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Cultural Values Differentially Moderate the Benefits of Basic Education on Two Types of National Innovation Outputs

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Abstract

The present study contributes to innovation research by distinguishing between national innovation in the knowledge and technology domain (knowledge and technology output) versus that in the creative industries (creative output), and examining how these two types of innovation would benefit from high-quality basic education in different cultural contexts. We argue that because creative output requires symbolic knowledge (i.e., negotiation of new meanings), it would benefit from a national context that has not only high-quality basic education but also favorable cultural values (low self-protective values or high self-expansion values). By contrast, knowledge and technology output requires analytic and synthetic knowledge mainly and thus would benefit from high-quality basic education regardless of cultural values. To test these ideas, we performed regression analyses using three archival datasets (the Programme for International Student Assessment [PISA], the Schwartz Value Survey, and the Global Innovation Index) of 32 nations. The results in general supported our predictions such that a high level of self-protective values dampens the positive relationship between quality of basic education and creative output only, but not knowledge and technology output. Implications of these findings were discussed.

Keywords

innovation, creative output, knowledge and technology output, PISA, education, Schwartz values, Global Innovation Index

As innovation is one of the key drivers of productivity and economic growth, increasing innovation output is at the forefront of investment and policy making in many countries (United Nations Educational, Scientific and Cultural Organization Press, 2015). Innovation is defined as "the multi-stage process whereby organizations transform ideas into new or improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace" (Baregheh, Rowley, & Sambrook, 2009, p. 1334). Through recursive cycles of testing, refining, and modifying, creative ideas, that is, ideas that are both novel and useful

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(Amabile, 1996), are passed from the creative insight stage to the implementation stage, where they are made commercially viable.

Innovation is a broad phenomenon that covers a range of products and processes. However, a more prevalent practice in the management literature has been to link innovation to scientific and technological developments, thereby overlooking products, goods, and services from the creative industries (Stupples, 2014). Recently, to sustain in a highly competitive global economy, policy makers are increasingly turning to the creative industries (including art, theater, cinema, music, and publishing and print sectors) as a means of fostering innovation, boosting economic growth, creating employment, and supporting businesses, in addition to the more conventional industries in the knowledge sectors, such as those involved in science and technology (S&T) innovation (Müller, Rammer, & Truby, 2009; Nivin & Plettner, 2009). For example, the Chinese national strategy for economic development has evolved from focusing solely on promoting scientific and technological innovation in the 1990s and early 21st century to adopting a more inclusive approach that is also focused on the cultivation of artistic talents (Pang & Plucker, 2013). Likewise, state governments in the United States are increasingly looking to the creative industries, including both traditional sectors—visual artists, cultural performances, and non-profit institutions—and also the more commercial domains—fashion, entertainment, publishing, and broadcasting—as viable sources of exports to boost the economy (National Governors Association, 2012). Indeed, the annually reported Global Innovation Index (GII), that ranks economies across the world on their overall innovation scores, innovation input, and innovation output, included the creative products component in its computation of the overall innovation output score beginning in 2010 (Cornell University, INSEAD, & World Intellectual Property Organization [WIPO], 2014; Institut Européen d'Administration des Affaires (INSEAD), (2010)). Specifically, the GII computes the overall innovation output of a country by equally weighting the knowledge and technology output component and the creative output component, thus signaling an emerging recognition of the importance of studying both types of outputs to gain a comprehensive understanding of national-level innovation. Despite this, in mainstream innovation management literature, innovation has been inextricably linked with the S&T sectors, to the extent that they are used almost synonymously and have focused, almost exclusively, on measures such as patents, trademark registrations, scientific research outputs, and R&D expenditure to study related antecedents and processes (Adams, Bessant, & Phelps, 2006; Institut Européen d'Administration des Affaires (INSEAD), (2010); Tidd, 2001). In contrast, there is little focus on the creative sectors for the most part and comparatively fewer studies have focused on processes and outcomes in creative industries (e.g., Lopes, 1992; Perretti & Negro, 2007; Zukauskaite, 2012). As such, the present research is among the few attempts that sought to distinguish creative outputs from knowledge and technology outputs. This research examines the predictors of innovation outcomes by taking both knowledge and technology output and creative output into account and testing whether success in these domains depends on similar or distinct input and contextual factors. In particular, we propose to examine the differentiated roles of education and cultural values on the two types of output at a national level, and build and test our hypotheses accordingly. That is, we make predictions of how quality of basic education may contribute to these two types of innovation outputs. Furthermore, we also examine when culture, in the form of value orientations, would differentially strengthen or weaken the relationships between the quality of basic education and the two types of innovation outputs.

The objective of the current research is threefold. First, we sought to consider a nation's level of creative output independently from its level of knowledge and technology output. To this end, we borrow from the framework of GII (Cornell University et al., 2014), which differentiates between two types of innovation outputs clearly: knowledge and technology output was calculated with indicators like patents, scientific and technical articles, ISO 9001 quality certificates, and so on, whereas creative output was calculated with indicators like literature, print and media publishing, film and music production, and so on. As such, the present research sheds light on the differential properties of the two types of innovation outputs.

Second, we focus on the beneficial effects of basic education quality for the two types of innovation outputs. Specifically, we consider how the quality of basic education (i.e., elementary and junior-high education) matters for national innovation outcomes, because arguably, basic education is where crucial cognitive skills are acquired and hence serves as a springboard for higher education. As such, we address a crucial gap in knowledge as most existing research focuses on the link between university or tertiary-level education and knowledge and technology output. The contribution of basic education quality on creative output is still unclear. This research helps to fill this knowledge gap.

Third, the most important goal of our research is to examine whether national culture differentially moderates the effectiveness of basic education on the two types of innovation outputs. Specifically, some previous studies have shown that individuals holding certain values, including self-direction and stimulation, showed greater creative behaviors than do their counterparts who hold other values—including tradition, conformity, security, and power (Dollinger, Burke, & Gump, 2007; Kasof, Chen, Himsel, & Greenberger, 2007; Rice, 2006; Sagiv, 2002; Shin & Zhou, 2003). Therefore, it is possible that the corresponding cultural values have effects on innovation outputs at the national level. However, instead of focusing on the main effects of national values, we argue that it is more nuanced to examine the moderating effects of national values on the link between education and the two types of innovation outputs. Specifically, innovation in the knowledge and technology domain relies primarily on the analytic and synthetic knowledge bases, which are comparatively universal (Asheim, Coenen, Moodysson, & Vang, 2007; Asheim & Hansen, 2009), and thus would benefit from high-quality basic education regardless of the national culture. In contrast, innovation in the creative domain relies on the context-specific symbolic knowledge base, which would be affected not only by education but also culture. Therefore, we predict that national culture moderates the benefits of high-quality basic education on creative output but not on knowledge and technology output. This prediction has important implications on the role of education in promoting national innovation outputs. To fully explicate our ideas, in the following sections, we first review relevant research on the key variables of our research, then develop our theory and hypotheses about the relationships between the key variables. Next, we describe the data and present our results; finally, we discuss implications for practice and avenues for future research.

Theory and Hypotheses

Education Quality and Innovation

National innovative capacity is defined as “the ability of a country—both as a political and economic entity—to produce and commercialize flow of new-to-the-world technologies over the long term” (Furman, Porter, & Stern, 2002, p. 900). According to the national innovation system perspective, one of the drivers of innovation is the education quality of a country (Freeman, 1995) including university systems, the size of the available pool of human capital resources, and the country’s available knowledge stock (Abel & Deitz, 2012; Freeman, 1995). Education significantly contributes to the accumulation of national human capital, which in turn drives innovation (Bontis, 2002; Bontis, Crossan, & Hulland, 2000; United Nations Educational, Scientific and Cultural Organization. (2014), Webster, 2000). Human capital refers to human-based resources and capabilities such as knowledge, skills, technical abilities, and competencies along with personality characteristics and attitudes (Tovstiga & Tulugurova, 2009). For example, a study conducted in Finland, a knowledge-intensive economy, found that the number of engineers holding master’s degrees had a significant impact on the number of patents obtained (Toivanen

& Väänänen, 2012). While both knowledge and creative economies draw on the educated talent pool for their supply of human resource capabilities, previous studies that have examined the effect of education on innovation output and processes have been conducted in the context of knowledge-intensive industries. Much less is known about whether education quality also contributes in similar ways to innovations in creative industries (e.g., film or publishing) as well, despite the increasing importance of the creative sector as a crucial driver of economic growth (Anderson, Potocnik, & Zhou, 2014; Müller et al., 2009; Nivin & Plettner, 2009; Stupples, 2014).

Furthermore, most existing studies have focused on education at the tertiary level, specifically, in the engineering and science fields, as a predictor of innovation success (e.g., Eriksson & Forslund, 2014; Florida, 2002; Gal & Ptacek, 2011; Toivanen & Väänänen, 2012). Likewise, based on the human capital theory (Becker, 1964; Mincer, 1974), research that links education to economic performance, such as worker productivity, wages, and socioeconomic success, has most commonly been operationalized through the number of years of schooling, the level of education, and the amount of time spent in accumulating skills or worker experience (Caragliu & Nijkamp, 2012; Cunha & Heckman, 2010; Murnane, Willett, & Levy, 1995). However, there is comparatively less research on whether pre-tertiary or secondary-level education quality matters for national innovation. While most specialized knowledge acquisition occurs at the levels of higher education, like universities and vocational training institutes, basic and foundational cognitive skills are acquired in the primary and secondary school levels. The acquisition of critical skills and knowledge that contribute to the accumulation of cognitive capital is established during lower levels of education and continues through later stages of learning (Knudsen, Heckman, Cameron, & Shonko, 2006). A weak foundation at the basic level would potentially impair the development of critical knowledge and skills that are crucial for success in higher education (Cunha & Heckman, 2010). This is because cognitive skill development is self-productive, self-reinforcing, and cross fertilizing, meaning that skills acquired and developed at early stages reinforce skills development at later stages and augment returns on investment from later stage skills. Hence, a sound educational foundation at the primary and secondary levels supports tertiary education which then equips students with the knowledge and skills that will be directly applicable in their jobs.

Consistent with this idea, recent studies have focused on cognitive capital, which is defined as "those human faculties such as memory, attention, perception, problem solving and mental imagery which can be drawn upon to create, and take advantage of, opportunities to sustain wellbeing in response to environmental challenge and stress" (Bynner & Wadsworth, 2010, p. 297). Cognitive skills acquisition at primary school levels have been found to have a number of implications for higher education as well as economic outcomes, beyond the number of years of educational attainment which is the most common measure of education in past research (Hanushek & Woessmann, 2008). These skills have been found to persist over time and to positively enhance skills attainment at later stages of education (Cunha & Heckman, 2010). Primary- and secondary-level students with highly developed cognitive skills were found to be more efficient in their learning and were more likely to pursue higher education (Hanushek & Woessmann, 2012). In this sense, education at the primary levels is self-reinforcing and has a multiplier effect through the later stages of learning. More importantly, education helps in building the human capabilities and innovative capacity of a country through acquisition and development of new knowledge that ultimately promotes economic growth (UN Millennium Project, 2005).

Consistent with this theorizing, in the current research, we operationalize quality of basic education through the Programme for International Student Assessment (PISA) scores that allow for cross-country comparison of performance of 15-year-old students, who are nearing the end of their compulsory education in most countries, on application of knowledge acquired during schooling to real-life situations and be equipped for full participation in society (OECD, 2012). In other words, PISA is an indication of literacy rather than an assessment of how well students have learned a specific curriculum. Moreover, countries around the world are paying increasing attention to the PISA rankings, with the implicit assumption that good performance based on PISA evaluation scores holds positive implications for the quality of the future workforce and, subsequently, the nation's economic performance, including innovation (Hanushek & Woessmann, 2008, 2012; OECD, 2012). Given that basic education is a foundation for cognitive skill development, having a high-quality basic education should aid both knowledge and technology output and creative output at the country level. We therefore predict the following hypothesis:

Hypothesis 1a: Quality of basic education, as operationalized by PISA score, is positively associated with knowledge and technology output at the country level.
Hypothesis 1b: Quality of basic education, as operationalized by PISA score, is positively associated with creative output at the country level.

That being said, the two types of innovation outputs, however, may also require different knowledge bases. Indeed, the human capital perspective (Glaeser, 1998) and the creative class approach (Florida, 2002) have stated that the concentration of qualified human capital promotes regional growth as different types of talent employ different kinds of knowledge bases and different dominant knowledge bases are drawn upon by different industries. Therefore, knowledge bases determine the focus of knowledge creation, mode of innovation, and source of competitive advantage of the firm or industry (Asheim et al., 2007; Asheim & Hansen, 2009).

Most industries employ one or more of the three kinds of primary knowledge bases—analytical (scientific), synthetic (engineering), and symbolic (artistic)—in varying proportions. In addition, each knowledge base may be employed by a diverse range of professions and occupations. The *analytic* knowledge bases involve highly coded knowledge that consists of formal models and scientific principles upon which new knowledge is created, such as the discoveries in the fields of bio-technology and nanotechnology. The new knowledge creation can be in the form of scientific discoveries or new products, processes, or businesses, and the mode of innovation is mostly radical. In short, analytical knowledge informs know-why.

The *synthetic* knowledge bases involve a greater degree of tacit knowledge along with codified knowledge. The innovations in industries that primarily employ synthetic knowledge bases are incremental in nature and involve knowledge application through the novel combination of existing knowledge. In this regard, synthetic knowledge involves the use of practical skills and know-how. Industries like plant engineering, industrial machinery, and so forth rely largely on this knowledge base. Most S&T industries predominantly employ both analytical and synthetic knowledge bases to create, apply, or combine existing knowledge to produce knowledge- and technology-related output. Examples of such output include number of patents filed, number of scientific and technical publications, exports of high-tech goods, communication, and computer and information services.

The *symbolic* knowledge bases, by contrast, are predominantly employed by creative industries to shape meaning, desire, and aesthetic sensibilities through the production of creative goods and services. Most creative work focuses on creating new ideas, images, and cultural artifacts. Sometimes, the term *cultural industries* is used interchangeably with creative industries to denote those for-profit, non-profit, or public organizations or establishments that produce creative goods and services. These products can be either wholly based in manufacturing sectors (such as textiles or furniture), in creative services (such as arts and live performances), or in a hybrid form (such as movie production or publishing and print services; Zukauskaite, 2012).

In short, creative or cultural industries are distinguished from science- and technology-intensive industries not only based on the nature of their respective outputs but also based on the dominant knowledge bases that they primarily employ. Because of these differences, we argue that cultural values play different roles to facilitate or dampen different industries. In particular, cultural values have differential moderating effects on the benefits of basic education on knowledge and technology output and creative output of a nation. Next, we develop the specific predictions of cultural values for the two types of innovation output.

The Moderating Role of Cultural Values

The creative innovation process, in both the knowledge and creative industries, is influenced by a multitude of factors, both from within the organizations and from external sources, including the market and social environments (Adams et al., 2006; Anderson et al., 2014). National culture is one particular contextual factor closely linked to innovation (Shane, 1992, 1993; Taylor & Wilson, 2012) because it provides an overarching motivational guide for how people go about preserving the old and creating the new. Culture is conceptualized as a set of shared knowledge, values, norms, and beliefs that exist within a collective group (Chiu & Hong, 2006). Culture shapes cognition and motivation (Leung, Maddux, Galinsky, & Chiu, 2008; Markus & Kitayama, 1991; Morris & Leung, 2010) and affects a host of cultural phenomena, including education (Hoffman, 2000; Tobin, 1995).

One important way in which culture influences people's behavior is culturally endorsed values. Value systems drive behavior by encouraging the display of those behaviors that are consistent with the values that are endorsed and internalized. Values are desirable trans-situational goals that guide the way individuals act; evaluate actions, people, policies, and events; and justify their actions and evaluations (Schwartz, 1992; Schwartz & Bardi, 2001). Values transform drives into desirable goals that are available to awareness and that can therefore be used in conscious planning and decision making.

A successful innovation process requires elements of possessing strong and relevant knowledge as well as creative ability to produce an innovative product (Smith, Ward, & Finke, 1995; Yusuf, 2009). Speaking analogously, knowledge can be likened to the essential raw ingredients and creative ability to the recipe that allows for the combination of the raw ingredients in a way that would turn them into a novel and feasible dish, or end product. Importantly, possessing the raw ingredients alone would not result in a creative dish. In relation to creativity, this means that the pattern of values that are endorsed determines the direction of motivation, which in turn facilitates or inhibits creative behaviors. In addition to the relevant knowledge, one needs to endorse values that encourage unconventional attempts and defiance of tradition and the status quo. Consistent with this idea, previous studies have revealed that individuals who endorse values like self-direction and stimulation showed more creative behaviors than did their counterparts who endorse values like tradition, conformity, security, and power (Dollinger et al., 2007; Kasof et al., 2007). In short, these studies show a link between value endorsements and creativity at an individual level.

In the current research, we sought to extrapolate the link between value endorsements and creativity from an individual level to a country level. To this end, we use Schwartz's (1994) value structure theory, which proposes 10 distinct value types identified across countries with underlying motivational goals. To elaborate, Schwartz's value types were found to be universally comprehensive across cultures and representative of the core values of these cultural groups as they are based on three universal tenets of human requirements: (a) the needs of individuals as biological organisms, (b) the requisites of coordinated societal interaction, and (c) the survival and welfare needs of groups (Schwartz, 1992). The core feature of the values theory is the dynamic nature of the conflict and congruence between the 10 value types that are represented in a circular model structure such that values located next to each other in the model have similar underlying motivational goals, while values located on the opposite sides are most incongruent (Schwartz, 1992). The 10 value types are Self-Direction, Stimulation, Hedonism, Universalism, Benevolence, Conformity, Tradition, Security, Power, and Achievement. Schwartz (2006) divided these values into two broad categories: values that serve the motivational goal of avoiding anxiety (e.g., Security) and serving self-protection (e.g., Power) or those that are relatively anxiety-free (e.g., Benevolence) and foster personal growth and self-expansion (e.g., Universalism). Of these, some are focused on personal-level outcomes while some are focused on outcomes at the collective level. Specifically, self-protective or anxiety-avoidance values at the personal level of focus are Power and Achievement, at the collective level, they are Conformity, Tradition, and Security. Self-expansive, anxiety-free values at the personal level are Self-Direction, Stimulation, and Hedonism, at the collective level, Universalism and Benevolence.

Linking Schwartz's values to previous literature on creativity (Dollinger et al., 2007; Kasof et al., 2007), the self-protective values (Power, Achievement, Conformity, Tradition, and Security) in general should undermine creativity, whereas the self-expansive values (Self-Direction, Stimulation, Hedonism, Universalism, and Benevolence) should enhance creativity. The crucial question for educators and policy makers is whether these values would matter given a high-quality basic education. As we argued before, a high quality of basic education is fundamental to cognitive skill development and eventually provides cognitive capital for the innovative industries to thrive in a nation. However, would the self-protective values undermine the benefits of quality basic education on innovative outputs, whereas the self-expansive values enhance the benefits? We argue that this is possible only for creative output but not knowledge and technology output.

To elaborate, we reason that based on the knowledge bases perspective, symbolic knowledge, used in the production of creative goods and services, is more affected by the shared values of the nation or culture than the analytic and synthetic bases that dominate the knowledge and technology industries (Asheim et al., 2007). On one hand, most scientific principles and models—or, the know-why of the analytic knowledge base and the practical know-how skills of the synthetic base—tend to be considerably universal across industry sectors and should benefit from a high-quality basic education regardless of national culture. On the other hand, symbolic knowledge is guided by cultural meaning and interpretation through the intangible value of the end products, and hence is highly contextual. Its creation, application, and interpretation are guided by the prevalent value systems of the country. Therefore, innovative outputs guided from a symbolic knowledge base would benefit from a high-quality basic education embedded in a culture that allows challenging tradition and status quo (i.e., low in self-protective values), and free self-expression and autonomy (i.e., high in self-expansive values). As such, we predict that cultural values would only moderate the link between quality of basic education and the levels of creative output but not the link between quality of basic education and the levels of knowledge and technology output. In other words, although we predict that quality of basic education would have a positive main effect on innovation outputs, cultural values should moderate this link for creative outputs but not for knowledge and technology outputs. In short, we hypothesize the following:

Hypothesis 2: Cultural values should moderate the relationship between quality of basic education and creative output, but not that between education and knowledge and technology outputs.

Hypothesis 3a: Self-expansive values positively moderate the relationship between education quality and creative outputs such that the relationship between education and creative output is strengthened (more positive) when self-expansive values are high rather than low.

Hypothesis 3b: Self-protective values negatively moderate the relationship between education quality and creative output such that the relationship between education and creative output is weakened (less positive) when self-protective values are high rather than low.

Method

To test our hypotheses, we used data from three datasets: the PISA (OECD, 2003), the Schwartz Value Survey (SVS; Schwartz, 1992), and the GII (Cornell University et al., 2014). These three datasets involve 32 overlapping countries,[1] which was the sample for data analysis.

Dependent Variable

Our dependent variable scores are obtained from the GII datasets from 2014 published by Cornell, INSEAD, and the WIPO. It covers 143 economies that account for 94.9% of the world's population and 98.7% of the world's gross domestic product (GDP) in U.S. dollars. Along with the overall innovation index score for each country, the GII report also provides data on the overall innovation input and output of a country along with two innovation output components, knowledge and technology output and creative output. The knowledge and technology output and creative output form two sub-pillars of the innovation output subindex of this framework. Both the measures encompass a wide range of indicators that are representative of the two respective outputs.

As the two innovation outputs form the focus of this study, we only consider them in our analyses.

Knowledge and technology output. The knowledge and technology output covers the more conventional aspects of innovation and is composed of three sub-pillars: Knowledge Creation, Knowledge Diffusion, and Knowledge Impact. The knowledge and technology output measure includes 14 items ($\alpha = .86$): (a) the number of patent applications filed by residents at the national patent office; (b) the number of international patent applications filed by residents at the Patent Cooperation Treaty; (c) the number of utility model applications filed by residents at the national patent office; (d) the number of scientific and technical journal articles; (e) The H index: the number of published articles (H) that have received at least H citations in the assessment period; (f) the growth rate of GDP per person engaged; (g) new business density; (h) total computer software spending; (i) the number of ISO 9001 certificates issued; (j) high-tech and medium-high-tech output; (k) royalty and license fees; (l) high-tech net exports; (m) communications, computer and information services exports; and (n) foreign direct investment net outflows. The knowledge and technology output measure was computed by taking an average of the 14 items.

Creative output. The creative output pillar comprises three sub-pillars: Intangible Assets, Creative Goods and Services, and Online Creativity. The creative output subindex consists of 13 items ($\alpha = .87$): (a) number of national office resident trademark registrations; (b) number of Madrid system trademark registration by country of origin; (c) number of information and communications technology (ICT) and business model creation; (d) number of ICTs and organizational model creation; (e) amount of audiovisual and related services exports; (f) number of feature films produced; (g) extent of daily newspapers circulation; (h) amount of printing and publishing output; (i) amount of creative goods exports; (j) number of generic top-level domains; (k) number of country-code top-level domains; (l) number of Wikipedia monthly edits; and (m) number of video uploads on YouTube. The creative output measure was computed by taking an average of the 13 items.

A more detailed description of the two pillars is provided in Table 1. It is important to note that the GII has been normalized against GDP Per Capita, GDP Per Capita Growth, and Population Density; hence, we do not need to control for these variables. Furthermore, knowledge and technology output is only moderately correlated with creative output ($r = .68$), lending support for differentiating the two types of outputs. Figure 1 shows the correlational plot of knowledge and

Table 1. Overview of Creative Output and Knowledge Technology Output Framework.

Creative output	Knowledge and technology output
Intangible assets	Knowledge creation
Domestic resident trademark applications	Domestic resident patent app/bn PPP$ GDP
Madrid trademark applications	PCT resident patent applications/bn PPP$ GDP
ICT in business model creation	Domestic resident utility model applications/bn PPP$ GDP
ICT in organizational model creation	Scientific and technical articles published in peer-reviewed journals/bn PPP$ GDP
	Citable documents H index
Creative goods and services	Knowledge impact
Cultural and creative services exports, % total trade	Growth rate of PPP$ GDP/worker, %
National feature films	Entry density of new businesses/th pop.
Global entertainment and media output	Computer software spending, % GDP
Printing and publishing manufactures, %	ISO 9001 quality certificates/bn PPP$ GDP
Creative goods exports, %	High-and medium-high-tech manufactures, % total manufactures output
Online creativity	Knowledge diffusion
Generic TLDs/th pop.	Royalty and license fees receipts, % total trade
Country-code TLDs/th pop.	High-technology exports less re-exports, %
Wikipedia monthly edits/mn pop.	Communication, computer and information services exports, % total trade
Video uploads on YouTube/pop.	FDI net outflows, % GDP

Source. Cornell University, INSEAD, and World Intellectual Property Organization (WIPO; 2014).
Note. bn = billion; PPP$ GDP = Gross Domestic Product (GDP) per capita based on purchasing power parity (PPP) in billion$; PCT = Patent Cooperation Treaty; ICT = Information and Communication Technologies; TLD = Top-Level Domains; FDI = Foreign Direct Investment; th = thousand; mn = million; pop. = population.

technology output and creative output across the 146 nations from the GII (2014) dataset (Cornell University et al., 2014).

Independent Variable

Quality of basic education. To operationalize the quality of basic education at the secondary school level, we use the scores from the PISA. The PISA dataset is a publicly available dataset published by the OECD. It is part of a triennial survey conducted by the OECD to assess the skills and knowledge of 15-year-old students across countries on reading, mathematics, science, and problem solving. It involves real-world knowledge application that goes beyond the students' school curricula and can be useful for their future life. We use the PISA scores from the 2003 dataset (OECD, 2003) instead of the most recently available dataset from 2012.[2] This is because the students who were assessed in the 2003 survey would logically constitute the current workforce of their respective countries. Hence, by using the PISA scores from 2003 and the innovation scores of a country from 2014, we hope to represent the most realistic economic scenario possible. Data in the 2003 survey were collected from 42 participating countries. The scales were constructed so that the average student score in OECD countries was 500 points, and about two thirds of students scored between 400 and 600 points (i.e., standard deviation equaled 100 points). With all four domains of assessment (reading, mathematics, science, and problem solving),

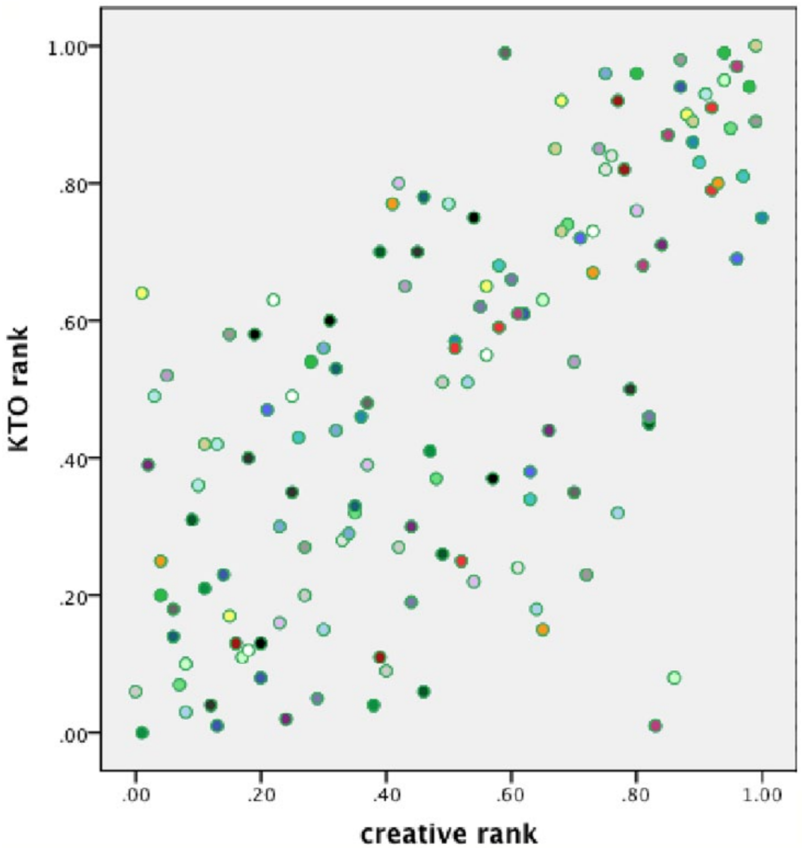

Figure 1. Scatterplot of KTO against creative output of 146 countries according to GII (2014).
Note. KTO = knowledge and technology output; GII = Global Innovation Index.

scores for each country can be summed up in a mean score. A correlation analysis demonstrates that all four domains of assessment are highly correlated with each other (all rs > .9, p = .00), thus indicating that the four subject areas may tap on a general underlying latent ability. To validate this idea, we have conducted an exploratory factor analysis, and the results showed that all four domains of the PISA test form one single factor (accounting for up to 64% of the variance); therefore, we used this factor score as our independent variable to indicate quality of basic education in all following analyses.

Moderator

Cultural values. The Schwartz Values Survey (SVS) (Schwartz, 1992) dataset measures values as abstract goals from 210 samples across 67 countries (total n = 64,271). Despite this dataset's age, research has shown that value endorsements at a country level remain relatively stable over time (Schwartz, 2006), and thus, it is justifiable to use this dataset as a proxy for country-level value orientations.

The SVS measure includes 56 or 57 abstract value items that are measured on a 9-point scale ranging from 7 to −1 with the following values: 7 (*of supreme importance*), 6 (*very important*), 5, 4 (*unlabeled*), 3 (*important*), 2, 1 (*unlabeled*), 0 (*not important*), and −1 (*opposed to my values*). Items were assessed in the participants' native language or official national language and participants were asked to rate each item "as a guiding principle in MY life," followed by a brief explanation in parentheses. Each individual value type is calculated by taking the average of centered value items corresponding to the particular type. For example, the value type Stimulation is calculated as an average of the centered importance ratings of three value items: Daring (seeking adventure, risk), Exciting life (stimulating experiences), Varied life (filled with challenge, novelty, and change). For all analyses, we follow Schwartz's (1992) recommendation to use the centered responses of value items to compute the corresponding higher order value types to correct for response bias.

We calculated the composite score for self-expansive values and self-protective values by computing an average of the corresponding lower level values. That is, the self-protective value score is computed by averaging the scores of Conformity, Tradition, Security, Power, and Achievement value types. The self-expansive value score is computed by averaging the scores of Self-Direction, Stimulation, Hedonism, Universalism, and Benevolence. The correlation between these two composite scores is high ($r = -.92$, $p < .01$) possibly due to the circumplex nature of the values model. That is, the structure of the model is such that the values that are located next to each other on the circumplex are most positively related to each as they share similar underlying motivational goals, whereas those that are located on the opposite side of the circumplex are most negatively related to each other because their underlying motivational goals are incompatible. For example, Self-Direction's location next to Stimulation and Universalism signals their compatibility, while its location on the opposite side of values such as Conformity, Tradition, and Security indicates their opposition. As such, the higher order composite values such as the self-protective and self-expansive values, each comprising a set of values located on the opposite sides of the circumplex model, would be expected to show high negative correlations.

A more detailed description of the two higher order dimensions, all 10 value types, and their corresponding value items are provided in Table 2.

Control Variables

Although the GII has already controlled some crucial variables (GDP Per Capita, GDP Per Capita Growth, and Population Density) as noted, it has not controlled the industrial structure, or the composition of industries, in a country. Past research has shown that industrial structure affects innovation outcomes as innovation is more common in some industries than others (Nelson & Winter, 1977). As the GII datasets are computed using inputs from a range of industries that vary in their level of structure, it is important to control for influence of industrial structure of each country. Specifically, as some industries are most likely to innovate, countries with a higher concentration of those industries where innovation is more common than in others are also more likely to have high total innovation output. Industrial composition could be a confound because countries with good quality education/human capital may also have an industrial structure which includes more innovation-producing units. Therefore, we control for it in our analysis. To this end, we follow Shane's (1993) example to control for percentage of total value added accounted for by industries typically generating large numbers of innovations. This variable was taken from the World Bank database and constructed by taking a percentage of GDP, total value added in manufacturing industries (International Standard Industrial Classification divisions 15-37). This ratio shows the tendency of a nation to have an industrial structure composed of industries most likely to innovate, and thus, it would be appropriate to include this ratio as a control variable. To this end, we can use the industrial structure dataset in 2011, 2012, or 2013. Because the dataset in 2011 contains the largest number of countries overlapping with GII, PISA, and SVS ($n = 32$) while the datasets in the other 2 years contain fewer overlapping countries ($n = 29$ for 2012, and

Table 2. Overview of the Schwartz Value Types, Definitions, and Individual Values (Schwartz, 1992, 2006).

Value type	Definition	Single values
Self-expansive values		
Universalism	Understanding, appreciation, tolerance, and protection for the welfare of *all* people and for nature	Broadminded, equality, protecting the environment, social justice, unity with nature, wisdom, world at peace, world of beauty
Benevolence	Preserving and enhancing the welfare of those with whom one is in frequent personal contact (the "in-group")	Forgiving, helpful, honest, loyal, responsible (Mature love, true friendship)
Self-Direction	Independent thought and action-choosing, creating, exploring	Choosing own goals, creativity, curiosity, freedom, independence (self-respect)
Stimulation	Excitement, novelty, and challenge in life	Varied life, exciting life, daring
Hedonism	Pleasure or sensuous gratification for oneself	Enjoying life, pleasure
Self-protective values		
Conformity	Restraint of actions, inclinations, and impulses likely to upset or harm others and violate social expectations or norms	Honoring parents and elders, obedience, politeness, self-discipline
Tradition	Respect, commitment, and acceptance of the customs and ideas that one's culture or religion provides	Accepting my portion in life, devout, humble, moderate, respect for tradition
Security	Safety, harmony, and stability of society, of relationships, and of self	Clean, family security, national security, reciprocation of favors, social order (healthy, sense of belonging)
Power	Social status and prestige, control or dominance over people and resources.	Authority, social power, wealth (preserving my public image, social recognition)
Achievement	Personal success through demonstrating competence according to social standards	Ambitious, capable, influential, successful (intelligent, self-respect)

$n = 20$ for 2013), we used the industrial structure dataset in 2011 as a control variable in our analysis. This should not distort our results as the 2011 values were highly correlated with those in 2012 and 2013 ($r = .99$ and $r = .99$, respectively).

Results

Descriptive and Correlational Analyses

Table 3 shows the means, standard deviations, and correlations among all major variables. The PISA score correlates strongly with both the creative output ($r = .63$, $p < .01$) and the knowledge and technology output ($r = .74$, $p < .01$). These associations provide initial support for our predictions that quality of basic education, measured through PISA scores, is positively related to both types of innovation outputs. Furthermore, self-protective values are negatively associated with

Table 3. Means, Standard Deviations, and Intercorrelations for All Major Variables.

		M	*SD*	*n*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	PISA factor score	0.00	1.00	38	1														
2	Creative output	32.82	13.03	143	.63**	1													
3	Knowledge and technology output	29.15	12.24	143	.74**	.68**	1												
4	Self-protective value	3.52	0.31	63	−.32	−.73**	−.60**	1											
5	Self-expansive value	3.99	0.28	64	.45**	.69**	.61**	−.92**	1										
6	Conformity	4.12	0.45	64	−.41*	−.70**	−.67**	.88**	−.86**	1									
7	Tradition	2.97	0.56	64	−.49**	−.67**	−.61**	.78**	−.78**	.78**	1								
8	Security	4.16	0.34	63	−.20	−.39**	−.31*	.71**	−.73**	.56**	.41**	1							
9	Power	2.37	0.44	64	−.23	−.40**	−.24	.67**	−.49**	.37**	.20	.52**	1						
10	Achievement	4.00	0.31	64	−.07	−.44**	−.30*	.62**	−.47**	.45**	.27*	.19	.53**	1					
11	Self-direction	4.41	0.30	64	.27	.54**	.49**	−.84**	.82**	−.87**	−.74**	−.65**	−.39**	−.35**	1				
12	Stimulation	3.15	0.44	64	.40*	.42**	.50**	−.58**	.76**	−.66**	−.60**	−.55**	−.05	−.16	.56**	1			
13	Hedonism	3.56	0.60	64	.43*	.65**	.59**	−.74**	.91**	−.74**	−.71**	−.59**	−.31*	−.31*	.67**	.65**	1		
14	Universalism	4.26	0.26	64	.05	.36**	.19	−.71**	.58**	−.48**	−.39**	−.50**	−.73**	−.60**	.54**	.07	.36**	1	
15	Benevolence	4.59	0.23	64	.35*	.46**	.32**	−.56**	.46**	−.27*	−.23	−.37**	−.74**	−.59**	.19	.09	.27*	.58**	1

Note. PISA = Programme for International Student Assessment.
$^{*}p < .05$. $^{**}p < .01$.

creative output ($r = -.73$, $p < .01$) and with knowledge and technology output ($r = -.60$, $p < .01$), while self-expansive values are positively associated with creative output ($r = .69$, $p < .01$) and with knowledge and technology output ($r = .61$, $p < .01$). The individual value types that constitute these two higher order value types are also in the consistent direction. For example, the Conformity value type, a self-protective value, has negative relations with both creative output ($r = -.70$, $p < .01$) and knowledge and technology output ($r = -.67$, $p < .01$) while Self-Direction, a self-expansive value, has positive relationships with both creative output ($r = .54$, $p < .01$) and knowledge and technology output ($r = .49$, $p < .01$). These correlations were consistent with the previous findings of the links between values and creative behavior at the individual level (Dollinger et al., 2007; Kasof et al., 2007; Sagiv, 2002; Shin & Zhou, 2003), lending confidence to our datasets.

Regression Analyses

To test our hypotheses, we conducted hierarchical regression analyses. We mean centered the two continuous composite moderator variables, self-protective values and self-expansive values. As we are using the factor score for PISA, it is not necessary to center it further. The interaction terms between each value and the PISA score were computed using the centered scores.

For the regression analysis, we entered the control variable in the first step. Next, we regressed the independent variable, that is, the PISA score, and the moderators, that is, self-expansive values or self-protective values, in the second step. In the last step, we entered the interaction term. We applied the same model specification to conduct separate regression analyses for the two types of innovation outputs. As self-expansive values and self-protective values have a very high negative correlation ($r = -.92$, $p < .01$), we modeled them in separate regression models rather than a single one to avoid multicollinearity complications.

Tables 4 and 5 summarize the regression results for Hypotheses 1 to 3, which states that PISA scores can predict both the knowledge and technology output and the creative output, and that the interaction between PISA and the moderator cultural values only significantly predict creative output.

The results of both sets of regression analyses (involving self-protective and self-expansive values) showed that the changes in the multiple squared correlation coefficient associated with the main effect of PISA scores on creative output, $\Delta R^2 = .52$, $F(2, 28) = 14.90$, $p < .001$; $\Delta R^2 = .48$, $F(2, 29) = 13.39$, $p < .001$, respectively, and knowledge and technology output, $\Delta R^2 = .63$, $F(2, 28) = 17.85$, $p < .001$; $\Delta R^2 = .67$, $F(2, 29) = 26.04$, $p < .001$, respectively, are significant. It was found that the PISA scores significantly predicted both creative output (βs ranged from .44 to .50, $p < .01$) and knowledge and technology output (βs ranged from .57 to .61, $p < .001$) of a country, providing support for Hypotheses 1a and 1b that indeed, high-quality education positively related to both types of innovation outputs.

Furthermore, PISA scores interacted significantly with self-protective values to predict only creative output ($\beta = -.31$, $p < .05$) but not knowledge and technology output ($\beta = -.14$, $p = .30$). The PISA score only has a positive effect on creative output when the society endorses self-protective values at a low level. However, the interaction between PISA scores and self-expansive values was not significant in predicting either creative output ($\beta = .24$, $p = .10$) or knowledge and technology output ($\beta = .05$, $p = .70$). Taken as a whole, the results provide support for Hypothesis 3b but not 3a, and thus only partially supporting Hypothesis 2 as a result.

Figure 2, Panel A, shows the pattern of the two-way interactions between PISA scores and self-protective values. Simple slopes were plotted (Aiken & West, 1991; West, Aiken, & Krull, 1996) for the two composite values at high (+1 *SD*) and low (−1 *SD*) levels. They reveal that only the slope for low self-protective values is significant such that only when self-protective values are de-emphasized in a country, does PISA score positively predict creative output.

Table 4. Summary of Hierarchical Regression Results for PISA Scores and Self-Protective Values Predicting Creative Output and Knowledge and Technology Output.

	Creative output									Knowledge and technology output								
	Model 1			Model 2			Model 3			Model 1			Model 2			Model 3		
Variables	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Industry structure (control)	0.01	0.17	.01	0.03	0.12	.03	−0.04	0.12	−.04	0.39	0.17	.38*	0.42	0.12	.41**	0.38	0.12	.38**
PISA factor score				5.14	1.43	.50**	4.36	1.37	.43**				6.42	1.39	.57**	6.04	1.43	.53**
Self-protective values				−14.12	5.2	−.38**	−11.05	5.04	−.30*				−10.54	5.06	−.26*	−9.04	5.24	−.22
PISA × Self-Protective Values							−16.65	7.31	−.31*							−8.12	7.61	−1.07
R^2	0			.52			.59			.15			.63			.64		
Adjusted R^2	−.03			.46			.53			.12			.59			.59		
F for change in R^2	0			14.9			5.18			5.19			17.85			1.14		
No. of observations	31									31								

Note. PISA = Programme for International Student Assessment.
$^*p < .05$. $^{**}p < .01$.

Table 5. Summary of Hierarchical Regression Results for PISA Scores and Self-Expansive Values Predicting Creative Output and Knowledge and Technology Output.

	Creative output									Knowledge and technology output								
	Model 1			Model 2			Model 3			Model 1			Model 2			Model 3		
Variables	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Industry structure (control)	−0.02	0.16	−0.03	0.01	0.12	0.01	−0.01	0.12	−0.01	0.29	0.18	0.28	0.36	0.12	0.34**	0.35	0.12	0.33**
PISA factor score				4.07	1.40	0.44**	4.40	1.37	0.48**				6.49	1.30	0.60**	6.57	1.33	0.61**
Self-expansive values				14.00	5.70	0.37*	10.40	5.92	0.28				12.33	5.30	0.28*	11.53	5.77	0.26
PISA × Self-Expansive Values							11.04	6.54	0.24							2.47	6.37	0.05
R^2	.00			.48			.53			.08			.67			.67		
Adjusted R^2	−.03			.43			.46			.05			.64			.64		
F for change in R^2	.02			13.39			2.85			2.58			26.04			0.15		
No. of observations	32									32								

Note. PISA = Programme for International Student Assessment.
$^*p < .05$. $^{**}p < .01$.

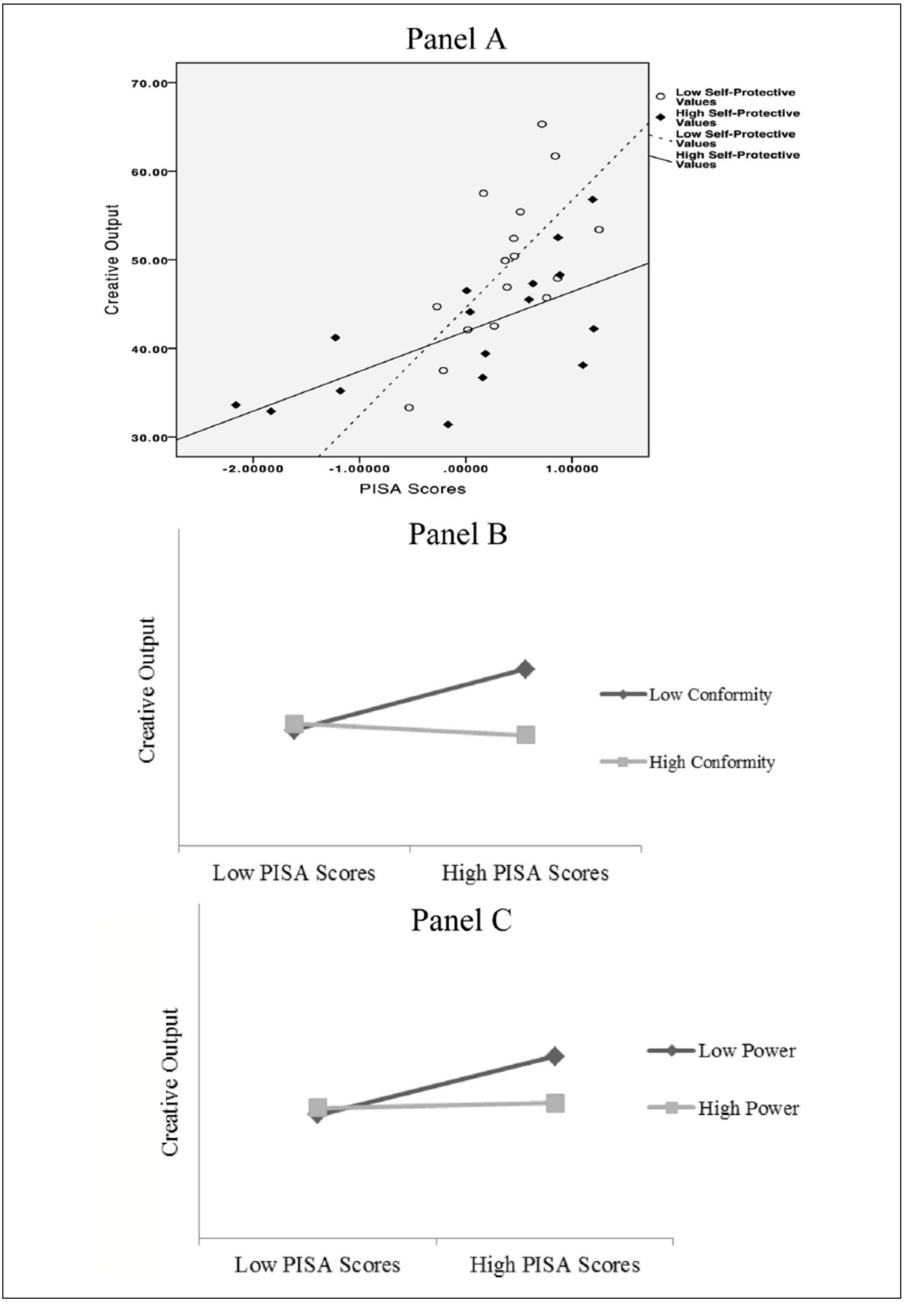

Figure 2. Simple slope plots with self-protective values (Panel A) and conformity (Panel B) and power (Panel C) as the moderators in the relationship between PISA scores and Creative Output.
Note. PISA = Programme for International Student Assessment.

Table 6. Summary of Hierarchical Regression Results for Conformity and Power Predicting Creative Output.

	Creative output								
	Model 1			Model 2			Model 3		
Variables	*B*	*SE B*	β	*B*	*SE B*	β	*B*	*SE B*	β
Industry structure	−0.02	0.16	−.03	0.06	0.13	.06	−0.09	0.12	−.09
PISA factor score				4.42	1.38	.48**	3.92	1.21	.43**
Conformity				−8.88	4.00	−.33*	−10.28	3.50	−.38**
PISA × Conformity							−12.73	3.95	−.42**
R^2	.00			.46			.61		
Adjusted R^2	−.03			.41			.55		
F for change in R^2	0.02			12.51			10.40		
No. of observations	32								
Industry structure	−0.02	0.16	−.02	0.08	0.13	.09	0.00	0.13	.00
PISA factor score				5.08	1.31	.55**	4.76	1.24	.52**
Power				−6.57	3.31	−.28	−6.87	3.13	−.30*
PISA × Power							−8.99	4.17	−.29*
R^2	.00			.45			.53		
Adjusted R^2	−.03			.39			.46		
F for change in R^2	0.02			11.71			4.65		
No. of observations	32								

Note. PISA = Programme for International Student Assessment.
*$p < .05$. **$p < .01$.

To further validate our predictions, we conducted additional hierarchical regression analyses by regressing creative output on the control variable, the PISA scores, each individual level value type (mean centered), and their interaction term. In all, we conducted 10 different regression analyses for each of the 10 value types. In Step 1, we entered the control variable. The PISA score and each of the values were entered in Step 2, and the corresponding interaction term was entered in Step 3. Results are shown in Table 6; they are largely consistent with our predictions and findings. Two of the self-protective values, conformity ($\beta = -.42$, $p < .01$) and power ($\beta = -.30$, $p < .05$), had a significant interaction with PISA scores to predict creative output but not knowledge and technology output. The simple slopes results, as shown in Panels B and C of Figure 2, indicate that the PISA score only has a positive effect on creative output when the country endorses conformity and power values at a low level, consistent with previous analyses.

In summary, the results supported Hypotheses 1a and 1b, that the quality of basic education has a positive effect on knowledge and technology output and creative output at the country level. However, the link between quality of basic education and creative output but not the link between that and knowledge and technology output was moderated by cultural values (as postulated in Hypothesis 2), but was only limited to self-protective values, such that the positive relationship between education and creative output is suppressed when self-protective values are high (vs. low), supporting Hypothesis 3b. However, we did not find supportive evidence for self-expansive values. Future research can continue to explore whether these null findings for self-expansive values are consistent over time. If we used the Industrial Structure in 2013 as the control variable ($n = 20$), we did find significant results as predicted for self-expansive values as well. However, because of a substantial drop in sample size, we were cautious in interpreting the findings.

Discussion

In this study, we demonstrate the importance of the influence of cultural context on the effect of education on national level of innovation output. Adopting the framework proposed in the GII (Cornell University et al., 2014), we differentiated innovation output into two types: knowledge and technology outputs and creative outputs. In a cross-country analysis involving 32 nations, we found support for our predictions. Specifically, our results show that a higher quality of basic education is associated with more knowledge and technology outputs and creative outputs, respectively. This suggests that high-quality basic education provides a sound foundation for developing a talented pool of human capital that drives innovation, both in the knowledge-intensive sectors and the creative industries.

In addition, based on the differentiated knowledge bases perspective (Asheim et al., 2007; Asheim & Hansen, 2009), we argued that the production of knowledge and technology output would primarily involve the use of the analytic (know-why) and the synthetic (know-how) knowledge bases while the production of creative output would predominantly be based on a symbolic knowledge base. Symbolic knowledge, which facilitates the shaping of cultural meaning and aesthetics, tends to be more embedded in the cultural context of a society compared with the analytic and synthetic knowledge bases, which are based on scientific principles and practical skills, and therefore can benefit from high-quality basic education regardless of the cultural context (Asheim et al., 2007). Therefore, we theorized that the cultural values of a nation would moderate the relationship between education and creative output but not knowledge and technology output.

Indeed, our results consistently show that self-protective values weakened the positive effect of quality education on creative output. Importantly, these cultural values did not have a significant moderating effect on the relationship between education and knowledge and technology output. Taken as a whole, our results suggest that the positive effect of quality education on creative output is weakened in countries that emphasize the maintenance of social order and discourage challenges to the status quo (as manifested in self-protective values of conformity and power).

Implications

Our findings provide some interesting insights into the implications of PISA scores, a subject that is constantly debated and discussed by the media and policy makers. As a worldwide survey of about 500,000 15-year-old students across 65 nations, the release of PISA scores and country rankings once every 3 years creates headline-grabbing news because it highlights the gap between the top-performers (including many Asian countries) and those lagging behind (OECD, 2012). These results are being increasingly used by governments and policy-making bodies as a means to compare and reflect on the quality of their school systems and as a proxy measure of students' readiness for higher education and career in a country. However, critics of this trend have argued that this only pushes schools to pay undue attention to skills in some areas (mathematics, language, and sciences) at the cost of other crucial aspects of education (such as the artistic, moral, physical domains; cf. Ravitch, 2013). The arguable result is an excessive focus on teaching "core" STEM subjects (Science, Technology, Engineering and Math), at the cost of what have been dubbed as "enabling" subjects, such as the humanities, liberal arts, and design (Andrews et al., 2014). Advocates of a holistic education system have pointed out that this would only result in a significant gap in the quality of talent and human capital of a country and would also result in the impediment of the development of creative industries (Ravitch, 2013).

Despite these concerns, our findings in the current study offer preliminary evidence that PISA scores have a significant and positive impact on national innovation output, in terms of both knowledge and technology and creative pursuits. This implies that the cognitive skills students gain at the school level have a compelling effect on the innovation outcomes and consequently the economic growth of a country. Although the different types of innovation output (knowledge and technology vs. creative) make use of different knowledge bases (analytic, synthetic, and/or symbolic), the acquisition of the knowledge bases themselves (presumably in institutions of higher education or vocational training) requires a sound foundation of high-quality primary and secondary education. For example, relevant to the present research context, the production of both knowledge- and technology-related output, such as acquiring a patent or publishing a research article, and creative output, such as print publications or music production, benefit greatly from high-quality basic education.

More importantly, our study demonstrates that this positive effect of education on creative output, in particular, is dependent on the accompanying cultural value systems of a nation. The benefits of a quality education system in boosting production of creative goods and services is undermined by the presence of self-protective values that impose social sanctions on group members who challenge the status quo and display behaviors that are inconsistent with existing norms. Values that represent conformity (focusing on restraint of actions, inclinations, and impulses that are likely to upset or harm others and violate social expectations or norms) and power (with an emphasis on social status and prestige, control or dominance over people and resources; Schwartz, 2006) do not allow for the negotiation of symbolic knowledge (a crucial component in the production of creative output) and its manifestations in ways that are inconsistent with existing societal preferences and norms.

That being said, however, our results also show that even when a nation is low in self-protective values, it does not necessarily translate into high creative output if the quality of basic education is poor (i.e., low PISA score). This signifies that a sound educational foundation in math, reading, science, and problem solving is equally important for success in the creative industries as it is for success in the S&T industries. This also refutes a misconception that one does not require a good STEM subject training if they wish to go into the arts or non-science/engineering career in the future.

Moreover, our findings have implications for educational policies and classroom practices. Given that societal values and norms have a top-down effect on education systems, influencing pedagogical practices and students' achievement goals and self-concept (Dekker & Fischer, 2008; Tao & Hong, 2014; Tobin, 1995; Zhu, Devos, & Tondeur, 2014), it is crucial for teachers in nations with high self-protective values to use teaching methods that combat the negative effect of self-protective values on the students' creative pursuits. For instance, they may create opportunities for students to challenge tradition and cultural norms and behave in non-conformed ways in the classroom. However, whether these classroom practices would have long-lasting effects would again depend on whether the society allows the students to apply what they have learnt in the classroom to the outside world. Education may need to serve as an agent for cultural change.

Limitations and Directions for Future Research

One of the limitations of our research is that we did not explicitly measure the knowledge bases, although we based our theoretical arguments on the differentiated knowledge bases perspective (Asheim et al., 2007). Also, we distinguished innovation output only on the basis of the final products (knowledge and technology output and creative output). Other ways of differentiating them can be through the industrial classification of firms and enterprises that constitute the knowledge sectors versus the creative sectors and also through the processes that result in the production of knowledge and technology output versus creative output. This would offer a more nuanced insight into the phenomenon explored in this study, as doing so would allow for the inclusion of innovative products that were conceived but did not reach the commercial stages. Furthermore, creative industries themselves are quite diverse and not homogeneous (Müller et al., 2009) and would likely employ symbolic knowledge in varying degrees and often in combination with analytic and synthetic knowledge bases. This could be a possible avenue for future research.

Another limitation is the sample size of our observations. As we used four independent datasets (including the data for our control, industrial structure) to test our hypotheses, the number of overlapping countries with available data was restricted to 32. Despite the limited sample size, the moderating effect of self-protective values on the link between education quality and creative output was significant and robust (shown in all the analyses regardless of whether we used the Industrial Structure in 2011, 2012, or 2013 as control and even when we did not include it as a control).

Moreover, as a singular test, the PISA scores may not be able to provide a complete picture of the educational system. However, they do provide many unique and comparable insights into the acquisition of cognitive skills. Future research can explore other aspects of education systems both within and outside of the curricula that would have a bearing on innovation outcomes.

Finally, we have an interesting observation that South Korea and Japan, societies known to endorse self-protective values, are often praised for their creative cultural products such as K-pop music, Korean dramas, and virtual pet simulations (e.g., the Japanese Tamagotchi) among many others. Yet they still rank relatively moderate on creative output (in 37th and 46th positions among 142 nations, respectively) in comparison with other countries, while they rank comparatively higher on their knowledge and technology output (at sixth and 12th, respectively). This is consistent with our findings that, given their relatively high PISA scores and high endorsement of self-protective values at a country level, South Korea and Japan did indeed do well in knowledge and technology output but not as well on creative output compared with other countries. However, there seems to be an emerging trend among certain subcultures of the younger generations in these Asian countries to show willingness to push boundaries and explore unconventional and creative modes of self-expression, resulting in an increase in novel ideas and products. Therefore, future research can track the longitudinal dynamics of the relationship among education, cultural values, and innovation output across countries, especially in those noticeable cases such as South Korea and Japan.

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Notes

1. The countries included in our sample, in alphabetical order, are Australia, Austria, Belgium, Brazil, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hong Kong (China), Hungary, Ireland, Italy, Japan, Korea, Republic of Latvia, Mexico, Netherlands, New Zealand, Norway, Poland,

Portugal, Russian Federation, Slovakia, Spain, Sweden, Switzerland, Thailand, Turkey, and United States of America.

2. The Programme for International Student Assessment (PISA) 2003 dataset was the oldest dataset that was provided by the Organization for Economic Cooperation and Development (OECD) as PISA was only launched in 2000. Therefore, we are constrained to use the education quality of a relatively young workforce as a proxy.

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