High on Creativity: The Impact of Social Liberalization Policies on Innovation

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Introduction

Many factors determine the rate and direction of innovation. A vibrant body of research has demonstrated that knowledge spillovers (e.g., Lucas, 1988; Glaeser, 1999), agglomeration economies (Shaver and Flyer, 2000; Furman and MacGarvie, 2002; Alcácer and Chung, 2014), search strategies (March, 1991; Rothaermel and Deeds, 2004), mobility (Almeida and Kogut, 1999; Agarwal, Ganco and Ziedonis, 2009; Corredoira and Rosenkopf, 2010; Campbell et al., 2012), and network position (Ahuja, 2000; Burt, 2004) are key factors that determine organizational and regional innovation. However, relatively less attention has been paid to the social attributes of the context in which innovation takes place. The omission is particularly puzzling given the vast literature in organizational sociology, psychology, and political science that highlights the importance of the social context and policies in shaping the interactions of individuals and their creative output (Gilfillan, 1970; Edmondson, 1999; Perry-Smith, 2006; Flores and Barclay, 2016).

The relationship between the social context and innovation is theoretically complex and involve various mechanisms operating in tandem. Meanwhile, the extant research in innovation and strategy has been largely silent on this link. Even in cases where there have been theoretical arguments linking innovation and the social context, robust empirical results have been limited due to data scarcity and significant empirical challenges. For instance, one prominent line of research on social context and innovation is the "Creative Class" theory, which argues that social attributes such as tolerance and openness to diversity can attract creative talent to a region, leading to higher innovative performance (Jacobs, 1961; Florida, 2002a, 2002b; Page, 2007; Florida et al., 2008; Wedemeier, 2015). Despite the popularity of the argument among scholars and policy makers, there remains little empirical evidence for the causal impact of openness on mobility of creative individuals (Glaeser, 2005).[2]

[2] The Creative Class theory has led to the implementation of various social liberal policies at the organizational, city levels to boost innovative outcomes. For example, the Governor of Michigan launched a "Cool Cities" program across the state to

Given the theoretical complexity of the impact of social policies and context on innovation, we use an inductive empirical approach in this paper. However, unlike most inductive papers in management literature that rely on small-N research designs, we use a large-N design. Our approach is similar to a few recent studies in strategy (e.g., Birhanu et al., 2016; Lyngsie and Foss, 2017) and relies on the rich data available on innovation at the state and individual levels, combined with an empirical design that allows us to get closer to the causal effect of social policies on innovation and the potential mechanisms that drive the main effect.

With this goal in mind, we first analyze the impact of two social liberalization policies – the legalization of same-sex civil unions and domestic partnerships, and the legalization of medical marijuana – and one anti-liberalization policy - the passing of abortion restrictions – on the rate and direction of innovation across various states in the United States. The focus on these social policies is motivated by a few factors. First, these policies have recently been at the center of heated policy debates in the United States and various other countries. While some of their economic, social and political outcomes are extensively debated, their impact on innovation has largely been missing from discussion. Second, as we discuss below, there is some evidence showing that these policies do indeed influence the social context and behavior of individuals, hence providing a fertile setting to look more closely into their impact on innovation. Third, the staggered implementation of these policies over time enables us to address some of the empirical challenges surrounding the estimation of the impact of social factors on innovation.

There are two main empirical challenges associated with assessing the impact of these social policies on innovation. Differences in innovative performance after the implementation of a social policy may be attributed to other unobservable factors that drive both changes in

attract and retain "urban pioneers and young knowledge workers who are a driving force for economic development and growth" (Michigan Office of the Governor, 2004). The mayor of Denver bought and distributed multiple copies of Florida's book to his senior staff, while initiating a strategy to rebrand the city as a creative center (Boston Globe, 2004). Atkinson and Easthope (2008) document various attempts to implement the ideas proposed by the Creative Class theory across five Australian cities. The website of The Creative Class Group (http://www.creativeclass.com/), a company founded by Richard Florida to give advisory service based on his theory lists numerous companies as clients and offers several reports of the implementation of the creative class theory in cities and provinces across the globe.

innovation as well as the implementation of the policy. For instance, investment in human capital through education or R&D spending may simultaneously increase both the innovation in a region and the likelihood of the implementation of social liberal policies in that region. One may also be concerned about reverse causality in that the implementation of these policies is triggered by changes in creative outcomes.

To address these challenges, we exploit the staggered timing of each policy across different states in the United States to implement a difference-in-differences (DD) strategy to estimate the causal effects of the (anti) liberalization policies: we compare the changes in patenting of states that have experienced a policy change in a particular year relative to other states with no policy change in that year. During our sample period of 1994 to 2006, 6 states and the District of Columbia legalized same-sex civil unions or domestic partnerships, 11 states legalized medical marijuana, and 34 states passed new restrictions on abortion at different points in time. Our baseline estimates control for state fixed effects and year fixed effects. We also include various longitudinal measures of political orientation, economic conditions, and human capital levels at the state level.

We find that the legalization of same-sex civil unions and domestic partnerships increases state-level patenting by 6%, and the legalization of medical marijuana increases patenting by 7%. In contrast, the passing of an additional abortion restriction reduces patenting by about 1%. A one percent increase (decrease) in patenting per year roughly translates to about 21 additional (fewer) patents per year at the state level. Consistent with our causal interpretation, we find no evidence of any effect before the enactment of the social liberal policies. Our main results are also robust to alternative specifications and falsification tests.

Next, we explore a few potential mechanisms that may explain our state-level results. Our goal here is not to establish a causal relationship between a specific explanatory variable and the outcome of interest. Instead, we follow the *reverse causal inference* approach, as recently advised by Gelman and Imbens (2013), to investigate some of the possible causes of the outcome variable of interest to the extent possible. In particular, we explore three

mechanisms in our setting. The first mechanism is proposed by the Creative Class theory and argues that liberalizations policies attract inventors from other states because inventors have a preference to work and live in regions with more tolerance and openness to diversity (Jacobs, 1961; Florida, 2002a, 2002b; Page, 2007; Florida et al., 2008; Wedemeier, 2015). The second mechanism draws upon the idea that social liberalization policies can influence individuals' attitude towards openness and diversity, leading them to have more diverse social interactions. In turn, more diverse interactions can lead to more diverse collaborations among inventors, and consequently result in higher levels of innovative performance. The third mechanism is built upon the idea that social liberal policies can lead to higher entrance into technology-based entrepreneurship by promoting more diverse social interactions and better access to complementary resources needed for entrepreneurial entry.

We do not find evidence that liberalization policies attract top inventors to a region, as predicted by the Creative Class theory. Our estimates suggest that the enactment of all three policies, regardless of whether they are socially liberal or anti-liberal, on average leads to a net loss of top inventors to other regions. Meanwhile, we show several results that are consistent with the idea that social liberalization policies influence individuals' attitudes towards openness and diversity. At the state level, we show that social liberal policies are associated with several proxies for openness such as the share of localized citations and the pace of regional knowledge diffusion. At the individual level, our results suggest that after controlling for the change in the total number of unique pair-wise collaborations, incumbent inventors increase the formation of new pair-wise collaborative ties by 24% after the implementation of social liberal policies. We also find that collaborations formed after the implementation of social liberal policies are composed of individuals with more diverse knowledge backgrounds. We further restrict our sample to non-mobile incumbent inventors and find that the social liberal policies increase the patenting rate of incumbent inventors while the anti-liberal policy reduces patenting. In addition, our results show that patents filed after the implementation of social liberalization policies are more likely to draw upon novel technological recombinations. We also find evidence suggesting that liberalization policies are associated with an increase in

technology-based entrepreneurship, possibly driven by more diverse social interactions. We find these policies are associated with an increase in the number of unique patenting organizations and appear to disproportionately increase the patenting rate of smaller firms. Speculatively, this suggests that these policies facilitated entrepreneurship entry and benefited smaller firms.

Our results make several contributions. First, our paper highlights the impact of the social context and social policies on the rate and direction of innovation. Discussions going back as early as Schumpeter (1934) note that a key determinant of innovation is an organization's or a society's openness to new ideas and tolerance towards disruptive behavior, or even "rebellion" against the "status quo" (pages 86-94). However, only recently have scholars started to empirically explore the role of social context in promoting or hindering innovation (Acemoglu, 2014; Benabou et al., 2015). Our paper provides one of the first empirical evidence on the relationship between the enactment of social liberalization or anti-liberalization policies and innovation and the mediating role of change in public opinion.

More broadly, our study contributes to the literature that has examined factors that determine regional innovation. A long line of research has demonstrated the role of skilled labor, knowledge spillovers, infrastructure, and intellectual property rights on regional innovation (Shaver and Flyer, 2000; Furman, Porter and Stern, 2002; Galasso and Schankerman, 2010; Alcácer and Chung, 2014; Agrawal et al., 2014, Moretti and Wilson, 2014). Our study emphasizes the role of social policies in promoting regional innovation and as an additional consideration. Our findings also contribute to the literature on the antecedents of collaboration. While most of prior research has largely assumed the composition of inventive teams and the network structure of inventors to be exogenous, we show how the social context and policies can influence interactions among individuals in a region and impact the formation of new collaborative ties.

Finally, our findings contribute to the growing corporate social responsibility (CSR) literature. Recent research has shown the positive impact of CSR practices on the financial

performance of firms (Eccles, Ioannou and Serafeim, 2014; Flammer, 2015). We provide evidence for potential mechanisms through which inclusive policies such as pro-LGBT or pro-marijuana mandates can affect companies' bottom line by positively affecting their innovative performance.

The next section describes each policy and timing of enactment across states. We then describe the data and empirical framework, respectively. We present state-level results of the effect of the three policies on innovation. After documenting a positive effect, we discuss potential mechanisms. The final section offers concluding remarks.

Institutional Background

This section provides institutional details surrounding the two liberalization policies - legalization of same-sex civil unions and domestic partnerships and legalization of medical marijuana - and the one anti-liberalization policy - passing of abortion restrictions.

Same-Sex civil union and domestic partnership legalization

Policies in favor of same-sex marriage (or civil unions and domestic partnerships) are widely associated with liberal mindset and liberal policies (Soule and Earl, 2001; Kane, 2003; Soule, 2004). In the United States, lesbian, gay, bisexual and transgender (LGBT) rights related laws are determined by each state and local jurisdiction. While the federal government traditionally recognizes any marriage that is recognized by the state, the federal Defense of Marriage Act of 1996 explicitly defines marriage as between a man and a woman. In the landmark *United States v. Windsor* case, the Supreme Court ruled on June 26, 2013 that section 3 of the Defense of Marriage Act is unconstitutional and the federal government is required to recognize marriages performed in states where same-sex marriage has been legalized, and provide federal rights, privileges and benefits. As of 2014, thirty-five states and Washington, D.C. offer marriage to same-sex couples. On June 26, 2015, the U.S. Supreme Court ruled in *Obergefell v. Hodges* that state-level bans on same-sex marriage are unconstitutional, thereby making same-sex marriage legal in the entire country.

Because the legalization of same-sex marriages occurred relatively recently (Vermont was the first state to legalize same sex-sex marriage in September 2009) and they all occurred after our sample period, we take advantage of changes in civil union and domestic partnership laws across states. Civil unions and domestic partnerships are a non-religious state-sanctioned form of partnership. Like same-sex marriages before 2015, civil unions do not confer federal benefits and are not recognized under the federal law. Six states and the District of Columbia changed the legal status of civil union and domestic partnerships during our sample period. Table 1 lists the states that changed the status of civil unions and domestic partnerships.[3]

-- Table 1 about here --

Medical marijuana legalization

Legalization of medical marijuana is broadly linked to liberal policies and liberal agendas in the United States and other countries (Haines-Saah et al., 2014; Robinson and Fleishman, 1984). Under the Controlled Substances Act of 1970, cannabis, or marijuana, is classified as a Schedule 1 drug in the U.S., having high potential for abuse, no medical use, and not safe to use without medical supervision. Starting in the late 1970s, several U.S. based advocacy groups attempted to change the drug policy and to decriminalize cannabis. In 2005, over 500 economists, including libertarian economist Jeffrey Alan Miron and Nobel Laureate Milton Friedman, called for legalizing cannabis in an open letter to George W. Bush. They argued that replacing prohibition with a system of taxation and regulation could save substantial state and federal expenditures on enforcement and generate tax revenue annually if marijuana were taxed similarly to alcohol or tobacco.[4]

Medical marijuana legalization policies vary across states. During our sample period, eleven states legalized medical marijuana (Table 2). They have received considerable media attention at the local and national level, in part because many occurred through voter

[3] In many of these states, the legalization of same-sex marriage has since superseded civil union and domestic partnership status.
[4] http://www.prohibitioncosts.org/endorsers/\#sthash.HgXSb66j.dpuf [accessed March 1, 2016]

referendum. The debate remains contentious and ongoing.

-- Table 2 about here --

Abortion restrictions

Support for legal abortion has long been considered as part of the liberal agenda and policies in the U.S. and many other countries (Legge, 1983). While there is no consensus among U.S. residents on whether women should have the legal right to abortion under any circumstance, various polls and surveys by Gallup, Pew Center and other institutes suggest that those who identify themselves as liberal are significantly more likely to be in favor of abortion rights for women (GALLUP, 2013).

From a legal point of view, abortion has traditionally been prohibited across many states during the early 20th century. The landmark U.S. Supreme Court 1973 decision *Roe v. Wade* invalidated the prior prohibitions and set the legal framework for the availability of abortion. The ruling gave women the legal right to have an abortion up to the third trimester. Since then, various states have imposed different forms of restriction on abortion through new state legislatures or amendments to the state constitution. According to the Guttmacher Institute, the number of abortion restrictions across various states in the U.S. has increased substantially over the past two decades (Guttmacher Institute, 2015). The number and extent of restrictions however vary considerably by state and time. They range from extended waiting periods and mandatory counseling, to limitations on insurance coverage and near-total abortion bans (Guttmacher Institute, 2015).

We collect the data on the timing of abortion restrictions passed across all the states from the Guttmacher Institute and various other public sources. In our analysis we use the change in the number of abortion restrictions in each state over time as the proxy for the change in the level of legal barrier for abortion in that state. The number of abortion restrictions across the states range from 0 to 15 during our sample period, with an average of about 5 restrictions and a standard deviation of 3 over the whole sample period. The average number of restrictions

changes from about 4 restrictions in 1994 to 6 in 2006. Figure 1 illustrates the number of enacted abortion restrictions in each state in 1994 and 2006.

Data

Our data is collected from various sources. Following prior research (Fleming, Mingo, and Chen, 2007; Audia and Goncalo, 2007; Vakili, 2016), we use patenting rate as a measure of innovation. To construct the patenting rate at the state and individual inventor levels, we used the Lai et al. (2013) dataset available on the Patent Network Dataverse. The data covers all the patents granted by the USPTO between 1975 and 2010. Due to the long delays between application and grant dates, there is considerable right truncation in the number of granted patents in the last three years of the sample. Given that the truncation problem is likely to be more severe for the states with higher patenting rates, we only used the data for the period between 1994 and 2007. We begin our sample in 1994 based on the availability of data for our control variables and the first legalization date (1996).

We collect data on the legalization dates of medical marijuana and same-sex civil unions and domestic partnerships from various public sources as well as prior research (Wen et al., 2014). Data on abortion restrictions is collected from the Guttmacher Institute (2015) and other online public sources. We also collect the yearly total public expenditure and education expenditure by each state from the U.S. Census Bureau. Data on business R&D per state is retrieved from the National Science Foundation's Science and Engineering Indicators dataset. We obtain data on the number of individuals with a bachelor degree from Census Education Attainment Reports.[5] Data on hate crimes is obtained from the Federal Bureau of Investigation's Uniform Crime Reports.[6] We also collected the data on cross-state population mobility from IRS' SOI Tax Stats.[7]

[5] See https://www.census.gov/hhes/socdemo/education/data/cps/index.html [accessed November 2015]
[6] See https://www.fbi.gov/about-us/cjis/ucr/ucr-publications\#Hate [accessed November 2015]
[7] See https://www.irs.gov/uac/soi-tax-stats-migration-data [accessed February 2017]

Empirical Design

Same-sex civil union and medical marijuana legalizations occurred at different times across states. Various states have also passed additional restrictions at different points in time. We exploit the variation in these timings to estimate the causal effect of each policy on innovation outcomes. Our strategy is similar in spirit to a differences-in-differences (DD) strategy, where we compare the changes in the outcomes of states that have experienced a policy change in a year to other states that have not had the same change at the same time.

To examine the impact of social liberal policies on state-level patenting rate, we estimate the following specification (Equation 1):

$$(1)\ Y_{st} = \alpha + \beta Legalization_{st} + \theta X_{st} + \delta State_s + \mu Year_t + \epsilon_{st}$$

where Y_{st} is the logged number of patents (plus 1) in state s in year t. The log normalization is used to address the skewedness in the distribution of patenting rates across states. In the case of the two social liberalization policies, $Legalization_{st}$ is equal to 1 after state s implements the social liberal policy of interest in year t. In the case of abortion restrictions, $Legalization_{st}$ is equal to the number of abortion restrictions in effect in state s in year t. β is the key coefficient of interest and captures the effect of each policy on state-level patenting rate. In the case of the two social liberalization policies, β captures the relative change in patenting rate after the policy change in a state. In the case of abortion restrictions, β captures the relative change in patenting rate due to the passage of an additional abortion restriction. X_{st} is a vector of economic and political orientation controls that are state-specific and time-varying, such as population, total state expenditure, share of education expenditure, business R&D expenditure, the size of state population with at least a bachelor degree, real per capita personal income, housing price index, income and corporate state tax, the share of democrats in the state senate and house, and the party affiliation of the state governor. $State_s$ and $Year_t$ are state and year fixed effects, respectively. State fixed effects control for all time-invariant differences between states, such as geographic characteristics and political orientation. Year fixed effects control

for changes over time that affect all states similarly (e.g., national policy changes, macroeconomic growth). We employ ordinary least squares (OLS) and cluster standard errors by state to adjust for autocorrelation within states in all of our specifications (Bertrand et al., 2004).

In order to explore some of the potential mechanisms, we largely rely on similar empirical design and estimation models at the state or individual level with different dependent variables. These models are discussed in more detail when we explore each potential mechanism.

State-Level Results

Table 3 provides the summary statistics for our main variables between 1995 and 2007. An average state produces 2,088 utility patents per year and has 2,828 inventors, as multiple inventors contribute to the same patented invention. About 32% of patents in the sample have zero citations and on average, each patent has 7 citations.

-- Table 3 about here --

States on average have an annual spending expenditure of $22.5 billion, of which approximately 32% is spent on education at primary, secondary and post-secondary levels. On average businesses and other institutions spend about $4.8 billion on research and development at the state-level. The average state population is about 5.6 million, out of which 16% has a bachelor (or higher) degree. The real per capita personal income – deflated with the national CPI (1982-1984 dollars) – is about $17,000. Average housing price index is 2.6. The average income tax is approximately 3% and the average corporate tax is just above 15% at the state-level. About 40% of the state governors are democrats, and democrats and republicans have roughly similar shares in the state senate and house over our sample period. There is considerable variance across states in these figures.

Table 4 reports our main results on the impact of the three policies on the log-normalized patenting at the state-level. All three policies have a significant effect on state-level

patenting and the magnitudes are economically meaningful. Both the legalization of same-sex civil unions and domestic partnerships and the legalization of medical marijuana increase patenting at the state-level by 6% and 7%, respectively. In contrast, the passage of an additional abortion restriction reduces patenting by about 1% during the sample period. One percent increase (decrease) in patenting is roughly equivalent to 21 more (fewer) patents per year at the state level. Most controls are insignificant due to their small within-state variance over time.[8]

-- Table 4 about here --

So far, our analysis has assumed that the timing of these policies is uncorrelated with factors that determine the outcomes of interest, conditional on the baseline controls. However, our estimates may suffer from reverse causality. In other words, it may be the case that states with higher patenting rate were more likely to implement social liberal policies and that what we are capturing is simply a continuation of trends started before these policy changes. To test this possibility, we conduct several analyses.

First, we examine the state-level patenting rates before and after policy changes. In the case of reverse causality, we should be able to observe pre-trends in state-level patenting in years leading to policy changes. To investigate the presence of pre-trends, we plot the yearly treatment estimates associated with the legalization of medical marijuana and the legalization of same-sex civil unions and domestic partnerships at the state level (Figures 1 and 2, respectively). Each point on these graphs is the estimated difference in log-normalized patenting between treated and control states in the years before and after the policy change. Both graphs show an increase in patenting at the state-level starting 2 to 3 years after the policy change. There is little evidence of upward trends before the implementation of the two social liberal policies.[9]

[8] Subsequent analyses include the full set of controls but we suppress them in the tables. The tables with full set of controls are available upon request.

[9] We cannot produce the yearly treatment graph for abortion restrictions because there are many instances of abortion restrictions in a state over time and thus there are no obvious pre- and post- periods.

-- Figures 1 and 2 about here --

We also run a series of falsification tests in the spirit of those performed by Bertrand et al. (2004), whereby we assign a hundred random placebo legalization dates for each state in the sample. Since the placebo legalization dates are selected randomly, we should see a significant effect (i.e., rejecting the null hypothesis that legalization had no effect) at the 5 percent level roughly 5 percent of the time. We obtained significant estimates for the placebo treatments only 4 percent of time, which suggest that our main findings are not driven by spurious trends in the data and are indeed linked to the observed policy changes. We also implemented a hazard rate analysis, where we examine whether past patenting rate could predict the timing of the implementation of these policies. The results show no significant relationship between past patenting rate and the timing of legalization events in our sample (available in Table A1 in the appendix).

Another concern is that the estimates may be driven by other concurrent policy changes that may increase innovation. To address this potential issue, we checked various public records to see if we can identify simultaneous policy changes in the states that have implemented each of these legalizations. We do not find consistent evidence of simultaneous policy changes at the state level. Moreover, our set of controls should at least partially capture the effect of unobserved policy changes that impact patenting through increased public spending, R&D expenditure, education, average income and living costs, and political affiliation. In short, while we cannot wholly rule out its possibility, we do not find evidence that suggests our estimates are fully driven by other concurrent policy changes.

Finally, in order to extend the external validity of our results, we repeat our state-level findings using a different measure of creative outcome. In unreported appendices, we estimate the effect of each policy on the total gross domestic product per capita from the "arts, entertainment, recreation, accommodation, and food services" (called "art product per capita"), a sub-category of total GDP per state reported annually by the Bureau of Economic Analysis. While this measure is not ideal since changes over time may be driven by changes in the

demand or supply of creative outputs and the measure includes items not commonly associated with creative outcomes (e.g., food services), we find consistent estimates to patenting. Overall, the findings indicate that both liberalization policies have a positive impact on patenting at the state-level, whereas an additional abortion restriction reduces patenting.

Explaining the Effect of Social Liberalization Policies on Innovation

Having established a robust relationship between social liberal policies and state-level patenting, we now turn to three potential mechanisms that can explain the positive effect of social liberalization policies on innovation. We then discuss other mechanisms that we do not explore in this paper.

Mechanism 1: Social liberal policies and mobility

Florida (2014) defines creative class as who are active in creative occupations such as research, engineering, art, entertainment, acting, design, entrepreneurship and management.[10] In a series of works, Florida and colleagues show that individuals belonging to the creative class have on average higher wages and salaries (Florida 2014), disproportionally contribute to economic development of regions (Lee, Florida and Acs, 2004), and are the main producers of creative output (Florida et al., 2008; Florida, 2014). The Creative Class theory argues that creative individuals on average have a taste for certain values, like meritocracy, diversity, and openness. Hence, the theory suggests that for companies, cities, states, and countries to attract creative talent and have higher levels of creative output, they need to devise social liberal policies that promote diversity and openness to different life styles and ideas.[11] If inventors have a taste for more liberal policies, as suggested by the Creative Class theory, we should expect an increase in their movement to states that implement these policies. In contrast, we should see an increase

[10] While all innovators fall into the creative class, the category itself is broader than only innovators.

[11] While the creative class argument has had considerable impact both outside and inside academia, it has also received criticism due to the vagueness of its measures (e.g., "Creative Class", "Bohemian Index") and endogeneity concerns surrounding the relationship between Florida's measures of tolerance and creative outcomes. For example, in his review of Florida's "The Rise of the Creative Class", Glaeser (2005) uses Florida and Knudson (2005)'s data to show that the estimated effect of bohemians in a metropolitan area on growth is economically and statistically insignificant after controlling for the fraction of educated adults.

in the number of inventors leaving a state if the state passes additional abortion restrictions.

To examine the impact of social liberal policies on the mobility of inventors, we estimate the following specification (Equation 2):

$$(2)\ Y_{s_1 s_2 t} = \alpha + \beta Legalization_{s_1 s_2 t} + \theta X_{s_1 t} + \theta X_{s_2 t} + \delta State_{s_1 s_2} + \mu Year_t + \epsilon_{st}$$

where $Y_{s_1 s_2 t}$ captures the number of inventors that moved from state s_2 to state s_1 in year t. We capture mobility based on changes in the location of inventors recorded on patents filed in different years. Since a median inventor has only one patent in our sample, the sample of mobile inventors is highly skewed towards top 15% inventors in the sample. Because of this limitation, we cannot observe the cross-state mobility of the potential to-be inventors in our sample. Hence, we can only test the mobility argument for the sample of top inventors. Below, we attempt to address this shortcoming by using complementary data sources. In the case of the two social liberalization policies, $Legalization_{s_1 s_2 t}$ captures the difference in the legalization status of state s_1 and state s_2 in year t. The value switches to 1 if state s_1 implements the policy in year t while it is not yet implemented in state s_2, and switches to -1 in the reverse scenario. It is equal to 0 if both states have a similar policy status. In the case of abortion restrictions, $Legalization_{s_1 s_2 t}$ is equal to the difference in the number of abortion restrictions in effect between state s_1 and state s_2 in year t. β is the key coefficient of interest and captures the effect of a change in policy status between s_1 and s_2 on the mobility of top inventors from state s_2 to s_1. We also include the full set of controls for each state (and hence their differences). All estimations include state-pair dummies, $State_{s_1 s_2}$, that would control for the time-invariant differences between each pair of states (such as their geographical distance) that could affect mobility between them.

Columns 1 to 3 in Table 5 present the results for the effect of each policy on the mobility of top inventors across states. A negative net flow to a state means that the state has on average lost a net portion of its top inventors to other states due to policy implementation. In contrast, a positive flow means that the state has attracted other states' top inventors after the policy

implementation. The estimates suggest that the effect of liberalization policies on inter-state net mobility of top inventors is inconsistent with the mobility arguments of the Creative Class theory. The direction of effects for the two liberalization policies is the opposite of what the Creative Class theory predicts with wide confidence intervals. The direction of the effect for the anti-liberalization policy is in line with the Creative Class prediction, but the size is small and close to zero. To corroborate our findings, we also restructured the data at the state-year-level and estimated the aggregated net flow into and out of each state in each year using an estimation model based on equation 1 (Table A2). Again, we do not find results consistent with the Creative Class mobility argument.[12]

-- Table 5 about here --

The main concern with these estimations is that the sample only includes top 15% inventors, hence potentially excludes the mobility of to-be inventors. To address this issue, we performed the analysis based on two other measures of mobility. We first used the cross-state mobility data based on tax records provided by the IRS' SOI Tax Stats. The data is constructed based on individual tax records for the entire population of the United States and covers our sample period. The downside of using this data is that it includes the whole population and not just the creative class. On the positive side however, the data is much more reliable and does not suffer from the usual false positives and false negatives of measures based on patent data (Ge et al., 2016). Using the estimation model in equation 2 (based on a state-pair structure), we re-estimated the mobility of population as the result of the three policies. The results are reported in columns 4 to 6 in Table 5. Again, the estimates are not consistent with the creative class mobility hypothesis. The direction of the effects for the legalization of same-sex civil unions and domestic partnerships and for the passage of additional abortion restrictions are the opposite of what the Creative Class theory would predict.

[12] The effects might be driven by a couple of factors. Top inventors may have a preference for political stability and thus react negatively to policy change. Further, while the loss of top inventors after the passage of additional abortion restrictions may be due to their distaste for anti-liberalization policies, the negative effects associated with liberalization policies may be driven by the tougher competition that they face from new entrant inventors following legalization. Overall, there is limited research on the impact of social policies on state-level migration. Past research has largely looked at economic factors such as tax policies and housing prices.

We also constructed a third measure of mobility based on two sets of education data: 1) the total number of individuals with a post-secondary degree in state s in year t, and 2) the number of individuals who received a post-secondary degree from state s in year t. Using these two sets of data, we calculated the net number of individuals with a post-secondary degree that moved to (or left) state s in year t. While this dataset does not capture the whole creative class population, it captures the part of population that is likely to be at risk of patenting, assuming that post-secondary education is usually needed for one to become an inventor. The results are reported in Table A3. Again, in the cases of both liberalization policies, the direction of effects is opposite of the creative class prediction. None of the effects are significant at the 10 percent level.

We performed an additional complementary hazard analysis at the individual level to test the robustness of our estimates. The results, presented in table A4 in the appendix, show no effect of legalization on the hazard of moving at the individual level. Taken together, we do not find support for the creative class argument that the implementation of social liberal policies would attract top talent from other regions. One should note that the lack of support for the Creative Class argument in our setting does not invalidate the theory. Inventors are only a subsample of the creative class population and they may perceive and react to these policy changes differently from other creative workers. Research based on more accurate data on the mobility of to-be inventors and the heterogeneous effects of these policies may also shed more light on inventors' mobility.

Mechanism 2: Social liberal policies and interactions among diverse individuals

The second potential mechanism that can explain the effect of social liberal policies on innovative outcomes is based on the argument that social liberal policies can influence social liberal public opinion and individuals' public opinions affect their social interactions. In particular, people with social liberal views are associated with social interactions with a more diverse set of individuals, and more diverse interactions can subsequently affect their innovation output through more diverse collaborations.

Over the past few years, public policy scholars have provided substantial empirical evidence that social liberal policies influence social liberal public opinion. For instance, Kreitzer et al (2014) show that the Supreme Court ruling in *Varnum v. Brien* which established same-sex marriage had a causal and significant effect on public opinion of minority rights. They argue that the signalling of the court decision shifted individuals' opinions toward being more consistent with the new state law, particularly for individuals who were on the margin. Hanley et al (2012) find that the *Roe v. Wade* decision shifted the public support towards more support for abortion among those who were aware of the decision. Flores and Barclay (2016) show that residents of states that legalized same-sex marriage subsequently significantly reduced their anti-gay attitudes. They suggest that consensus and legitimacy are the plausible mechanisms behind the effect. Other research in sociology and political science shows that social liberal policies are associated with higher levels of social diversity, increase general trust, and promote interactions between individuals with more heterogeneous views, life styles, and racial-ethnic backgrounds (Woolcock and Narayan, 2000; Levi, 1998; Tendler and Freedheim, 1994; Heller, 1996; Szalacha, 2003). Hence, social liberalization policies can impact the public opinion of a region towards openness and diversity.

Individuals' public opinions affect their social interactions and behaviors. For example, studies in sociology and psychology have shown that liberal individuals are more likely to be in favor of social change and equality, while non-liberals usually place more emphasis on tradition and stability (Tetlock, 2000; Jost et al., 2003; Schwartz,1996). Particularly relevant to our argument, liberal views are shown to be strongly associated with more diverse social interaction. Anderson et al., (2014) find that individuals with stronger liberal views express lower levels of same-race preference (i.e., racial homophily) for their dating partners and are more likely to date individuals from a different race than those with more conservative views. Work on applied psychology suggest that individuals' attitudes toward diversity shape their

social interactions (Perrine, 2005).[13]

Given individuals with more liberal attitudes have more diverse social interactions, it is not surprising that they would also have more diverse collaborations, which impacts the rate and direction of their innovative outputs. Prior research in strategy and innovation has highlighted the importance of diversity in knowledge, background and perspectives in the innovation process (Hong and Page, 2004; Jeppesen and Lakhani, 2010). Diverse teams tend to have higher performance than homogenous teams because individuals on diverse teams are more likely to evaluate problems differently and have less redundant knowledge (Hong and Page, 2004; Burt, 2004). Given that knowledge recombination is central to the innovation process (Simonton, 1999; Fleming, 2001; Kaplan and Vakili, 2015), more diverse collaborations that combine distinct knowledge and ideas are more likely to produce more breakthrough innovation.

In summary, social liberal policies can influence the views of individuals towards openness and diversity. Consequently, they can increase the diversity of individuals' social interactions and collaborations, which can in turn boost individuals' innovation output and result in more novel knowledge recombinations and more breakthrough innovations.

We first present state-level evidence that social liberalization policies can impact the state-level innovation outcomes by influencing public opinion. In particular, we use a measure of public opinion, developed by Enns and Koch (2013)[14] to show that the effect of these policies on state-level patenting rate is at least partially mediated through changing the liberal views of individuals using a generalized structural model (Figure A1 in the appendix). Furthermore, we also constructed two other measures of openness at the state-level based on patent data to more closely estimate the impact of these policies on openness within the innovation context. The first measure is based on the measure developed in Gambardella and Girratana (2010). The

[13] Perrine (2005) find that freshmen students who were more open to diversity during orientation week tended to develop more interpersonal interactions with other students and faculty and improved their learning outcomes.
[14] Enns and Koch (2013) use demographic and geographic information from more than 740,000 respondents to generate a dynamic state-measure of partisanship, ideology, and the public's policy mood from 1956 to 2010. We use a mean centered and standardized version of their measure.

measure is based on the ratio of the local citations by each patent to prior patents with at least one inventor in the same city as focal patent's inventors over the total number of citations by that patent to previous patents. At the state level, we construct the measure as the average share of local citations for all patents filed in each state in any given year. An increase in social interactions and diversity of interactions in a location should arguably lead to an increase in local knowledge diffusion, which would manifest in an increase in the share of local patent citations (Gambardella and Girratana, 2010). Columns 1 to 3 in Table 6 present the estimated effects of each policy on the share of local citations at the state-level. The results confirm this argument. Approximately 5.8% of the citations in each state are local (i.e. are to prior patents with at least one inventor in the same city as the focal patents' inventors). The estimates suggest that the liberalization of same-sex civil unions and domestic partnerships, and the liberalization of medical marijuana increase the share of local citations by 15% and 11% respectively. The increase is equivalent to approximately 1 percentage point increase in the share of local citation. The estimated effect of the passage of additional abortion restrictions is not significant but is in the predicted direction.[15]

-- Table 6 about here --

The second measure is based on the pace of knowledge circulation in each region. If social liberal policies do indeed lead to more openness and social interactions among inventors in a region, we should expect an increase in the pace of knowledge diffusion. We use the time gap (measured in number of days) between the application date of each patent and the application dates of patents cited as prior art as a proxy for the pace of knowledge diffusion. We then constructed the measure at the state level in any given year by calculating the mean time gap for each patent and its prior arts filed in that state-year. We expect the time gap to shrink if the pace of knowledge circulation in a region increases. The average time gap between

[15] The measure is somewhat noisy due to the use of city names to construct the measure. For example, while in practice a citation from an inventor in San Francisco to another inventor in Berkeley is arguably a local citation, due to our reliance on city names, such a citation would be considered non-local. We do not expect the noisiness in data to be systematically biasing our estimates, but they can increase the standard deviations of the estimated coefficients, working against us finding significant effects.

patents and prior arts at the state-year level is approximately 3329 days (or 9.1 years) during our sample period. The results in columns 4 to 6 of Table 6 suggest that the legalization of same-sex civil unions and the legalization of medical marijuana decreases the time gap by 10% and 3% (equivalent to 340 days and 112 days), respectively. The estimated effect for the additional abortion restrictions is not significant at the 10 % level, but the direction of the effect is in line with the prediction.

In addition, we exploit the variation in acceptance of the subject matter of the two liberalization policies at the time of their implementations in treated states to explore the role of public opinion in shaping the effect of these policies on innovation output. The core idea is that in states where public opinion is already largely aligned with these policies, their implementation will not cause a large change in public opinion and hence should not have a large effect on innovation output. In contrast, we should expect larger effects in states where the subject matter of these policies is more contested and hence there is arguably more room for the legalization events to influence the public opinion.[16] The results are presented in Table A5. The estimates in the first column suggest that the legalization of the same-sex civil unions and domestic partnerships have larger effects in states where the crime rates based on sexual orientation are higher. The preceding analyses suggest that social liberalization policies can impact the state-level innovation outcomes by influencing public opinion, and their effects are larger in states where the public opinion is less aligned with the policies.

We then present individual-level evidence on the effect these policies. To isolate the causal effect of each policy on individual inventors, we only include incumbent inventors in the sample, i.e., inventors who had at least one patent prior to a policy change in their state of

[16] In the case of medical marijuana legalization, the issue was put to ballot vote in the majority of states (eight out of eleven). In our estimations we exclude the three states that passed the legalization laws through senate and house voting. In the cases of the legalization of same-sex civil unions and domestic partnerships, and the passage of additional abortion restrictions, the policy changes have been largely passed through senate and house voting where votes are along party lines. This makes senate and house voting less useful for our identification strategy. Instead, we proxy for the level of social acceptance of same-sex civil unions and domestic partnerships using FBI data on hate crimes based on sexual orientation. We assume lower rates of hate crime based on sexual orientation indicate more acceptance of same-sex marriage. Alternatively, higher crime rates show higher resistance against the issue and potentially more room for the policy to have an effect. We cannot use this strategy in the case of abortion restrictions since there are multiple treatments for a state over time.

residence. We also exclude mobile inventors to control for the mobility dynamics to the extent possible. In the case of abortion restrictions, since some states have passed additional abortion restrictions at different points of time, we only include inventors that have at least one patent before the first event in our sample and never change their state throughout the sample period. We thus expect the estimates associated with additional abortion restrictions to be noisier and more attenuated due to more restrictive sampling and the longer time needed to observe the effects. To estimate the impact of the policies on inventor level outcomes, we use the following equation:

$$(3)\ Y_{ist} = \alpha + \beta Legalization_{ist} + \theta X_{ist} + \delta Inventor_i + \mu Year_t + \epsilon_{ist}$$

where Y_{ist} is the outcome of interest for inventor i (residing in state s) in year t. $Legalization_{ist}$ is equal to 1 if inventor i is located in a state s that has implemented the policy of interest in year t, and 0 otherwise. Again, in the case of abortion restrictions, $Legalization_{ist}$ is the number of abortion restrictions in effect for inventor i located in state s in year t. X_{ist} includes time-varying state-level controls from the above specification as well as inventor experience measured by the number of patents granted to inventor i in a five-year window. In addition, we control for inventor and year fixed effects ($Inventor_i$ and $Year_t$, respectively).

First, we test the effect of each policy on the patenting rate of incumbent inventors. Table 7 reports the results for the impact of each policy on the logged-normalized patenting of non-mobile incumbent inventors. The estimated coefficients suggest that the legalization of same-sex civil unions and domestic partnerships increase individual patenting by approximately 2.9%. Similarly, legalization of medical marijuana increases incumbent inventors' patenting by over 4.6%. In contrast, the passage of an additional abortion restriction reduces individual patenting by approximately 0.1%.

-- Table 7 about here --

Next, we test the impact of the three policies on collaboration diversity of inventors. We use two different measures of diversity in collaboration. The first measure is based on the number of new collaborative ties formed by each inventor. A pair-wise collaboration between inventor i and another inventor is considered new if no such collaboration has occurred between 1976 (the first year in both Lai et al. and NBER patent datasets) and year $t-1$. We only use unique observations of pair-wise collaborations. In other words, if inventor i collaborates with the same person on two different patents in the same year, we count only one unique collaboration.

The second measure captures the diversity in the knowledge base of inventors involved in each patent at the individual level. To construct the measure, we first extracted the set of technological classes in which each inventor and her co-inventors have patented prior to focal patent on which they are collaborating. For each inventor and her co-inventors, we then calculated the breadth of inventive experience of the team as measured by the count of unique technological classes in which they have patented before. We then take the mean of this measure across all patents of each inventor in any given year to construct the new variable. An increase in the co-inventors' knowledge breadth signals an increase in the diversity of knowledge that the focal inventor gains access to through collaboration. In all estimations, we further control for the total number of pair-wise collaborations for inventor i in year t to capture the effect of each policy on collaboration diversity above and beyond its effect on the total number of collaborations.

Models 1 to 3 in Table 8 report the estimated effect of each policy on the number of new collaborative ties formed by incumbent inventors. The estimates suggest that the legalization of same-sex civil unions and domestic partnerships lead to a 22% increase[17] in the incumbent inventor's new pair-wise collaborative ties. The change in the number of new collaborative ties is above and beyond the change in the total number of collaborative ties.

[17] The percentage increases are calculated based on the mean number of new collaborative ties for the inventors included in each regression. The mean values used for each regression are slightly different from those reported in Table 3 since the set of incumbent inventors changes depending on the implementation date of each policy.

Similarly, the legalization of medical marijuana leads to an increase of approximately 17% in incumbent inventor's new collaborative ties. The estimate for the passage of abortion restrictions is not significant at the 10% level. Models 4 to 6 present the estimated effects of each policy on the average knowledge breadth of co-inventors. Incumbent inventors on average have worked in inventive teams with a prior experience of patenting across more than 3 technological classes. The results suggest that the legalization of same-sex civil unions and the legalization of medical marijuana increase technological breadth of inventive teams involving incumbent inventors by approximately 1% and 5%, respectively.[18] The estimated effect for the passage of additional abortion restrictions is not significant at the 10% level, though the sign is consistent with the prediction. Thus, while we do not provide direct evidence that social interactions of individuals increased after the implementation of social liberal policies, we find empirical support that these policies are associated with more diverse collaborations.

-- Table 8 about here –

Next, we estimate the impact of each policy on the share of novel recombinations and the number of breakthrough innovations. The U.S. Patent Office organizes technological domains into approximately 100,000 technological subclasses and assigns one or more subclasses to each patent. Following Fleming, Mingo and Chen (2007), we define a novel technological recombination as an instance where a new subclass pair is assigned for the first time to a patent. For each patent, we then define the share of novel recombinations as the ratio of novel subclass pairs to total subclass pairs assigned to the patent. We subsequently construct inventor i's share of novel recombinations in year t by taking the mean of the share of novel recombinations in i's patents in year t. To calculate the share of breakthrough inventions, following prior research, we use the share of inventor i's patents that belong to the top 10% highly cited patents in year t. Table 9 reports the results. The results in Model 1 suggest a 0.2 percentage point increase in the incumbent inventors' share of novel recombinations after the

[18] The percentage increases are calculated based on the mean technological breadth of inventive teams for the inventors included in each regression.

legalization of same-sex civil unions and domestic partnerships. Given that approximately 2 percent of all class recombinations are novel in the sample, a 0.1 percentage point increase is equivalent to an average 5 percent increase in the share of novel recombinations. Similarly, the estimates in Model 2 suggest a 0.3 percentage point increase in the incumbent inventor's share of novel recombinations after the legalization of medicinal marijuana. The estimated effect is not significant at the 10% level for the passage of additional abortion restrictions. Models 4 to 6 in Table 9 report the effect of each policy on the share of breakthrough innovations. The results in Model 4 suggest that the effect of same-sex civil unions and domestic partnerships on the share of breakthrough innovations is positive, but not significant at the 10% level. The estimates in Model 5 show a 0.4 percentage point increase in incumbent inventor's share of breakthrough innovations after the legalization of medical marijuana. Results in Model 6 suggest that an additional abortion restriction reduces incumbent inventor's share of breakthrough innovations by 0.1 percentage points.

-- Table 9 about here --

Finally, we test whether the policy effects on innovation rate, novel recombinations and breakthrough innovations are mediated through the change in collaboration patterns. Figures A2 and A3 present the results for the mediation analyses in the cases of the legalization of same-sex civil unions and domestic partnerships and the legalization of medical marijuana. They suggest that more than 70% of the effect of these policies on rate, novelty and impact of innovation outcomes is driven by the increase in the diversity of incumbents' collaborations (as measured by the share of new collaborative ties and inventive team's knowledge diversity). While these results do not provide causal evidence on the relationship between the policies and outcomes, they provide a more fine-grained depiction of the chain of effects at the individual level and are consistent with the idea that social liberal policies are associated with more diverse collaborations, which in turn can lead to more novel and impactful innovations.

Mechanism 3: Social liberal policies and entrepreneurship

By promoting more diverse social interactions, social liberal policies can also facilitate higher rates of entrance into entrepreneurship. Access to more diverse connections can enable individuals to receive more timely information on entrepreneurial opportunities, an important driving factor of entrepreneurial entry (Burt, 1987, 2004). Moreover, individuals with more diverse interaction are more likely to find and mobilize the complementary resources, including financial human, and physical capital, needed to start an entrepreneurial venture (Burt, 2000). To the extent that a social liberal policy lowers discriminatory behavior, it can facilitate their access to the labor market and more mainstream channels for raising capital, further supporting their entrepreneurial activities. Higher rates of entrepreneurship, particularly in high-tech segments, can further lead to higher levels of innovation undertaken by new ventures.

One should note that the impact of social policies on incumbent inventors is not fully separate from their impact on entrepreneurial entry. Both rely on an increase in diverse social interactions at the individual level. Moreover, entrepreneurial entry may be partly driven by incumbent inventors starting their ventures. However, the two have some theoretical distinctions. The former effect largely relies on knowledge recombination advantages created by more diverse networks. The latter relies more on access to complementary resources and better access to labor and capital markets.

Empirically testing the impact of social liberal policies on entrepreneurship and its underlying mechanisms require rich data on new ventures, the characteristics of entrepreneurs, and their network structure. Unfortunately, our data does not allow us to observe this information. Nevertheless, we can provide some indirect evidence for the impact of the social policies on entrepreneurship in our setting. Specifically, we use the number of new firms patenting in a state as a proxy for entrepreneurship. We use the assignee information on a patent to identify the organization to which the patent is assigned. Location of inventors on each patent

is used to determine the state location of each organization.[19]

Table 10 presents the estimated impact of each policy in our setting on the number of patenting organizations at the state level using the estimation model in equation 1. The results show that the legalization of same-sex civil unions and domestic partnerships and the legalization of medical marijuana increase the number of patenting organizations in each state by 9% and 12%, respectively. In contrast, the passage of an additional abortion restriction decreases the number of patenting organizations in a state by approximately 1%. All three estimates are significant at the 1% level. Our mediation analysis (presented in Figure A4 in the appendix) further suggests that the change in individuals' liberal views partially mediates the effect of each policy on new patenting organizations. In Table 11 we explore the effect of these policies by organization size. The results suggest that social liberal policies disproportionately increase the effect on the patenting rate of smaller organizations (where the size is proxied by the size of patent stock at the time of policy implementation), while they disproportionately decrease the effect on larger organizations.[20] Taken together with the extensive margin effect from Table 11, these results suggest that social liberal policies may have facilitated entrepreneurship entry and disproportionately benefited smaller firms.

-- Table 10 about here --

Our measure of entrepreneurial entrance has some limitations. Most importantly, if an established organization starts patenting for the first time, it will be identified as a new venture in our data. Unfortunately, we cannot separate new ventures from large organizations that patent for the first time after a policy change using patent data. Hence, the readers should interpret this result with caution. We hope that future research can investigate the link between social policies and entrepreneurship more extensively.

[19] Note that many companies register their headquarters in states other than where they actually operate for legal and tax purposes. To address this issue, we use the state location of inventors to assign organizations to states. An organization may be assigned to multiple states if its inventors reside in multiple states.

[20] In the case of abortion restrictions, we cannot construct the "size of patent stock" since there are several states with multiple restrictions implemented at different points of time.

-- Table 11 about here --

Other mechanisms

So far, we have explored three possible channels through which social liberal policies could influence innovation. There are potentially other mechanisms that we have not tested here. For example, the social liberal policies may influence the incentive structure for innovation within firms and their hiring and promotion policies by affecting the views of their CEOs and the management layer. Past research shows that firms whose managers have more liberal views are more likely to have gender parity in hiring and promotion rates (Carnahan and Greenwood, 2017). These policies may also directly influence the motivations of creative individuals. Legally mandated social policies, similar to those in our setting, can also affect discriminatory behavior which can have important labor productivity outcomes.

In addition, these policies can lead to reallocation of resources that differentially impact some organizations and individuals. Our aim in this paper is not to unravel all the possible mechanisms behind the estimated first-order effect of social policies on innovation. Rather, our goal is to establish the significant role of social policies in shaping innovation outcomes across regions and to take a first step towards exploring some of the possible underlying mechanisms.

Discussion

Innovation is shaped by the social interactions of individuals. Yet, little is known about how social policies and context influence innovation. Our paper documents the first-order impact of social policies and context on innovation. To address the endogeneity issues, we exploit the staggered timing of two social liberal policies - the legalization of same-sex civil unions and domestic partnerships and the legalization of medical marijuana - and one anti-liberalization policy - the passage of abortion restrictions - across different states of the United States. The results show that the two social liberalization policies have a significant, positive, and economically meaningful effect on state-level innovation output, while passage of additional abortion restrictions has the opposite effect.

We also test three possible mechanisms through which social (anti) liberal policies can influence innovative outcomes in a region: attracting talent from other regions, increasing incumbent inventors' innovation output through promoting more diverse social interactions, and increasing entrance into entrepreneurship. We do not find support for the claim that regions with more liberal environments attract creative talent from other regions. Our estimates suggest that the enactment of all three policies, regardless of whether they are socially liberal or anti-liberal, leads to a net loss of top inventors to other regions. However, we find support for the argument suggesting that social liberal policies can promote more diverse social interactions, potentially through promoting more openness towards diversity. Our results show that social liberal policies increase incumbent inventors' innovation output, the diversity of their collaborations, and consequently the novelty and impact of their innovations. Speculatively, we also find evidence for the positive impact of social liberal policies on entrepreneurship.

Our analyses are not without its limitations. While we have attempted to provide evidence of micro-mechanisms at the individual and state level that drive the main results, there are many steps between the implementation of the policies and innovation outcomes. Thus, there is still the concern that changes in individual outcomes are attributed to other concurrent policies at the regional level. Moreover, we lack fine-grained data on the mobility of to-be inventors, which precludes us from teasing out the channel through which social liberal environments impact the mobility of inventors. Our mobility estimates also ignore the possible heterogeneity in inventors' mobility decisions in response to these policies. For instance, experienced inventors may have lower location switching costs or they may face increasing competition from the entrance of new inventors. For these reasons, we are limited in our ability to provide causal evidence on the underlying drivers of social liberal policies on innovation. Nevertheless, we provide one of the first empirical evidence for the impact of social liberal policies on innovation outcomes at the state and individual levels.

Our findings have several other implications as well. From a theoretical point of view, we provide additional insight into the antecedents of collaborative ties within the innovation

context. Prior research has largely assumed teams and inventive ties as given and focused on the consequences of team composition on innovation outcomes. Here we take a step back and show how the social context within which innovation takes place can shape the inventive collaborations among individuals and thus influence innovation. Our theory builds upon the idea that innovation for the most part is a social process (Gilfillan, 1970; Perry-Smith, 2006). Social interactions among individuals play a crucial role in facilitating knowledge transfer, knowledge recombination, idea evaluation and innovation execution. Moreover, past research shows that teams, rather than lone individuals, are increasingly becoming the dominant source of innovation (Wuchty, Jones and Uzzi, 2007). Increasing the diversity of interactions among individuals in a social context can hence increase the diversity of interactions through the innovation process within that context, leading to more innovative outcomes, more novel recombinations, and potentially more breakthrough innovations.

Our results have implications for the location decision of firms as well. Prior literature on location decisions largely emphasizes the role of knowledge, human capital and other agglomeration factors in shaping the location decision of firms (Shaver and Flyer, 2000; Alcácer and Chung, 2007). Our results suggest that the effect of social liberal policies at the regional level operate, at least partially, at the individual level and through the interactions of individuals in that region. This highlights the importance of considering the social environment of a region when making location decisions.

At the firm level, our findings also inform the literature on corporate social responsibility (CSR). Recent studies have provided some evidence for the positive effect of CSR practices on the financial performance of companies (Eccles, Ioannou and Serafeim, 2014; Flammer 2015). Past research shows how CSR can increase employees' morale (Soloman and Hansen, 1985) and appeal to employees' preference for non-pecuniary benefits by adding purpose and meaningfulness to their work (Burbano, 2016). Our findings add a new potential mechanism through which CSR can positively influence firms' financial performance. In particular, our findings suggest that the CSR practices that particularly

promote diversity and inclusive employment at the workplace (such as pro-LGBT policies) can influence the competitive advantage of firms by increasing the innovative productivity of existing employees by promoting more diverse teams and connections in the organization.

At the national and regional level, enacting more social liberal policies can potentially lead to superior creative and innovative performance and create regional competitive advantage. Some states are in the process of reviewing the impact of civil right laws on the economic productivity of the region.[21] Our results can provide more insights into the implications of these decisions.

Finally, our work calls for further research into the relatively unexplored relationship between innovation and social context. For instance, what are the contingencies under which social liberal policies may positively (or negatively) influence innovation outcomes? How does the interaction between social policies and economic policies affect the innovation process? What is the effect of social liberal policies on other issues related to creativity and innovation such as job creation and labor productivity? Shedding light on these questions will undoubtedly inform our understanding of the determinants of individual, organizational, and regional innovation.

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Figure 1- The Number of Abortion Restrictions Enacted Across States in 1994 and in 2006

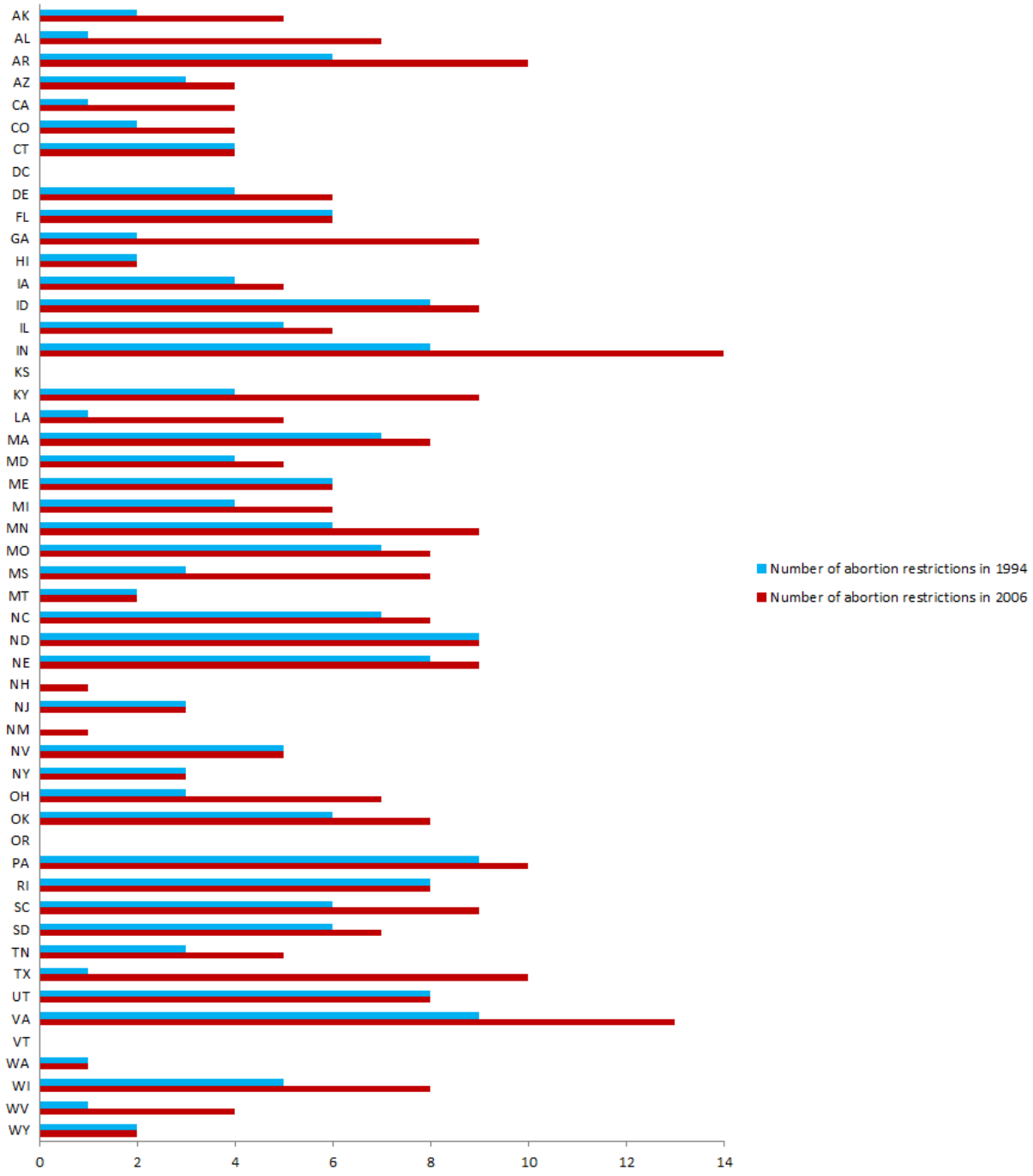
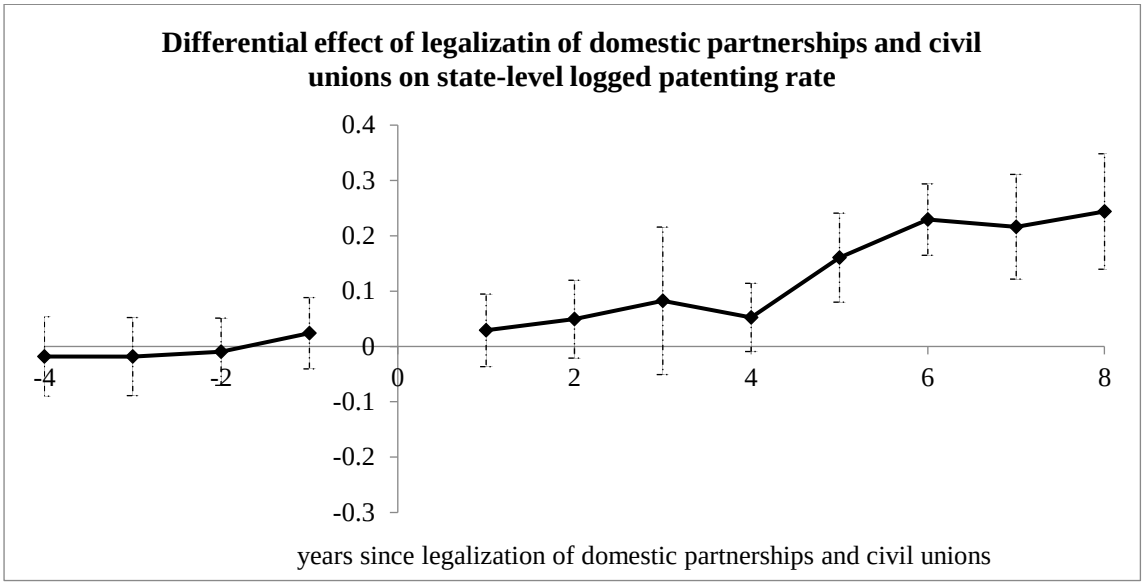
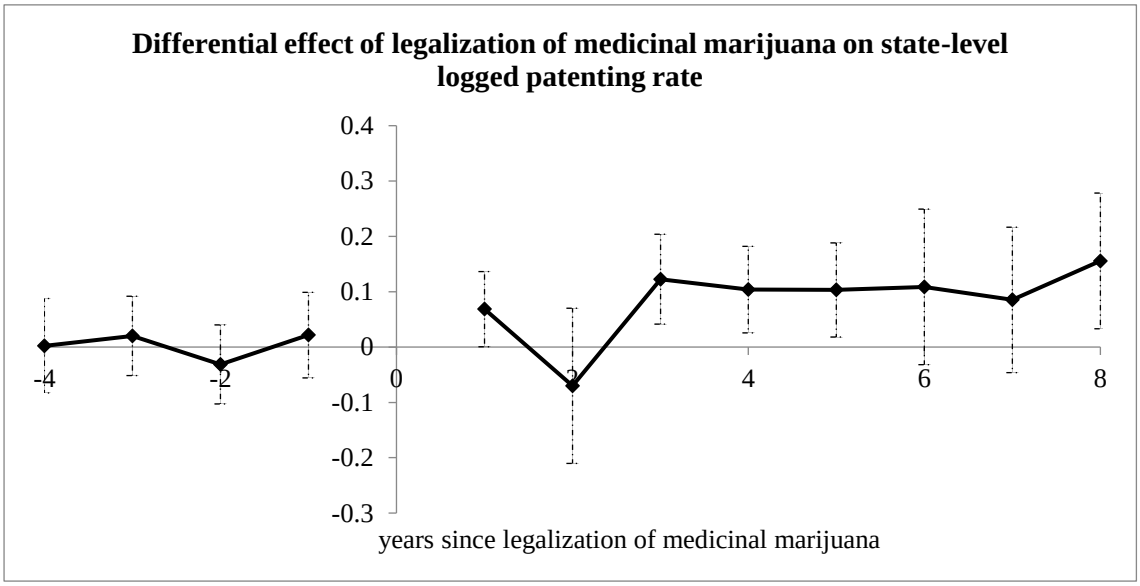


Figure 2- Yearly Treatment Effect of Legalization of Civil Unions and Domestic Partnerships on State-Level Logged Patenting



Notes: Figure plots estimated year by year pre- and post-legalization changes in patenting from OLS regressions with state and year fixed effects and controls. Each point represents the estimated difference between the treated (legalized) and control (non-legalized) state in each year, along with upper and lower bounds for 95% confidence intervals.

Figure 3- Yearly Treatment Effect of Legalization of Medical Marijuana on State-Level Logged Patenting



Notes: Figure plots estimated year by year pre- and post-legalization changes in patenting from OLS regressions with state and year fixed effects and controls. Each point represents the estimated difference between the treated (legalized) and control (non-legalized) state in each year, along with upper and lower bounds for 95% confidence intervals.

Table 1- Effective Time of Civil Union and Domestic Partnership Status

State	Effective Year
Hawaii	1998
Vermont	2000
District of Columbia	2002
Maine	2004
Massachusetts	2004
California	2005
Connecticut	2005

Note: This table lists the dates that changed the status of civil unions and domestic partnerships across states in the United States between 1995 and 2006. Civil unions and domestic partnerships in the United States are determined by each state or local jurisdiction.

Table 2- Effective Time of State Medical Marijuana Laws

State	Effective Year
California	1996
Oregon	1998
Washington	1998
Alaska	1999
Maine	1999
Hawaii	2000
Colorado	2001
Nevada	2001
Montana	2004
Vermont	2004
Rhode Island	2006

Note: This table lists the dates of medical marijuana legalization across states in the United States between 1995 and 2006.

Table 3- Summary Statistics

Variable	Level of Observation	Obs.	Mean	Std. Dev.	Min.	Max.
Dependent Variables:						
Number of new collaborative ties	Individual-Year	15,451,368	0.217	1.094	0	77
Collaborative team's knowledge diversity	Individual-Year	15,451,368	3.234	4.468	0	134
Patent count	Individual-Year	15,451,368	0.143	0.631	0	98
Share of novel recombinations	Individual-Year	15,451,368	0.021	0.109	0	1
Share of patents in the top 10% highly cited patents	Individual-Year	15,451,368	0.013	0.108	0	1
Net mobility of top inventors to state	State-Year	599	0.055	32.617	-219	183
Liberal views of individuals	State-Year	599	0.000	0.136	-0.235	0.765
Patent count	State-Year	599	2,088.115	3,398.681	28	28,011
Inventor count	State-Year	599	2,828.574	4,594.529	37	35,387
Patenting organizations count	State-Year	599	495.688	643.120	11	4861
Share of local citations	State-Year	599	0.058	0.027	0.007	0.190
Time gap between patents and prior art	State-Year	599	3329.326	536.6829	881.8828	5275.205
Controls:						
Total number of collaborative ties	Individual-Year	15,451,368	0.311	1.437	0	83
5-year experience	Individual-Year	15,451,368	1.479	3.896	0	649
Business R&D	State-Year	599	4,761.258	7,998.678	55	71,334.99
State expenditure	State-Year	599	22,500,000	2,8100,000	1,825,640	225,000,000
Share of education expenditure	State-Year	599	31.784	5.587	16.061	44.58
Number of individuals with a bachelor degree	State-Year	599	902,793.4	1,051,393	47,880	7,004,432
Population	State-Year	599	5,637,151	6,171,149	478,447	36,300,000
Real per capita personal income	State-Year	599	16.576	2.609	11.271	26.94
Housing price index	State-Year	599	2.612	1.027	1.200	7.142
Average state tax	State-Year	599	3.055	1.601	0	6.210
Average corporate tax	State-Year	599	15.411	1.518	11.730	19.290
Party of the governor is democrat	State-Year	599	0.414	0.484	0	1
Share of democrats in the state senate	State-Year	599	0.507	0.158	0.0857	0.92
Share of democrats in the state house	State-Year	599	0.510	0.155	0.129	0.881

Table 4: The Impact of Social-Liberalization Policies on State-Level Patenting

	DV:	**Logged Number of Patents at the State-Level**	
	Model:	**Panel OLS with fixed effects**	
	(1)	**(2)**	**(3)**
Legalization of same-sex civil unions	0.062 (0.031) (P=0.050)		
Legalization of medical marijuana		0.068 (0.033) (P=0.046)	
Number of abortion restrictions			-0.011 (0.005) (P=0.024)
Lagged Patenting Rate (logged)	0.574 (0.046)	0.562 (0.033)	0.569 (0.046)
Logged Business R&D Expenditure (lagged)	0.081 0.039	0.075 (0.039)	0.083 (0.038)
Logged State Expenditure (lagged)	0.170 (0.122)	0.209 (0.127)	0.202 (0.129)
Share Of Education Expenditure (lagged)	-0.000 (0.002)	0.001 (0.002)	0.000 (0.002)
Logged number of Bachelor degrees (lagged)	0.034 (0.066)	0.045 (0.067)	0.033 (0.067)
Logged population	0.148 (0.232)	0.022 (0.226)	0.090 (0.235)
Real per capita personal income	0.012 (0.014)	0.013 (0.015)	0.010 (0.014)
Housing price index	-0.013 (0.014)	-0.011 (0.014)	-0.012 (0.014)
State tax	-13.169 (11.270)	-15.440 (10.962)	-14.869 (11.334)
Corporate tax	8.941 (12.979)	11.022 (12.651)	10.263 (13.063)
Governor is democrat	-0.001 (0.011)	0.001 (0.011)	-0.003 (0.011)
Share of democrats in the state senate	-0.115 (0.122)	-0.155 (0.113)	-0.108 (0.122)
Share of democrats in the state house	0.144 (0.128)	0.102 (0.125)	0.071 (0.124)
State and year fixed effects	Yes	Yes	Yes
Number of states	50	50	50
Observations	599	599	599
R-Squared	0.850	0.852	0.850

Notes: The dependent variable is the logged number of patents in each state-year. "Legalization of same-sex civil unions" and "Legalization of medical marijuana" are indicator variables that equal to 1 after the state implements the policy change. “Number of abortion restrictions” is a count measure of the number of abortion restrictions in each state-year. All specifications include state and year fixed effects. Robust standard errors are clustered by state.

Table 5: The Impact of Social-Liberalization Policies on Cross-State Mobility

DV:	Mobility of Top Inventors to State			Mobility of Individuals to State		
Model:	**Panel OLS with state-pair fixed effects**					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Difference in the legalization of same-sex civil unions between the focal state and the paired state	-0.142 (0.097) (P=0.143)			-86.021 (46.968) (P=0.067)		
Difference in the legalization of medical marijuana between the focal state and the paired state		-0.058 (0.044) (P=0.186)			67.227 (21.743) (P=0.002)	
Difference in the number of abortion restrictions between the focal state and the paired state			-0.042 (0.020) (P=0.040)			10.478 (11.218) (P=0.350)
Full set of controls for both sates	Yes	Yes	Yes	Yes	Yes	Yes
State-pair fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of state-pairs	2,450	2,450	2,450	2,450	2,450	2,450
Observations	29,302	29,302	29,302	29,230	29,230	29,230
R-Squared	0.155	0.155	0.156	0.048	0.048	0.048

Notes: In models 1 to 3, mobility is defined as the number of top inventors that move to the focal state from the paired state in year t. In models 4 to 6, mobility is defined as the number of individuals that move to the focal state from the paired state in year t (based on tax data). The independent variables capture the difference in the legalization state of the focal state and the paired state. All specifications include state-pair and year fixed effects. Robust standard errors are clustered by state.

Table 6: The Impact of Social-Liberalization Policies on State-Level Openness

DV:	Share of local citations			Time gap between patents and cited prior arts		
Model:	**Panel OLS with state fixed effects**					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Legalization of same-sex civil unions	0.009 (0.005) (P=0.065)			-340.206 (197.542) (P=0.091)		
Legalization of medical marijuana		0.007 (0.003) (P=0.016)			-111.856 (60.846) (P=0.072)	
Number of abortion restrictions			-0.000 (0.001) (P=0.780)			14.736 (11.798) (P=0.218)
Full set of controls	Yes	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of states	50	50	50	50	50	50
Observations	599	599	599	599	599	599
R-Squared	0.113	0.114	0.105	0.850	0.843	0.550

Notes: Share of local citations for a patent is defined as the ratio of the number of citations to patents by at least one inventor in the same city over the total number of citations. The share of local citations at the state level in a year is the mean of the share of local citations for all patents filed in that state in that year. Time gap between a patent and its cited prior arts is calculated as the average number of days between the focal patent's application date and the application dates of the cited patents by the focal patent. The time gap between patents and cited prior arts at the state level in a year is equivalent to the mean of time gap for all patents filed in the state in that year. All specifications include state and year fixed effects. Robust standard errors are clustered by state.

Table 7: The Impact of Social-Liberalization Policies on Incumbent Inventors' Patenting

DV:	Logged Patent Count		
Model:	**Panel OLS with fixed effects**		
	(1)	**(2)**	**(3)**
Legalization of same-sex civil unions	0.029 (0.006) (P=0.000)		
Legalization of medical marijuana		0.045 (0.007) (P=0.000)	
Number of abortion restrictions			-0.001 (0.000) (P=0.092)
Full set of controls	Yes	Yes	Yes
Inventor and year fixed effects	Yes	Yes	Yes
Number of Inventors	1,006,913	890,902	447,586
Observations	8,395,661	7,509,846	5,327,600
R-Squared	0.166	0.320	0.115

Notes: This table examines the impact of liberalization policies on the patenting rate of incumbent inventors. All specifications include inventor and year fixed effects. All specifications include the inventor's experience and the full set of state-level time varying controls. Robust standard errors are clustered by state.

Table 8: Impact of Liberalization Policies on Incumbent Inventors' Collaboration Diversity

DV:	New Collaborative Ties			Collaborators' Knowledge Diversity		
Model:	**Panel OLS with fixed effects**					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Legalization of same-sex civil unions	0.072 (0.010) (P=0.000)			0.037 (0.016) (P=0.026)		
Legalization of medical marijuana		0.053 (0.012) (P=0.000)			0.161 (0.024) (P=0.000)	
Number of abortion restrictions			0.000 (0.000) (P=0.133)			-0.003 (0.004) (P=0.502)
Full set of controls	Yes	Yes	Yes	Yes	Yes	Yes
Inventor and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of Inventors	961,686	890,902	404,567	1,006,913	890,902	362,825
Observations	7,388,748	7,509,846	4,854,435	8,395,661	7,872,671	4,353,587
R-Squared	0.703	0.703	0.613	0.013	0.020	0.007

Notes: New collaborative ties measure the number of new unique pair-wise collaborations for each inventor in each year. Collaborators' knowledge diversity is calculated as the count of unique technological classes in which all collaborators on each patent have previously patented. All specifications include inventor and year fixed effects. All specifications include the inventor's experience, inventor's total number of collaborative ties, and the full set of state-level time varying controls. Robust standard errors are clustered by state.

Table 9: Impact of Social-Liberalization Policies on Novel and Breakthrough Innovations

DV:	Share of Novel Subclass Recombinations			Share of Patents in the Top 10% Highly Cited Patents		
Model:	**Panel OLS with fixed effects**					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Legalization of same-sex civil unions	0.002 (0.000) (P=0.000)			0.001 (0.002) (P=0.671)		
Legalization of medical marijuana		0.003 (0.001) (P=0.000)			0.004 (0.002) (P=0.058)	
Number of abortion restrictions			-0.000 (0.000) (P=0.488)			-0.001 (0.000) (P=0.000)
Full set of controls	Yes	Yes	Yes	Yes	Yes	Yes
Inventor and year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of Inventors	1,006,913	890,902	404,567	977,121	890,902	404,567
Observations	8,395,661	7,509,846	4,854,435	8,280,528	7,509,846	4,854,435
R-Squared	0.006	0.008	0.004	0.019	0.015	0.006

Notes: The share of novel recombinations is the share of novel subclass pairs out of total subclass pairs assigned to each inventor's patents in a year. Share of patents in the top 10% highly cites patents is the logged number of patents that fall into the top 10% highly cited patents at the inventor level. All specifications include inventor and year fixed effects and controls for inventor's experience, inventor's number of patents, and the full set of state-level time varying controls. Robust standard errors are clustered by state.

Table 10: Impact of Social-Liberalization Policies on the Number of Patenting Organizations

DV:	Logged Number of Patenting Organizations		
Model:	**Panel OLS with state fixed effects**		
	(1)	**(2)**	**(3)**
Legalization of same-sex civil unions	0.085 (0.029) (P=0.006)		
Legalization of medical marijuana		0.117 (0.033) (P=0.001)	
Number of abortion restrictions			-0.014 (0.005) (P=0.005)
Full set of controls	Yes	Yes	Yes
State and year fixed effects	Yes	Yes	Yes
Number of states	50	50	50
Observations	599	599	599
R-Squared	0.788	0.798	0.789

Notes: The dependent variable is the logged number of patenting organizations per state per year. All specifications include state and year fixed effects. Robust standard errors are clustered by state.

Table 11: Impact of Social Liberal Policies on Patenting Rate by Organization Size

	DV:	**Logged patenting rate (organization-level)**	
	Model:	**Panel OLS with organization fixed effects**	
		(1)	**(2)**
Legalization of same-sex civil unions		0.187 (0.008) (P=0.000)	
Legalization of same-sex civil unions × Logged size of patent stock at the time of policy implementation		-0.155 (0.008) (P=0.000)	
Legalization of medical marijuana			0.165 (0.005) (P=0.000)
Legalization of medical marijuana × Logged size of patent stock at the time of policy implementation			-0.130 (0.003) (P=0.000)
Number of abortion restrictions			
Full set of controls		Yes	Yes
Organization and year fixed effects		Yes	Yes
Number of Organizations		180,296	195,390
Observations		1,640,750	1,572,346
R-Squared		0.032	0.027

Notes: We use the size of patent stock at the time of policy change as a proxy for the organization size. Only organizations whose first patent was filed before policy enactment are included. All specifications include organization and year fixed effects, and the full set of state-level time varying controls. Robust standard errors are clustered by state.