Unlocking Innovativeness: Exploring the Moderating Role of Cultural Tightness-Looseness in the Relationship between Educational Attainment and National Innovativeness

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This article contributes to the scarce literature on the relationship between education and innovation at the country level. In this article, it is examined whether educational attainment and cultural tightness-looseness have a positive relationship with national innovativeness. This study contributes by using a more refined approach and analyzing how the combination of the two drivers affects national innovativeness. A generalized linear model is used to study the relationship between countries categorized as tight or loose by Gelfand et al. (2011) and Uz (2014). The results show that both education level and cultural looseness, when measured as a spread of norms, have a positive effect on national innovativeness. In addition, the results indicate that the combination of the two indicators has a negative interaction effect. Hence, it is important to consider the cultural context when discussing the effectiveness of national innovativeness stimuli.

Keywords*: National innovativeness, Tightness-looseness, Culture, Educational Attainment*

1. Introduction

1.1 Problem Indication

Since the 1980s, the rise of the global economy has been a fundamental aspect of the international business environment (Dabić et al., 2020). This phenomenon is commonly referred to as globalization, which entails the transformation of social relations into more distant and borderless characteristics so that human lives are increasingly played out in a single place (Baylis et al., 2011). Paired with globalization are increased numbers of foreign direct investments (FDI), including investments in research and development centers abroad (Hansen & Rand, 2006). However, it is essential to recognize that the suitability of countries for the establishment of research and development centers varies significantly (Jun-Qian, 2008). Hence, understanding the drivers of innovation is important for effective investments.

Over the past decades, innovation has been studied extensively (for a review see; Bocken et al. (2014), Dani and Gandhi (2021), and Grama-Vigouroux et al. (2023)). Most of the studies focused on organizational innovativeness, whereas this study will focus on national innovativeness. Many different drivers of innovativeness have been identified, under which human capital (Taylor, 2016), property rights (Park, 2008), education (Sidhu et al., 2010),

research institutions (Rodrik, 2017), and culture (Clerc & Landes, 2001; Kumar, 2014). The focus of this study will be on the effect of education on national innovativeness because it is a fundamental driver of knowledge acquisition, problem-solving abilities, critical thinking, and skill development (OECD, 2016). More specifically, this study will look at educational attainment, which represents the percentage of the population aged 25 years and older that has earned or completed a bachelor's degree or equivalent in a country (WorldBank, 2022). As such, this provides insight into the investments a country has made in higher education and nurturing a skilled workforce, which both are important in fostering innovation and economic prosperity.

In examining the relationship between educational attainment and national innovativeness, it is necessary to acknowledge the nuanced impact of culture (Clerc & Landes, 2011). Culture serves as a pair of glasses through which individuals constantly look and use a schema to help them evaluate and organize information (Matsumoto, 2019). Culture is shared by a group and transmitted across generations and enables the group to pursue happiness and well-being, meet basic needs of survival, and derive meaning from life. Culture can be measured and expressed in many different ways (Mohr et al., 2020). This study will focus on the concept of cultural tightness-looseness which was first introduced by Pelto (1968) as a cultural trait but was later transformed into a cultural dimension by Triandis (1989). Here, being a tight culture implies that a country has many strong norms and a low tolerance for deviant behavior, whereas being a loose culture implies that a country has weak norms and a high tolerance for deviant behavior (Gelfand et al., 2011). Hence, the concept of cultural tightness-looseness focuses on social or cultural norms, whereas most cultural dimensions focus on values (Gelfand et al., 2017). According to Triandis (1989), tight societies tend to be more homogeneous and less influenced by external factors. Moreover, they tend to isolate themselves from external influences such as ideas and people. On the other hand, loose societies are heterogeneous and are open to diversity. This openness to diversity, results in loose societies being more creative than tight societies. Additionally, Gilson and Litchfield (2016) note that creativity is a major driver of innovation. Hence, cultural tightness-looseness has a direct effect on national innovativeness (Deckert & Schomaker, 2022), where loose societies are more innovative. However, among the same lines of reasoning, one can also reason that cultural tightness-looseness moderates the relationship between educational attainment and national innovativeness. Gelfand et al. (2011) find that weak social norms and openness to deviant behavior encourage individuals to follow their personal values. Following this line of reasoning, this fosters an environment where individuals challenge conventional ideas, which results in the expression and exploration of innovative

ideas. In such a situation, being educated allows the individual to realize more radical ideas. Hence, societies characterized by weak social norms and openness to deviant behavior could potentially strengthen the direct effect of education on innovation.

The relationship between educational attainment, national innovativeness, and cultural tightness-looseness has been studied extensively. However, there is at least one research gap existing in previous research. Previous research has only partially examined the relationship, meaning that no study has addressed the relationship between these variables exactly as will be done in this study. For illustration, Deckert and Schomaker (2022), among others, focused only on the relationship between cultural tightness-looseness and national innovation, without considering educational attainment. On the other hand, Sidhu et al. (2010) and Taylor (2016), among others, focused only on the relationship between educational attainment and national innovativeness. This implies that no previous research has included cultural tightness-lessness as a moderating variable between educational attainment and national innovativeness. Consequently, research on this conceptual construct is lacking. Nevertheless, cultural tightness-looseness could play an important moderating role because social norms can have a major influence on the expression of ideas that are perceived as distinctive (Triandis, 1989). Therefore, this study attempts to fill the current research gap by examining whether a culture's tightness-looseness has a significant impact on the relationship between educational attainment and national innovativeness.

1.2 Problem Statement

How are educational attainment and tightness-looseness of a national culture related to the innovativeness of a country, and how does the effect of educational attainment on national innovativeness depend on the tightness-looseness of a national culture? (Figure 1)

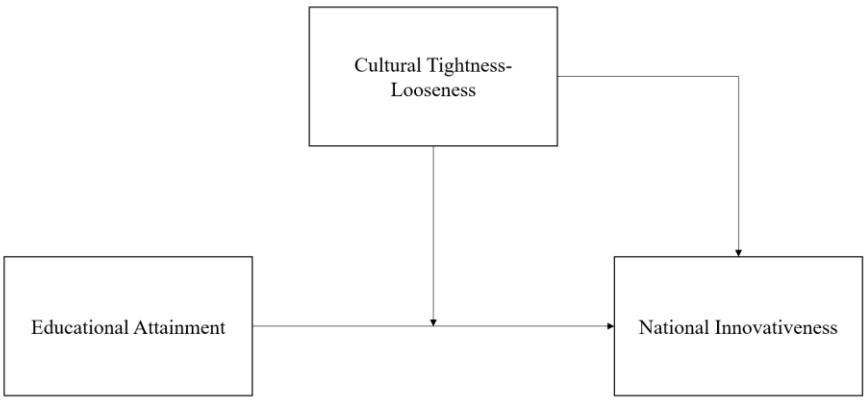

Figure 1: Conceptual Model.

1.3 Research Questions

To address the problem statement, it is broken down into smaller, more manageable research questions. The following sub-questions are established:

1. What is national innovativeness and how does it contribute to economic growth and competitiveness on a global scale?
2. What is educational attainment and how does it influence societal progress and development?
3. What empirical evidence exists regarding the relationship between educational attainment and national innovativeness?
4. What is the concept of cultural tightness-looseness and how is it related to national innovativeness?
5. How are educational attainment and tightness-looseness of a national culture related to the innovativeness of a country, and how does the effect of educational attainment on national innovativeness depend on the tightness-looseness of a national culture? (= answer to the problem statement).

1.4 Thesis structure

The rest of this thesis will be structured as follows. First, Chapter 2 will provide theoretical background and hypotheses. Second, Chapter 3 will discuss the methodology and data used to conduct the empirical analysis. Third, Chapter 4 will elaborate on the results found by conducting a statistical analysis. Finally, Chapter 5 will discuss the findings and implications arising from these results.

2. Theoretical framework

This section elaborates on and establishes the foundational ideas and concepts relevant to the thesis. Here hypotheses will be written based on the relations that can be seen in the conceptual model (Figure 1). This review will be done in a systematic way. First, national innovativeness will be elaborated on. Second, educational attainment will be elaborated on. Third, the relation between the previously mentioned concepts will be discussed. Fourth, cultural tightness-looseness will be introduced. Fifth, the relationship between cultural tightness-looseness and national innovativeness will be elaborated on. Lastly, the moderating effect will be elaborated on.

2.1 Innovation and innovativeness

Although people tend to use the terms innovation and innovativeness interchangeably, they do have two distinct meanings (Deckert & Schomaker, 2018). Innovation comprises the transformation of an existing state of things, to introduce something new (Gault, 2013). Innovation is a process that starts with a novel idea and concludes with a market introduction (Freeman & Engel, 2007). Phases in the process are invention, product development, and introduction (either commercialization or implementation). On the contrary, innovativeness refers to the creation of conducive conditions within a system, fostering a continuous environment for generating innovations (Trantow et al., 2011). More specifically, national innovativeness can be defined as the ability of a country to produce and commercialize a flow of innovative technology over the long run (Furman et al., 2002). In short, innovation pertains to the concrete outcomes of implementing new ideas, while innovativeness encompasses the broader capacity, attitude, and environment conducive to generating innovation.

According to Cooper and Helpman (2004), technological change caused either directly by R&D investments or indirectly by spillover effects contributes significantly to the economic growth of countries. This effect remains even when taking creative destruction into account (Schumpeter, 2006). Creative destruction here refers to the intentional dismantling of existing processes to pave the path for enhanced methods of production. In addition, innovativeness fosters production, competitiveness, and the creation of new jobs (Verspagen, 2006). Hence, it can be seen as a driving force of economic development (Deckert & Schomaker, 2018). Furthermore, innovative activities improve the prosperity and the overall quality of life of consumers (Ahlström, 2010). Yet, the spendings the R&D spendings by countries differ significantly (OECD, 2016). Therefore, the question remains which factors affect the innovativeness of countries.

2.1.1 Measure of innovativeness

National innovativeness largely depends on so-called National Systems of Innovation (NSI; C. Freeman, 1995; Lundvall et al., 2002). NSI consists of creating, disseminating, and using knowledge and technology in a society supported by national research policies and by a network of related actors and institutions such as entrepreneurs, private companies, public research institutions, and universities (Deckert & Schomaker, 2018). Hence, NSI emphasizes the interconnectedness of various actors and institutions and the dynamic nature of the innovation ecosystem. Due to NSI being a complex construct with many diverse variables, the construct is often measured using innovation indices.

In research, the Global Innovation Index (GII), which is annually compiled by the World Intellectual Property Organization (WIPO, 2022), is most often used. The index consists of two sub-indices, namely: the innovation input sub-index and the innovation output sub-index. When considering the input side, the GII takes into account institutions, human capital and research, infrastructure, market sophistication, and business sophistication. These factors account for the dynamic nature of the innovation ecosystem. When these factors are understood, a more comprehensive understanding of the components affecting the innovation capacity of a country is created. On the output side, a distinction is made between creative and knowledge outputs. All in all, the GII provides a more nuanced picture of the evolving innovation landscape. A more detailed overview is provided in Figure 2.

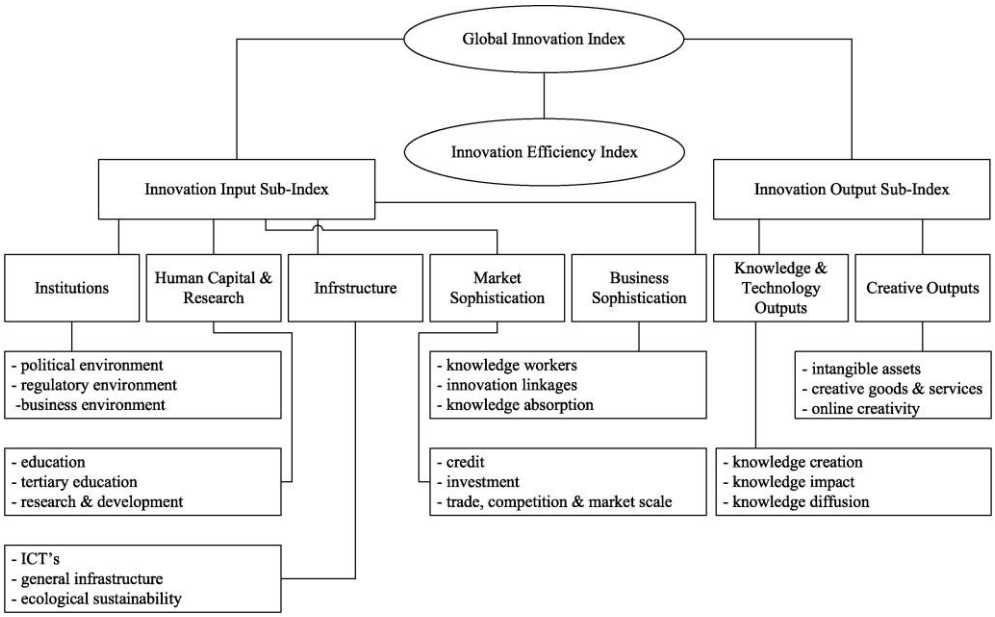

Figure 2: Components of the Global Innovation Index (Cornell University et al., 2014)

2.2 Educational attainment

In the past, education has often been associated with national innovativeness (Atkinson, 2007). However, the way education was measured had a major impact on the significance of the relationship found. To illustrate: Taylor (2016) examined the relationship between national data on education spending and national innovativeness and found that many top innovators were also top education spenders. Yet this relationship was not strong because countries such as Japan and South Korea had low education spending for the most part and yet rose to become top innovators. Moreover, educational spending declined over time especially in innovative countries without compromising their national competitiveness in science and technology. Thus, merely looking at educational spending does not fully capture the effect of education on national innovativeness.

Therefore, Taylor (2016) identified educational attainment as a more appropriate measure of national education. This metric evaluates the actual student performance by expressing the percentage of the population aged 25 and above who have attained or finished a particular level of education (WorldBank, 2022). Consequently, it reflects the socioeconomic status of a country's residents. While typically attained early in life, educational attainment has a long-term impact on the life course of individuals (Lin et al., 2021). However, as the definition shows, one can look at different levels of education. More specifically, educational attainment is often expressed as at least completed primary, at least completed lower secondary, at least completed upper-secondary, at least completed post-secondary, at least completed short-cycle tertiary, at least completed Bachelor's, at least completed Master's, or, finally, completed Doctoral or equivalent. According to Hanushek and Woessmann (2012), tertiary education has a much greater payoff for innovation than overall education (primary and secondary education). Moreover, Toivanen and Väänänen (2012) found that the proportion of engineers with bachelor's degrees significantly influenced the number of patents obtained in Finland. Building upon the preceding analysis, low-level educational attainment is measured via the Programme for International Student Assessment (PISA). Here, the reading, math, and science capabilities of fifteen-year-old students are tested (OECD, 2014). However, top-scoring countries on the PISA scale do not rank among the top innovating countries. Conversely, top innovators sit among the middle ranks of PISA. Hence, low-level educational attainment rates are not a good predictor of national innovativeness (Hanushek & Woessmann, 2012). Therefore, educational attainment implies *the percentage of the population ages 25 and over that attained or completed a Bachelor's or equivalent in a country* in the continuation of this research paper. The effects of different educational levels on technology and science are depicted in Figure 3.

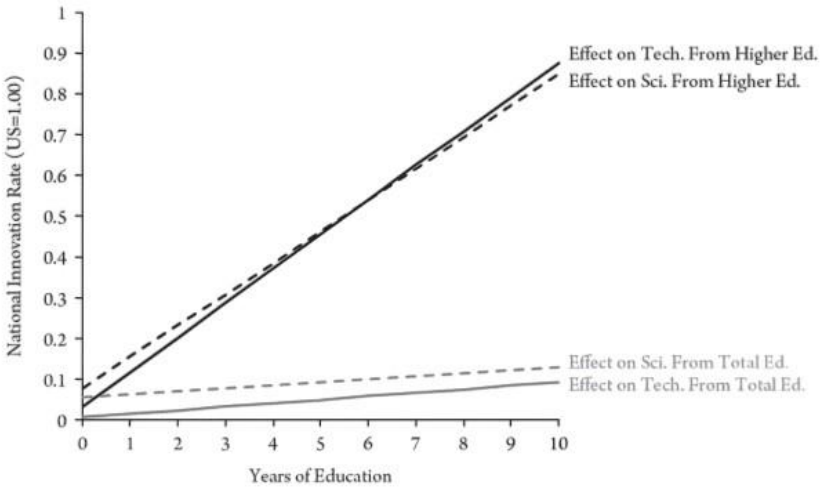

Figure 3: Level of Education on National Innovation Rate (Taylor, 2016).

Lastly, it is crucial to closely examine the Human Capital & Research indicator of the GII model (see Figure 2) because there might be a potential overlap between this factor and one of the independent variables in the conceptual model. The variables used by WIPO (2022) to compile the Human Capital & Research indicator are listed in Table 1. From this table, it becomes evident that the educational attainment variable used in this study is not fully incorporated in the computation of the GII indicator. Therefore, the results of the analyses are not affected by the inclusion of the independent variable in the computation of the dependent variable.

***Table 1**: Second-level indicator meanings of GII's Human Capital & Research indicator (WIPO,2022).*

Subindicator	Second-level indicator	Meaning
Education	Expenditure on education	Total general government expenditure on education, expressed as a percentage of GDP
	Government funding	Average total general government expenditure per student at secondary level, expressed as a percentage of GDP per capita
	School life expectancy	Total number of years that a person of school entrance age can expect to spend within the primary to tertiary levels of education
	PISA scales	15-year-olds' ability to use their reading, mathematics and science knowledge skills based on OECD's PISA assessment
	Pupil-teacher ratio	The number of pupils enrolled in secondary school divided by the number of secondary school teachers
Tertiary education	Tertiary enrolment	The ratio of total tertiary enrolment, regardless of age, to the population of the age group that officially corresponds to the tertiary level of education
	Graduates in science and engineering	The share of all tertiary-level graduates in natural sciences, mathematics, statistics, information and technology, manufacturing, engineering and construction as a percentage of all tertiary-level graduates
	Tertiary inbound mobility	The number of students from abroad studying in a given country as a percentage of the total tertiary-level enrolment in that country

2.2.1 Relation with national innovativeness

Having examined educational attainment and national innovativeness in the preceding sections, it is now pertinent to explore the interconnection between these two constructs. In the 17th century, it was assumed that relying on the division of labor to increase skills and foster innovation would be sufficient (A. Smith, 1776). However, this assumption was challenged by List (1885) who argued that education plays a central role in determining the productivity of nations. More specifically, education appeared to be inseparable from science and

innovativeness, and thus from national economic competitiveness. There are three ways in which education fosters national innovativeness, namely: individuals as direct input, synergistic growth, and consumer demand. These will be addressed in the following paragraphs.

First, formally schooled individuals are a direct input to innovative activity. Since the rise of universities, laboratories, and research and development (R&D) facilities in the 18th century, educated workers have steadily emerged as pivotal drivers of national innovation (Carlsson et al., 2009). Skilled workers with at least ten years of formal education, followed by in-house specialized training, demonstrated significant contributions to innovative activities, such as process innovations and product improvements (Taylor, 2016). To illustrate, Shapira (1995) attributes the so-called manufacturing miracles in Japan and Germany during the 70s and 80s to the innovative contributions of skilled employees. Similarly, the case study of Seoul, South Korea, as examined by Sohn and Kenney (2007), emphasizes the transformative role of high-quality university graduates on economic development through higher levels of innovativeness.

Second, Shove and Hicks (1933) noted that a change in relative prices of factors of production is itself an incentive for invention aimed at saving the use of a factor that has become relatively expensive. During the last century, this implies the need for skilled workers who can use the developed technology effectively (Taylor, 2016). Based on the theory by Shove and Hicks (1933) and the recent developments, Acemoğlu's (2002) theory of skill-biased technical change emerged. This theory explains how educated workers will demand more and better technology to work with. Therefore, technological advancements can synergize with a skilled workforce, resulting in mutual reinforcement where the growth in one sector fosters the demand for the other (Autor et al., 1998). In short, the increased difficulty of the technology requires training skilled workers, who in turn require even more complicated technology to employ. Hence, this demands for innovativeness.

Third, well-educated consumers stimulate demand for continuous technological advancements (Von Hippel, 1988). Consequently, consumers play an essential role in initiating technological change. In particular, technology enthusiasts exhibit a notable ability to identify areas for product improvement, with estimates suggesting that between 10 and 40 percent of these consumers are actively engaged in creating new prototypes (Von Hippel, 2005). Furthermore, it is important to delineate between the two main types of innovation. Innovation can either be incremental or radical (Subramaniam & Youndt, 2005). Here, incremental innovation encompasses the refining and reinforcing of existing products and services (Ettlie, 1983), whereas radical innovation involves significantly transforming existing products and services

(Chandy & Tellis, 2000). In the case of well-educated consumers, they often demand incremental innovation. Yet they are also a crucial target group for the launch of radical innovations such as the personal computer and automobile (Von Hippel, 2005).

Since List's proposal in 1885, scholars have concurred that education plays a critical role in fostering national innovation. Empirical results from numerous research support this agreement by repeatedly showing a strong positive correlation between education and several national innovativeness indices. Research indicates, for instance, that there are strong relationships between education and innovation rates (Barro & Lee, 2013), the volume of STEM research publications (Taylor, 2016), the number of new product launches (Căpățînă, 2014; Damanpour, 1991), national innovative capacity (Furman et al., 2002), patent filings (De Rassenfosse & Van Pottelsberghe, 2009), productivity of research activities (Engelbrecht, 1997), and overall growth in researcher productivity (Griliches, 1997). In light of the aforementioned theories and findings, the subsequent hypothesis is formulated:

H1: Higher national educational attainment levels have a positive effect on national innovativeness levels.

2.3 Cultural tightness-looseness

Culture acts as a set of lenses through which individuals consistently look, utilizing a framework to assess and structure information (Matsumoto, 2019). Culture is shared by a group and passed down from generation to generation while enabling the group to pursue happiness and well-being, meet basic survival needs, and extract meaning from life (Matsumoto & Juang, 2016). According to Karahanna et al. (2005), culture explains behavior. To illustrate, one of the more typical Japanese behavioral characteristics is the almost obsessive attention to rank and status in social intercourse (Fusé, 1982). This behavioral trait can be explained by Japan scoring high on the cultural dimension of power distance by Hofstede (1984). There are three different theoretical approaches to measuring culture (Mohr et al., 2020). This is either done by assessing nations by values (Hofstede, 1984; House et al., 2004; Inglehart, 2006; P. B. Smith et al., 1996), by the self (Markus & Kitayama, 1991), or by social norms (Gelfand et al., 2011). This thesis will focus on investigating the influence of social norms because social norms play a crucial role in shaping individual behavior and societal outcomes (Triandis, 1989). More specifically, there will be a focus on cultural tightness-looseness.

Cultural tightness and looseness, initially introduced in anthropology, categorize various traditional societies along a spectrum (Pelto, 1968). Anthropological research on tight and loose

societies has covered a wide variety of societies. For instance, literature has explored the looseness of Thai culture and noted the absence of a sense of duty and obligation to parents (Embree, 1950); the variation in tightness among primitive societies categorized as individualistic, corporative, and competitive societies (Mead, 1937); the collectivistic tendencies of Eskimos resulting in tight societal structures (Hughes, 1958); and the looseness of the Kenyan Kamba tribe characterized by an elastic system (Ewers & Oliver, 1963). Ryan (1961) set forth criteria for looseness, including norms expressed through a wide range of alternative channels, tolerance for deviant behavior, and underdeveloped values of group organization, formality, permanence, durability, and solidarity. These findings suggest two important points regarding the applicability of the concept. The contrast between tight and loose societies is theoretically significant and can potentially predict cultural characteristics, but there lacks a clear operational definition of the cultural trait (Pelto, 1968).

Triandis (1989) dealt with this operational problem by identifying the cultural tightness-looseness construct not merely as a cultural trait but as a cultural dimension. The concept was thus extended to a fundamental dimension of cultural variation and acknowledged the role it plays in shaping social norms and behavior beyond the boundaries of a single characteristic. Tightness-looseness in the cultural context is defined by Witkin and Berry (1975) as the extent of hierarchical organization within the sociocultural components of a society. Here, Triandis (1989) adds, that tight cultures are homogeneous and loose cultures are heterogenous. This can be attributed to the emotional impacts of excluding members who diverge from the social norm since the occurrence of deviant behavior is more common in heterogeneous societies. More specifically, tight cultures have clear norms that are reliably imposed and little deviating behavior is tolerated. On the other hand, loose cultures have either unclear rules or tolerate the deviating behavior of in-group members (Pelto, 1968). Last but not least, Gelfand et al. (2006) characterize cultural tightness-looseness as the extent to which social standards in a society are either strong or weak. Loose societies are more tolerant of deviation from social standards and have weaker norms than tight societies, which have stronger norms and less tolerance for deviant behavior.

In the literature, two approaches arose to operationalize the concept of cultural tightness-looseness (Shkurko, 2020): first, the tightness scores of Gelfand (2011), and second, the cultural tightness-index (CTL) index of Uz (2014). Gelfand (2011) collected primary data from 6823 individuals spanning numerous occupations and university students across 33 countries to construct the respective scores. A survey consisting of six questions was used to examine the

extent to which social norms are ubiquitous, clearly defined, and reliably imposed within countries. Respondents rated these items on a 6-point Likert scale. The resulting measure was proven to be both reliable and valid. When a country received a high tightness score, it indicated a correspondingly higher level of cultural tightness within that country. On the other hand, following Triandis' (1989) reasoning, Uz (2014) applies the concept of similarity to determine cultural tightness-looseness by looking at the homogeneity and heterogeneity of a country. Uz (2014) gathered secondary data from the World Value Survey database across 68 countries and calculated the standard deviation of selected items to create three indices; the domain-specific index, the domain-general index, and the combination index. For all three, a higher standard deviation implies that a society is looser compared to other societies. Especially the combination index is useful for this thesis as it conflates the advantages of the other two indices. Moreover, the resulting measure has been proven to be reliable and valid (Deckert & Schomaker, 2022). Hence, both indicators measure the concept of tightness-looseness in different ways. Where high values on the Gelfand et al. (2011) scale imply that a culture is tight, high values on the Uz (2014) scale imply that a culture is loose. Deckert and Schomaker (2022) found that these two constructs are negatively correlated, though the linear relationship is weak.

2.3.1 Relation with national innovativeness

After exhaustively examining the constructs of cultural tightness-looseness and national innovativeness, the focus will now shift to clarifying the relationship between these two central concepts. According to Gelfand et al. (2011), cultural tightness and looseness exhibit close relations not only with individual behaviors but also with institutions at the national level. Therefore, this section will look into the direction of the possible effect.

While most cultural dimensions in the literature focus on values (see Hofstede, 1984; House et al., 2004; Inglehart, 2006; P. B. Smith et al., 1996), cultural tightness-looseness focuses on norms. As mentioned earlier, norms look at the acceptance of deviant behavior by individuals and the strength of these social norms in terms of their number and clarity within a society (Gelfand et al., 2006). Hughes (1958) found that Siberian Eskimos tend to isolate themselves from outside influences and therefore, exhibit a tendency to resemble each other. In addition, Hughes (1958) notes that the change in complexes of sentiments is difficult because of the lack of contact with other systems of belief. More generally, Triandis (1989) shows that tight societies are often more homogeneous compared to looser societies due to the isolation from extraneous cultures. Consequently, the phenomenon of isolation leads to a lack of diverse ideas, individuals, and cultural stimuli, reducing the propensity for creative efforts (Gelfand, 2019).

Moreover, according to Deckert and Schomaker (2022), cultural looseness is linearly related to individualism, which in turn is associated with creativity (Gilson & Litchfield, 2016) and innovation (Lubart, 2010). Following this line of reasoning, nations characterized by cultural looseness are likely to be more creative than nations characterized by cultural tightness. Similarly, loose societies are more likely to exhibit higher levels of innovativeness as opposed to tight societies.

In addition, Deckert & Schomaker (2022) demonstrate how organizations in loose societies exhibit higher tendencies towards exploration, experimentation, and learning by doing, reflecting cultures of lower constraints. Therefore, the concept of cultural tightness-looseness has close links to national institutions. Institutions are human-conceived constraints that shape political, economic, and social interaction (Khan et al., 2017). There are three types of institutions: social, political, and economic institutions. Some are more formal, while others are more informal (Acemoğlu et al., 2005). The different types of institutions are interconnected and mutually influential (Acemoğlu & Robinson, 2012). Social and political institutions, for example, contribute to the formation of economic institutions. Moreover, government institutions and policies, as noted by Taylor (2016), also play a role in explaining varying levels of national innovativeness globally. Decentralized and inclusive political institutions, such as transparent regulatory frameworks, open access to information, and support for entrepreneurship, create an environment that favors innovation (Acemoğlu & Robinson, 2012). For instance, robust intellectual property rights protection encourages inventors and entrepreneurs to invest in research and development because their inventions are protected from unauthorized use. Following Acemoğlu & Robinson's (2012) argument of economic institution formation, societies can influence economic institutions via social and political institutions, such as elections and the composition of organizations. In addition, it is noteworthy that the concept of cultural tightness and looseness is correlated with societal values and the expression of personal opinions, as elucidated by Deckert & Schomaker (2022). Consequently, cultural tightness-looseness will affect the influence of society on economic institutions and, hence, innovation. Specifically, nations characterized by cultural looseness are inclined to exhibit more expressions of personal opinions on government institutions compared to nations characterized by cultural tightness.

Furthermore, political institutions, and therefore innovativeness, are influenced by two cultural dimensions closely related to cultural tightness and looseness (Deckert & Schomaker, 2018). First, power distance has a close connection to cultural tightness. Power distance, as explained

by Hofstede (1984), refers to the degree to which citizens tolerate unequal power distribution within their institutions and organizations. High power distance is associated with unequal distribution of power, high levels of corruption, and unequal opportunities for members of society (House et al., 2004). Several researchers investigated the relationship between power distance and national innovativeness. All found that power distance is negatively related to national innovativeness. To illustrate, Rinne et al. (2011) and Deckert & Schomaker (2018) found strong negative relationships between Hofstede's dimension of power distance and national innovativeness, Shane (1992) found a negative relationship between power distance scores and the number of patents issued, and Shane (1993) found a negative relationship between power distance scores and the number of trademarks issued. Second, collectivism has a close connection to cultural tightness. Collectivism, as explained by Hofstede (1984), refers to the level of interconnectedness that a society upholds among its members. Similarly to the power distance dimension, Rinne et al. (2011) found a strong positive relationship between individualism and national innovativeness, Deckert & Schomaker (2018) found a positive relation between in-group collectivism and national innovativeness, Shane (1992) found a negative relationship between collectivism scores and the number of patents issued, and Shane (1993) found a negative relationship between collectivism scores and the number of trademarks issued. Living in a collectivistic society typically limits the personal freedom of individual members and, therefore, solidifies the existing status quo of elites in a society (Deckert & Schomaker, 2018). Hence, innovative ideas are hindered and unable to succeed within the institutional landscape. Following this line of reasoning, societies characterized by cultural looseness are more likely to exhibit higher levels of national innovativeness.

All in all, the research on cultural tightness-looseness and national innovativeness shows a significant relationship between these constructs. Cultural tightness-looseness not only influences individual behavior but also shapes cultural and socioeconomic institutions at the national level. In light of the aforementioned theories and findings, the subsequent hypotheses are formulated:

H2: Higher tightness scores of Gelfand et al. (2011) have a negative effect on national innovativeness.

H3: Higher cultural tightness-looseness scores of Uz (2014) have a positive effect on national innovativeness.

2.3.2 Moderating effect

After looking into the direct relationships between educational attainment and cultural tightness-looseness on national innovativeness. It was hypothesized that educational attainment and cultural tightness-looseness by Uz (2014) are positively related to national innovativeness, while cultural tightness by Gelfand et al. (2011) is negatively related to national innovativeness. However, research on other cultural measures shows the moderating influence that culture can have on actual outcomes (Clerc & Landes, 2001). Therefore, the review will shift its focus on the influence of cultural tightness-looseness on the relationship between educational attainment and national innovativeness.

Although the moderating effect of cultural tightness-looseness on the relationship between educational attainment and national innovativeness has not been examined till this moment in time, research has investigated the moderating effect of other cultural values on this direct relationship. To illustrate, Bendapudi et al. (2018) found that cultural values moderate the relationship between basic educational quality and creative innovation outputs. More specifically they observed that Schwartz's (1999) self-protective value negatively moderates this relationship. Additionally, Jiang et al. (2018) demonstrated how collectivism negatively moderates the relationship between creativity and innovation. Wang et al. (2009) identified that organizational culture promoting innovation orientation and lower stability standards had a positive moderating role on the relationship between human development R&D expenditures and innovation. Finally, Hofstede's (1984) dimension of uncertainty avoidance negatively moderates the relationship between CEO power and innovation, according to Pucheta-Martínez and Gallego-Álvarez (2024). Moreover, they also discovered that indulgence strengthens the positive relation between the two concepts. All in all, cultural values have been found to interact, both positively and negatively, with drivers of innovation. This underscores the broader impact of cultural dimensions on innovativeness and reveals that it is possible for the concept of cultural tightness-looseness to also moderate the relationship.

In addition, Tang et al. (2019) examined the moderating effect of cultural tightness-looseness on the relationship between social media use and the control of corruption. They found cultural tightness-looseness to be a negative moderator. This finding suggests that cultural tightness-looseness shapes attitudes, behaviors, and outcomes, potentially even beyond the specific context of social media and anti-corruption. Furthermore, Elster and Gelfand (2020) examined whether guiding principles in people's lives drive universal behavior across cultures. They found that this is not true for cultures that emphasize norms. Hence, countries characterized by

cultural tightness are more likely to behave in accordance with social expectations, while countries characterized by cultural looseness are more likely to behave in accordance with their values. Thus, behavior cannot be explained by solely looking at personal values. All in all, this highlights the importance of considering cultural norms, like tightness-looseness, in shaping behavior across different settings.

As mentioned in Chapter 2.2.1, educational attainment is expected to be positively related to national innovativeness. However, given the findings by Elster and Gelfand (2020), the association between values and behavior is not straightforward. In tight societies, behavior is restricted by social norms (Chua et al., 2019; Gelfand et al., 2011). From a young age, individuals in tight cultures are encouraged to adapt their behavior to fit social institutions, adhere to rules, and conform to an existing order (Gelfand et al., 2017). Thus, when choosing a particular course of action, they are more likely to consider the extent to which they act in accordance with social expectations (Roccas & Sagiv, 2009). Individuals who deviate from this social norm are less tolerated and severely punished (Elster and Gelfand, 2020). In contrast, loose societies are characterized by the prevalence of weak situations in which there is no predetermined way to behave (Gelfand et al., 2011). Therefore, individuals are socialized to follow their internal guiding principles when making decisions (Tam & Chan, 2017). Thus, when choosing an appropriate course of action, individuals in loose cultures are more likely to rely on their values, and their behavior is less likely to be guided by norms or social expectations (Elster & Gelfand, 2020). Following this line of reasoning, individuals in tight societies, regardless of their level of education, are less likely to come up with and implement innovative ideas than individuals in loose societies because they are less creative in using their knowledge (Gilson & Litchfield, 2016). Moreover, educated individuals in loose societies are better able to achieve their innovative ideas that follow from their internal guiding principles.

All in all, the research on cultural tightness and looseness, educational attainment, and national innovativeness shows a significant relationship between these constructs. Not only is the link between education and national innovativeness proven to be impacted by multiple cultural traits, but cultural tightness-looseness is also shown to be an important factor in shaping individuals' behavior. In light of the aforementioned theories and findings, the subsequent hypotheses are formulated:

H4: Higher tightness scores of Gelfand et al. (2011) have a negative impact on the relation between educational attainment and national innovativeness.

H5: Higher cultural tightness-looseness scores of Uz (2014) have a positive impact on the relation between educational attainment and national innovativeness.

3. Data and methodology

To test the hypotheses, data is used from four datasets: the Global Innovation Index (GII; Cornell University et al., 2014), the Educational attainment by level of education (WorldBank, 2022), the tightness-looseness scale (Gelfand et al., 2011), and the cultural tightness and looseness scale (Uz, 2014). Models include only one of the two measures of tightness-looseness. Gelfand et al.'s (2011) tightness-looseness scale combined with the other two datasets involves 27 overlapping countries, while Uz's (2014) cultural tightness-looseness scale combined with the other two datasets includes 58 overlapping countries. This is the sample used for the data analysis.

3.1 Dependent variable

National Innovativeness. The dependent variable scores are obtained from the GII datasets from 2022 published by Cornell University, INSEAD, and the WIPO. It covers 132 economies, representing 94.1% of the world's population and 98.5% of the world's gross domestic product (GDP) in U.S. dollars, and tracks the most global innovation trends (WIPO, 2022). The GII model is based on 81 indicators spanning 7 themes (see Figure 2). 65 indicators are based on quantitative data, 13 indicators on index data, and 3 indicators on qualitative data. For an economy to be included in the GII, there is a minimum symmetric data coverage requirement of at least 66% of the indicators and the timeliest possible data is used. By rule, data is not allowed to be older than ten years. However, almost 75% of the data is less than three years old and only 5.3% is older than five years. For the sake of transparency, missing values are not estimated but reported as "not available". Overall, the GII presents three indices; the Innovation Input Sub-Index, the Innovation Output Sub-Index, and the overall GII scores index. Countries receive both a rank (between 1 and 132) and an innovation score (between 1 and 100). Following an audit by the European Commission's Competence Centre on Composite Indicators and Scoreboards (COIN), the index is representative of the vast majority of the economies[1]. These details underscore the robustness and reliability of the GII as a measure of

[1] Some caution is warranted in regard to the Input Sub-Index for five economies – Belarus, the Islamic Republic of Iran, Brunei Darussalam, Uganda, and the United Republic of Tanzania – and some caution is also warranted in regard to the Output Sub-Index for five economies – Zimbabwe, Nigeria, the United Republic of Tanzania, Belarus and Côte d'Ivoire. To account for this, regressions were also conducted excluding these countries.

global innovation trends and ensure that the dependent variable in this study is both comprehensive and credible.

3.2 Independent variable

Educational Attainment. The independent variable scores are obtained from the Educational attainment by level of education dataset from 2022 by the UNESCO Institute for Statistics (UIS). Covering 126 economies, this dataset provides annual data on sex, gender gaps, and educational levels. Data are collected by UIS, primarily from national censuses, household surveys, and labor force surveys. The percentage of the population with a Bachelor's degree is calculated by dividing the number of individuals with a Bachelor's degree by the total population of the same age group and multiplying by 100, where 100 represents the entire population having attained a Bachelor's degree or equivalent. The data used covers the period from 2017 to 2022. Over 75% of the data is less than three years old. The use of this indicator for cross-country comparisons should be treated with caution since countries do not necessarily classify degrees and qualifications at the same level, even if they were obtained at approximately the same age or after a similar number of school years. To overcome the challenge, all data are linked to the International Standard Classification of Education (ISCED) ensuring comparability of educational programs at the international level. The application of internationally accepted standards and norms results in a consistent, reliable source of information. In cases where data on educational attainment is not available in the UIS database, the decision was made to include data from OECD (2022). From here, educational attainment scores for China, Luxembourg, and Turkey were obtained. Both reporting agencies followed rigorous procedures and stringent guidelines to ensure the reliability and validity of the data (Tang et al., 2019).

3.3 Moderating variable

Tightness scale. The first moderating variable scores are obtained from the research by Gelfand et al. from 2011. The scores stem from data collected from 6,823 participants covering 33 nations. Participants were selected based on a sampling strategy that aimed to maximize the variability of nations concerning the expected correlation and the variability of participants within nations. These procedures resulted in a sample compromising of about 200 respondents in each country where individuals differed in their personal and professional characteristics. However, the sampling did not take the national spread into account. More specifically, participants within countries were selected only in one major city for 27 out of 33 countries. Yet urban and rural areas within a country differ significantly when considering cultural traits

(Chen et al., 2015). Therefore, the applicability of the scale for the entire country can be questioned and should be treated with caution. Looking at the scale, it consists of six statements that are responded to on a 6-point Likert scale. The scale was proven to be both reliable and valid, with checks for factor validity, scale equivalence, adequate reliability, within-nation agreement, high convergent validity, and distinctness from other known cultural values. After the data collection, scores were standardized to facilitate comparison across countries. Lastly, it must be noted that prior research was unable to detect a significant relationship between tightness scores and national innovativeness (Deckert and Schomaker, 2022). However, they did not include control variables in their analysis and recommended that future research examine this relationship with the inclusion of control variables.

Cultural tightness-looseness scale. The second moderating variable scores stem from Uz's 2014 research. The scores are derived using data from the European and World Values Surveys (EWVS) conducted in 2006. Utilizing EWVS data ensures representative national samples for each society (WVS, 2020). Whereas Gelfand et al. (2011) created one scale, Uz (2014) established three indices. More specifically, the domain-specific, the domain-general, and the combination index. This study will use the combination index during the data analysis because it integrates the domain-specific and domain-general indices. These variables were analyzed using PCA and categorized into factors, with weights assigned based on the relative importance of the domains in each society. The final scores were normalized and adjusted to obtain a score of 0 for the most culturally tight society.

3.4 Control variables and robustness test

According to Deckert and Schomaker (2022), GDP per capita, GDP per capita growth, and population density are important factors that need to be controlled to test for national innovativeness. However, Bendapudi et al. (2018) found that these factors are already controlled for by the inclusion of the GII variable. Yet, other variables need to be controlled for. First, the industrial structure of a country because innovative activity is more common in certain industries (Nelson & Winter, 1977). To include the industrial structure, this paper follows Shane's (1993) approach by taking a percentage of gross national product, the total value added in rubber, plastics, chemicals, petroleum, non-electrical manufacturing, electrical manufacturing, transportation, and professional and scientific equipment. These ratios were obtained from the World Bank (2023) database. This ratio reflects the propensity of a nation to have an industrial structure dominated by sectors that are most likely to innovate. Therefore, it is appropriate to include this ratio as a control variable. Second, Elster and Gelfand (2020) note

that national-level individualism needs to be controlled due to the established associations between individualism, creativity, and national innovativeness. Individualism scores were obtained from Hofstede (2001) and matched with the included countries.

To test the findings for robustness, two alternative specifications for the dependent variable are used. Doing so reduces potential biases that arise due to the aggregate nature of the GII. More specifically, the innovation output sub-index of the GII and data from the Innovation Union Scoreboard (IUS)/European Innovation Scoreboard (EIS) will replace the original measure of national innovativeness. Besides addressing the limitations of the GII and assessing the robustness of the model, this approach also controls for potential overlap between the educational attainment variable and the education factors included in the innovation input sub-index of the GII. Moreover, including a different measure of innovativeness strengthens the validity of the findings and contributes to a more nuanced understanding of the drivers of national innovativeness.

3.5 Analysis strategy

Although the values of cultural tightness-looseness as well as of national innovativeness stand for ranks, certain assumptions to use an Ordinary Least Squares (OLS) model are violated. For instance, the distribution of the dependent variable is non-normally distributed (see section 4.1). Therefore, a Generalized Linear Model (GLM) with a log link and a gamma family is used. This model fits a link between a vector of independent variables, a vector of control variables (as independent variables), and a dependent variable. The regression coefficients, displayed as Exp(B), represent multiplicative effects on the expected value of the dependent variable. The inclusion of a gamma family type accounts for the usage of data with a skewed distribution by ensuring that the analysis is tailored to fit the actual shape of the data. This leads to the following equation of the generalized linear model:

$$\mathrm{y} = \beta_0 + \beta_1 X_{\mathrm{EA}} + \beta_2 X_{\mathrm{CTL}} + \beta_3 X_{\mathrm{EA}} X_{\mathrm{CTL}} + \beta_4 X_{\mathrm{is}} + \beta_5 X_{\mathrm{ind}} + \epsilon \qquad (1)$$

Here, y represents national innovativeness, X_{EA} represents educational attainment, X_{CTL} represents cultural tightness-looseness, X_{is} and X_{ind} represent the control variables, and ϵ represents the error term. However, the error term is expected to be zero because on average the model's predictions are assumed to be correct. Hence, positive and negative errors cancel each other out.

4. Findings

Before running regressions with the constructs of national innovativeness, education attainment, cultural tightness-looseness, industrial structure, and individualism, it is important to first test for normality and multicollinearity and look at the descriptive statistics. Then the hypotheses are tested. Regressions are performed twice, once with the tightness scores of Gelfand et al. (2011) and a second time with the cultural tightness-looseness scores of Uz (2014).

4.1 Preliminary analyses

Before running regressions, the normality assumption is checked. Figure 4 provides a histogram showing the score distribution of the dependent variable with the normal distribution curve and the kernel density estimate (KDE). From this visualization, it becomes evident that there is an absence of normality and centeredness in the data. Moreover, skewness and kurtosis tests for normality reveal significant deviations from normality with a probability of 0.0028 for kurtosis and 0.0194 for the joint test, including skewness and kurtosis. This implies that the data is significantly different from a normal distribution. Therefore, it was decided to utilize a Generalized Linear Model (GLM) instead of an Ordinary Least Squares (OLS) model for the analysis as suggested by Deckert and Schomaker (2018, 2022).

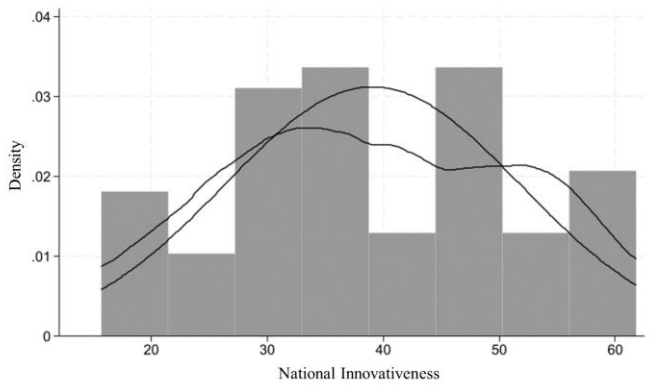

Figure 4: Distribution of the GII scores and the kernel density estimate.

Moreover, variance inflation factor (VIF) tests for multicollinearity were conducted, revealing highly inflated estimated regressions due to the inclusion of the individualism control variable. In more detail, individualism reported a VIF score of 14.72 (1/VIF of 0.067933) in the Uz model and a VIF score of 15.99 (1/VIF of 0.062556) in the Gelfand model. Since the VIF scores surpassed the commonly accepted threshold of 10, there was a significant indication of multicollinearity. Therefore, the individualism variable was deemed unfit for inclusion in the analysis. As a result, individualism was excluded from the analysis to ensure the reliability and validity of the generalized linear models.

4.2 Descriptive statistics

In the context of the research at hand, Table 2 provides the descriptive statistics and correlation coefficients relevant to the Gelfand model, whereas Table 3 presents analogous data for the Uz model. Educational attainment levels correlate strongly to the GII score in both models ($r = 0.62$, $p < 0.05$; $r = 0.66$, $p < 0.05$). This association provides initial support for the prediction that educational attainment levels are positively related to national innovativeness, measured through GII scores. Furthermore, the cultural tightness-looseness scores of Uz (2014) correlate strongly to national innovativeness ($r = 0.5731$, $p < 0.05$) and the tightness scores of Gelfand et al. (2012) correlate negatively to national innovativeness ($r = -0.2242$, n.s.). These associations provide initial support for the prediction that cultural looseness is positively related to national innovativeness. However, the non-significant correlation between the tightness scores and national innovativeness needs to be examined by including control variables. These correlations were consistent with previous findings of the links between education and innovativeness at the national level (Bendapudi et al., 2018; Furman et al., 2002) and the link between cultural tightness-looseness and national innovativeness (Deckert & Schomaker; 2018, 2022), lending confidence to the used dataset.

***Table 2**: Descriptive statistics and correlations Gelfand model.*

	Variables	N	Mean	SD	Min	Max	1	2	3	4
1	National Innovativeness	27	47.0815	9.8255	23	61.8	1			
2	Educational Attainment	27	24.8259	9.5419	3.9	37.3	0.6169*	1		
3	Cultural Tightness-Looseness	27	6.9	2.7995	2.6	12.3	-0.2242	-0.5099*	1	
4	Industrial Structure	27	14.8138	5.9574	4.8758	27.6989	-0.0669	-0.4557*	0.4376*	1

* indicates significant at $p < 0.05$

***Table 3**: Descriptive statistics and correlations Uz model.*

	Variables	N	Mean	SD	Min	Max	1	2	3	4
1	National Innovativeness	58	38.8431	12.9551	15.7	61.8	1			
2	Educational Attainment	58	22.3862	9.9525	0.9	44	0.6612*	1		
3	Cultural Tightness-Looseness	58	53.4189	26.8442	3.1	119.8	0.5731*	0.4816*	1	
4	Industrial Structure	58	15.6013	6.2672	3.8277	37.8277	-0.1624	-0.2336	-0.3406*	1

* indicates significant at $p < 0.05$

Figure 5 presents the countries included in the Gelfand model within the sample, while Figure 6 illustrates the countries included in the Uz model within the sample. It is evident that the theoretical overlap between these two rankings is minimal in most instances. For example,

Estonia is identified as the most "loose" country according to Gelfand et al. (2011), yet it is positioned in the lower half of the cultural tightness-looseness spectrum by Uz (2014).

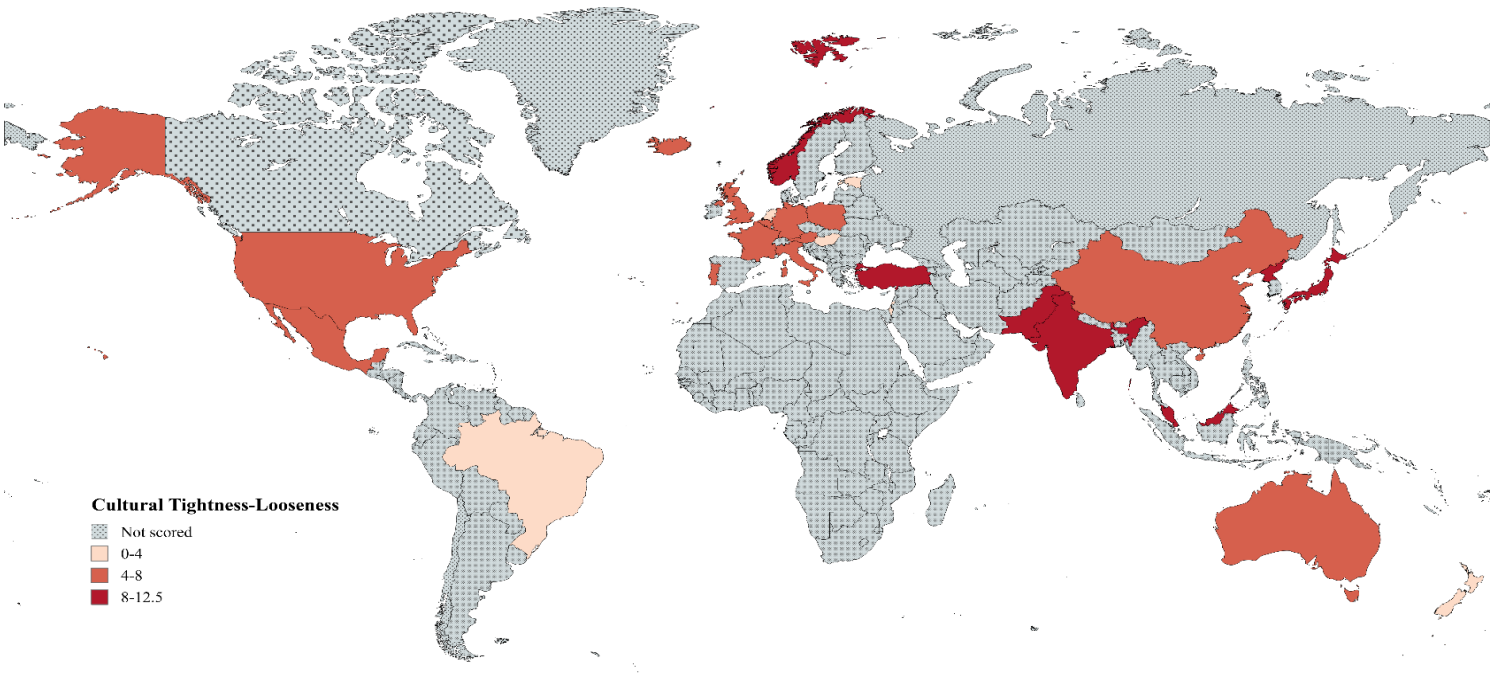

Figure 5: Gelfand et al. (2011) mapped tightness scores.

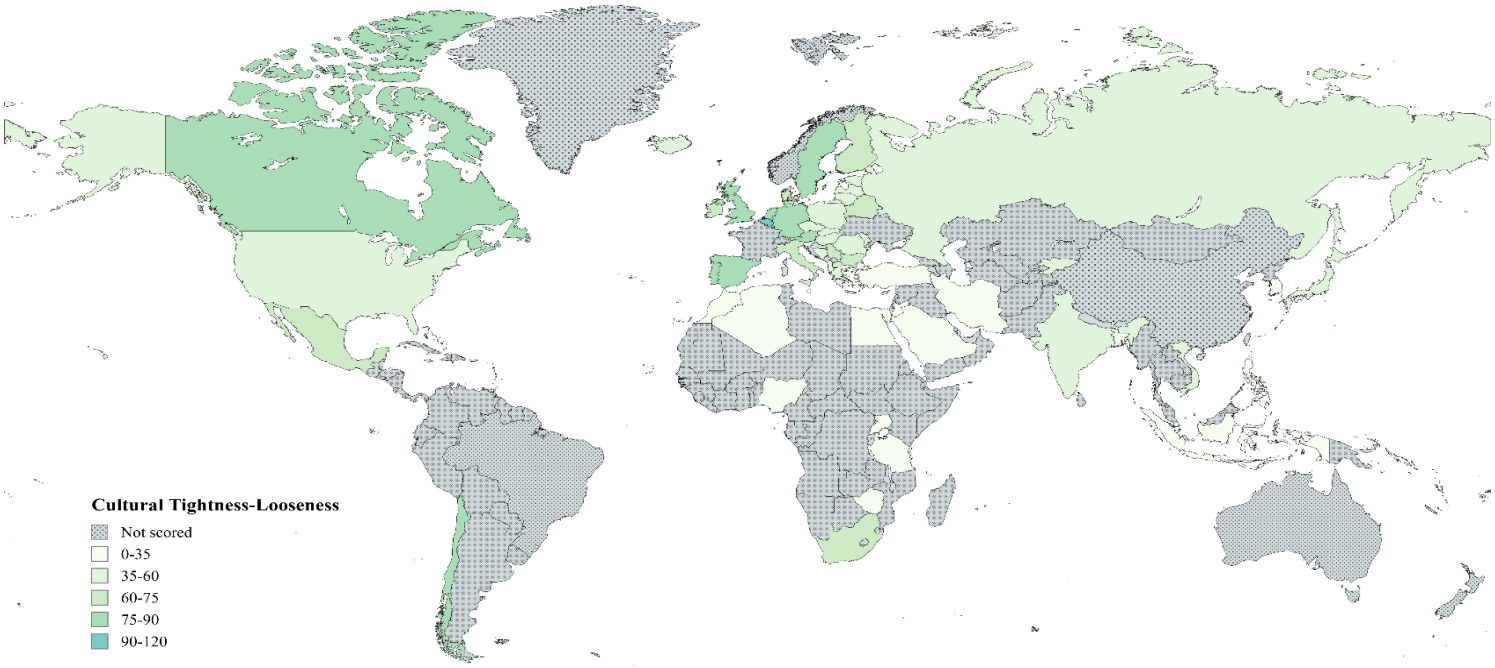

Figure 6: Uz (2014) mapped cultural tightness-looseness scores.

Moreover, Figure 7 depicts the relationship between the countries[2] that have been ranked by both Gelfand et al. (2011) and Uz (2014) in the dataset. As predicted by the theoretical framework, the fitted line has a negative slope. However, this negative relationship is weak and not statistically significant (β = -0.0283, p = 0.181). This outcome comes as no surprise considering the presented descriptive statistics and findings by Deckert and Schomaker (2022).

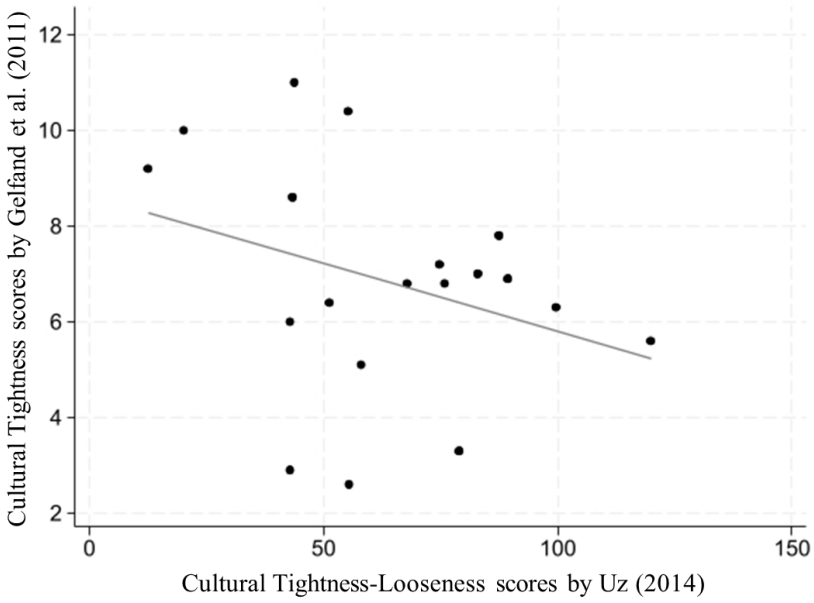

Figure 7: Relation between cultural tightness-looseness rankings.

4.3 Results

Table 4 reports the results of the generalized linear models performed to test the hypotheses. Model 1 is the baseline model including only the control variable. Models 2-4 add the direct effects of the two independent variables to the model, models 5 and 6 include both direct effects and models 7 and 8 add the interaction effect between educational attainment and cultural tightness-looseness. Models 3, 5, and 7 are identical to models 4, 6, and 8 except that the first three include the cultural tightness-looseness ranks by Gelfand et al. (2011), whereas the latter three models include the cultural tightness-looseness ranks by Uz (2014).

Regarding the control variable, results differ from the expectations. Industrial structure was found to be positively related to national innovativeness by both Shane (1993) and Bendapudi et al. (2018). However, in the current study, the control variable is not significant at $p<0.05$ in models 1-8 and therefore cannot be interpreted. This can be explained by the fact that both studies used a different way to measure national innovativeness.

[2] The list of countries included in this study, and their assigned scores, is provided in Appendix B.

***Table 4**: Generalized linear models predicting cultural influence on the relation between education and innovativeness.*

	Model 1			Model 2			Model 3			Model 4			Model 5		
	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p
Variables	*All countries*			*All countries*			*Gelfand et al. (2011)*			*Uz (2014)*			*Gelfand et al. (2011)*		
Industrial Structure	-.007	0.006	0.345	0.002	0.005	0.692	0.002	0.008	0.793	0.002	0.006	0.722	0.011	0.007	0.115
Educational Attainment				0.023	0.004	0.000							0.017	0.005	0.000
Cultural Tightness-Looseness							-.021	0.018	0.251	0.008	0.002	0.000	-.001	0.157	0.933
Edu x CTL															
Constant	43.712	0.100	0.000	22.362	0.134	0.000	52.580	0.129	0.000	24.527	0.163	0.000	25.950	0.216	0.000
N	66			66			27			58			27		
Log Likelihood	-308.27			-306.81			-130.97			-269.17			-130.73		

Model 6			Model 7			Model 8		
Coef.	SE	p	Coef.	SE	p	Coef.	SE	p
Uz (2014)			*Gelfand et al. (2011)*			*Uz (2014)*		
0.002	0.006	0.695	0.008	0.007	0.232	0.001	0.005	0.821
0.020	0.004	0.000	0.015	0.005	0.001	0.019	0.004	0.000
0.004	0.001	0.002	-.004	0.015	0.793	0.004	0.001	0.001
			0.056	0.399	0.158	-.071	0.030	0.018
18.336	0.144	0.000	29.719	0.236	0.000	19.424	0.138	0.000
58			27			58		
-268.37			-130.69			-268.22		

With regard to the educational attainment variable, the effect is highly similar across all models. However, the effect of cultural tightness-looseness largely differs across all models. Here, the usage of tightness scores by Gelfand et al. (2011) or cultural tightness and looseness scores by Uz (2014) makes the difference as evident from models 3-8. With regards to the interaction effect, comparing model 5 with model 7 and model 6 with model 8 reveals that the full model has a superior fit.

Model 2 introduces the direct effect of educational attainment alongside the control variable. The results show significant support for the first hypothesis. Specifically, attaining or completing a Bachelor's degree or equivalent ($\beta = 0.023$, $p = 0.000$) does seem to increase national innovativeness. In terms of effect size, attaining or completing a Bachelor's degree or equivalent appears to have a substantial impact, with a factor of 1.023 (e0.0228206) per one-percentage increase in educational attainment. In other words, a one-percent increase in educational attainment increases national innovativeness by approximately 2.3%. Moreover, models 5 and 6 introduce the concept of educational attainment alongside the control variable and the other direct effects. The results reaffirm support for the first hypothesis. Attaining or completing a Bachelor's degree or equivalent ($\beta = 0.017$, $p = 0.000$; $\beta = 0.020$, $p = 0.000$) appears to significantly increase the innovativeness of a country. In short, the null hypothesis is rejected.

Model 3 introduces the direct effect of tightness scores by Gelfand et al. (2011) on national innovativeness. The results do not show significant support for Hypothesis 2. Scoring higher

on the tightness scale (β = -0.021, p = 0.251) does not seem to have a negative effect on national innovativeness when controlling for the industrial structure of a country. Additionally, model 5 reaffirms that tightness scores (β = -0.001, p = 0.993) do not seem to impact national innovativeness when being introduced alongside educational attainment and the control variable. Hence, there is no evidence to reject the null hypothesis.

Model 4 shows significant support for Hypothesis 3 which predicts that higher cultural tightness-looseness scores of Uz (2014) have a positive effect on national innovativeness. Scoring higher on the cultural tightness-looseness scale (β = 0.008, p= 0.000) seems to have a positive effect on national innovativeness levels. In terms of effect size, being categorized as a looser culture has a substantial impact, with a factor of 1.008 ($e^{0.0075473}$) per one-percentage increase in educational attainment. In other words, a one-unit increase in cultural looseness increases national innovativeness by approximately 0.8%. In addition, when introducing both independent variables alongside the control variable (model 6), these findings are reaffirmed (β = 0.004, p = 0.002). Hence, the null hypothesis is rejected and H3 is supported.

Hypothesis 4 predicted that the higher tightness scores of Gelfand et al. (2011) would negatively interact with the relation between educational attainment and national innovativeness. Model 7 introduces this moderating effect and shows no support for Hypothesis 4. Hence, scoring higher on the tightness scale (β = 0.056, p = 0.158) does not seem to negatively influence the relation between educational attainment and national innovativeness and there is no evidence to reject the null hypothesis. However, it is noteworthy that the direction of the interaction effect is positive, although not significant.

Lastly, Hypothesis 5 predicted that the higher tightness-looseness scores of Uz (2014) would positively interact with the relationship between educational attainment and national innovativeness. Model 8 finds evidence of the opposite. This implies that being a looser culture (β = -0.071, p= 0.018) negatively moderates the relationship between educational attainment and national innovativeness. Hence, the presence of higher levels of cultural looseness weakens the relationship between educational attainment and national innovativeness with a factor of 0.931. Thus, when the interaction term increases by one standardized unit, it dampens the positive effect of educational attainment on national innovativeness by approximately 6.9%. Figure 8 predicts the margins with 95% confidence intervals on the relationship between national innovativeness and educational attainment moderated by cultural tightness-looseness. As can be observed, lower levels of the interaction terms lead to higher predicted margins

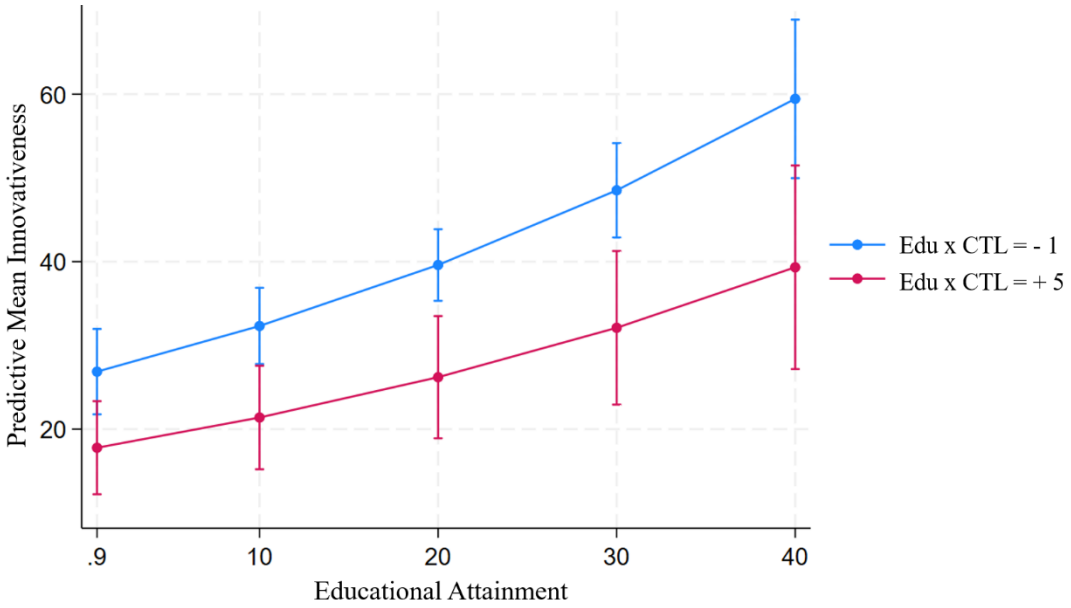

Figure 8: Predictive margins with 95% CIs.

compared to higher levels of the interaction term. Moreover, there is no overlap in the 95% confidence intervals when education levels are between 15 and 35 percent.

Looking at models 7 and 8, results remain unchanged with regard to significance within the full model. All in all, results support Hypothesis 1, Hypothesis 3, and Hypothesis 5, while there is no significant evidence to support Hypothesis 2 and Hypothesis 4. Hence, both hypotheses including tightness scores by Gelfand et al. (2011) are not shown to be significantly different from the null hypotheses, while those including the cultural tightness-looseness scores by Uz (2014) are both accepted.

4.4 Robustness check

To verify the hypothesized effects, two additional models were executed wherein the dependent variable was substituted with an alternative metric of innovativeness. The initial model incorporates the innovation output sub-index of the GII, while the subsequent model utilizes the Innovation Union Scoreboard (IUS)/European Innovation Scoreboard (EIS) rankings. Notably, the majority of the previously reported effects remained significant despite replacing the dependent variable, as depicted in Table 5. However, in model 3, the significant effect between educational attainment and national innovativeness disappeared. This can, however, be attributed to the constrained sample size (n = 14). Therefore, the reported values in model 3 should interpreted with caution. Moreover, the direction of the insignificant results does not change. Specifically, the Gelfand et al. (2011) tightness scores are still negatively related to

national innovativeness and continue to positively moderate the relationship between educational attainment and national innovativeness albeit insignificantly.

***Table 5**: Innovation output sub-index and IUS summary innovation index scores as robustness check.*

	Innovation output Sub-Index score						IUS Summary Innovation Index					
	Model 1			Model 2			Model 3			Model 4		
	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p
Variables	*Gelfand et al. (2011)*			*Uz (2014)*			*Gelfand et al. (2011)*			*Uz (2014)*		
Industrial Structure	0.014	0.009	0.123	0.004	0.008	0.674	-.036	0.020	0.081	0.005	0.008	0.555
Educational Attainment	0.016	0.006	0.009	0.026	0.006	0.000	0.004	0.012	0.763	0.025	0.008	0.002
Cultural Tightness-Looseness	-.008	0.020	0.688	0.006	0.002	0.005	-.020	0.063	0.745	0.011	0.003	0.000
Edu x CTL	0.055	0.052	0.293	-.102	0.045	0.025	0.008	0.228	0.972	-.132	0.067	0.048
Constant	23.296	0.308	0.000	11.905	0.212	0.000	162.52	0.662	0.000	21.605	0.271	0.000
N	27			58			14			32		
Log Likelihood	-126.32			-254.44			-78.17			-174.03		

To account for the nuances inherent in the Global Innovation Index (GII) metrics, regressions were run omitting data points for Belarus, Iran, Uganda, Tanzania, Zimbabwe, and Nigeria. Since these countries were exclusively assessed by Uz (2014), model 8 from Table 4 was re-estimated and presented in Table 6. The results obtained remained consistent, but the observed interaction effect no longer reached the usual levels of statistical significance ($p < 0.05$). Nevertheless, it retained significance at the $p < 0.10$ threshold.

***Table 6**: Results excluding six countries; Belarus, Iran, Uganda, Tanzania, Zimbabwe, and Nigeria.*

	Model 1		
	Coef.	SE	p
Variables	*Uz (2014)*		
Industrial Structure	0.002	0.006	0.669
Educational Attainment	0.016	0.004	0.000
Cultural Tightness-Looseness	0.004	0.001	0.001
Edu x CTL	-.054	0.031	0.076
Constant	20.889	0.149	0.000
N	52		
Log Likelihood	-243.70		

5. Discussion and conclusion

5.1 Discussion

This study aimed to provide insight into the relationship between educational attainment, national innovativeness, and cultural tightness-looseness while taking into account the possible moderating role of cultural dimensions. More specifically, it examined whether cultural tightness and looseness influence the association between educational attainment and national

innovativeness, thereby contributing to a more thorough understanding of how cultural factors shape national-level innovation dynamics.

An important departing point of this study was to find evidence of a relationship between educational attainment and innovation at the national level in the dataset. The findings support Hypothesis 1 and confirm the findings of Barro and Lee (2013), Damanpour (1991), and Taylor (2016), among others. Education attainment has a positive influence on national innovativeness, specific to this study, within countries ranked by cultural tightness and looseness. This is in line with what the theory suggests. Formal education systems enable individuals to acquire technical skills, problem-solving abilities, and critical thinking skills that are essential for generating new ideas, technologies, and processes (Carlsson et al., 2009). This educational effect affects both the supply side, through direct inputs from workers (Taylor, 2016) and synergistic growth (Autor et al.,1998), and the demand side, through consumer demand (Von Hippel, 1988). This effect was also confirmed in both robustness checks.

Analyzing these effects on national innovativeness further, this study hypothesized that these will be augmented in such cases when the referent country is considered to have a loose culture, as opposed to a tight culture. Based on the literature, a distinction was made between two rankings; the tightness scores of Gelfand et al. (2011) and the cultural tightness-looseness scores of Uz (2014). As theorized, this study found that the tightness-looseness scores of Uz (2014) were significantly related to national innovativeness, supporting Hypothesis 3. However, in line with Deckert and Schomaker (2022), there was no significant relationship with national innovativeness when using the scores of Gelfand et al. (2011), contradicting Hypothesis 2. This discrepancy can be explained by several differences in the methodology used to construct the cultural ranks. First, Gelfand et al. (2011) use primary data by asking individuals about their perception of tightness in their society, while Uz (2014) uses secondary data and indirectly infers the tightness of a country. Moreover, the sample used by Gelfand et al. (2011) consists only of the urban population, while the sample used by Uz (2014) is based on country characteristics. Second, Gelfand et al. (2011) use a measure of central tendencies. As a result, they are unable to measure the spread of norms, indicating greater diversity and thus cultural looseness. Uz (2014) addresses this problem by using a measure of dispersion. Third, while Gelfand et al. (2011) ask questions about tolerance for norms in general, Uz (2014) also incorporates questions about tolerance in specific situations. As a result, Uz (2014) is able to capture the inconsistency between general norms that people adhere to and specific norms that people apply. In short, cultural looseness is positively related to national innovativeness when

measured as a spread of norms – as evidenced by Uz's (2014) ranks. Diversity in the levels of specific tolerance among individuals is thus conducive to innovativeness by exposing people to different viewpoints.

Although the analysis using the tightness scores of Gelfand et al. (2011) did not yield significant results, this study was able to improve on Deckert and Schomaker's (2022) model. Controlling for industrial structure, as proposed by Shane (1993), increased the significance of the relationship between cultural tightness-looseness and national innovativeness when using either the GII, the GII output subindex, or the EIS as the measure of innovativeness. The inclusion of this control variable highlights the importance of the economic environment when discussing innovativeness. In addition, it also provides an opportunity for future research to further explore possible control variables. In doing so, it might be worthwhile to look at the differences in the methodologies mentioned in the previous paragraph and account for them.

Moreover, this study hypothesized about the impact that cultural tightness-looseness could play in amplifying the effect of educational attainment on national innovativeness in Hypothesis 4 and Hypothesis 5. It was theorized that being characterized by cultural looseness would strengthen this relationship. In line with the main effect, this study found a significant interaction between the tightness-looseness scores of Uz (2014) and educational attainment, while there was no significant moderating effect when using the scores of Gelfand et al. (2011). However, contrary to the expectations, being characterized as a loose society did not have the anticipated positive effect; instead, it exhibited a negative interaction effect. This unexpected result suggests that higher scores on either interaction variable would decrease the effectiveness of educational attainment by approximately 6.9%, or with a factor of 0.931.

A positive interaction was expected because a society characterized as loose allows more tolerance for deviant behavior (Gelfand et al., 2011), encourages individuals to follow their internal guiding principles, and fosters an environment where innovative ideas can prosper without the constraints of strict social norms (Tam & Chan, 2017). This environment enables individuals with higher levels of education to more effectively apply their knowledge and skills in innovative ways, thereby increasing the national capacity for innovativeness. Yet, it turns out that the higher tolerance and weaker social norms have a negative impact on the relation between educational attainment and national innovativeness. Gelfand et al. (2006) examined the relationship between societal culture and accountability at the individual level and concluded that individuals in a tight society have a greater preference for the cognitive styles of adaptors, as opposed to the cognitive styles of innovators. Adaptors employ established

procedures for deriving solutions to problems and are characterized as reliable, cautious, efficient, and disciplined (Kirton, 1976), while innovators challenge established processes for deriving solutions to problems and are characterized as being original and risk-seeking, as well as undisciplined, impractical and disrespectful of habits (Kirton et al., 1991). This implies that individuals in tight societies prefer incremental improvements, whereas individuals in loose societies can sometimes overemphasize the need for novelty and radical improvements (Gelfand et al., 2006). Considering the educational background of individuals in a society, it is evident that education is often more aligned with enhancing existing systems. Hence, the approach used by adapters, typically in tight societies, fits well with educational attainment, which results in a positive interaction effect. On the other hand, the focus on radical innovation leads to a misalignment between an individual's educational expertise and the practical application of their knowledge. More specifically, although innovators are creative and original, they may still struggle because their cognitive style results in fragmented efforts by individuals and lacks practical implementation. Instead of focusing on incremental improvements, many different and uncoordinated radical improvements are pursued simultaneously because of the high tolerance for deviant behavior and weaker social norms in loose societies. While people devote educational experience to these radical improvements, many of them are not feasible or sustainable in the long run. This leads to a negative moderation effect. In short, strong social norms and a low tolerance for deviant behavior in tight societies result in coordinated efforts and practical implementation of incremental ideas, enhancing the positive impact of educational attainment on national innovativeness. On the contrary, weak social norms and a high tolerance for deviant behavior in loose societies result in fragmented and uncoordinated efforts, diminishing the positive of educational attainment has on national innovativeness.

Overall, the findings provide evidence for the diverse drivers of national innovativeness. This is an important condition for a more comprehensive understanding of innovativeness at the national level (Yeganeh, 2023). The study integrates insights from multiple theoretical perspectives and is among the first that studies the effect of cultural tightness-looseness on innovativeness, both directly and indirectly. The findings show that innovativeness is indeed influenced by a diverse set of factors, including cultural traits as well as social characteristics. However, the results also show that culture is complex and not always comparable, even when measures attempt to capture the same concept.

5.2 Limitations

This study involves many conceptual and operational limitations and intricacies that future research could address. First, the empirical analysis highlights the positive effect of cultural looseness on national innovativeness. Yet some eastern cultures, namely South Korea, Singapore, Japan, and China, characterized by opposing cultural values, have demonstrated remarkable advances in national innovativeness in recent decades (Barreto et al., 2022). These exceptional cases do not invalidate the theoretical framework but instead emphasize the complexity of innovativeness and the need for further theoretical refinement. Second, this study assumes that the inheritance of cultural tightness-looseness is valid as a country-level construct. This implies that similar levels of tightness and looseness are inherited by members of a country. However, the cultural values of individuals within a country may vary due to immigration and individual heterogeneity. Nevertheless, Hong et al. (2016) note that the inheritance of cultural values is true for the majority of a country's inhabitants because such values are embraced by that society. Third, the variables used in this study, innovativeness, and educational attainment, are culture-specific and may have different meanings worldwide. As such, current methodologies and instruments used to measure these concepts are constrained in their scope and precision. Fourth, only cross-sectional data are available, making it difficult to detect causality. However, Deckert and Schomaker (2022) noted that the relationship between culture and innovativeness is causal by nature. Finally, this study covered only 58 countries. This limited sample size may not be able to fully reflect the diversity of socioeconomic, cultural, and political contexts in different regions of the globe. Therefore, it is questionable whether the results are robust and generalizable.

5.3 Implications

5.3.1 Academic implications

This research has made contributions to the fields of innovation and culture. To reflect on the contributions and expand on them, some areas for future research are suggested while taking into account the aforementioned limitations. First, to test any of the cultural tightness-looseness relations more accurately, it might be useful to employ a lower-level sample in which organizations rather than countries are utilized as a variable. It might be that cultural norms are not similar between organizations within a given country and therefore might offer a more nuanced look into the effect of cultural norms on innovativeness. Moreover, this would enable research to use larger samples, which would improve the robustness and generalizability of the results. Second, this study has proposed an explanation for the negative interaction effect

between cultural looseness and educational attainment. Future research can further investigate the interaction effect and try to find the underlying mechanism that explains the negative effect. Third, to overcome the challenge of detecting causality, future research could use longitudinal data to empirically investigate the direction of causality. An alternative way to solve this problem would be using instrumental variables that do not directly impact national innovativeness. Fifth, this study aimed at improving the results of Deckert and Schomaker (2022) with respect to the effect of the tightness scores by Gelfand et al. (2011) on national innovativeness by controlling for the industrial structure of a country. Unfortunately, the relation remained insignificant. Further exploration of this relationship, along with introducing additional control variables, could potentially yield significant results. Lastly, it was beyond the scope of this thesis to address the other drivers of national innovativeness that have been discusses in research. Yet, these drivers might be very insightful. Future research could expand the current model by including these drivers and looking for the interaction with cultural tightness and looseness. For example, Park (2008) found strong property rights to incentivize companies to invest in research and development. Yet, it might be the case that tight societies, compared to looser societies, are more likely to adhere to intellectual property rights and therefore offer more security to innovators.

5.3.2 Practical implications

This study offers some relevant insights for practitioners and managers. The findings of this study highlight the impact of diversity of teams on national innovativeness. More specifically, heterogeneous societies, characterized by tolerance for deviant behavior and weak social norms, turn out to be more innovative compared to homogeneous societies, characterized by lower tolerance for deviant behavior and strong social norms. While proven that diversity can lead to more conflict (Montalvo & Reynal-Querol, 2005), it can also enhance creative problem-solving when managed in a constructive way (Paulus et al., 2016). Hence, managers should take these differences into account in several ways. First, managers should recognize the influence of culture on employees' innovativeness. In tight societies, encouraging employees to take slightly more risks and to challenge the existing way of doing things can be beneficial for innovativeness, whereas, in looser societies, creating some structure and coordination can enhance the effectiveness of innovative efforts by employees. Here, Gelfand et al. (2006) note that it is essential to make employees feel more accountable in loose societies, and less accountable in tight societies, to change individuals' behavior. Second, managers need to understand the strengths of employees in different societies. By focusing on incremental

improvements in tight societies and more radical solutions in loose societies, organizations can leverage the strengths of their employees more effectively. Moreover, multinational organizations can benefit from cross-cultural teams by combining the strengths of tight and loose cultures.

A similar line of argumentation goes for the implications for educational institutions. Gelfand et al. (2017) noted that from a young age people in tight societies are being socialized to adapt their behavior to fit social institutions. So when choosing a course of action, individuals rely on the technical skills that they learned while attaining their degree. Hence, to boost creativity among employees in tight societies, both innovative and adaptive cognitive styles should be promoted. Therefore, educational institutions should foster abilities such as critical thinking, creativity, and risk-taking alongside technical skills. Similarly, educational institutions in loose societies should also teach about structured project management and implementation skills. In short, curricula should be aligned with the innovation needs of society.

Lastly, investors should recognize cultural differences before making a foreign direct investment. As evidenced by the exceptional cases of some Eastern cultures, there is no need to invest only in societies characterized by cultural tightness or looseness. However, it is important to understand the different needs of the two types of societies to truly stimulate innovation capacity. Therefore, cross-cultural investment requires a nuanced approach where different cultural norms require different actions. For example, when investing in a loose society, it is essential to align the interests of both parties to avoid fragmented and uncoordinated efforts.

5.4 Conclusion

Although several studies have analyzed the relationship between cultural dimensions and drivers of innovation, this study is one of the first to look at the impact of cultural tightness-looseness on aspects of innovativeness. This study attempts to model national innovativeness and understand the direction of different drivers, and the interaction between them. Both educational attainment and cultural looseness turn out to be significant drivers of national innovativeness. More specifically, the findings show that broader diversity in social norms, which is a characteristic of looser societies, correlated positively with national innovativeness. However, this diversity also undermines the positive impact of educational expertise on national innovativeness through fragmented and uncoordinated efforts by individuals. Conversely, tighter cultures enhance the positive effect of education by promoting coordinated and practical implementation of ideas. Hence, the effectiveness of educational attainment on national innovativeness largely depends on the cultural context. All in all, the findings advance the

existing literature by showcasing how cultural factors can affect the effectiveness of drivers of national innovativeness, while also having valuable implications for practitioners by stressing the need to consider cultural dimensions when promoting innovation.

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Appendix A: Disclosure of the use of AI tools

While writing this thesis, AI tools were used during different stages of the process. These tools were only utilized to finetune my own work, rather than do my work. Below are example queries.

Tool	Range of access	URL	Query
ChatGPT	20/05/24 - 25/05/24	https://chatgpt.com/	I intend to run a GLM model with a log link in **Stata**. However, I do not understand the differences between the types of family options. Can you explain them to me?
	25/03/24 - 15/05/24	https://chatgpt.com/	How can I ideally **structure** a chapter discussing X?
DeepL	25/03/24 - 10/06/24	https://www.deepl.com/	Translate the following English paragraph X to Dutch, and then use **back translation**.

Appendix B: Countries and Scores

Country	Gelfand et al. (2011)	Uz (2014)	Country	Gelfand et al. (2011)	Uz (2014)
Albania		37.2	Latvia		42.7
Algeria		19.2	Lithuania		54.4
Australia	4.4		Luxembourg		113.9
Austria	6.8	75.8	Malaysia	11.8	
Bangladesh		6.6	Malta		28.1
Belarus		60.5	Mexico	7.2	74.7
Belgium	5.6	119.8	Moldova		41.9
Bosnia and Herzegovina		51.9	Netherlands	3.3	78.9
Brazil	3.5		New Zealand	3.9	
Bulgaria		60.4	Nigeria		17.9
Canada		84.6	North Macedonia		64.3
Chile		86.8	Norway	9.5	
China	7.9		Pakistan	12.3	
Czech Republic		59.6	Philippines		31.5
Denmark		65.5	Poland	6	42.8
Egypt		3.9	Portugal	7.8	87.4
Estonia	2.6	55.4	Romania		42.4
Finland		74.5	Russian Federation		57.2
France	6.3	99.6	Saudi Arabia		22.4
Germany	7	82.9	Serbia		61.8
Great Brittain	6.9	89.3	Singapore	10.4	55.2
Greece		58.3	Slovakia		59
Hungary	2.9	42.8	Slovenia		55.1
Iceland	6.4	51.2	South Africa		67.6
India	11	43.7	South Korea	10	20.1
Indonesia		3.1	Spain		83.9
Iran		31.5	Sweden		87.9
Ireland		71.2	Tanzania		31.6
Israel	3.1		Turkiye	9.2	12.5
Italy	6.8	67.8	USA	5.1	58
Japan	8.6	43.4	Uganda		34.7
Jordan		5.1	Vietnam		35.9
Kyrgyzstan		52.6	Zimbabwe		30.4