Does LGBT inclusion promote national innovative capacity?

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Abstract

This paper empirically investigates the extent to which the social inclusion of lesbian, gay, bisexual and transgender (LGBT) people matters for technological innovation. The central hypothesis, in particular, postulates that the acceptability of LGBT individuals helps foster human capital skills, thus strengthening innovation. The reverse holds true in societies where significant discrimination against homosexuality prevails. To test this proposition, I perform empirical analysis using data for a world sample of countries. The results indicate that social tolerance toward homosexuality is positively correlated with the economic complexity index, a novel measure of innovation. To achieve causal inference, I conduct several falsification exercises, none of which alters the baseline findings. Further, individual-level analysis, based on data from the World Values Survey, lends strong credence to the international evidence. I also find that LBGT inclusion exerts a positive influence on human capital skills, which is a potential mechanism explaining the baseline findings.

JEL Classification: J71, O35, O40, Z13

Key words: LGBT, innovation, economic complexity, gender discrimination.

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1. Introduction

The existence of large and persistent disparities in economic prosperity across the world remains one of the most perplexing issues facing economists. Some early contributions to this line of inquiry hold that the exclusion of women and/or marginalized groups within a society matters for international differences in income levels. In particular, there exists a strong consensus in this literature that gender discrepancies in various dimensions of empowerment and well-being, particularly education, health and employment opportunities, exert a negative influence on economic growth and development (e.g., Hill & King, 1995; Knowles et al., 2002; Lagerlöf, 2003; Klasen & Lamanna, 2009; Duflo, 2012). Recently, Badgett et al. (2019) postulate that the social inclusion of lesbian, gay, bisexual, and transgender (LGBT) people positively affects income per capita. The empirical analysis is mainly based on using an internationally comparable index of LGBT inclusion that reflects legal rights and protections afforded to LGBT individuals across 132 countries (Badgett et al., 2019).

Much of the existing literature has focused on estimating the effect of gender differences in different aspects of well-being on the worldwide distribution of income levels. By contrast, the extent to which the social exclusion of homosexual people matters for economic performance is still open to question. Badgett et al. (2019), to the best of my knowledge, is the only study investigating the relationship between discrimination against the LGBT community and comparative development across the globe. The interest of their paper, however, lies exclusively in the effect of the acceptability of homosexuality on income per capita. Unfortunately, little is known about the mechanisms through which the social exclusion of LGBT people helps shape global income inequality.[1] If innovation, as proposed by this research, is a key channel through which homosexuality-supportive policies transmit to economic growth, we need to understand this reduced-form link. To speak to those debates, the current study attempts to examine the effect of the social inclusion of LGBT people on technological innovation based on cross-country and individual-level analyses.

The empirical exercises of this paper are further motivated by three main arguments. *First*, there has been significant progress in the acceptability of homosexuality in many Western societies. By contrast, substantial discrimination against LGBT people remains

[1] The empirical evidence of Badgett et al. (2019) is mainly drawn from estimating cross-country OLS regressions in which the dependent variable is GDP per capita. For this reason, this paper leaves it open to debate whether the social inclusion of LGBT people helps promote innovative activities, which are key ingredients of economic growth and development. Badgett et al. (2019) also argue that LGBT inclusion affects growth via human capital. The authors, however, provide no empirical evidence supporting this transmission mechanism.

widespread in much of the developing world (Figure 1). Specifically, homosexual behaviours are still illegal and may result in severe punishments, including the death penalty, in many parts of Asia, Africa and the Middle East (Bailey et al., 2016). *Second*, the third Millennium Development Goal emphasizes the importance of espousing equality in gender roles (UN, 2011). Therefore, reducing discrimination against LGBT people is essential for achieving this goal. Further, the extent to which we can create an LGBT-supportive environment across the world arguably depends on our understanding about the contribution to economic performance of the social inclusion of homosexual people. This paper puts forward the idea that promoting human rights and protections of the LGBT community helps spur technological innovation and economic growth. If my prediction is true, the findings of this study at least partially advocate the social inclusion of LGBT people, particularly in developing economies where homophobia prevails. *Third*, technological innovation is widely perceived as a key driver of productivity improvements and economic prosperity (Solow, 1957). There also exists an unequal distribution of innovation levels across the globe (Figure 2). This necessitates exploring the institutional and social environment that nurtures innovative activities.[2]

The main objective of this paper is to explore the link between the acceptability of LGBT people and cross-country differences in innovative activities. I posit that reducing discrimination against homosexual behaviours enhances human capital skills, thus strengthening innovative activities. Further, creating an LGBT-friendly environment would attract inflows of human capital because it signals the acceptance of diversity, creativity and open-mindedness. It follows from this line of reasoning that improvements in the social tolerance toward LGBT people can contribute to prosperity through bolstering innovation. The proposed hypothesis is tested by performing the empirical analysis at both the macro- and micro-level. I first use the LGBT inclusion index of Badgett et al. (2019) to estimate cross-country OLS regressions. The findings are broadly consistent with my propositions. A number of sensitivity tests are conducted to provide a basis for causal inference. I further carry out an individual-level analysis based on data from the World Values Survey. The results demonstrate that the acceptability of homosexuality is positively correlated with respondents' attitudes

[2] Understanding the drivers of innovation is particularly important given the efforts of the government to spur technological progress in many countries all over the world. For instance, recent experience of robust economic growth observed in several Asian economies, including China, was largely induced by technological adoption and imitation, along with large savings and investments (Liang, 2010). Thus, the transformation toward innovation-led growth plays an important role in eliminating large and persistent discrepancies in income per capita across the globe. To the extent that LGBT-supportive policies exert an influence in the innovation process, my findings help enrich our understanding of the perennial question about comparative development across the world.

toward science and technology, and new ideas, creativity, taking risks, adventure and changes. This is largely in line with the cross-country evidence. I also find that LGBT inclusion affects innovation by reinforcing human capital skills.

The approach adopted within this research offers a fresh perspective to the following strands of research. Specifically, this paper builds upon the literature investigating the economic impacts of wide discrepancies in gender roles throughout the world (e.g., Klasen, 2002; Knowles et al., 2002; Lagerlöf, 2003; Klasen & Lamanna, 2009; Duflo, 2012). I add evidence to this debate that the social exclusion of marginalized groups of a population, particularly LGBT people, exerts a positive influence on national innovative capacity – a key determinant of economic growth. Furthermore, this research directly relates to several studies documenting a relationship between discrimination against LGBT people and firm performance (see, for instance, Button, 2001; Griffith & Hebl, 2002; Tejeda, 2006; Brenner et al., 2010; Wang & Schwarz, 2010; Pichler et al., 2018). Specifically, discrimination against homosexual people at the work place is associated with significantly lower levels of job satisfaction and organizational commitment among LGBT employees. By contrast, LGBT-supportive policies in the work environment reduce job anxiety among gay and lesbian employees. These factors are ultimately conducive to firm productivity.

The present research is also in line with various studies demonstrating that the acceptability of homosexuality matters for regional development (Mokyr, 1990; Florida, 2002, 2003; Noland, 2005; Florida et al., 2008). A strong consensus shared among these studies is that social tolerance toward homosexuality signals low barriers to entry of human capital. It also creates an environment that supports diversity and creativity. As demonstrated below, innovators are generally unconventional people, so any discrimination toward these individuals deters innovative activities. My study, however, departs from these papers in two dimensions. First, previous studies focus on discrimination against homosexuality at the work place and firm performance, while I pay a special attention to the broad social inclusion of LBGT people within a society and national innovative capacity. Therefore, the findings drawn from this paper are based on estimating a world sample of countries instead of firm-level evidence. Second, the empirical analysis of earlier studies is largely based on differences across regions within a country, particularly the US. This is mainly attributable to the difficulty of measuring the social inclusion of LGBT people across the world. While their analyses advance our understanding about discrimination against homosexuality and economic development in a specific country, the evidence cannot be generalized to obtain an overall understanding of the relationship between LGBT inclusion and prosperity across countries.

A final distinguishing feature of the current study stems from adopting the economic complexity index as a new measure of innovative capacity. As presented in Section 3, this proxy for innovation helps address several concerns regarding conventional innovation metrics that economist have typically used. By doing this, I directly contribute to an emerging line of research examining economic complexity as a driver of economic growth and development across countries (e.g., Hausmann et al., 2007; Hidalgo & Hausmann, 2009; Felipe et al., 2012; Hausmann et al., 2014; Hartmann et al., 2017; Lee & Vu, 2019).[3] Importantly, very few studies pay attention to the social and institutional environment that shapes the level of economic complexity.[4] My study, by contrast, reveals that reducing the social exclusion of LGBT people plays a key role in affecting economic complexity.

The rest of this study proceeds as follows. Section 2 provides a theoretical perspective. Section 3 discusses problems associated with conventional innovation metrics and the motivation for using economic complexity as a new measure of innovation. Section 4 presents estimation strategies, followed by a discussion of the cross-country evidence in Section 5. Next, I report individual-level evidence and a mechanism analysis in Sections 6 and 7, respectively. The main findings are summarized in Section 8.

2. The economic argument

The central hypothesis of this paper rests upon the premise that the social inclusion of LGBT people helps promote innovative capabilities through enhancing human capital skills. A conventional wisdom shared among development economists holds that human capital is a key conduit of national innovative capacity, which critically affects productivity and income differences across the globe (see, for instance, Nelson & Phelps, 1966; Murphy et al., 1991; Gennaioli et al., 2012). It follows from this line of reasoning that countries endowed with better human capital tend to innovate more, because technological innovation arguably has its roots from people's curiosity, imagination, risk-taking and cooperation. By this logic, the social

[3] More details about this indicator will be presented later.

[4] The determinants of economic complexity have recently gained interests among economists (Sweet & Maggio, 2015; Bahar et al., 2019; Vu, 2019). I differ from these studies by focusing on the social inclusion of LGBT people, an issue that remains largely unexplored so far.

inclusion of LGBT people promotes innovative activities by accelerating a country's pool of knowledge and skills as presented below.[5]

Social tolerance toward LGBT people would allow them to accumulate education, and helps improve their health outcomes, income and employment opportunities. I argue that this is conducive to enhancement of the quality of human capital of the entire economy. By contrast, discrimination against the LGBT community could be detrimental to human capital, thus hindering innovation.[6] The basic explanation for this holds that the exclusion of the LGBT community may force them to drop out of school, thus hindering educational attainment.[7] Further, people facing any discrimination in employment opportunities may end up with unproductive occupations or even become unemployed (see, for instance, Bergmann, 1971).[8] In general, the positive effect of the social inclusion of LGBT people on innovation parallels conventional arguments that gender differences in education, health and labour market opportunities are impediments to human capital accumulation and economic growth (see, e.g., Klasen, 2002; Knowles et al., 2002; Berik et al., 2009; Klasen & Lamanna, 2009).

According to an early view proposed by Mokyr (1990), diversity and tolerance constitute the fundamental drivers of the innovation process. Innovative activities, in particular, tend to proliferate in places with less discrimination against nonconformists. The main intuition is that technological advances critically depend on the social acceptability of unconventional people because innovators are mostly eccentric individuals (Mokyr, 1990). Therefore, social tolerance afforded to homosexual people spurs creativity, knowledge, skills and innovation. There also exists ample empirical evidence supporting the argument that the social inclusion of LGBT people fosters technological change and economic outcomes. Florida (2002), for instance, documents a positive link between the share of bohemians and the quality of human capital

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[5] A more detailed discussion of the theoretical connections between the social inclusion of LGBT people and economic performance is provided by Badgett et al. (2019).

[6] It is widely acknowledged in the epidemiological literature that non-heterosexual people face significantly poorer health compared with heterosexual counterparts (e.g., Meyer, 1995, 2003; Hipple et al., 2011). This arguably reduces productivity of LGBT people and increase the social cost, which is ultimately detrimental for a country's technological innovation.

[7] There exists ample empirical evidence postulating that discrimination against homosexuality negatively affects educational attainment in many countries, mostly based on micro-level studies (see, for instance Khan et al., 2005; Kosciw et al., 2013).

[8] Many studies find that non-heterosexual people are discriminated at the work place and in the labour market. The employment discrimination, for instance, includes wage disparities (Klawitter, 2015) and less chances of being invited for first-round interview (Tilcsik, 2011; Ahmed et al., 2013; Drydakis, 2015; Mishel, 2016). These disparities in employment opportunities may result in LGBT people working in less productive sectors or even becoming unemployed. For this reason, the national innovative capacity is negatively affected.

across regions in the US. Thus, the social tolerance toward marginalized individuals, including homosexual people, acts as a catalyst for technological-based industries. Consistent with this finding, Florida et al. (2008) indicate that the social inclusion of gays and lesbians is conducive to human capital skills and regional development in the US.

The positive link between LGBT inclusion and innovation is also based on the findings of a number of studies demonstrating that treating these marginalized individuals equally at the work place results in better firm performance (see, e.g., Griffith & Hebl, 2002; Tejeda, 2006; Wang & Schwarz, 2010; Pichler et al., 2018). This viewpoint, in particular, asserts that reducing any discrimination against LGBT people in the work environment could nurture business outcomes because it helps improve productivity of these workers. Furthermore, LGBT-friendly policies implemented at the firm level would reduce the negative consequences associated with any discrimination against homosexuality, such as health care and absenteeism costs (Badgett et al., 2019). According to Button (2001), equal treatment in the work place would benefit LGBT employees by improving their mental health and enhance their commitment to companies.

Griffith and Hebl (2002) also find that LGBT-supportive policies are associated with lower levels of job anxiety and help improve job satisfaction among gay and lesbian employees. Consequently, non-discrimination toward homosexuality enhances firm productivity. Additionally, the inclusion of the LGBT community plays an important role in strengthening the relationship between these marginalized groups and their co-workers and employers (Brenner et al., 2010). This is particularly essential for technology-intensive industries that typically require coordination in the work place. Additionally, better cooperation at the firm level may arguably enhance the utilization of the existing human capital and bolster innovative capabilities. Importantly, firm productivity is an important determinant of national productivity and innovation. For this reason, if reducing discrimination against homosexual people fosters firm performance, such policies would arguably strengthen national innovative capacity.

Another argument for why an LGBT-friendly environment matters for national innovative capacity lies in the assertion that the acceptability of homosexuality signals low barriers to entry of human capital. The main intuition behind this proposition is that places with greater social diversity and tolerance are more likely to attract inflows of talents (Florida, 2003). For this reason, social inclusion of the LGBT community creates an open business environment that nurtures diversity and creativity, which is of great importance for immigration and national innovative capacity (Florida, 2003; Badgett et al., 2019).[9] This is particularly relevant for the development of technology-intensive industries and economic prosperity when examining the effect of LGBT inclusion on innovation from a cross-country framework. Noland (2005), for instance, demonstrates that the social tolerance of homosexuality exerts a statistically and economically significant influence on foreign direct investment even after controlling for a wide range of FDI determinants. Therefore, I argue that innovative activities proliferate in countries with better inclusiveness of the LGBT community.

3. Measuring national innovative capacity

3.1. Problems with existing innovation metrics

A key challenge in innovation-related research is to measure national innovative capacity across the world in a consistent manner. Conventional proxies for technological innovation include the number of patents and R&D expenditure as a proportion of GDP, to name but a few. Some concerns about measurement bias induced by using these indicators have been well documented (e.g., Varsakelis, 2001; Duguet & MacGarvie, 2005; Hong et al., 2012; Sweet & Maggio, 2015; Fernandez Donoso, 2017). Nevertheless, these innovation metrics remain widely adopted in a number of papers, arguably due to their convenience of measurement and worldwide comparison (Hong et al., 2012).

Economists, in particular, have typically made use of R&D expenditure as an input-based measure of innovative capabilities, beginning in the late 1950s (Fernandez Donoso, 2017). The main advantage of using this index is that it reflects firms' effort to focus on innovative activities, which is an important driver of technological innovation and productivity growth (Varsakelis, 2001). Another merit of this indicator lies in the ease of international comparison because data have been consistently recorded across countries since the 1950s. However, the extent to which R&D spending translates into real innovative capacity critically depends on the institutional environment that shapes the efficiency of utilizing this input (Kleinknecht et al., 2002; Sweet & Maggio, 2015).

By the above logic, we can hardly infer anything about the output side of the innovation process from R&D expenditure (e.g., commercially oriented innovation such as the introduction of new products, services or processes). Importantly, this measure underestimates true innovative capacity in small- and medium-sized firms and low-income countries because

[9] This argument suggests that fostering the social inclusion of the LGBT community can be a potential instrument for a country to attract immigration and investments to improve its technological capacity.

firm size and income levels determine how effectively R&D resources are used in the innovation process (Kleinknecht et al., 2002). Furthermore, designing R&D survey questionnaires is generally skewed toward large-scale conglomerates, thereby missing much information about technological innovation of small firms.[10] Meanwhile, data obtained in low-income economies are criticized for being scattered and inconsistent (Sweet & Maggio, 2015).

An alternative metric, namely the number of patents granted, has been popularly used as an (intermediate) output-based indicator of innovative capabilities. This measure has a comprehensive coverage of both countries and years. Yet it is still subject to severe measurement issues, particularly in low- and middle-income countries that are typically technologically backward. Part of the reason is that a "culture of patenting" is much less common in poor countries than in the US and other western societies (Sweet & Maggio, 2015). This poses a challenge for studies examining the determinants of innovation from a cross-country perspective (Varsakelis, 2001). Needless to say, measurement bias may provide an invalid basis for causal inference.

Furthermore, in some cases, technological progress takes places in the form of non-patented or unpatented inventions (Kleinknecht et al., 2002). In this regard, the number of patents appears to be an imperfect proxy for innovation when it comes to measuring technological advances that are concealed from the patent system. It is also important to note that innovation is defined as an incremental process, obtained via the accumulation of both tangible (explicit) and intangible (tacit) knowledge (Nelson, 2005). The number of patents reflects only the "explicit" side of innovation but it says nothing about "tacit" knowledge (Nelson, 2005; Sweet & Maggio, 2015). Moreover, some patents are never translated into commercially valuable products, and they may be largely irrelevant for economic prosperity.[11] Thus, counting the number of patents reflects inventions rather than the national innovative capacity per se. It follows from these arguments that using conventional measures of innovation may be subject to measurement bias.

3.2. Economic complexity index – a novel measure of innovation

[10] More specifically, Kleinknecht et al. (2002) demonstrate that R&D survey questionnaires are much more confusing for small firms than for large-scale firms. This is attributable to the fact that R&D spending is typically not well organized in small firms, making the nature of R&D expenditure questions more perplexing in these firms (e.g., the difference between applied and basic R&D, and sources of funding).

[11] Duguet and MacGarvie (2005) employ patent citations to quantify the cross-country variation in innovative capacity. Using this index, however, does not help address some well-known concerns about the patent-based measure of innovation mentioned above.

The above discussion suggests that the choice of innovation metrics is non-trivial. The criticism of traditional innovation measures holds that the estimated effect of LGBT inclusion on technological innovation can be biased and inconsistent if R&D spending or the number of patents are only weakly correlated with national innovative capacity. Motivated by this potential measurement bias, this paper endeavours to capture cross-country differences in innovation by using the economic complexity index (ECI). Below, I argue that this measure helps address several measurement issues of conventional innovation metrics.

Innovative activities generally take place in the form of creating new products, services, and processes (Hong et al., 2012). This allows an economy to foster productivity growth, thus achieving a higher level of income (Grossman & Helpman, 1991; Coe & Helpman, 1995). Therefore, the national innovative capacity critically hinges on the stock of "*tacit*" and "*explicit*" knowledge available within a country. For this reason, innovation can be directly inferred from the availability of productive capabilities embedded in an economy and its ability to assimilate and exploit existing knowledge. Incorporating this idea in a quantitative indicator, Hidalgo and Hausmann (2009) develop the ECI index in which the accumulation of productive knowledge is attributable to the type of products a country can produce and export with revealed comparative advantage.

As scholars struggle to capture tacit (intangible) knowledge, which constitutes part of the innovation process, the novelty of the ECI index lies in its exploitation of information on the type of products made by an economy. Specifically, Hidalgo and Hausmann (2009) formalize this idea by using two concepts to quantify the level of economic complexity across countries, including "*diversity*" and "*ubiquity*". First, ***diversity*** captures the number of products a country can produce. The central idea holds that a country is endowed with a larger set of productive knowledge if it can make a diverse range of products. Moreover, product diversification arguably reflects the ability to assimilate and utilize innovative capabilities to create commercially valuable products, which is relevant for technological progress and economic growth. This measurement method attempts to incorporate tacit knowledge and transferable skills of production, which are difficult to capture by conventional innovation metrics. Importantly, innovation does not merely encompass inventions, as reflected by the number of patents. The ECI index, by contrast, reflects the extent to which a country can utilize the creation of knowledge in production, which is particularly important for economic prosperity.

Second, ***ubiquity*** reflects product sophistication as it measures whether a country's products are popularly produced in many other economies. Low-ubiquity products (e.g., smartphones, machinery, chemicals and metals), which require many hard-to-find capabilities, are generally produced only in a few economies (Felipe et al., 2012). This is because the production of sophisticated products is viable only in places where prerequisite technologies and knowledge are available. By contrast, ubiquitous products (e.g., agricultural, wood, raw materials and commodities, and textiles), can be easily produced as they require much less productive knowledge (Felipe et al., 2012). For example, Japan, Germany and the US, among others, are the most complex economies in the world because they can produce a diverse range of low-ubiquity products, such as medical imaging and machinery. Meanwhile, Cambodia, Papua New Guinea, and Nigeria are relatively technologically backward because they mainly produce ubiquitous commodities. These arguments, taken together, suggest that innovative economies are those whose productive structure comprises of a wide range of technologically sophisticated products, evidenced by a high ECI index.

To summarize, this paper seeks to overcome several measurement issues of commonly used metrics of innovation such as R&D expenditure and patents. To this end, I employ the ECI index that takes a more nuanced approach toward quantifying internationally comparable innovative capabilities. More specifically, this output-based measure of innovation covers knowledge embodied in commercially oriented and value-added products, which is more relevant for economic growth and development (Sweet & Maggio, 2015). This accounts for much of technological innovation that cannot be reflected in non-patented inventions. This approach goes well beyond the input-based measure of knowledge and innovation (e.g., R&D expenditure) by focusing on the output side of the innovation process. It also reflects whether an economy is improving its productive capacity and creating innovation, which accelerates productivity and income growth (Bahar et al., 2014; Hausmann et al., 2014). Furthermore, it attempts to account for not only explicit but also tacit knowledge to capture a more comprehensive coverage of innovative activities. The ECI index demonstrates a country's ability to apply its technologies and productive knowledge in enhancing innovative capacity. Importantly, this measure is calculated in a consistent manner across countries and over time, relying on information about the type of products made and exported by an economy.

While the ECI index appears to be a novel innovation metrics, it is not free from criticism. A major concern holds that the construction of this indicator is based on trade data, which do not account for innovation stemming from non-tradeable activities (Sweet & Maggio, 2015). It also focuses only on trade in manufacturing rather than in services. The ECI builds upon the idea of traditional innovation metrics by capturing explicit knowledge, but it further incorporates tacit knowledge. An increase in economic complexity also implies a country's ability to accumulate productive knowledge and translate it into innovative products.

Additionally, the limitation of input-based innovation metrics (R&D expenditure) can be evident when looking at data of macro-economically similar countries. For example, Malaysia and Brazil are relatively comparable in terms of their income per capita, which are approximately 10751USD and 11351USD in 2015, respectively. Similarly, these two countries spent around 1.2% to 1.3% of their GDP on R&D in 2015.[12] By contrast, Brazil still lags behind Malaysia in innovative capacity, evidenced by the Global Innovation Index. More precisely, Malaysia ranked 32nd in the global innovation ranking while Brazil placed at 70th in 2015.[13] Hence, the measure of R&D spending fails to compare innovation in these two countries. Importantly, Malaysia's ECI index is around 0.93 in 2015, which is nearly 2.5 times higher than that of Brazil.[14] This is consistent with the innovation ranking, suggesting that the ECI index provides better information about cross-country differences in innovative capacity compared with R&D spending. The remainder of this paper, therefore, relies on using the ECI index to explore the effect of health capital on innovation.

4. Estimation strategies

Model specification

To estimate the causal effect of LGBT inclusion on economic complexity, a novel measure of innovative capabilities, I set up the following cross-country OLS model.

$$ECI_i = \alpha + \beta LGBT_i + \gamma X_i + \varepsilon_i$$

where ECI denotes the economic complexity index, the main measure of innovative capacity. $LGBT$ stands for the LGBT inclusion index of Badgett et al. (2019), which is the main variable of interest in this paper. β captures the estimated effect of the social inclusion of LGBT on national innovative capacity. X corresponds to the set of control variables that will be discussed below. Subscript i denotes country i, taking values ranging from one to up to 116.[15] ε reflects the unobserved error term.

[12] Both data on GDP per capita and R&D spending is obtained from the World Bank's World Development Indicators (https://wdi.worldbank.org).

[13] The global innovation index is an alternative proxy for innovative capacity. This measure is highly correlated with ECI. Later, I will also use this metric as a sensitivity check and present some details.

[14] Data are taken from the Observatory of Economic Complexity (https://oec.world/en/rankings/country/eci/).

[15] The list of countries used in this paper is provided in the online appendix.

It is important to discuss the motivation for estimating cross-sectional data to explore the link between LGBT inclusion and innovation. First, the main interest of the current study lies in the impact of the social inclusion of LGBT people on the cross-country variation in innovative capabilities. Estimating a cross-country regression, therefore, is relevant for this purpose. This empirical exercise is also relevant for capturing the long-term relationship between ECI and LGBT inclusion, of which the differences across countries remains relatively constant over the years. Second, the LGBT index, constructed by Badgett et al. (2019), exhibits little variation within a country across years. This time-series property is consistent with the observation that social tolerance toward homosexuality appears to be a persistent cultural feature of the population. Therefore, the main variation in the data stems from pooling data across countries. Later, I will present evidence that the effect of social inclusion of LGBT people on innovation across the world remains largely unchanged when I compute the average of the LGBT index across different periods.

Data and variables[16]

This paper draws on a recent contribution of Badgett et al. (2019) that constructs an index reflecting the social inclusion of LGBT people across 132 countries (Figure 1). As discussed earlier, this index is computed from 1966 to 2011, but it is changing slowly over the years within a country. This is consistent with the argument that the acceptability of homosexuality is presumably a persistent culture feature of the society. Thus, much of the variation of the data is induced by cross-country differences in the extent to which LGBT individuals are discriminated in a population. Thus, I calculate the average of this index across the period from 1966 to 2011 for each of 132 countries. I further conduct a sensitivity to show that the main results are not driven by the period chosen.

The social inclusion of LGBT people can be measured by differences in different aspects of well-being, such as health outcomes, earnings and education, between homosexual and heterosexual people in a given country. Unfortunately, such data are not available across countries throughout the world. The interest of the current research, by contrast, lies exclusively in the effect of the social acceptability of homosexuality on disparities in innovative capabilities across countries. Thus, the empirical analysis requires using an internationally comparable index reflecting the tolerance toward LGBT people. For this reason, I employ the LGBT inclusion index that captures the extent to which homosexual people are afforded legal

[16] See also the online appendix for more details.

rights and protections. This is derived from the original Global Index of Legal Recognition of Homosexual Orientation introduced by Waaldijk (2009).

As argued earlier, this paper attempts to address several concerns about the use of conventional innovation metrics by adopting the economic complexity index.[17] This indicator is constructed based on the method of reflections proposed by Hidalgo and Hausmann (2009). Specifically, the authors develop an iterative algorithm combining information on countries' diversity and products' ubiquity as discussed earlier. This method yields a single ECI for each countries from 1964 to 2010. I calculate the mean values for each countries to use in the cross-country analysis.[18]

I follow a recent study by Vu (2019) to select the set of control variables included in the baseline regressions.[19] A potential confounder is trade liberalization, which promotes national innovative capacity and productivity through enhancing the dissemination of knowledge and skills across borders (see, e.g., Edwards, 1997; Baldwin & Gu, 2004; Sweet & Maggio, 2015). Further, financial development may foster technological innovation as suggested by Hsu et al. (2014). Government size may exert a positive influence on the development of technology-intensive industries through providing public resources including education, health care, public order and legal systems (e.g., Sweet & Maggio, 2015; Vu, 2019). Innovative activities, measured by ECI, may just reflect the size of a country's population. The explanation is that the population size corresponds to diversity of ideas and creativity. A bigger market size may correspond to the product diversification that the measure of innovation used in this paper captures. Further, population size may capture the extent to which my findings just proxy for the effect of increasing returns to scale of export productivity (Sweet & Maggio, 2015). Therefore, I include these variables as baseline controls. Data are obtained from the World Bank's World Development Indicators. Additionally, a series of other potential confounders will be incorporated in the regression as sensitivity analyses.

Estimation methods

A key challenge in achieving causal inference stems from potential omitted variable bias. Specifically, if an unobserved variable is correlated with both social tolerance toward LGBT

[17] Data are obtained from the Observatory of Economic Complexity.

[18] For more details about the construction of this index, please see Hidalgo and Hausmann (2009) and Hausmann et al. (2014). Alternative measures of innovation will be used as a robustness check later.

[19] To my knowledge, Vu (2019) is among very few studies exploring the determinants of economic complexity across countries with a special focus on the quality of institutions. Several control variables included in this paper are also relevant for the current study, given that the main measure of innovation here is ECI.

people and ECI, the estimated coefficients (β) are biased and inconsistent. To obtain unbiased and consistent estimates, I follow the existing comparative development literature in incorporating a number of potential confounders in the regression (see, e.g., Acemoglu, 2009, Ch. 4). This helps mitigate the concern that the results may just reflect the effect of a third omitted factor (Vu, 2020).

It is worth noting that reverse causation is unlikely to exist in this case because it is difficult to justify the direct influence of innovative activities on social tolerance toward the LGBT community. One may argue that the development of technology-intensive industries would trigger structural change in institutional quality, coupled with economic growth. This may improve the acceptability of homosexuality within a country. As such, the potential bias is induced by the effect of either institutional quality or income per capita on LGBT inclusion rather than reverse causality per se.[20] For this reason, I will rule out this possibility by controlling for these potential confounders in a sensitivity test presented later.

5. Cross-country evidence

5.1. Main results

Figure 3 represents the unconditional cross-country correlation between the social inclusion of the LGBT community and innovative capacity, measured by ECI. Accordingly, the acceptability of LGBT people is positively correlated with national innovative capabilities. This finding lends support to the main hypothesis discussed earlier. It suggests that countries with better legal rights and protections afforded to homosexual people are associated with higher levels of economic complexity, which corresponds to better ability to innovate. Nevertheless, this unconditional correlation should be interpreted with care because it does not necessarily imply a causal influence when I do not control for any confounding factors.

The baseline findings, which measure the partial effect of the LGBT inclusion index on innovation, are presented in Table 1. In column (1), I report the unconditional estimates. Accordingly, the estimated coefficients of LGBT is positive and statistically significant at the 1% level. This is consistent with the positive correlation shown in Figure 3. From columns (2) to (5), I gradually incorporate each of the main control variables in the regression. These factors arguably exert some influence on national innovative capacity. Thus, including them in the

[20] Indeed, it is relatively difficult to identify sources of exogenous variation in the social inclusion of LGBT people across countries. This is partly explained by the fact that macro-level research on determinants of the acceptability of homosexuality throughout the world is largely non-existent.

benchmark model helps mitigate concerns about omitted variable bias. The results presented in Table 1 demonstrate that the estimated effect of the social inclusion of LGBT individuals appears to be very precise even when I account for the impact of potential confounding factors. More specifically, a one-unit increase in the LGBT index is associated with a 0.32-unit increase in ECI, approximately one third of a standard deviation of ECI, a sizeable effect (column 5, Table 1).[21] This lends strong credence to the main proposition.

Trade openness is expected to facilitate the diffusion of knowledge and technologies, which may foster technological innovation. This paper, however, finds that the effect of trade liberalization on innovative capacity, measured by ECI, is imprecisely estimated (column 2, Table 1). Therefore, I do not find evidence supporting the argument that trade is a key factor affecting the innovation process. In contrast, the effect of financial development, government size, and population on ECI is positive and statistically significant at conventionally accepted levels (columns 3 to 5, Table 1). This is in line with the findings of previous studies (e.g., Hsu et al., 2014; Sweet & Maggio, 2015; Vu, 2019).

5.2. Robustness checks

As highlighted above, the baseline findings may not provide a valid basis for causal inference if an omitted factor is correlated with both the dependent variable and the main variable of interest. This motivates including a rich set of potential confounding factors to minimize this potential bias. Below, I further perform some additional sensitivity tests and discuss the results.

Robustness to including additional controls

I replicate the baseline findings in column (5) of Table 1 by including a series of potential confounders as presented in Table 2. *First*, I account for the effect of the diversity of birthplaces of immigrants.[22] This is mainly motivated by some recent contributions linking birthplace diversity and economic development (see, e.g., Alesina et al., 2016; Bahar et al., 2019). In particular, Bahar et al. (2019) find that an index of population diversity is positively correlated with ECI, the baseline innovation metric used in this paper. It may also be the case that countries with greater social tolerance toward LGBT people would attract immigrants, thus enhancing population diversity. The results shown in column (1) indicate that my findings are robust to accounting for this effect. Interestingly, the effect of birthplace diversity on ECI is

[21] A summary statistics of variables is provided in the online appendix.

[22] Data are taken from Alesina et al. (2016) who document a strong and robust effect of birthplace diversity on income differences across the world.

imprecisely estimated, which is in contrast to Bahar et al. (2019). This suggests that discrimination toward LGBT people plays a more prominent role in affecting innovation.

Second, I control for the effect of legal origins by including dummy variables of common law and mixed law.[23] The explanation for this holds that common law with greater protection of private property rights may be conducive to innovative activities. Further, this partly addresses a concern that my results just reflect the persistent effect of colonization on comparative development across countries (Acemoglu et al., 2001; La Porta et al., 2008). The baseline findings, however, remain relatively insensitive to this empirical exercise (column 2, Table 2).[24] *Third*, I control for the effect of land suitability and the abundance of resources because these factors may affect technology-intensive industries, following Vu (2019). The results in columns (3) and (4) of Table 2 are broadly similar to the baseline findings. *Finally*, my results may yield a spurious relationship between the social inclusion of LGBT people and innovation if I fail to control for the quality of institutions and income levels as highlighted earlier. For this reason, I incorporate the measures of democracy, institutional quality, and income per capita in columns (5) to (7) of Table 2.[25] Accordingly, the estimated coefficients of LGBT are still positive and statistically significant at the 1% level. When all of the additional control variables are included in the regression, the estimated impact of the social tolerance toward homosexuality remains precise at conventionally accepted levels of significance (column 8, Table 2).[26] Overall, I find that the baseline findings are largely robust to controlling for a number of confounding factors.

Robustness to alternative samples

As illustrated in Figure 1, much of the social exclusion of LGBT people remains widespread in many parts of Asia, the Middle East, and Africa. By contrast, European and Oceania countries have achieved significant progress toward enhancing the social acceptability of homosexuality (Bailey et al., 2016). Figure 2 also demonstrates spatial dependence in innovation across the globe. One implication from this spatial distribution across the globe is that the benchmark estimates may just proxy for some unobserved region-specific factors. As

[23] I follow the classification of Klerman et al. (2011). Countries adopting civil law are excluded as the base group.

[24] Although the size of the coefficients reduces a little, the positive effect of LGBT inclusion on innovation is still precisely estimated.

[25] Democracy is proxied by the polity2 index taken from Marshall et al. (2014). Further, I calculate the average of six governance indicators obtained from the World Bank's data to capture institutional quality. GDP per capita is taken from the World Bank's World Development Indicators.

[26] Most of additional controls are highly correlated. Thus, including all of them in one regression would reduce efficiency of the estimates. However, the main results are largely robust to doing this.

such, the positive correlation established earlier may be spurious. To address this concern, I reproduce the baseline estimates by gradually removing some countries located in the same continent (columns 1-5, Table 3). Next, I exclude countries whose LGBT inclusion index equals zero because they are potential outliers as shown in Figure 3 (column 6, Table 3). As a final test, I include dummy variables for each continent (column 7, Table 3). The results based on estimating alternative samples in Table 3 are broadly similar to the baseline findings.

Robustness to controlling for religion and culture values

Individuals sharing common religious beliefs may arguably possess the same cultural traits. This may exert some influence on the social tolerance toward homosexuality while affecting the national innovative capacity. Cultural values may also drive innovation and attitudes toward homosexual behaviours through affecting institutional quality. For example, the level of social capital, which may vary across cultures and religions, may be conducive to coordination at the work place, and the exchange of ideas, knowledge and skills within an economy. These factors help foster technological innovation. Meanwhile, the lack of social trust could hinder the inclusion of homosexual people in a population. Moreover, individualistic cultures may drive technological innovation by affecting the institutional environment as highlighted by Gorodnichenko and Roland (2017). Collectivistic societies tend to punish those deviating from norms and standards and emphasize conformity. Hence, it may spur the social exclusion of the LGBT community. These arguments, taken together, suggest that the baseline estimates may be biased and inconsistent if we fail to account for cross-country differences in cultural and religious values. This motivates the falsification test presented in Table 4.[27] I find that the effect of the social inclusion of LGBT people on innovation remains precisely estimated even when I control for different measures of culture values and religions. Importantly, this falsification exercise also helps address a concern that the benchmark findings just proxy for the effect of overall tolerance for diversity and nonconformists.

Robustness to potential measurement bias

As demonstrated above, I calculate the mean values of the LGBT inclusion index across the period from 1966 to 2011. This is mainly motivated by an observation that the acceptability

[27] In particular, I control for social capital based on data from the World Values Survey. This index measures the number of respondents who answer that "most people can be trusted" as a proportion of total respondents. Next, I incorporate the Hofstede's index of individualistic cultures in the regression. This indicator is constructed by Hofstede (2001). Further, I include religious variables, calculated by the fraction of Catholics, Muslims, and Protestants in the population, following La Porta et al. (1999).

of homosexuality, as measured by the LGBT index, exhibits little variation across the years with a country. One may well argue that the baseline estimates may be driven by the period chosen to compute the LGBT inclusion index. To address this concern, I reproduce the benchmark results by using the main variable of interest computed in different years. The results presented in Table 5 indicate that the estimated coefficients of the LGBT index remain statistically significant at the 1% level. This reinforces the main hypothesis that fostering human rights and protection of LGBT people helps strengthen innovative activities.

ECI was first adopted as a proxy for innovative activities by Sweet and Maggio (2015). As presented above, this innovation metric helps address several pitfalls of using traditional measures of innovative capacity. However, we cannot rule out the possibility that the baseline findings are merely driven by the use of this index. Further, I calculate the average of ECI from 1964 to 2010 in the main regressions, which may arguably induce some concerns of measurement bias. For these reasons, I employ alternative innovation metrics to replicate the baseline results (Table 6). In particular, I use the Global Innovation Index, which reflects cross-country differences in innovative capacity and the ability to apply innovation in production (column 1, Table 6).[28] Next, I use an alternative measure of economic complexity, namely the Fitness index constructed by Tacchella et al. (2012).[29] Results are presented in column 2 of Table 6. I further compute the average of ECI from 2000-2010, the most recent decade when data are available and use it as a dependent variable in column 3 of Table 6.

The original ECI has been widely adopted in previous studies exploring its effect on economic performance (see, e.g., Hidalgo & Hausmann, 2009; Hausmann et al., 2014; Sweet & Maggio, 2015; Hartmann et al., 2017; Lee & Vu, 2019; Vu, 2019). For this reason, I use it as the benchmark measure of national innovative capacity. Recently, Albeaik et al. (2017) revise the method of reflections of Hidalgo and Hausmann (2009) to construct an improved

[28] This index is computed by using a wide range of information such as institutional quality, human capital and research, infrastructure for innovation, market and business sophistication, knowledge and technology outputs, and creative outputs. The indicator is constructed by Cornell University, INSEAD, and the World Intellectual Property Organization. I use data from the most recent report in 2019 (https://www.globalinnovationindex.org/gii-2019-report).

[29] The method of reflections developed by Hidalgo and Hausmann (2009) relies on information on a country's diversity and a product's ubiquity to calculate the ECI for each country. Tacchella et al. (2012), however, argue that it may be misleading to define a product as complex based on the average of complexity of countries exporting such as product. For this reason, the authors demonstrate that a sophisticated product should be exported only by highly competitive countries. Thus, Tacchella et al. (2012) develop a non-linear iterative algorithm for computing countries' competitiveness and products' complexity to address some concerns of the method of reflections of Hidalgo and Hausmann (2009). Importantly, the baseline findings remains largely insensitive to using different innovation metrics as well as the methods of calculating the ECI.

ECI (*ECI_plus*).[30] Specifically, the authors further considers how difficult it is to export each product, which helps capture a country's productive capabilities better as argued by the authors. Therefore, I include this measure in column 4 of Table 6. As evident in Table 6, the baseline estimates appear to be strong and robust to using alternative measures of innovation.

Other sensitivity tests

An additional concern holds that cultural values and innovative capabilities of proximate countries may transcend across borders. The basic explanation rests upon the conventional wisdom that geographic proximity facilitates trade and knowledge dissemination (see, e.g., Eaton & Kortum, 2002; Keller, 2002). It follows from this argument that distance plays a key role in affecting a country's technologies through enhancing trade and economic interactions. Further, countries located in the same region may share common cultural values. If such spatial dependence exists, the OLS estimates may reflect a spurious relationship between the inclusion of LGBT people and innovation.[31] Following Conley (1999), I mitigate this concern by computing corrected standard errors in Table 7.[32] The baseline findings appear to be largely insensitive to this consideration.

A final falsification test is to check whether the baseline findings are affected by the presence of outliers. In a previous robustness check, I restrict the sample to countries whose LGBT inclusion index is greater than zero. The results suggest that my findings are insensitive to that exercise. Now, I examine this issue more thoroughly by conducting some formal tests to identify and remove outliers (see, e.g., Vu, 2019). To this end, I restrict the sample size using three different methods (Table 8). In column (1) of Table 8, I calculate the Cook's distance and remove countries with a value greater than four divided by the number of observations. I further constrain the sample size to only countries with a standardized residual smaller than 1.96 (column 2, Table 8). The final exercise is performed by first estimating robust regression weights, following Li (1985). Next, the baseline model is re-estimated using these weights (column 3, Table 8). Accordingly, the benchmark findings remains statistically significant at the 1% level even when I rule out the potential effect of outliers.

[30] Data for the improved ECI are also obtained from the Observatory of Economic Complexity.

[31] The discussion here suggests that the disturbance term may be correlated across countries, thus violating the basic assumption of OLS regression.

[32] This is done using weighted covariance matrices. The weight equals the inverse of the distance between countries and it is assumed zero after a specified threshold. Following the related literature, I specify the thresholds as twenty and fifty coordinate degrees (Table 7). Recent studies applying this approach include Ashraf and Galor (2013), Borcan et al. (2018) and Vu (2020).

6. Subnational evidence from an individual-level analysis

The cross-country evidence lends strong credence to a positive link between the acceptability of the LGBT community and national innovative capabilities. Although I attempt to control for a number of confounding factors, the main concern regarding the validity of my results stems from the effect of unobserved country-specific factors. It is difficult to account for these potential confounders given that the findings are drawn from a cross-country framework. This motivates an analysis at the subnational level. Unfortunately, there exists no comprehensive dataset of both LGBT inclusion and innovation at the region level across countries. Additionally, the construction of such data would be very challenging. Therefore, instead, I employ data from the World Values Survey.[33] The empirical analysis in this section is mainly based on respondents' attitudes toward homosexuality and technological innovation (Table 9).

In particular, I use data conducted from face-to-face interviews in up to 100 countries throughout the world. I pool data across six waves from 1981 to 2014.[34] The main proxy for the social inclusion of LGBT people is derived from a question in which respondents are asked about the extent to which they think homosexuality is justifiable. Higher values correspond to greater acceptability of homosexual behaviours. I adopt seven questions reflecting people's attitudes toward science and technology, and new ideas, taking risks, and changes as dependent variables as discussed below.[35] Further, control variables are incorporated in all regressions to capture individuals' characteristics. These include age, age squared, income levels, dummy variables for male, social trust and educational attainment.[36] Country-fixed effects are also added to all regressions, which helps control for a number of country-specific factors as discussed earlier. I further include religion- and wave-fixed effects in all models.[37]

Table 9 reports the estimation results from the individual-level analysis. Accordingly, the estimated coefficients of *homosexuality* are statistically significant at the 1% level except in column (6). The positive sign of the coefficients is consistent with my prediction that the

[33] Data can be accessed via this link: http://www.worldvaluessurvey.org/wvs.jsp.

[34] More specifically, data are collected in six periods including 1981-1984, 1990-1994, 1995-1998, 1999-2004, 2005-2009, and 2010-2014. The number of countries covered in each regression is reported in Table 9.

[35] More details about these variables are also provided in the online appendix.

[36] Social trust is measured by question "most people can be trusted", taking the value of one if respondents answer yes and zero otherwise. Educational attainment is coded in three scales, including lower, middle and upper levels. For ease of interpretation, I create two binary variables for middle and upper education, with lower excluded as the base group.

[37] The discussion in the cross-country analysis suggests that people following the same religion may share some common cultural values, which may shape their attitudes toward homosexuality and technological innovation. This motivates the inclusion of religion dummies.

acceptability of LGBT individuals promotes technological innovation. The first dependent variable used in column (1) is whether survey participants agree that we depend too much on science versus faith (*E220*). The answers are coded from one to ten with higher values corresponding to negative views about science and technology. For ease of interpretation, I recode this variable by multiplying it by minus one so that higher values represent positive attitudes toward technological advances. The second question is whether respondents agree that science and technology are changing our life too fast (*E219*). Higher values, therefore, imply negative views about technological progress. I also recode this question so that higher values denote positive views about technological changes (column 2, Table 9). The next question is whether respondents think our world is better off because of science and technology (column 3, Table 9). As evident in columns (1) to (3) of Table 9, social tolerance toward homosexual behaviours exerts a positive influence on attitudes toward science and technology.

The remaining columns of Table 9 demonstrate the effect of homosexuality on respondents' views about new ideas, taking risks and changes. In column (4), the dependent variable is whether survey participants agree that new ideas are better than old ones (*E046*). Further, I use the question about attitudes toward the importance of new ideas and creativity (*A189*). The answers are also coded from one to ten of which higher values mean greater disagreements with this view. I also recode this variable to make it easy to interpret the findings.[38] Next, I use the question in which respondents are asked whether they welcome or worry about changes as shown in column (6) (*E047*). An increase in this variable is associated with positive views about changes. The final dependent variable is whether survey participants disagree about the importance of taking risks and adventure (*A195*). For ease of interpretation, this variable is also re-calculated by multiplying it by minus one. The estimated coefficients of homosexuality are statistically significant at the 1% level when different dependent variables are used (except in column 6).[39] Taken altogether, my findings suggest that the social acceptability of homosexuality has a positive effect on people's attitudes toward new ideas, creativity, changes, adventure and taking risks.

Overall, the estimates reported in Table 9 demonstrate that people who self-report tolerance toward homosexuality tend to have positive attitudes toward technological progress.

[38] This is done by multiplying the variable by minus one.

[39] In column (6) of Table 9, the effect of homosexuality on innovation is positive but imprecisely estimated. It is important to note that the dependent variable used in this column contains a lot of missing values, thus constraining the sample size significantly.

The effect of homosexuality on innovation remains precisely estimated even when I control for a series of confounding factors including individuals' characteristics, unobserved country- and time-specific factors. The inclusion of religion dummies also helps address a concern that my findings just proxy for other cultural and religious factors. Therefore, the subnational evidence established in this section lends strong support to the cross-country results.

7. Channels of transmission (cross-country evidence)

The central idea of this paper rests on the premise that strengthening the social acceptability of LGBT people helps improve the quality of human capital skills of the entire economy. Further, LGBT-supportive policies may also signal low barriers to inflows of human capital. These factors are conducive to enhancement of innovative activities. My analyses presented so far broadly align with this notion by documenting a robust effect of the LGBT inclusion index on innovative capabilities, measured by ECI. The magnitude of the estimated coefficients also suggests a sizeable effect of LGBT inclusion on national innovative capacity. This section provides evidence on a potential mechanism explaining the baseline findings.

To this end, I first replicate the benchmark estimates, controlling for different measures of human capital skills (Panel A, Table 10). These indicators will be discussed in some details below. As evident, the effect of the social inclusion of LGBT people on innovation is still precisely estimated at the 1% level of significance. Importantly, the magnitude of the estimated coefficients reduces significantly when a potential channel of influence is incorporated in the regression. The results in column (1) of Panel A, for instance, indicate that the baseline estimates decrease to nearly a half when I control for the human capital index. This suggests that much of the effect of LBGT inclusion on innovative capacity is working through human capital skills.

Next, I regress the LGBT inclusion index on different measures of human capital skills as reported in Panel B of Table 10. Following a recent study by Kraay (2019), I employ the new World Bank's human capital index in column (1) of Panel B. This indicator, in particular, captures the expected human capital that a child born today may obtain by the age of 18, considering any risks associated with poor health and education prevailing in his or her country (Kraay, 2019).[40] In column (2) of Panel B, I estimate the effect of the social acceptability of homosexuality on years of schooling, which has been widely adopted as a proxy for human

[40] Data can be accessed via this link: https://datacatalog.worldbank.org/dataset/human-capital-index.

capital.[41] Hanushek and Woessmann (2012) demonstrate that the measure of cognitive skills performs better than years of schooling when it comes to predicting comparative development across countries. For this reason, I adopt this index as the dependent variable in column (3) of Panel B. In the last column of Panel B, I use an index of national IQs (intelligence) obtained from Lynn and Meisenberg (2010). This metric captures the cross-country variation in cognitive attainment, which is highly correlated with educational attainment (Lynn & Meisenberg, 2010). Using these different proxies for human capital skills, I find that the social inclusion of LGBT individuals exerts a positive influence on human capital accumulation (Panel B, Table 10). This provides empirical support to the proposition that the acceptability of homosexuality affects innovation through enhancing human capital skills.

The effect of LGBT inclusion on the quality of human capital remains largely robust to controlling for a number of confounding factors as shown in Table A1 in the online appendix. This empirical exercise is similar to that in Table 2. It is important to note that LBGT-supportive policies may affect the innovation process through other channels such as national creativity. However, a major problem in exploring other potential mechanisms stems from the availability of comparable data across the world. Thus, a potential avenue of future research is to examine other channels of transmission that would help advance our understanding of the relationship between social tolerance toward LGBT individuals and innovation.

8. Conclusion

It has been well documented in the literature that gender disparities in many aspects of empowerment and well-being, such as education, health and employment opportunities, are generally detrimental to economic growth and development (Klasen, 2002; Knowles et al., 2002; Klasen & Lamanna, 2009). Nevertheless, the extent to which discrimination against LGBT people affects economic performance has received scant attention among economists. This observation is surprising given a growing interest in promoting the social inclusion of LBGT and other marginalized groups of a population in many parts of the world. To the extent fostering social inclusiveness of the LGBT community contributes to enhancing social justice and economic development, we need to understand properly this link before proposing appropriate policy suggestions.

This paper builds upon a recent study by Badgett et al. (2019) that introduces an index of LBGT inclusion across the world. They document a positive effect of the social inclusion of

[41] Data are taken from Barro and Lee (2013).

LGBT people on income per capita using a world sample of countries. The main distinguishing feature of the current study lies in postulating that human rights and protection afforded to homosexual people play a key role in fostering national innovative capacity. To test this proposition, I carry out empirical analysis at the global and subnational level. I also employ ECI as a novel measure of innovative activities. This arguably helps address several concerns about conventional innovation metrics. The baseline results from estimating cross-country OLS regressions lend strong credence to the positive link between LGBT inclusion and innovation. My findings also withstand a series of robustness checks.

To rule out the possibility that the cross-country evidence is confounded by unobserved country-specific factors, I further conduct an individual-level analysis, using data from the World Values Survey for up to 97 countries from 1981-2014. This allows for accounting for a number of potential confounders at the national level. The findings based on this falsification test reveal that survey participants who self-report that homosexuality is justifiable have positive attitudes toward science and technology, new ideas and creativity, adventure and taking risks, and changes. This is broadly consistent with the international evidence. Having established a positive link between the social inclusion of LGBT people and national innovative capacity, this paper examines a potential mechanism behind this relationship. I find that the acceptability of the LGBT community exerts positive influence on different proxies for human capital skills, which presumably act as a catalyst for innovation activities.

To conclude, this research documents a strong and robust effect of LGBT inclusion on innovation at both the macro- and micro-level. My findings, however, by no means suggest that cross-country differences in innovative capacity are fully attributable to attitudes toward homosexuality. Instead, the results imply that reducing discrimination against LGBT people may advance economic prosperity through strengthening innovation. Therefore, development strategies aiming at inclusive growth should not ignore the social inclusion of marginalized groups such as LGBT people. This is because such inclusiveness may further reinforce economic development.

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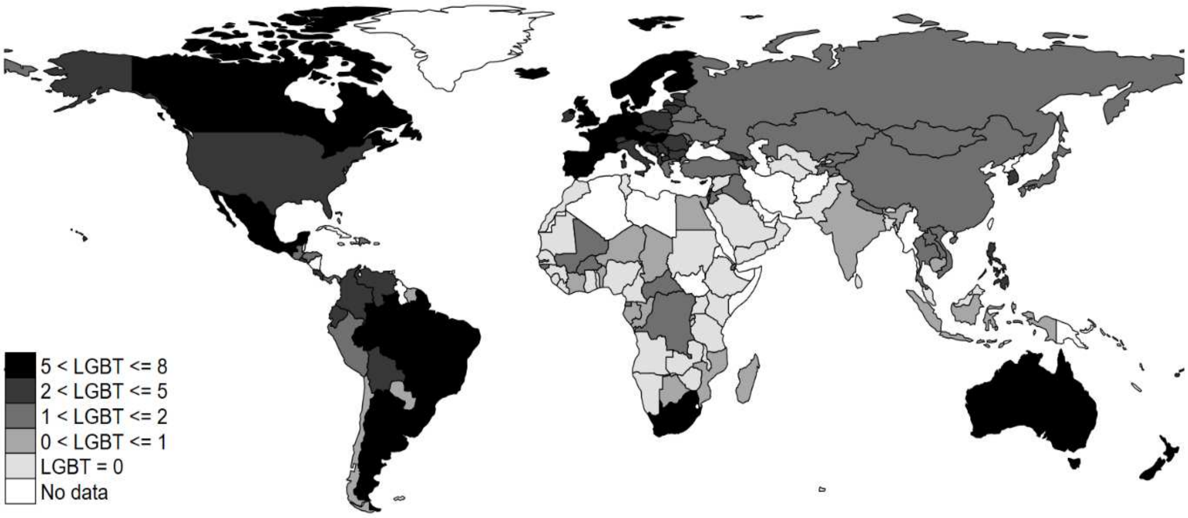

Figure 1. Cross-country differences in the LGBT inclusion index

Notes: This figure illustrates the spatial distribution of the social inclusion of LGBT people across the world. Higher values correspond to higher acceptability of homosexuality.

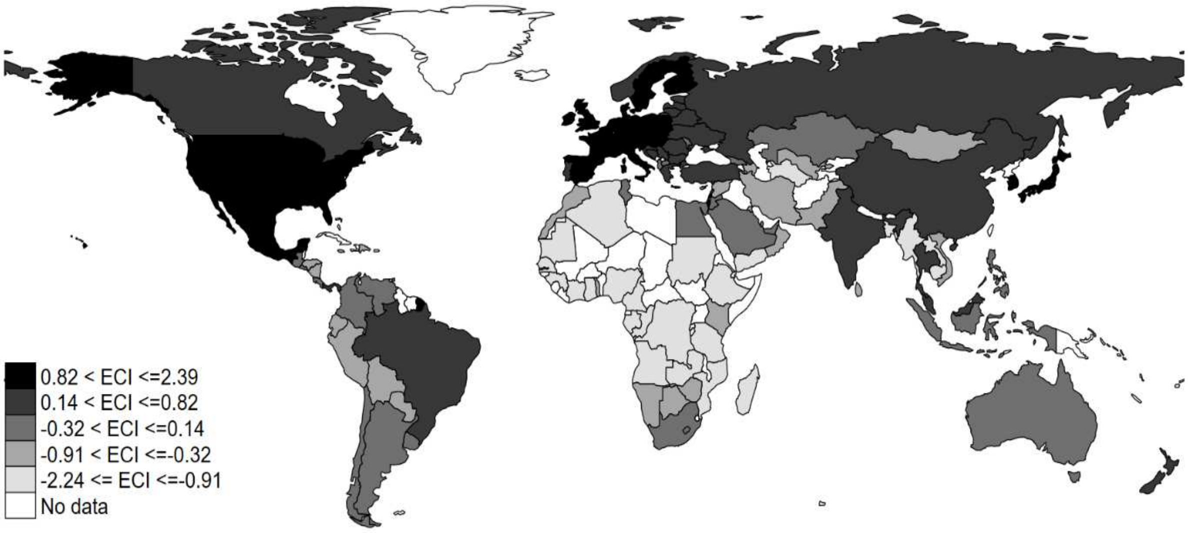

Figure 2. Cross-country differences in innovative capacity, as measured by ECI

Notes: This figure illustrates the spatial distribution of innovative capacity across the world, as measured by the economic complexity index. Higher values denotes more innovative capabilities.

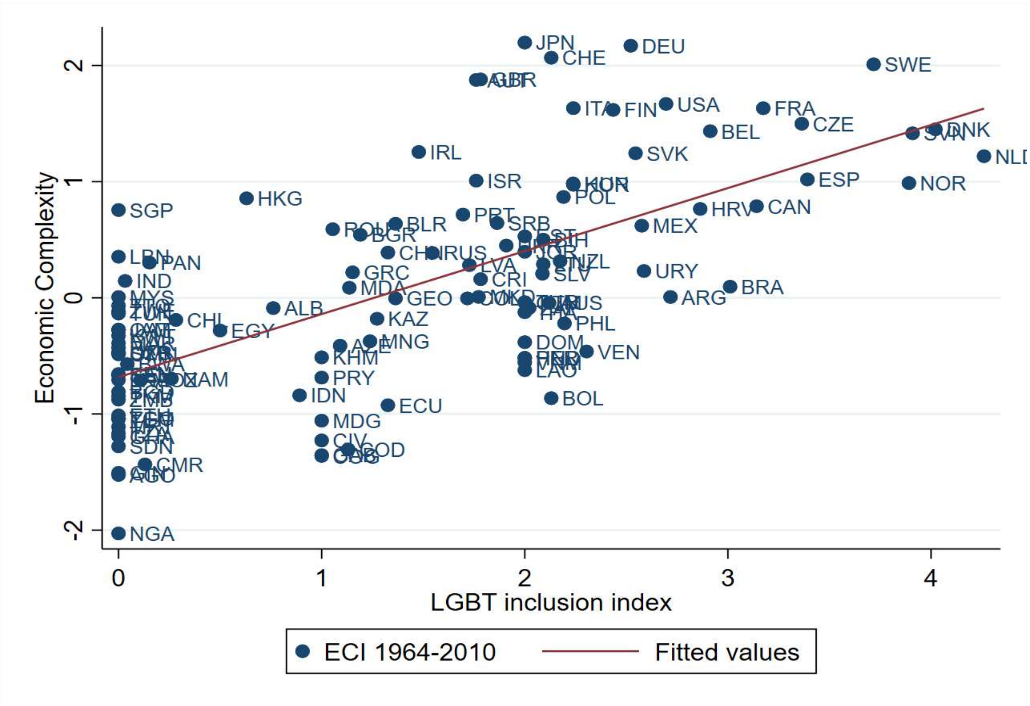

Figure 3. Correlation between the LGBT inclusion index and technological innovation

Table 1. Main results

	(1)	(2)	(3)	(4)	(5)
Dependent variable: economic complexity index					
LGBT	**0.543*****	**0.539*****	**0.354*****	**0.330*****	**0.318*****
	[0.047]	[0.048]	[0.046]	[0.044]	[0.045]
Trade openness		0.001	-0.001	-0.001	-0.001
		[0.002]	[0.001]	[0.001]	[0.001]
Financial development			1.491***	1.413***	1.378***
			[0.190]	[0.182]	[0.184]
Government size				0.038***	0.046***
				[0.010]	[0.011]
Population (log)					0.070*
					[0.039]
Observations	116	114	112	110	110
R-squared	0.448	0.443	0.675	0.712	0.721

Notes: LGBT is the LGBT inclusion index of Badgett et al. (2019), with higher values corresponding to better acceptability of homosexuality. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The regressions include an intercept estimates but omitted for brevity.

Table 2. Robustness to controlling for other effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Dependent variable: economic complexity index							
LGBT	**0.306*****	**0.309*****	**0.290*****	**0.318*****	**0.283*****	**0.238*****	**0.243*****	**0.114***
	[0.047]	[0.056]	[0.050]	[0.044]	[0.048]	[0.043]	[0.052]	[0.061]
Birthplace diversity	-0.337							-0.506
	[0.308]							[0.315]
Common law		0.018						-0.176
		[0.149]						[0.131]
Mixed law		-0.250						-0.078
		[0.176]						[0.172]
Land suitability			0.857***					0.832***
			[0.190]					[0.183]
Fuel exports				-0.002				-0.001
				[0.001]				[0.002]
Polity2 index					0.020**			-0.012
					[0.009]			[0.011]
Institutional quality						0.391***		0.338***
						[0.102]		[0.124]
GDP per capita (log)							0.197***	0.172**
							[0.060]	[0.078]
Baseline controls	✓	✓	✓	✓	✓	✓	✓	✓
Observations	109	106	103	110	106	110	110	103
R-squared	0.725	0.727	0.773	0.728	0.732	0.769	0.752	0.835

Notes: Baseline controls denote the set of main control variables included in Table 1. ✓ stands for the inclusion of controls. Descriptions of additional controls included here are presented in the online appendix. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Robustness to sample selection

	Excluded continents					Excluding countries with zero LGBT index	Adding continent dummies
	Europe	America	Asia	Oceania	Africa		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dependent variable: economic complexity index						
LGBT	0.243***	0.346***	0.356***	0.322***	0.228***	0.301***	0.150***
	[0.055]	[0.053]	[0.051]	[0.045]	[0.052]	[0.065]	[0.056]
Baseline controls	✓	✓	✓	✓	✓	✓	✓
Observations	76	89	85	108	85	85	106
R-squared	0.672	0.740	0.735	0.725	0.674	0.684	0.803

Notes: In columns (1) to (5), I remove countries in each continent. Next, I drop observations of which the value of the LGBT inclusion index equals zero, as presented in column (6). I further include continent dummies in column (7). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See also notes to Table 2.

Table 4. Robustness to controlling for cultural values

	(1)	(2)	(3)	(4)
	Dependent variable: economic complexity index			
LGBT	**0.288*****	**0.293*****	**0.322*****	**0.249*****
	[0.053]	[0.052]	[0.057]	[0.071]
Social trust	0.002			0.003
	[0.002]			[0.003]
Individualism		0.609		0.745
		[0.398]		[0.478]
Catholic			-0.002	-0.001
			[0.002]	[0.002]
Muslim			-0.003*	-0.003
			[0.002]	[0.002]
Protestant			-0.002	-0.006
			[0.003]	[0.004]
Baseline controls	✓	✓	✓	✓
Observations	89	81	105	75
R-squared	0.705	0.721	0.725	0.721

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See also notes to Table 2.

Table 5. Robustness to measurement of the LGBT inclusion index

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: economic complexity index				
LGBT inclusion index in 1970	**0.230*****				
	[0.071]				
LGBT inclusion index in 1980		**0.262*****			
		[0.070]			
LGBT inclusion index in 1990			**0.223*****		
			[0.048]		
LGBT inclusion index in 2000				**0.181*****	
				[0.036]	
LGBT inclusion index in 2010					**0.147*****
					[0.025]
Baseline controls	✓	✓	✓	✓	✓
Observations	93	93	110	110	110
R-squared	0.675	0.693	0.663	0.682	0.715

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See also notes to Table 2.

Table 6. Robustness to using alternative innovation metrics

Dependent variable	Global innovation index	Fitness index	ECI (2000-2010)	ECI_plus
	(1)	(2)	(3)	(4)
LGBT	**2.980*****	**0.212*****	**0.317*****	**0.300*****
	[0.613]	[0.074]	[0.054]	[0.054]
Baseline controls	✓	✓	✓	✓
Observations	102	103	110	110
R-squared	0.728	0.727	0.704	0.655

Notes: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See also notes to Table 2.

Table 7. Robustness to spatial dependence

Independence	Twenty coordinate degrees		Fifty coordinate degrees	
	(1)	(2)	(3)	(4)
Dependent variable: economic complexity index				
LGBT index	**0.543*****	**0.318*****	**0.543*****	**0.318*****
	[0.047]	[0.045]	[0.047]	[0.045]
	(0.034)	(0.014)	(0.029)	(0.012)
Baseline controls		✓		✓
Observations	116	110	116	110
R-squared	0.448	0.721	0.448	0.721

Notes: I report Conley's (1999) standard errors that corrects for spatial dependence. Conventional robust standard errors are presented in squared brackets for the ease of comparison. *** p<0.01, ** p<0.05, * p<0.1.

Table 8. Robustness to excluding outliers

	(1)	(2)	(3)
Dependent variable is economic complexity			
LGBT	**0.361*****	**0.360*****	**0.325*****
	[0.039]	[0.040]	[0.040]
Baseline controls	✓	✓	✓
Observations	103	105	110
R-squared	0.756	0.767	0.743

Notes: This paper reproduces the baseline estimates by removing potential outliers. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. See also notes to Table 2.

Table 9. Individual-level evidence

	Attitudes toward science and technology			Attitudes toward new ideas, taking risks and changes			
Dependent variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	E220	E219	E234	E046	A189	E047	A195
Homosexuality	**0.055*****	**0.022*****	**0.015*****	**0.035*****	**0.012*****	**0.016**	**0.015*****
	[0.003]	[0.005]	[0.003]	[0.004]	[0.002]	[0.025]	[0.002]
Male	-0.080***	-0.063***	-0.152***	-0.114***	-0.113***	-0.087	-0.347***
	[0.016]	[0.022]	[0.014]	[0.021]	[0.007]	[0.086]	[0.008]
Age	0.009***	-0.011***	-0.011***	-0.030***	-0.007***	-0.035**	-0.040***
	[0.003]	[0.004]	[0.002]	[0.004]	[0.001]	[0.016]	[0.001]
Age squared	-0.000***	0.000**	0.000***	0.000***	0.000	0.000	0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Income	-0.000	0.000	0.084***	0.027***	0.031***	0.082***	0.033***
	[0.004]	[0.005]	[0.004]	[0.005]	[0.002]	[0.020]	[0.002]
Education (upper)	0.023	-0.111***	0.263***	-0.064**	0.359***	0.740***	0.117***
	[0.025]	[0.034]	[0.021]	[0.032]	[0.012]	[0.142]	[0.013]
Education (middle)	-0.031	-0.164***	0.191***	0.054*	0.134***	0.477***	0.041***
	[0.021]	[0.028]	[0.018]	[0.028]	[0.010]	[0.143]	[0.011]
Social trust	0.141***	0.076***	0.146***	0.051**	0.053***	0.178*	0.105***
	[0.020]	[0.027]	[0.016]	[0.024]	[0.009]	[0.099]	[0.010]
Country FE	✓	✓	✓	✓	✓	✓	✓
Wave FE	✓	✓	✓	✓	✓	✓	✓
Religion FE	✓	✓	✓	✓	✓	✓	✓
Observations	113,780	44,842	117,140	72,118	119,982	5,239	119,800
R-squared	0.127	0.101	0.096	0.127	0.117	0.057	0.160
Number of countries	72	43	73	52	75	4	75

Notes: This table reports the estimation results based on data from the World Values Survey. The unit of analysis is individual. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Respondents whose answers are coded as "don't know", "no answer", "missing, unknown", "not asked in survey" and "not applicable" are excluded in the regressions. More details on variables' description are presented in the online appendix.

Table 10. A mechanism analysis

	(1)	(2)	(3)	(4)
Panel A. The effect of LGBT inclusion on innovation, controlling for a channel of influence				
LGBT	**0.173*** **	**0.207*** **	**0.210*** **	**0.226*** **
	[0.041]	[0.047]	[0.046]	[0.059]
Human capital index	3.089***			
	[0.398]			
Years of schooling		0.129***		
		[0.025]		
Cognitive abilities			0.580***	
			[0.102]	
National IQs				0.031***
				[0.007]
Baseline controls	✓	✓	✓	✓
Observations	107	95	65	80
R-squared	0.817	0.778	0.729	0.750

Panel B. The effect of LGBT inclusion on human capital skills, a channel of influence				
	(1)	(2)	(3)	(4)
Dependent variable	Human capital index	Years of schooling	Cognitive abilities	National IQs
LGBT	**0.051*** **	**0.776*** **	**0.128** **	**3.668*** **
	[0.008]	[0.191]	[0.051]	[0.697]
Baseline controls	✓	✓	✓	✓
Observations	107	95	65	80
R-squared	0.631	0.503	0.429	0.513

Notes: Robust standard errors in parentheses. A sensitivity test for the results reported in Panel B of this table is presented in Table A1 in the online appendix. *** p<0.01, ** p<0.05, * p<0.1.