appendix A). Overall, the inclusion of academic perseverance in the regression model further explains the remaining variance in achievement in each country, as small as an additional 0.3 percent in Vietnam to as much as nearly 14 percent of the variance in achievement in Norway.

Another noteworthy finding is that five Scandinavian countries are at the top in terms of the largest size of the association between academic perseverance and achievement. Norway (1^{st}), Finland (2^{nd}), Iceland (3^{rd}), Sweden (4^{th}), and Denmark (6^{th}) all have the largest coefficients for academic perseverance of 30.41, 30.27, 28.52, 27.19, and 22.25, respectively. This means, for instance, that each unit increase in academic perseverance is associated with an increase of just a bit over 30 points in mean math achievement score among students in Norway and Finland.

These results also suggest the possibility of national cultural differences conditioning the association between academic perseverance and achievement, which is beyond the scope of this study, but worthwhile to speculate a bit. Perhaps perseverance is a virtuous personal—and national—characteristic especially in these Scandinavian countries such that it is highly culturally prevalent and students are encouraged to develop it, both at home and in school, and perhaps it is rewarded in academic achievement. In fact, Duckworth (2016) highlights the Finnish concept of *sisu*, which captures the perseverance component of grit and one that is touted as a key characteristic of the Finnish national and cultural identity. Although Finnish students may or may not think that they are particularly perseverant when compared with other Finnish students, it is possible that they are in fact more perseverant than students in other countries. Thus, the mean level of perseverance for Finnish students is close to the international mean of zero while the

positive and significant association between academic perseverance and achievement is one of the largest in the empirical sample.

At the other end of the spectrum, some of the smallest size for the association between academic perseverance and achievement is found in countries with the highest mean levels of academic perseverance. For instance, Kazakhstan, Bulgaria, Russia, and Vietnam have some of the highest mean levels of academic perseverance, with a mean perseverance level of nearly .8, .6, .5, and .45, respectively. However, they rank at the bottom for the size of the association between academic perseverance and achievement, with a barely above 6-point increase in mean achievement for Bulgaria, a bit over 5-point increase for Russia and Kazakhstan, and less than a 5-point increase for Vietnam for every unit increase in mean academic perseverance.

There are some interesting patterns in terms of countries having a similar size of the academic perseverance-achievement association by geographical and cultural proximity, which bolsters the cultural argument as a potentially feasible explanation. As previously mentioned, the Scandinavian countries, including Norway, Finland, Iceland, Sweden, and Denmark all have a similarly large size of the academic perseverance-achievement association. In Western Europe, France, Spain, Switzerland, and Portugal share a similar size of the association, ranging roughly from a 13- to 15-point increase in mean achievement associated with every unit increase in mean academic perseverance. Belgium and Luxembourg have an almost identical size of the association as evidenced in the coefficients for academic perseverance of 10.37 and 10.35, respectively, while South American countries, including Peru, Argentina, Uruguay, and Brazil, also have a similar size, with coefficients for academic perseverance of 9.65, 9.33, 9.29, and 8.85, respectively.

Perhaps East and Southeast Asian countries are a bit of anomalies since there are no clear groupings of countries by the size of the academic perseverance-achievement association. In the

top ten list of countries in terms of the size of the association between academic perseverance and achievement, Korea is the only Asian country at 8th spot with the size of a nearly 21-point increase in mean achievement associated with each unit increase in mean academic perseverance. For Japan, 26th, each unit increase in academic perseverance is associated with about a 12-point increase in achievement. Perhaps Vietnam and Indonesia are exceptions as they are very similar in having some of the smallest size of a less than a 5-point increase in mean achievement associated with each unit increase in mean academic perseverance. While other East and Southeast Asian countries greatly vary in terms of the size of the academic perseverance-achievement association, Middle Eastern countries, such as Qatar (11th), the United Arab Emirates (14th), and Jordan (18th) are found to have a relatively large association between academic perseverance and achievement.

While the national cultural difference may be one potential source of explanation, it is possible to speculate other potential explanations, including theoretical (e.g., reference bias), statistical, and otherwise. Reference bias in self-reporting of academic perseverance could be a potential explanation for the large cross-national variation in the mean level of academic perseverance as well as the variation in the association between academic perseverance and achievement. Another potential explanation may be more statistical (e.g., restriction of range, ceiling effect). For instance, it could be the case that in some countries there is less variance in achievement to explain, thus even a high mean of academic perseverance can explain the variance only so much. In other words, when there is less variance to explain, it is harder to explain the remaining variance and hence the low correlation between academic perseverance and achievement. Conversely, if there is more variance in achievement within a country, even a relatively low mean of perseverance can explain a relatively larger proportion of variance in achievement. The slightly negative correlation between the standard deviation of academic

perseverance and the standard deviation of achievement (-0.173) explains it. Standard deviations of academic perseverance and achievement for each country are reported in Appendix C.

Another potential source of explanation is the national differences in the broader educational systems in terms of their structure (e.g., level of differentiation), selectivity (e.g., high-stakes college entrance exams), and quality (e.g., government spending on education, teachers' salaries, etc.). Even though school fixed effects regression models control for school-level factors that may be associated with the outcome variable and the association between academic perseverance and achievement, the entire educational system within a country as a whole may still play a role. With regards to the structure of educational systems, the variance in achievement would be at the student level in more equitable educational systems, while a larger proportion of the variance might be at the school level in more differentiated school systems.

Selectivity within a given educational system is another facet that needs to be examined, which relates to educational policy. For instance, the presence of high-stakes testing policy (e.g., higher education entrance exam) in Korea, require students to endure long study hours in and outside of school. The average student displays an academic perseverance level that is higher than found in other countries with no high-stakes college entrance exam in place. Moreover, it is also possible that students in Korea, for instance, have access to better quality of schooling. Standardized curricula and equalization policies may have contributed to higher mean achievement levels of Korean students, although students themselves might not particularly feel that they work hard enough compared to their competitive and hard-working peers everywhere.

Relatedly, the significantly varying quality of educational systems in each nation may explain the observed difference in achievement, as well as the strength of the association between academic perseverance and achievement. Much akin to a ceiling effect, perhaps there is only so much being academically perseverant can do for the average student's achievement on standardized tests, when the education system of a country produces only a certain level of

educational quality. It is also possible that being academically perseverant does not matter as much for achievement as some other factors in some countries. For instance, it is plausible that more students believe that they have high academic perseverance (or they really do) in some educational systems, but it could be that the educational system is not as effective as those in other countries as to make any difference in achievement. Or, the education system does not reward academic perseverance in the same way and to the same degree as other educational systems would.

Although potential explanations are speculated for the results, omitted variable bias is still likely to be present, especially at the country- and student-levels. This study shows some of the ways in which the omitted variable bias can be mitigated by employing country- and school-fixed effects. However, future study with better data will have to do more to address this serious issue that is inevitable in working with survey data.

Overall, the results from all regression models show that academic perseverance is positively and significantly associated with achievement in all countries in the sample, supporting Hypothesis 1. The strong positive association remains positive and significant in all 57 countries in the empirical sample even after controlling for between-country and between-school differences, as well as key student-level factors, which support Hypothesis 2. The size of the academic perseverance-achievement association varies across countries, although there is evidence for trends that hint at the plausibility of the cultural argument to explain the cross-national trends and sources of variation. These findings are significant in light of the recent theory of grit, the mixed findings of recent studies, and the virtual lack of cross-national evidence to date.

Policy implications

This study provides some of the first cross-national evidence on the association between academic perseverance as a non-cognitive skill and achievement. While causal evidence is considered to be the gold standard to inform any policy-making, this study nonetheless provides useful cross-national evidence for policy discussions, particularly with respect to non-cognitive skills. In particular, it directly informs the international and national educational policy discussions around developing national curricula with the explicit goal of developing students' academic perseverance, along with other non-cognitive skills deemed important.

Findings of this study on the positive and significant association between academic perseverance and achievement across all 57 countries inform ongoing international educational policy discussions on non-cognitive skills. International interests in measuring, studying, and developing students' non-cognitive skills have been growing rapidly in recent years. International organizations, such as UNESCO, OECD, and the World Bank, which play a significant role in setting educational agenda, goals, and directions for policy discourse on a global level, have in recent years highlighted the importance of various types of skills, particularly non-cognitive or soft skills. The human capital logic undergirding the efforts to stress the salience of skills is based on the link between education, various types of skills that will meet the needs of the changing society and its labor market, and subsequent national and global competitiveness and sustained development. The international educational policy discourses have called the need for education reforms, particularly highlighting non-cognitive skills as key skills needed for the fourth industrial revolution (Gray, 2016; WEF, 2015). However, the present dearth of systematic cross-national data on non-cognitive skills makes it difficult to move forward with international educational policy dialogues or any implementable action. This study provides some of the first cross-national and systematic evidence on a key non-cognitive skill theorized to be linked with

achievement to inform the ongoing policy discussions on non-cognitive skills measurement and research, which in turn will shape policy-making.

Moreover, the within-country findings have the potential to inform educational policy-making and practice in many countries included in the empirical sample for this study. Many national educational systems have increasingly emphasized non-cognitive skills development in their learning goals of national curricula, and some have integrated curriculum on non-cognitive skills, albeit the selection and definitions of non-cognitive skills may vary (Zhou, 2016). However, the assessment of non-cognitive skills is difficult and only a few countries have begun to measure non-cognitive skills on a national level. For instance, the increased attention on recent research findings on grit has spurred the U.S. national government, through the National Assessment of Educational Progress, to start collecting student data on level of grit since 2017 as part of the national assessments of student outcomes.

However, many countries have not kept up with measuring non-cognitive skills, such as perseverance or grit, despite the growing interest in educational policy discourse around different types of skills development. Given this backdrop, this study provides empirical evidence for one key non-cognitive skill and its association with achievement for nations that have not collected data on non-cognitive skills of their students. Thus, the findings of this study can inform national educational policy on developing curricula to encourage students to build academic perseverance.

Yet, caution is warranted in terms of making decisions about including an explicit goal of developing academic perseverance in school curricula, even though the results of this study show a positive and significant association between academic perseverance and achievement. It is important to note that high academic perseverance may not always be associated with a higher achievement of the same magnitude. For instance, although the data show that 15-year-old students in Kazakhstan have a much higher mean level of academic perseverance compared to their peers in other countries, the size of the academic perseverance-achievement association is

one of the smallest in the sample. This finding questions whether there is a threshold at which point academic perseverance become less effective, much akin to the idea of diminishing marginal utility in a sense. Similarly, additional emphasis on academic perseverance may not be so effective for some high-pressure education systems like Japan and Korea where students are already enduring long hours of study for years to do well on high-stakes tests for college entrance, thus inadvertently inducing more perseverance.

Limitations and directions for future research

There are several limitations for this study due to the cross-sectional nature of the PISA data. First, due to the lack of data on prior math achievement or IQ scores of students to control for, this dissertation makes no causal claims about the effects of perseverance on math achievement. Any estimates of the association between perseverance and achievement are likely to be overestimated, due to unobserved variables that might influence the outcome variable. In other words, the analyses done for this research cannot perfectly isolate the causal effects of perseverance on math achievement due to unobserved heterogeneity at the student level, leaving room for future studies to address these issues if and when cross-national and longitudinal data capturing prior achievement IQ, and perhaps other non-cognitive skills become available. To address this data-based limitation, this dissertation does control for key student characteristics that have been documented to be strongly associated with achievement as well as between-school differences by using fixed effects modeling techniques. Relatedly, reverse causality is another limitation due to the nature of the data, however, there is not much that can be done to address this issue.

Second, the use of self-reported questionnaires to measure non-cognitive skills can be problematic, given the potential reference bias as well as other various factors, such as incentives, emotional state at the time of survey, and other types of biases, all of which can influence the respondents' answers (Zhou, 2016). However, there are no cross-national measurement surveys or tools that address this issue. The PISA data is one of the very few cross-national datasets that measure several non-cognitive skills of 15-year-olds across 60+ countries around the world.

Third, we do not know or can model the variability of perseverance over time, given the cross-sectional data, where both perseverance and math achievement were recorded concurrently. Thus, this study assumes that perseverance as fixed at the time of the PISA survey—whether it was influenced by national, school, or family context or not cannot be determined—and only focuses on how the association between perseverance and achievement varies between countries.

Fourth, this study focuses on only one non-cognitive skill—academic perseverance. Despite the apparent challenges, futures studies should explore the effects of more non-cognitive skills on achievement and other outcomes, again if and when better data that contain more diverse sets of non-cognitive skills measures over time become available. All of the limitations mentioned above call for the development of cross-nationally valid longitudinal measurement tools to measure and record non-cognitive and cognitive skills at various stages over the life course.

Aside from data limitations, much room remains for future research in the study of non-cognitive skills particularly in a cross-national framework. Future research can examine how the association between academic perseverance—along with other measures of non-cognitive skills—and achievement (and other outcomes) are shaped or influenced by family, schools, and societies. This line of research sheds light on the ways and the extent to which different institutions either amplify or suppress the association between non-cognitive skills and achievement. Furthermore, future research can examine whether or not, and if so, the degree to

which non-cognitive skills might explain achievement gaps along the lines of class, gender, and race/ethnicity. While some past research has pursued said line of research, evidence is often spotty, outdated, and based on small samples and an assortment of measures of non-cognitive skills that are unique to the samples.

Future research can also contribute to policy-making. Studies that examine the determinants of perseverance or grit should investigate both school contexts, inputs, and interventions to explore how they help develop students' perseverance or grit along with other non-cognitive skills. This would constitute an important line of research that could inform education policy. For public policy more broadly, scholars can investigate family effects on children's perseverance or grit and other measures of non-cognitive skills during earlier years of child development, which would be another fruitful avenue of research to contribute to both scholarship and policy at large.

The research on non-cognitive skills, particularly perseverance and grit, and their effects on academic achievement is still relatively young, despite its tremendous growth over the recent years. This means that there is relatively limited research evidence on the varying effects of perseverance and grit in different situations and different national and school contexts. This study is one of the first steps in establishing cross-national evidence on the association between academic perseverance and achievement. Future research should identify and explore more national and school context measures that may mediate or moderate the association between non-cognitive skills and achievement. Future research should also examine the interrelationships between non-cognitive skills and other academic and non-academic outcomes, including student/youth development and empowerment outcomes (Mitra, 2004), and how national and school contexts shape them.

References

Adelman, C. (2006). The toolbox revisited: Paths to degree completion from high school through college. *US Department of Education*, 1–223. https://doi.org/ED490195

Alexander, K. L., Entwisle, D. R., & Dauber, S. L. (2003). *On the success of failure : a reassessment of the effects of retention in the primary grades*. Cambridge University Press.

Almlund, M., Duckworth, A. L., Heckman, J. J., & Kautz, T. D. (2011). *Personality psychology and economics*. Retrieved from http://www.nber.org/papers/w16822

Arum, R. (2005). *Judging school discipline : the crisis of moral authority*. Harvard University Press. Retrieved from http://www.hup.harvard.edu/catalog.php?isbn=9780674018143

Baker, D., & LeTendre, G. K. (2005). *National differences, global similarities: World culture and the future of schooling*. Stanford University Press.

Baker, D. P., Eslinger, P. J., Benavides, M., Peters, E., Dieckmann, N. F., & Leon, J. (2015). The cognitive impact of the education revolution: A possible cause of the Flynn Effect on population IQ. *Intelligence*, *49*, 144–158. https://doi.org/10.1016/j.intell.2015.01.003

Baker, D. P., Goesling, B., & LeTendre, G. K. (2002). Socioeconomic Status, School Quality, and National Economic Development : A Cross-National Analysis of the "Heyneman - Loxley Effect" on Mathematics and Science Achievement. *Comparative Education Review*, *46*(3), 291–312. https://doi.org/10.1086/341159

Becker, G. S. (1975). Chapter Title: Investment in Human Capital: Effects on Earnings. Retrieved from http://www.nber.org/books/beck75-1

Bempechat, J. (2004). The Motivational Benefits of Homework: A Social-Cognitive Perspective. *Theory Into Practice*, *43*(3), 189–196. https://doi.org/10.1207/s15430421tip4303_4

Benda, B. B. (2005). The Robustness of Self-Control in Relation to Form of Delinquency. *Youth & Society*, *36*(4), 418–444. https://doi.org/10.1177/0044118X04268071

Blair, C., & Peters Razza, R. (n.d.). Relating Effortful Control, Executive Function, and False Belief Understanding to Emerging Math and Literacy Ability in Kindergarten. *Source: Child Development Child Development*, *78*(2), 647–663. Retrieved from http://www.jstor.org/stable/4139250%0Ahttp://www.jstor.org/stable/4139250?seq=1&cid=pdf-reference#references_tab_contents%0Ahttp://about.jstor.org/terms

Bol, T., Witschge, J., Van de Werfhorst, H. G., & Dronkers, J. (2014). Curricular tracking and central examinations: Counterbalancing the impact of social background on student

achievement in 36 countries. *Social Forces*, *92*(4), 1545–1572. https://doi.org/10.1093/sf/sou003

Borghans, L., & Duckworth, A. (2008). The Economics and Psychology of Personality Traits. *IZA Discussion Paper*, *No. 3333*. Retrieved from http://arno.unimaas.nl/show.cgi?fid=9675

Borghans, L., Duckworth, A. L., Heckman, J. J., & ter Weel, B. (2008). The economics and psychology of personality traits. *Journal of Human Resources*, *43*(4), 972–1059. https://doi.org/10.3368

Borghans, L., Golsteyn, B. H. H., Heckman, J., & Humphries, J. E. (2011). Identification problems in personality psychology. *Personality and Individual Differences*, *51*(3), 315–320. https://doi.org/10.1016/j.paid.2011.03.029

Borghans, L., Meijers, H., & Ter Weel, B. (2008). The role of noncognitive skills in explaining cognitive test scores. *Economic Inquiry*, *46*(1), 2–12. https://doi.org/10.1111/j.1465-7295.2007.00073.x

Bourdieu, P. (1984). *Distinction*. Cambridge: Harvard University Press.

Bowles, S., & Gintis, H. (2002). Schooling in Capitalist America Revisited. *Sociology of Education*, *75*(1), 1. https://doi.org/10.2307/3090251

Bowles, S., Gintis, H., & Osborne, M. (2001). The Determinants of Earnings: A Behavioral Approach. *Journal of Economic Literature*, *39*(4), 1137–1176. https://doi.org/10.1257/jel.39.4.1137

Brunello, G., & Checchi, D. (n.d.). Does school tracking affect equality of opportunity? New international evidence. Retrieved from http://nbn-resolving.de/urn:nbn:de:101:1-2009062691

Buchmann, C., & Dalton, B. (2002). Interpersonal Influences and Educational Aspirations in 12 Countries: The Importance of Institutional Context Sociology of Education Interpersonal Influences and Educational Aspirations in The Importance of Institutional Context. *Source: Sociology of Education*, *75*(2), 99–122. Retrieved from http://www.jstor.org/stable/3090287

Buchmann, C., & Park, H. (2009). Stratification and the formation of expectations in highly differentiated educational systems. *Research in Social Stratification and Mobility*, *27*, 245–267. https://doi.org/10.1016/j.rssm.2009.10.003

Cattell, R. B. (1963). Theory of fluid and crystallized intelligence: A critical experiment. *Journal of Educational Psychology*, *54*(1), 1–22. https://doi.org/10.1037/h0046743

Chmielewski, A. (2014). An International Comparison of Achievement Inequality in Within- and Between-School Tracking Systems. *American Journal of Education*, *120*(3), 293–324. https://doi.org/10.1086/675529

Coleman, J. S. (1966). *Equality of educational opportunity [summary report* (Vol. 2). US

Department of Health, Education, and Welfare, Office of Education.

Credé, M., Tynan, M. C., & Harms, P. D. (2016). Much Ado About Grit: A Meta-Analytic Synthesis of the Grit Literature. *Journal of Personality and Social Psychology*. https://doi.org/10.1037/pspp0000102

Cunha, F., Heckman, J. J., & Schennach, S. M. (2010). Estimating the technology of cognitive and noncognitive skill formation. *Econometrica*, *78*(3), 883–931. Retrieved from http://onlinelibrary.wiley.com/doi/10.3982/ECTA6551/abstract

Cunha, F., Heckman, J., Lochner, L., & Masterov, D. V. (2005). Interpreting the Evidence of Life-Cycle Skill Formation. *IZA Discution Paper*, *1*(1675), 697–812. Retrieved from http://www.sciencedirect.com/science/article/pii/S1574069206010129

Datu, J. A. D., Valdez, J. P. M., & King, R. B. (2016). Perseverance Counts but Consistency Does Not! Validating the Short Grit Scale in a Collectivist Setting. *Current Psychology*, *35*(1), 121–130. https://doi.org/10.1007/s12144-015-9374-2

DiPrete, T. A., & Jennings, J. L. (2012). Social and behavioral skills and the gender gap in early educational achievement. *Social Science Research*, *41*(1), 1–15. https://doi.org/10.1016/j.ssresearch.2011.09.001

Duckworth, A. (2016). *Grit: The power of passion and perseverance*. Simon and Schuster.

Duckworth, A. L., & Carlson, S. M. (2013). Self-regulation and school success. *Self-Regulation and Autonomy: Social and Developmental Dimensions of Human Conduct*, *40*, 208. Retrieved from http://books.google.com/books?hl=en&lr=&id=qVlbAgAAQBAJ&oi=fnd&pg=PA208&dq=%22now+unequivocally+established+that+intelligence,+defined+as+the%22+%22as+“constitutionally+based+individual+differences+in+reactivity%22+%22attainment+(e.g.,+years+of+education,

Duckworth, A. L., Eichstaedt, J. C., & Ungar, L. H. (2015). The Mechanics of Human Achievement. *Social and Personality Psychology Compass*, *9*(7), 359–369. https://doi.org/10.1111/spc3.12178

Duckworth, A. L., Kirby, T. A., Tsukayama, E., Berstein, H., & Ericsson, K. A. (2011). Deliberate practice spells success: Why grittier competitors triumph at the National Spelling Bee. *Social Psychological and Personality Science*, *2*(2), 174–181. https://doi.org/10.1177/1948550610385872

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology*, *92*(6), 1087–1101. https://doi.org/10.1037/0022-3514.92.6.1087

Duckworth, A. L., & Quinn, P. D. (2009). Development and validation of the short grit scale (Grit-S). *Journal of Personality Assessment*, *91*(2), 166–174.

https://doi.org/10.1080/00223890802634290

Duckworth, A. L., & Seligman, M. E. P. (2006). Self-discipline gives girls the edge: Gender in self-discipline, grades, and achievement test scores. *Journal of Educational Psychology*, *98*(1), 198–208. https://doi.org/10.1037/0022-0663.98.1.198

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., … Japel, C. (2007). School readiness and later achievement. *Developmental Psychology*, *43*(6), 1428–1446. https://doi.org/10.1037/0012-1649.43.6.1428; 10.1037/0012-1649.43.6.1428.supp (Supplemental)

Dweck, C. (2007). *Mindset: The new psychology of success*. *Head Neck* (Vol. 19). Random House. https://doi.org/10.5860/CHOICE.44-2397

Dweck, C. S. (1999). *Self-theories: Their role in motivation, personality, and development.* https://doi.org/10.1007/BF01544611

Eskreis-Winkler, A. L. D. and L. (2013). True Grit. *APS Observer*, *26*(4). Retrieved from http://www.psychologicalscience.org/observer/true-grit

Eskreis-Winkler, L., Shulman, E. P., Beal, S. A., & Duckworth, A. L. (2014). The grit effect: predicting retention in the military, the workplace, school and marriage. *Frontiers in Psychology*, *5*. https://doi.org/10.3389/fpsyg.2014.00036

Eskreis-Winkler, L., Shulman, E. P., Young, V., Tsukayama, E., Brunwasser, S. M., & Duckworth, A. L. (n.d.). PERSONALITY PROCESSES AND INDIVIDUAL DIFFERENCES Using Wise Interventions to Motivate Deliberate Practice. Retrieved from http://dx.doi.org/10.1037/pspp0000074.supp

Farkas, G. (2003). Cognitive Skills and Noncognitive Traits and Behaviors in Stratification Processes. *Annual Review of Sociology*, *29*(1), 541–562. https://doi.org/10.1146/annurev.soc.29.010202.100023

Farkas, G., Grobe, R. P., Sheehan, D., & Shuan, Y. (1990). Cultural Resources and School Success: Gender, Ethnicity, and Poverty Groups within an Urban School District. *American Sociological Review*, *55*(1), 127. https://doi.org/10.2307/2095708

Farrington, C. A., Roderick, M., Allensworth, E., Nagaoka, J., Keyes, T. S., Johnson, D. W., & Beechum, N. O. (2012). The Role of Noncognitive Factors in Shaping School Performance: A Critical Literature Review. *LITERATURE REVIEW JUNE*.

Gray, A. (2016). The 10 skills you need to thrive in the Fourth Industrial Revolution. Retrieved April 3, 2017, from https://www.weforum.org/agenda/2016/01/the-10-skills-you-need-to-thrive-in-the-fourth-industrial-revolution/

Heckman, J. J., & Rubinstein, Y. (2001). The importance of noncognitive skills: Lessons from the GED testing program. The American Economic Review, 91(2), 145-149. (n.d.).

Heckman, J. (2005). *Inequality in America: What role for human capital policies? Focus* (Vol. 23). MIT. https://doi.org/10.1007/s10888-006-9028-6

Heckman, J. J. (2008). Schools, skills, and synapses. *Economic Inquiry*, *46*(3), 289–324. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1465-7295.2008.00163.x/full

Heckman, J. J., Humphries, J. E., & Kautz, T. (2014). *Achievement Tests and the Role of Character in American Life*. *University of Chicago Press*. Retrieved from http://home.uchicago.edu/~tkautz/Heckman_Kautz_2014_Achievement Tests.pdf

Heckman, J. J., & Kautz, T. (2012). Hard evidence on soft skills. *Labour Economics*, *19*(4), 451–464. https://doi.org/10.1016/j.labeco.2012.05.014

Heckman, J. J., & Rubinstein, Y. (2001). The benefits of skill: The importance of noncognitive skills: Lessons from the GED testing program. *American Economic Review*, *91*(2), 145–154. https://doi.org/10.1257/aer.91.2.145

Heckman, J. J., Stixrud, J., & Urzua, S. (2006). The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behavior. *Journal of Labor Economics*, *24*(3), 411–482. https://doi.org/10.1086/504455

Heckman, J., & Kautz, T. (2015). Fostering and Measuring Skills Heckman and Kautz Fostering and Measuring Skills.

Heyneman, S. P., & Loxley, W. A. (1983). The effect of primary-school quality on academic achievement across twenty-nine high-and low-income countries. *American Journal of Sociology*, 1162–1194. Retrieved from http://www.jstor.org/stable/2778968

Horn, J. L., & Cattell, R. B. (1966). Refinement and test of the theory of fluid and crystallized general intelligences. *Journal of Educational Psychology*, *57*(5), 253–270. https://doi.org/10.1037/h0023816

Jencks, C. (1979). *Who gets ahead? : the determinants of economic success in America*. Basic Books.

Jencks, C., & Others. (1979). *Who Gets Ahead? The Determinants of Economic Success in America.* Basic Books, Publishers, 10 East 53rd Street, New York, NY 01122. Retrieved from https://eric.ed.gov/?id=ED183100

Kautz, T., & Research, M. P. (2015). Advances in Measuring Non-Cognitive Skills. Retrieved from http://www.riseprogramme.org/sites/www.riseprogramme.org/files/RISE_2016-06-12a_tdkautz.pdf

Kingston, P. W. (2001). The Unfulfilled Promise of Cultural Capital Theory. *Sociology of Education*, *74*, 88. https://doi.org/10.2307/2673255

Kyllonen, P. C., & Bertling, J. P. (2013). Innovative questionnaire assessment methods to increase cross-country comparability. *Handbook of International Large-Scale Assessment:*

Background, Technical Issues, and Methods of Data Analysis, 277–286.

Lareau, A. (2006). *Unequal Childhoods: Class, Race and Family Life*. *American Journal of Sociology* (Vol. 112). https://doi.org/10.1086/510036

Maddi, S. R., Matthews, M. D., Kelly, D. R., Villarreal, B., & White, M. (2012). The Role of Hardiness and Grit in Predicting Performance and Retention of USMA Cadets. *Military Psychology*, *24*(1), 19–28. https://doi.org/10.1080/08995605.2012.639672

Marks, G. N. (2006). Are between- and within-school differences in student performance largely due to socio-economic background? Evidence from 30 countries. *Educational Research*, *48*(1), 21–40. https://doi.org/10.1080/00131880500498396

Martin, R. P. (1989). *Activity level, distractibility, and persistence: Critical characteristics in early schooling. Temperament in childhood.* John Wiley & Sons. Retrieved from http://libproxy.tulane.edu:2048/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=1990-97271-024&site=ehost-live&scope=site

Meyer, J. W., Bromley, P., Ramirez, F. O., Meyer1, J. W., Bromley1, P., & Ramirez1, F. O. (2010). Human Rights in Social Science Textbooks: Cross-national Analyses Sociology of Education. *Source: Sociology of Education*, *83174254*(2), 111–134. https://doi.org/10.1177/0038040710367936

Meyer, J. W., Ramirez, F. O., Frank, D. J., & Schofer, E. (2005). Higher Education as an Institution*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.534.8917&rep=rep1&type=pdf

Meyer, J. W., Ramirez, F. O., & Soysal, Y. N. (1992). World expansion of mass education, 1870-1980. *Sociology of Education*, 128–149. Retrieved from http://www.jstor.org/stable/2112679

Mincer, J. (1958). Investment in Human Capital and Personal Income Distribution. *Journal of Political Economy*, *66*(4), 281–302. https://doi.org/10.1086/258055

Mincer, J. (1974). Schooling, Experience, and Earnings. Human Behavior & Social Institutions No. 2. National Bureau of Economic Research, Inc., 261 Madison Ave., New York, New York 010016 ($10.00). Retrieved from https://eric.ed.gov/?id=ED103621

Mitra, D. L. (2004). The significance of students: Can increasing "student voice" in schools lead to gains in youth development? *Teachers College Record*, *106*(4), 651–688. https://doi.org/10.1111/j.1467-9620.2004.00354.x

Normandeau, S., & Guay, F. (1998). Preschool behavior and first-grade school achievement: The mediational role of cognitive self-control. *Journal of Educational Psychology*, *90*(1), 111–121. https://doi.org/10.1037/0022-0663.90.1.111

Oecd. (2012). *Chapter 16. Scaling Procedures and Construct Validation of Context*

Questionnaire Data. Retrieved from https://www.oecd.org/pisa/pisaproducts/PISA 2012 Technical Report_Chapter 16.pdf

OECD. (2014). *PISA 2012 Results in Focus: What 15-year-olds know and what they can do with what they know*. Paris. Retrieved from http://www.oecd.org/pisa/keyfindings/pisa-2012-results-overview.pdf

Our Finnish Heritage - Finlandia University : Finlandia University. (n.d.). Retrieved January 23, 2018, from http://www.finlandia.edu/about/our-finnish-heritage/

Parsons, T. (1959). The school class as a social system - some of its functions in American Society. *Harvard Educational Review*, *29*(4), 298–318. Retrieved from http://edf.stanford.edu/sites/default/files/scan001.pdf

Peterson, C., & Seligman, M. E. P. (2004). *Character strengths and virtues : a handbook and classification*. American Psychological Association.

PRATT, T. C., & CULLEN, F. T. (2000). THE EMPIRICAL STATUS OF GOTTFREDSON AND HIRSCHI'S GENERAL THEORY OF CRIME: A META-ANALYSIS. *Criminology*, *38*(3), 931–964. https://doi.org/10.1111/j.1745-9125.2000.tb00911.x

Roberts, B. W. (2009). Back to the Future: Personality and Assessment and Personality and Assessment. *Journal of Research in Personality*, *43*(2), 137–145. Retrieved from http://www.sciencedirect.com/science/article/pii/S0092656608001657

Robertson-Kraft, C., & Duckworth, A. L. (2014). True Grit: Trait-level perserverance and passion for long-term goals predicts effectiveness and retention among novice teachers. *Teachers College Record*, *116*(3), 1–27. https://doi.org/10.3851/IMP2701.Changes

Rose, H., & Betts, J. R. (2004). The Effect of High School Courses on Earnings. *Review of Economics and Statistics*, *86*(2), 497–513. https://doi.org/10.1162/003465304323031076

Rosenbaum, J. E. (2001). *Beyond college for all : career paths for the forgotten half*. Russell Sage Foundation.

Ryans, D. G. (1939). The measurement of persistence: an historical review. *Psychological Bulletin*, *36*(9), 715–739. https://doi.org/10.1037/h0060780

Schultz, T. W. (1961). Investment in human capital. *The American Economic Review*, 1–17. Retrieved from http://www.jstor.org/stable/1818907

Schutz, G., Ursprung, H. W., & Woessmann, L. (2008). Education policy and equality of opportunity. *Kyklos*, *61*(2), 279–308. https://doi.org/10.1111/j.1467-6435.2008.00402.x/full

Sewell, W. H., Haller, A. O., & Ohlendorf, G. W. (1970). The Educational and Early Occupational Status Attainment Process: Replication and Revision. *American Sociological Review*, *35*(6), 1014–1027. https://doi.org/10.2307/2093379

Sewell, W. H., & Hauser, R. M. (1975). Education, Occupation and Earnings: Achievements in the Early Career. Academic Press Inc., 111 Fifth Avenue, New York, New York 10003 ($16.50). Retrieved from https://eric.ed.gov/?id=ed116041

Stevenson, H. W., Lee, S.-Y., Chen, C., Stigler, J. W., Hsu, C.-C., Kitamura, S., & Hatano, G. (1990). Contexts of Achievement: A Study of American, Chinese, and Japanese Children. *Monographs of the Society for Research in Child Development*, *55*(1/2), i. https://doi.org/10.2307/1166090

Strayhorn, T. (2014). What Role Does Grit Play in the Academic Success of Black Male Collegians at Predominantly White Institutions. *Journal Of African American Studies*, *18*(1), 1–10. https://doi.org/10.1007/s12111-012-9243-0

Swidler, A. (1986). Culture in Action: Symbols and Strategies. *American Sociological Review*, *51*(2), 273. https://doi.org/10.2307/2095521

Trautwein, U., Lüdtke, O., Schnyder, I., & Niggli, A. (2006). Predicting homework effort: Support for a domain-specific, multilevel homework model. *Journal of Educational Psychology*, *98*(2), 438–456. https://doi.org/10.1037/0022-0663.98.2.438

Trzesniewski, K. H., Moffitt, T. E., Caspi, A., Taylor, A., & Maughan, B. (2006). Revisiting the association between reading achievement and antisocial behavior: New evidence of an environmental explanation from a twin study. *Child Development*, *77*(1), 72–88. https://doi.org/10.1111/j.1467-8624.2006.00857.x

Turner, R. H. (1960). Sponsored and Contest Mobility and the School System. *American Sociological Review*, *25*(6), 855–867. https://doi.org/10.1017/CBO9781107415324.004

Van de Werfhorst, H. G., & Mijs, J. J. B. (2010). Achievement Inequality and the Institutional Structure of Educational Systems: A Comparative Perspective. *Annual Review of Sociology*, *36*(1), 407–428. https://doi.org/10.1146/annurev.soc.012809.102538

Walsh, D. (2004). *Why do they act that way?: A survival guide to the adolescent brain for you and your teen.* Free Press. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,url,uid,shib&db=psyh&AN=2005-13730-000&site=ehost-live

WEF. (2015). New Vision for Education Unlocking the Potential of Technology. Retrieved April 3, 2017, from www.weforum.org

West, M. R., Kraft, M. A., Finn, A. S., Martin, R. E., & Duckworth, A. L. (2016a). Promise and Paradox : Measuring Students ' Non-Cognitive Skills and the Impact of Schooling. *Educational Evaluation and Policy Analysis*, *38*(1), 1–23. https://doi.org/10.3102/0162373715597298

West, M. R., Kraft, M. A., Finn, A. S., Martin, R. E., & Duckworth, A. L. (2016b). Promise and Paradox : Measuring Students ' Non-Cognitive Skills and the Impact of Schooling.

Educational Evaluation and Policy Analysis, *38*(1), 1–23. https://doi.org/10.3102/0162373715597298

Woelfel, J., & Haller, A. O. (1971). Significant Others, The Self-Reflexive Act and the Attitude Formation Process. *American Sociological Review*, *36*(1), 74. https://doi.org/10.2307/2093508

Zhou, K. (2016). *Paper commissioned for the Global Education Monitoring Report 2016, Education for people and planet: Creating sustainable futures for all -- Non-cognitive skills: definitions, measurement and malleability*.

Appendix A. Correlation matrix of all variables

	Perseverance	Age	Grade	Female	Family SES	Immigrant	PV1MATH	PV2MATH	PV3MATH	PV4MATH	PV5MATH
Perseverance	1										
Age	0.016	1									
Grade	0.048	0.192	1								
Female	-0.013	-0.002	0.056	1							
Family SES	0.035	-0.008	0.243	-0.030	1						
Immigrant	0.026	0.005	-0.035	-0.003	0.048	1					
PV1MATH	0.110	0.027	0.312	-0.072	0.429	-0.008	1				
PV2MATH	0.110	0.027	0.311	-0.072	0.428	-0.009	0.935	1			
PV3MATH	0.110	0.026	0.312	-0.072	0.428	-0.010	0.934	0.935	1		
PV4MATH	0.110	0.026	0.311	-0.072	0.428	-0.010	0.935	0.935	0.934	1	
PV5MATH	0.110	0.025	0.312	-0.072	0.428	-0.010	0.934	0.935	0.934	0.934	1

Note: Based on a pooled sample of 57 countries.

Appendix B. Correlation between academic perseverance and achievement by country

Country	Correlation coefficient
1. ARE	0.256
2. ARG	0.156
3. AUS	0.302
4. AUT	0.163
5. BEL	0.159
6. BGR	0.175
7. BRA	0.136
8. CAN	0.273
9. CHE	0.179
10. CHL	0.156
11. COL	0.133
12. CRI	0.105
13. CZE	0.107
14. DEU	0.195
15. DNK	0.260
16. ESP	0.238
17. EST	0.044
18. FIN	0.309
19. FRA	0.306
20. GBR	0.298
21. GRC	0.288
22. HRV	0.076
23. HUN	0.132
24. IDN	0.124
25. IRL	0.264
26. ISL	0.336
27. ISR	0.003
28. ITA	0.168
29. JOR	0.303
30. JPN	0.227
31. KAZ	0.159
32. KOR	0.264
33. LTU	0.135
34. LUX	0.175
35. LVA	0.181
36. MEX	0.199
37. MYS	0.153
38. NLD	0.076
39. NOR	0.408
40. NZL	0.312
41. PER	0.138
42. POL	0.282
43. PRT	0.294
44. QAT	0.286
45. ROU	0.134
46. RUS	0.104
47. SGP	0.115
48. SRB	0.116
49. SVK	0.213
50. SVN	0.098
51. SWE	0.335
52. THA	0.211
53. TUN	0.225
54. TUR	0.167
55. URY	0.184
56. USA	0.208
57. VNM	0.076

Appendix C. Standard deviation of academic perseverance and achievement by country (in descending order) and their correlation

SD of academic perseverance		SD of achievement	
ISR	1.182	SGP	103.8
BGR	1.170	SVK	100.2
KAZ	1.119	ISR	98.54
TUN	1.105	KOR	98.39
NOR	1.092	QAT	97.52
TUR	1.077	NZL	97.49
SRB	1.063	BEL	96.90
FRA	1.055	AUS	95.38
PRT	1.052	LUX	94.67
USA	1.048	FRA	94.60
RUS	1.041	DEU	93.49
JOR	1.032	CZE	93.45
POL	1.029	JPN	92.89
HRV	1.024	TUR	92.56
IRL	1.015	CHE	92.04
ITA	1.012	THA	91.48
URY	1.011	HUN	91.00
MEX	1.007	BGR	90.56
SVK	1.005	POL	89.95
SWE	1.004	ITA	89.35
CAN	1.002	SWE	89.24
GBR	0.994	AUT	88.87
CRI	0.986	GBR	88.76
GRC	0.986	ISL	88.71
QAT	0.985	NLD	88.71
COL	0.976	ARE	88.58
ARG	0.974	PRT	88.46
CHL	0.971	USA	87.92
ARE	0.968	LTU	87.85
ISL	0.963	NOR	87.56
ROU	0.954	SRB	87.41
BRA	0.953	ESP	86.82
AUS	0.951	GRC	86.65

DNK	0.945	RUS	86.42
LUX	0.942	FIN	86.35
ESP	0.941	SVN	86.25
CHE	0.939	CHL	85.94
BEL	0.938	URY	85.94
SVN	0.929	HRV	85.80
EST	0.920	CAN	85.31
NZL	0.917	DNK	84.55
FIN	0.902	IRL	83.49
AUT	0.885	VNM	81.69
DEU	0.883	LVA	81.34
IDN	0.882	PER	81.30
PER	0.876	ROU	80.07
LVA	0.871	MYS	79.83
CZE	0.867	EST	78.98
VNM	0.864	TUN	77.56
JPN	0.862	ARG	77.12
HUN	0.844	BRA	75.45
LTU	0.844	COL	72.81
MYS	0.841	MEX	72.70
SGP	0.829	KAZ	72.28
NLD	0.818	JOR	71.50
KOR	0.754	IDN	70.03
THA	0.743	CRI	66.94

Note: The correlation between the standard deviation of academic perseverance and the standard deviation of achievement is slightly negative, -0.173.

VITA
HyoJung Jang

EDUCATION

2014–2018	Ph.D. in Educational Theory and Policy & Comparative and International Education Minor: Sociology **The Pennsylvania State University**, University Park, PA
2009–2011	M.A. in East Asian Studies (Concentrations: Sociology and History) Thesis: "Multiculturalism in Korea: The Tension between Ethnic Nationalism and Global Human Rights Norms" **Stanford University**, Stanford, CA
2004–2008	B.M. Piano Performance, graduated with honors, *Phi Kappa Lambda* B.A. Mass Communications (Broadcast Journalism), graduated with honors **Anderson University**, Anderson, IN

SELECTED AWARDS & GRANTS

2018	New Scholars Committee Merit Travel Grant, **Comparative & International Education Society**
2016–2017	Graduate Research Assistantship, **The Pennsylvania State University**
2014–2016	Dean's Graduate Research Assistantship, **The Pennsylvania State University**
2010	Tuition Fellowship (Fall), **Stanford University**
2010	Summer Tuition Fellowship, **Stanford University**
2010	Scholarship, **The Kang Young Artists and Scholars Fund**
2004–2008	Dean's List, **Anderson University**
2004–2008	Full Scholarship, **Anderson University**

PROFESSIONAL EXPERIENCE

2012–2014	**Education Consultant** at The World Bank, Vientiane, Lao PDR Country Office
2011–2012	**Curriculum Writer**, Stanford Program on International and Cross-Cultural Education (SPICE), Stanford University, Stanford, CA

TECHNICAL QUALIFICATIONS

Statistical Packages: STATA, SPSS, Minitab, and Lisrel
Data Analysis Experience: PISA, PIAAC, TALIS, TIMSS, STEP, HSLS:09

PUBLICATIONS

Manuscripts in preparation:

Jang, H. "Non-cognitive skills and achievement: A cross-national analysis"
Jang, H. "The Role of National Context on Gender Gaps in Achievement"
Jang, H. "The Role of School Context on Gender Differences in Math Achievement in Korea"
Jang, H. "Gendered Effects of Education and Skills on Wages: Evidence from Laos"

CONFERENCE PRESENTATIONS

Jang, H. (2018). "School context and the gender gap in math achievement, self-efficacy, and STEM majors". Paper presented at the American Educational Research Association Conference, New York City, New York.
Jang, H. (2018). "The role of academic perseverance on achievement: A cross-national analysis." Paper presented at the Comparative and International Education Society Conference, Mexico City, Mexico.
Jang, H. (2017). **"**Gendered Effects of Education and Skills on Wages: Evidence from Laos and Vietnam." Paper presented at the Comparative and International Education Society Conference, Atlanta, Georgia.
Jang, H. and Jeon, H. (2016). "Math gender gap in East Asia: Role of school context." Paper presented at the Comparative and International Education Society Conference, Vancouver, Canada.
Jang, H. (2015). "Exploring the impact of national context on within-school gender gaps in achievement: Evidence from PISA 2012." Paper presented at the Comparative and International Education Society Conference, Washington D.C.