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Religion, gambling attitudes and corporate innovation

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ABSTRACT

We find that firms headquartered in areas with a taste for gambling tend to be more innovative, i.e. they spend more on R&D, and obtain more and better quality patents. These results are supported by several robustness checks, tests to mitigate identification concerns, and analyses of several secondary implications. Investment in innovation makes a stock more lottery-like, a feature desired by individuals with a taste for gambling. Gambling preferences of both local investors and managers appear to influence firms' innovative endeavors and facilitate transforming their industry growth opportunities into firm value.

1. Introduction

Considerable research finds that innovation is a key driver of firm value as well as overall economic growth (see, e.g., Solow (1957); Hall et al. (2005), and Kogan et al. (forthcoming). However, firms are often reluctant to invest in innovation projects because these projects tend to have long gestation periods and high probabilities of failure, and thus require a culture of failure-tolerance (see, e.g., Holmstrom (1989); Manso (2011), and Tian and Wang (2014)). This paper examines one cultural trait of a firm's local area, namely a preference for gambling, that can potentially overcome managerial reluctance to invest in corporate innovation.

Many innovative endeavors, i.e., attempts to come up with new products, services and methods, represent gambles because they promise relatively small probabilities of large success and large probabilities of failure. Local gambling culture can promote innovation for at least two reasons. First, managers, who may be from the local community (see Yonker (forthcoming)), or adopt its key cultural traits, likely share the community's gambling preferences, as Kumar et al. (2011) (hereafter KPS) find for rank-and-file employees. So managers in communities with a gambling culture are more likely to find innovation projects attractive and to invest in them. Second, as prior research on local bias finds, both retail and institutional investors tend to overinvest in local stocks (see, e.g., Coval and Moskowitz (1999); Grinblatt and Keloharju (2001), and Ivković and Weisbenner (2005)). In addition, investors in gambling-tolerant areas are more likely to hold lottery-type stocks and are even willing to pay a premium for the lottery factor in a stock (see Kumar (2009) and KPS (2011)).[1] So investment in innovation projects, which tend to have risky

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[1] A large literature documents investors' tendency to overweight small probabilities of very high returns and to underweight large probabilities of smaller losses, i.e., prefer positively-skewed (or lottery-like) payoffs (see, e.g., Friedman and Savage (1948); Kahneman and Tversky (1979); Tversky and Kahneman (1992), and Barberis and Huang (2008)). Using stock market data Kumar (2009) and KPS (2011) find this lottery-preference to be more pronounced in gambling-tolerant areas.

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and positively-skewed payoff distributions, can make a stock more attractive to local investors in gambling-tolerant areas by making the stock more lottery-like. So our first hypothesis is that firms located in areas with a gambling culture are more likely to invest in innovation and to generate higher innovation output.

Moreover, we expect the effect of gambling preferences on innovation outcomes to be larger in innovative industries for two reasons. First, firms in these industries have more opportunities for innovation (see Hirshleifer et al. (2012), henceforth HLT), and greater flexibility and resources (e.g., a higher R&D budget, and excess capacity in physical assets and skills) to pursue them. Moreover, their ability to innovate is crucial for their success. So, for these firms the expected benefit from tapping risky growth opportunities is likely to exceed the expected adjustment costs of doing so. Second, firms in such industries are more likely to have experienced extremely successful events, a trait which is valued by individuals with gambling preferences (e.g., Kumar (2009), and Bali et al. (2011)). Therefore, our second hypothesis is that the influence of local gambling culture on innovation should be greater among firms in innovative industries.

To test these hypotheses, we make use of a large dataset of US public companies and investigate their research and development (R&D) expenditures as innovative inputs and patents and citations as innovative outputs. Since direct measures of people's gambling preferences are hard to find in sufficient detail over time, we follow the previous literature and examine the heterogeneity in gambling preferences of firms' local communities induced by their religious beliefs. Specifically, we follow Kumar (2009), KPS (2011), and Schneider and Spalt (forthcoming-a) and consider the ratio of Catholics-to-Protestants (CPRatio) in the county of a firm's headquarters as a measure of local gambling preferences. There is ample justification for choosing this variable as a proxy for local gambling preferences. Protestant philosophy strongly condemns any kind of gambling, whereas Catholic philosophy is somewhat tolerant of gambling.[2] This difference in religious teaching is also reflected in practice. For example, at least two surveys conducted in 1963 and 2007 in the US find that Catholics are more tolerant of gambling than Protestants.[3] In fact, Catholic churches even use bingo and lotto for their own fundraising.

The empirical gambling literature finds that local religious composition into Catholics and Protestants is an important predictor of gambling behavior (see, e.g., Edmondson (1986); Berry and Berry (1990); Ellison and Nybroten (1999), and Diaz (2000)). Many recent studies in financial economics have employed the relative proportions of Catholics and Protestants in a county as a proxy for local gambling preferences in a variety of contexts. Kumar (2009) finds that individual investors in predominantly Catholic (Protestant) locations invest more (less) in lottery-type stocks. Moreover, KPS (2011) find that even institutional investors, who generally avoid high-risk stocks, hold disproportionately higher levels of lottery-type stocks if they are located in counties with relatively greater concentrations of Catholics. In a corporate finance setting, Schneider and Spalt (forthcoming-a) find that acquiring firms in high CPRatio areas tend to buy firms whose stocks have lottery-like features such as higher idiosyncratic volatility and idiosyncratic skewness. Schneider and Spalt (forthcoming-b) find that conglomerates invest more in high-skewness segments than matched stand-alone firms, and this effect is stronger in high CPRatio areas. Similarly, Shu et al. (2012) find that mutual funds located in low-Protestant or high-Catholic areas take more risks.

Following previous studies, we assume a local 'contagion' effect, i.e., the dominant religion in an area affects local culture and systematically influences the behavior of local residents even if they do not personally adhere to that belief system. We follow the previous literature and consider a firm's location as the location of its headquarters.[4] This approach seems reasonable because of two reasons. First, as Pirinsky and Wang (2006) note, a firm's headquarters are usually close to its core business activities. Second, major capital budgeting decisions, such as those involving the level and type of spending on R&D, usually require headquarters' approval.

We focus our analysis on one country, the United States, for two reasons. The first reason is similar to Hilary and Hui (2009). Although there is probably more variation in CPRatio across countries, the heterogeneity of a cross-country sample increases the risk of confounding effects of variables such as legal environment and economic structure, which are difficult to separate from religion.[5] Second, the US is one of the most innovative countries and has substantial geographic variation in religious composition and innovative activities. Consequently, it serves as a great setting for testing our hypotheses.

We find that firms headquartered in counties with higher Catholic-to-Protestant ratios are more innovative, i.e. they spend more on R&D and generate more and better quality patents. Fig. 1 previews a part of our main findings. Panel A to panel D show increasing averages of R&D to assets ratio, patent counts, technology class-adjusted citations, and citations per patent, respectively, over increasing CPRatio quintiles. All of these suggestive depictions are later confirmed by more rigorous analysis and stand up to numerous robustness tests. Moreover, these effects are larger for firms in more innovative industries. Exploring further, we find that investment in R&D makes stock return distributions more lottery-like, making them more attractive to managers and investors with a taste for gambling. Underscoring the role of local investors' gambling preference, we find that the sensitivity of the level of R&D expenditures to local gambling preferences is higher among firms for which local investors

[2] The following excerpt from the online version of 1913 Catholic Encyclopedia (http://www.newadvent.org/cathen/06375b.htm) conveys the view of the Catholic church on gambling: "On certain conditions, and apart from excess or scandal, it is not sinful to stake money on the issue of a game of chance any more than it is sinful to insure one's property against risk, or deal in futures on the produce market." On the other hand, the following excerpt from the United Methodist Church's 2012 Book of Resolutions (http://www.umc.org/what-we-believe/gambling) provides the view of typical Protestant churches on gambling: "Gambling is a menace to society, deadly to the best interests of moral, social, economic, and spiritual life, and destructive of good government. As an act of faith and concern, Christians should abstain from gambling…."

[3] See the 1963 Survey of Northern California Church Bodies (question: How do you feel about gambling?), and the 2007 Baylor Religion Survey, Wave II (question 12b: By your best guess, how would your current place of worship feel about gambling?). See http://www.thearda.com.

[4] See, e.g., Coval and Moskowitz (1999); Loughran and Schultz (2005); Pirinsky and Wang (2006); Hilary and Hui (2009), and Becker et al. (2011).

[5] For example, Italy has more Catholics, but fewer patents, than UK. But Italy also has weaker protection of property rights than the UK.

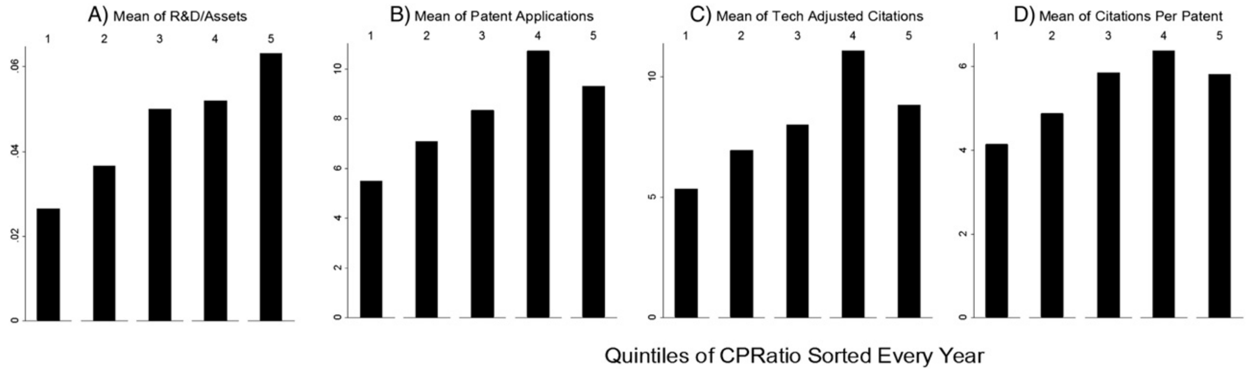

Fig. 1. Catholics-to-Protestants ratio (CPRatio) and innovative activities. Panels A through D show the R&D expenditure to total assets ratio, number of patent applications, technology-adjusted citations, and citations per patent averaged within each CPRatio quintile in the county of firm headquarters. For each year of available data on CPRatio during our sample period (1980, 1990, and 2000), we sort firms into CPRatio quintiles, where quintile 1 is the lowest. Heights of the bars represent mean values within each quintile.

are likely to be economically more important. In the smaller Execucomp subsample for which we also have data on CEO pay, we find that managers' gambling preferences also appear to matter for innovation. Consistent with our hypothesis that local gambling preferences induce a corporate culture of failure tolerance, which can lead to riskier exploratory research, we find that the productivity of R&D expenditures in producing innovation output is lower and the variance of patent quality is higher for firms in high CPRatio areas. Finally, firms in more gambling-tolerant areas appear to be more adept at transforming industry growth opportunities into firm value as measured by Tobin's Q.

Our proxy for local gambling preferences, CPRatio, likely contains a measurement error because differences in religious adherence can have other implications in addition to differences in gambling preferences. To the extent that this measurement error is uncorrelated with the error term in the regression, it only leads to regression attenuation, and biases us against finding significant results in support of our hypotheses. A more concerning issue is whether our results are caused by a possible correlation of the measurement error in CPRatio with an important omitted variable. Identification concerns may also arise about other potentially omitted variables and potential self-selection by innovative firms into areas with relatively large Catholic populations. While identification concerns are generally difficult to completely rule out, we take numerous steps to mitigate them.

First, we develop our research question as a natural off-shoot of previous studies of gambling preferences in financial economics, which employ CPRatio as a measure of gambling preferences. We follow these closely-related studies to mitigate the concern about spurious correlation caused by omitted variables, and in our regressions control for a number of county-level characteristics such as population, proximity to larger cities, and demographic compositions, in addition to several firm-level determinants of innovation. Moreover, we control for non-gambling implications of local religious compositions that may be related to innovation. We first consider some socio-demographic differences among religious groups.[6] Hispanics tend to be disproportionally Catholic, so we control for the fraction of Hispanic population in a county. Catholics tend to have higher birth rates, which we control for by including counties' population growth rates and age composition. We also control for potential differences in political ideologies across religious groups by using the ratio of votes to Democratic and Republican presidential candidates in a county because Catholics are more often Democrats whereas Protestants tend to be Republicans.[7]

Next, we consider some of the historically hypothesized differences between these groups. For example, Barro and McCleary (2006, pp 51) summarize Weber's (1930) view on the influence of Protestantism that greater religiosity could spur investment and economic growth “by fostering traits such as work ethic, honesty (and hence trust), thrift, charity, and hospitality to strangers”. We employ several proxies to control for potential differences in these traits. For instance, places that are hospitable to strangers likely attract more immigrants. So we control for the 10-year growth in the share of foreign-born population, available at the state level. To account for differences in thrift, we control for an estimate of state-level personal savings. We control for the level of accrual-based earnings management to account for differences in trust of the capital market, which can influence the cost of capital (see, Beyer et al. (2010)) and hence innovation. Becker and Woessmann (2009) challenge Weber (1930) and show that differences in economic growth between Catholic and Protestant areas are not due to differences in their work ethic, but differences in their human capital acquired through better education. So we also control for the fraction of college graduates in the county.

Second, we check the robustness of our main specifications by replacing CPRatio with two more direct proxies of local gambling culture based on state laws on various types of gambling and per capita state lottery ticket sales. These alternative proxies

[6] In various surveys available on American Religious Data Archive's (ARDA) website (http://thearda.com/mawizard/), we did not find much difference between Catholics and Protestants in their views on some issues which may be important for growth and innovation, such as compatibility of science and religion and roles of husbands and wives.

[7] Source: Gallup Polls (http://www.gallup.com/poll/11911/protestant-catholic-vote.aspx).

yield results similar to our baseline results, especially in relevant subsamples, thus alleviating the concern that a potential bias in CPRatio may be driving the results.[8] Third, we tackle identification issues by 1) ruling out some underlying economic stories about endogeneity, and 2) employing two-stage least squares regressions and propensity score matching methods. Fourth, to mitigate the possibility of a spurious correlation due to firm and county fixed characteristics, we analyze the effect on R&D of 1) firm relocation decisions, 2) large changes in CPRatio within a county over time, and 3) an immigration law that caused plausibly exogenous variation in counties' religious compositions. Finally, we test several secondary implications of our main hypotheses, which serve to sharpen identification by narrowing the set of alternative stories that can consistently explain all of our empirical results. While our evidence suggests that the difference in gambling attitudes among these religious groups is a channel that leads to differences in corporate innovation, we do not claim that this is the *only* channel.

A concurrent paper by Chen et al. (2014) also finds that firms located in higher CPRatio areas spend more on R&D and produce greater innovation output. While both our paper and theirs start from the same basic premise, they emphasize different issues. While Chen et al. focus on differentiating the effect of local gambling preference from CEO overconfidence, we develop and test the motivation, channels and secondary implications of our main hypothesis. Specifically, our paper differs from Chen et al. in the following ways. We (1) show that innovation activities directly contribute to a stock's lottery factor, which motivates these firms to engage in innovation (2) present tests that explicitly identify two underlying channels, namely managers and local investors, through which local gambling preference affects innovation, (3) examine several secondary implications of our main hypothesis to aid identification, (4) provide more extensive checks for robustness and identification, and (5) examine firm valuation implications of local gambling preferences.

Our work contributes to the literatures on religion and finance, corporate innovation, the influence of local demographics on financial decisions, and culture and finance. First, we build on the growing literature on religion-induced behavioral differences and their impact on firms and financial markets. Our paper extends the work of Kumar (2009) and KPS (2011) to corporate behavior, in particular corporate policies on innovation, an arena where gambling preferences can play a key role. Our paper is also related to Hilary and Hui (2009) and Adhikari and Agrawal (forthcoming), who find that firms and banks headquartered in counties with higher proportions of religious residents take significantly lower risk. While these papers examine the effects of a community's risk-aversion as measured by its religiosity (i.e., whether they are religious or not), we analyze the effects of its gambling preference as measured by the ratio of Catholics-to-Protestants. Gambling preference is a more appropriate metric for our analysis because it has stronger theoretical relation to innovative endeavors, which tend to have highly-skewed payoff distributions. We examine R&D expenditures as innovation inputs, and patents and citations as innovation outputs. Second, the paper makes a unique contribution to the growing literature on finance and innovation. Most existing papers on firm innovation appeal to rationality and are based on factors such as a firm's industry, economic environment and managerial incentives.[9] To our knowledge, the only papers that identify a behavioral determinant of innovation are Galasso and Simcoe (2011) and HLT (2012), who find a positive effect of CEO overconfidence on innovation. We extend this literature by examining local residents' gambling preferences as another behavioral trait that can influence corporate innovation. Third, this paper contributes to a new and growing area of research that examines the effect of local demographics on firm policies. For example, Becker et al. (2011) examine the effect of local elderly population on corporate dividend policies, and Cohen et al. (2013) analyze the effect of local diaspora on firms' foreign trade. More broadly, our paper contributes to a large and growing literature on culture and finance.[10]

2. Data and summary statistics

2.1. Sample, data and innovation measures

Our sample period starts in 1980 and ends in 2006, which is the last year for which data on patents and citations matched to companies is available. For our analysis, we combine data from numerous sources. Data on company financials and stock returns, firm headquarters etc. come from Compustat and CRSP databases. We exclude companies in the financial (2-digit SIC codes 60 to 69) and public utility (2-digit SIC code 49) industries because they are highly regulated. Most of our analyses use an unbalanced panel of 32,424 firm-years that contain 3934 unique firms during our 27-year sample period across 566 US counties. The numbers of observations vary somewhat across the tables based on data availability.

We obtain county-level religion data from the Churches and Church Membership files of the American Religion Data Archive (ARDA) website, which contains decennial data on county-level religion statistics on 133 Judeo-Christian bodies. For our analysis, we use the datasets for 1980, 1990, 2000, and 2010. We obtain county-level data on demographic and economic characteristics (such as population, age, sex, race, education, income and the proportion of married couples) from the US Census Bureau, and data for estimating personal savings from the Bureau of Economic Analysis.[11] Following the previous literature (Alesina and

[8] We do not use these variables as our main proxies for local gambling preferences because, as discussed in Section 3.3 on identification tests, one of them has limited cross-sectional variation and no time-series variation, and the other is not a general proxy for gambling preferences.

[9] See, e.g., Aghion et al. (2005); Manso (2011); Tian and Wang (2014); Nanda and Rhodes-Kropf (forthcoming); Atanassov (2013); Fang et al. (2014); He and Tian (2013); Hsu et al. (2014); Bena and Li (2014)) and Balkin et al. (2000).

[10] See, e.g., Guiso et al. (2006); Guiso et al., 2009), Li et al. (2013); Ahern et al. (2015); Shi and Tang (2015); Holderness (forthcoming), and the papers presented at the *Journal of Corporate Finance* and Wake Forest University conference on culture and finance (2015).

[11] We estimate personal savings by subtracting consumption from income, both in 1997 because consumption data is available at state level since 1997. We follow KPS (2011) who find that the education measure and income are highly correlated (correlation = .82) and do not include income in our regressions.

La Ferrara (2000); Hilary and Hui (2009), and KPS (2011)), we linearly interpolate the data to obtain estimates for the intermediate years.

Our main source of data for patents and citations is the 2006 edition of the NBER patent database. We supplement the NBER data with another database put together by Kogan et al. (forthcoming), which we obtain from Noah Stoffman's website (http://kelley.iu.edu/nstoffma/). The latter database covers patent application data until 2010, so it largely solves the issue of a mechanical decline in the number of patent applications toward the end of our sample period (because patent applications are recorded only if granted). Our sample includes all Compustat firms that operate in the same four-digit SIC industries as those in the patent database, so it is not limited to firm years with patents.

Following the previous literature (see e.g., HLT (2012) and He and Tian (2013)), we construct one measure of a firm's innovation input and three measures of innovation outcomes. The measure of innovation input is R&D scaled by book assets. The first measure of innovation output, which represents the quantity of innovation, is the number of patents applied for in a given year that are eventually granted. Our second measure of innovation outcome, which measures innovation quality, is the sum of the number of technology class-adjusted citations received during our sample period on all patents filed (and eventually received) by a firm in a given year. The adjustment is done by scaling each patent's citation count by the average citation count of all patents filed (and eventually granted) in the same technology class in a given year. This measure of innovation quality takes into account the non-uniform propensity for patents in different technology classes to cite other patents. To correct for the truncation problem in citation counts (as older patents are more likely to receive more citations), we follow the previous literature and multiply the raw citation count by the weighting index provided by Hall et al. (2001; 2005). Our third measure of innovation outcome, which also measures innovation quality, is the number of citations per patent, which is calculated as the total number of citations received during our sample period on all patents filed (and eventually received) by a firm in a given year, scaled by the number of the patents filed (and eventually received) by the firm during the year. To save space, we present the analysis of this measure in section A.2 of the Internet Appendix (IA). Due to the right-skewness of patent and citation proxies, in our main regression analyses, we follow the previous literature and use the natural logarithm of one plus the number of patents applied in a given year (*LnPatent*), the log of one plus the number of technology-class adjusted citations (*LnTechAdjCites*), and log of one plus the number of truncation-adjusted citations per patent (*LnCitePerPat*). Following prior work, we set these variables to zero for firm-years without data available in the NBER database but realize that some of the zero values might be due to match failure rather than true absence of patents. Our results are similar if we exclude all firm-years with zero R&D, patents and citations, as discussed in section A.5 in IA and shown in row (4) of Table A.5.

2.2. Measuring gambling preferences

We follow KPS (2011) and consider the ratio of Catholic adherents to Protestant adherents (CPRatio) in a county as a proxy for its residents' gambling attitudes. The introduction contains a detailed discussion of the rationale for using this ratio as a measure of local gambling preference. Our regressions employ the natural logarithm of one plus this ratio (*LnCPRatio*) as the main explanatory variable of interest. This log measure is less skewed than the raw CPRatio variable and parallels our patents and citations variables.[12]

2.3. Control variables

Following the previous literature on innovation, all our regressions of R&D, patents and citations include industry and year fixed effects and control for a number of firm characteristics that are related to a firm's innovation input and output. We control for measures of firm size (sales), leverage, growth opportunities (Tobin's Q), performance (ROA), capital intensity (the ratio of net property plant and equipment to the number of employees), institutional ownership, analyst coverage, financial constrains (Kaplan and Zingales' (1997) KZ Index), industry concentration (Herfindahl–Hirschman index based on sales), and positive discretionary accruals that can be important predictors of a firm's investment in innovation (see, e.g., Coles et al. (2006), HLT (2012), Aghion et al. (2013)and He and Tian (2013)).[13] All firm-specific control variables are lagged by one year in all the regressions. The only exception is that in the regressions of patents and citations as dependent variables, we include the average of the first and second lags of R&D to asset ratio as a control. Our choice of this lag structure is based on prior evidence that the average lead time between investment in R&D and patent applications is between one and two years.[14]

In addition to the firm-specific variables, we also control for a number of contemporaneous county-level variables in all our regressions that can be important for innovation and, as discussed in Section 1, capture other differences among religious groups. In particular, we control for county population, population growth, age structure, degree of urbanization, education (fraction of college graduates), Hispanic population, male to female ratio, an estimate of personal savings, inflow of immigrants, fraction of

[12] As shown in robustness checks in IA, our results are essentially unchanged if we replace *LnCPRatio* by C / (C + P). The two variables are highly correlated (Pearson correlation = 0.97).

[13] In Section 5, the results are similar when we control for executive pay-related variables for the S&P 1500 subset of our sample after 1993, for which such data is available from Execucomp.

[14] Pakes and Griliches (1980) find this lag to be 1.6 years on average. Data from Rapoport (1971) and Wagner (1968) also suggest this lag to be between one and two years for most industries. Our results do not change if we replace the average with the first lag or the second lag.

Table 1
Summary statistics.
The table reports summary statistics of our key variables of interest at the firm-year level. The sample consists of US public companies on CRSP and Compustat, excluding financial firms (2-digit SIC codes 60 to 69) and utilities (2-digit SIC code 49), from 1980 to 2006. All the variables used in the regression analyses are defined in Table A.1 in the Internet Appendix.

	Mean	Std. dev.	25th percentile	Median	75th percentile	N
CPRatio	1.933	1.731	0.567	1.402	2.806	32,424
LnCPRatio	0.916	0.562	0.449	0.876	1.337	32,424
R&D	48.186	322.583	0.000	0.162	8.192	32,424
R&D/Assets	0.044	0.096	0.000	0.003	0.045	32,424
Patent applications	9.228	34.309	0.000	0.000	2.000	32,424
LnPatent	0.728	1.311	0.000	0.000	1.099	32,424
Tech adjusted citations	7.683	31.805	0.000	0.000	0.335	32,424
LnTechAdjCites	0.574	1.230	0.000	0.000	0.289	32,424
CitePerPat	4.989	12.191	0.000	0.000	6.170	32,424
LnCitePerPat	0.797	1.246	0.000	0.000	1.970	32,424
Lottery stock	0.272	0.445	0.000	0.000	1.000	32,013
Idio. volatility	0.034	0.022	0.018	0.027	0.042	32,013
Idio. skewness	0.533	1.174	0.050	0.432	0.911	32,009

married households, ratio of votes to Democrats and Republicans and overall religiosity. Table A.1 in IA defines all the variables that appear in our regressions.

2.4. Summary statistics

Our county-level summary statistics, presented in panel A of Table A.2 in IA, are generally comparable to those in KPS (2011, Table 1, panel B). Table 1 shows summary statistics of our main variables of interest at the firm-year level, which we use later to infer the economic significance of our regression estimates. The mean and median values of CPRatio (*LnCPRatio*) are 1.933 (0.916) and 1.402 (0.876), respectively. The higher mean value of CPRatio compared to the median indicates the presence of positive outliers. Hence we normalize this variable by taking its log.[15] On average, a firm applied for about 9.2 patents per year which were eventually granted and received 7.7 technology-class adjusted citations and 5.0 citations per patent. A firm spent an average of 4.4% of its assets on R&D. The median numbers of patents, technology class-adjusted citations and citations per patent are all zero. The average annual idiosyncratic standard deviation of stock returns is 0.034 and idiosyncratic skewness (i.e., the skewness of the residuals from a regression of daily stock returns on market returns and squared market returns) is 0.53. Following the KPS (2011) definition, we classify about 27.2% of the stocks as lottery stocks (i.e., stocks with above-median idiosyncratic volatility and above-median idiosyncratic skewness). The distributions of other variables are reported in IA.

3. Analysis and discussion

We present pairwise correlations among the key variables of interest in section A.1 of IA. Sections 3.1, 3.2 and 3.3 present the results from tests of our main hypotheses, robustness and identification, respectively.

3.1. R&D, patents and citations

We estimate the following regression model to examine how local gambling preferences affect firms' innovation input and outcomes:

$$(R\&D/Assets)_{i,j,k,t}\, or\, LnPatent_{i,j,k,t}\, or\, LnTechAdjCites_{i,j,k,t}\, or\, LnCitePerPat_{i,j,k,t} = \alpha + \beta \mathrm{LnCPRatio}_{k,t} + \gamma \mathrm{FirmLevelControls}_{i,t-1} + \delta \mathrm{CountyLevelControls}_{k,t} + \mathrm{Year}_{t} + \mathrm{Industry}_{j} + \varepsilon_{i,j,k,t}$$

where i, j, k and t are indices of firm, industry (2-digit SIC code), county and year. The dependent variables are innovation inputs and outcomes. $(R\&D/Assets)_{i,j,k,t}$ is a measure of innovation input. *LnPatent* is the natural logarithm of one plus the number of patents applied for and eventually granted by firm i in year t. Similarly, *LnTechAdjCites* is the natural logarithm of technology class-adjusted citations, and *LnCitePerPat* is the natural logarithm of one plus adjusted citations per patent. Our main explanatory variable of interest *LnCPRatio*, is the natural logarithm of one plus the Catholic to Protestant ratio in year t in county k of the firm's headquarters. *FirmLevelControls* is a vector that includes several firm characteristics found by the prior literature to affect a firm's innovation activity, discussed in Section 2. *CountyLevelControls* includes county-level variables that have been identified by prior studies to affect individual and firm decisions in the county and might also be correlated with other differences between the religious groups, as discussed in Sections 1 and 2.

[15] In addition, our main results continue to hold when we omit the states that have the five highest and the five lowest CPRatios (see Section 3.3.1.2 and Table 4, panel A, row 2d).

3.1.1. Innovation input: R&D expenditures

We examine whether firms in counties with higher CPRatios invest more in R&D which is an essential input for generating patents and citations. Table 2 shows the estimated coefficients from OLS regressions of R&D expenditures. All regressions include year and industry dummies, where industry is defined based on 2-digit SIC codes. Intercepts are estimated but not tabulated. All continuous variables are winsorized at 1% in both tails. Because CPRatio is measured at the county level, we follow Shu et al. (2012) and report two-way clustered standard errors, where applicable, by *county* × *year* and by firm and corrected for heteroscedasticity.

We start with a parsimonious model where the only explanatory variables included are our main variable of interest, *LnCPRatio*, along with year and industry dummies in column 1. We find that, consistent with our hypothesis, this model yields a positive and significant coefficient (at the 1% level) of 0.011 on *LnCPRatio*, suggesting that gambling preferences of a county's residents positively predict R&D expenditures of firms headquartered in the county. Next, as shown in column 2, we control for several firm-specific variables discussed in Section 2. The point estimate on *LnCPRatio* decreases, but remains statistically significant at the 5% level. Finally, in column 3 we add several county-specific variables discussed in Sections 1 and 2 that are likely to be correlated with our proxy for gambling preference and might also influence innovation decisions of local firms. The estimated coefficient on *LnCPRatio* in this regression with the full set of control variables is much larger than that obtained from the model without county-level controls, and is statistically significant at the 1% level. So, even after controlling for firm-specific as well as country-level variables, local gambling culture significantly predicts R&D expenditures of a firm. In economic terms, the point estimate of 0.006 on *LnCPRatio* suggests that moving from a firm in the 25th percentile of *LnCPRatio* to a firm in the 75th percentile increases *R&D/Assets* by 0.0053 (= 0.006 ∗ (1.337 − 0.449), see Table 1). This estimate is economically significant because it represents a 12% increase over the unconditional mean of 0.044 for *R&D/Assets*. We compare the magnitude of this effect to that of a firm's growth opportunities, as measured by lagged Tobin's Q, which have been shown to be an important determinant of its R&D spending (see, e.g., Coles et al. (2006)). Calculated similarly, the effect of lagged Q on *R&D/Assets* is about 16% which is slightly higher than effect of *LnCPRatio*.

Control variables take the expected signs. Firms with higher investment opportunities (Tobin's Q), higher excess cash savings, low but growing sales and low past profitability spend more on R&D. Highly levered firms, and firms with higher institutional ownership spend less on R&D, both consistent with the findings of HLT (2012). Firms with positive discretionary current accruals have lower R&D perhaps because of financing difficulties due to investors' lack of trust. Among county-level variables, the male-to-female ratio and the percentage of college graduates in a county positively predict R&D expenditures of local firms. Population growth, the fraction of Hispanic population, per capita savings rate, and the number of religious adherents per 1000 people are negatively related to R&D expenditures, the latter being consistent with Hilary and Hui (2009).

Next we proceed to test our second hypothesis that that the influence of gambling preference on innovation input should be higher in firms in innovative industries. Such firms likely have greater past success in innovation, which attracts gamble-lovers, and likely face lower adjustment costs to cater to a gambling preference. We follow HLT (2012) and perform our analysis on samples split into innovative and non-innovative industries. We consider an industry, defined by its 4-digit SIC code for this purpose, to be innovative if its citations per patent exceed the median value across all industries.[16] Consistent with our hypothesis, firms in innovative industries (column 4), *LnCPRatio* has a coefficient estimate of 0.012 which is statistically significant at the 1% level. In non-innovative industries (column 5), the coefficient estimate on *LnCPRatio* is a much lower 0.001, statistically insignificant at conventional levels. In addition, this coefficient in the innovative industries subsample is also statistically different from that in the subsample of non-innovative industries ($p < .01$).

3.1.2. Innovation outputs: Patents and citations

In this section we examine the quantity and quality of a firm's innovation output as measured by patents and citations. Table 3 presents our first set of regressions of patents and citations. Our main variables of interest are the natural logarithm of successful patent applications (*LnPatent*), and the natural logarithm of technology class adjusted citations (*LnTechAdjCites*). Similar analysis of citations per patent, *LnCitePerPat*, is presented in section A.4 of IA.

Similar to the analysis of R&D, in unreported tests we run the regressions of *LnPatent*, *LnTechAdjCites* only on *LnCPRatio* and 1) industry and year fixed effects, and 2) all firm level controls, and find that *LnCPRatio* obtains positive and significant coefficients in these parsimonious specifications. In column 1 (column 4), we report the regressions of *LnPatent* (*LnTechAdjCites*) with all firm- and county-level controls. The estimated coefficient on *LnCPRatio* in this model, which includes the full set of controls (untabulated), indicates that firms located in counties with higher concentrations of Catholics relative to Protestants tend to apply for and receive larger numbers of patents (citations). In terms of economic significance, the point estimate of 0.143 (0.156) suggests that moving from a county at the 25th percentile to the 75th percentile of *LnCPRatio* increases *LnPatent* (*LnTechAdjCites*) by 0.127 (0.139). This represents an increase of about 17% (24%) compared to the unconditional mean value of 0.728 (0.574) for *LnPatent* (*LnTechAdjCites*). Once again, we compare the size of this effect to that of the firm's growth opportunities, measured by lagged Tobin's Q, which are an important determinant of a firm's innovation output (see, e.g., He and Tian (2013) and HLT (2012)). Computed similarly, the effect of lagged Q on *LnPatent* (*LnTechAdjCites*) is 9% (11%).

[16] This definition follows HLT and is based on prior evidence that citations per patent, compared to raw number of patents, are better indicators of innovativeness, as evidenced by their impact on firm value (Hall et al. (2005)). We define industry using 4-digit SIC codes here because they provide a sharper contrast in innovative activities across industries than 2-digit SIC codes. The results are similar if we define industry innovativeness based on the level of patenting by an industry.

Table 2
Innovative input and gambling preference.
The table reports the results of regressions of an innovation input (R&D expenditures scaled by total assets) on the local gambling preference proxy, *LnCPRatio*. All the variables are defined in Table A.1 in the Internet Appendix. All firm-level independent variables are lagged by one year. County-level control variables are contemporaneous. Standard errors, shown in parentheses, are heteroscedasticity robust and double-clustered at *county* × *year* and firm levels. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Dependent variable	Full sample			Innovative industries	Non-innovative industries
LnCPRatio	0.011***	0.003**	0.006***	0.012***	0.001
	(0.002)	(0.001)	(0.002)	(0.003)	(0.002)
LnSales		−0.006***	−0.006***	−0.007***	−0.006***
		(0.001)	(0.001)	(0.001)	(0.001)
Sales growth		0.008***	0.008***	0.009**	0.006**
		(0.002)	(0.002)	(0.004)	(0.003)
Excess cash		0.026***	0.021***	0.002	0.033***
		(0.007)	(0.007)	(0.011)	(0.008)
LnFirmAge		−0.005***	−0.004***	−0.007***	−0.000
		(0.001)	(0.001)	(0.002)	(0.001)
ROA		−0.217***	−0.214***	−0.219***	−0.204***
		(0.009)	(0.008)	(0.013)	(0.010)
Ln(PPE/Emp)		−0.003***	−0.003***	−0.004***	−0.003***
		(0.001)	(0.001)	(0.001)	(0.001)
Book leverage		−0.041***	−0.040***	−0.061***	−0.023***
		(0.003)	(0.003)	(0.006)	(0.004)
Capex		0.044***	0.046***	0.082***	0.034***
		(0.009)	(0.009)	(0.018)	(0.009)
Tobin's Q		0.009***	0.008***	0.007***	0.009***
		(0.001)	(0.001)	(0.001)	(0.001)
KZ Index		−0.000	−0.000	0.000	−0.000
		(0.000)	(0.000)	(0.000)	(0.000)
HHI		−0.019***	−0.019***	−0.023***	−0.014***
		(0.003)	(0.003)	(0.005)	(0.003)
Inst. own		−0.005*	−0.005	−0.005	−0.003
		(0.003)	(0.003)	(0.005)	(0.003)
LnAnalysts		0.014***	0.013***	0.016***	0.011***
		(0.001)	(0.001)	(0.001)	(0.001)
Discr. current accr. > 0		−0.004***	−0.004***	−0.004***	−0.003***
		(0.001)	(0.001)	(0.002)	(0.001)
County Controls[#]	No	No	Yes[#]	Yes	Yes
Year/industry FE	Yes	Yes	Yes	Yes	Yes
Observations	32,424	32,424	32,424	12,289	20,135
Adjusted R^2	0.231	0.507	0.516	0.466	0.565

[#] In column (3), *County Controls* with their coefficients (and standard errors) are: *LnPopulation* 0.001 (0.001), *Pop. Growth* −0.016*** (0.004), *Younger* −0.003 (0.002), *Rural Urban Continuum* −0.000 (0.001), *College Grads* 0.001*** (0.000), *Hispanics* −0.046*** (0.009), *Foreign Born Growth* 0.000 (0.000), *Savings rate* −0.070*** (0.017), *Married Household* −0.013 (0.014), *Male to Female Ratio* 0.150*** (0.030), *LnAdherentsPer1000* −0.017*** (0.004), *Dem/Rep* −0.000 (0.001).

We repeat this analysis with the full set of controls in sub-samples partitioned by industry innovativeness in columns 2 and 3 (for *LnPatent*), and 5 and 6 (for *LnTechAdjCites*). Among innovative industries, the regression of *LnPatent* (*LnTechAdjCites*) obtains a coefficient of 0.196 (0.237) on *LnCPRatio* which is statistically significant at the 1% (1%) level. In the sample of non-innovative

Table 3
Innovation outcomes and gambling preference.
The table reports estimates of regressions of innovation outcomes (patents and technology-adjusted citations) on the local gambling preference proxy, *LnCPRatio*. All the control variables are the same as in Table 2, with the addition of $(R\&D/Assets)_{12}$. Standard errors in parentheses are heteroscedasticity robust and double-clustered at *county* × *year* and firm levels. **, and *** indicate statistical significance at the 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	*LnPatent*	*LnPatent* (innovative)	*LnPatent* (non-innovative)	*LnTechAdjCites*	*LnTechAdjCites* (innovative)	*LnTechAdjCites* (non-innovative)
LnCPRatio	0.143***	0.196***	0.089**	0.156***	0.237***	0.065**
	(0.037)	(0.047)	(0.038)	(0.034)	(0.048)	(0.031)
$(R\&D/Assets)_{12}$	1.735***	1.883***	1.454***	1.314***	1.681***	0.701***
	(0.159)	(0.186)	(0.202)	(0.144)	(0.201)	(0.147)
Firm and County Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year/industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	31,164	12,010	19,154	31,164	12,010	19,154
Adjusted R^2	0.456	0.521	0.416	0.400	0.488	0.329

industries, *LnCPRatio* obtains a much smaller coefficient of 0.089 (0.065), which is significant at the 5% (5%) level. A formal test rejects the null hypothesis of equality of these two coefficients at 5% (1%) level of significance. These results support our hypothesis and suggest that the effect of *LnCPRatio* on a firm's innovation output is larger in innovative industries.

Higher innovation output by firms in more gambling-tolerant areas could come from either greater R&D expenditure or greater efficiency or riskier but more promising R&D spending. In Table 3, the coefficient on *LnCPRatio* remains positive and highly statistically significant even after controlling for the intensity of R&D, measured as $(R\&D/Assets)_{12}$. So while firms in higher CPRatio areas spend more on R&D (see Table 2), and past R&D expenditures strongly predict patents and citations, *LnCPRatio* has incremental explanatory power over R&D expenditure in predicting patents and citations.[17] As reported in IA, using a reasonable functional form, we find that high CPRatio firms are less efficient at generating patents per dollar of R&D spending. Also, the patents they obtain have higher variance in quality, as measured by citations. Together, these findings suggest that firms in more gambling-tolerant areas achieve higher innovation output not only from higher R&D spending, but also from investment in riskier, more exploratory research with a greater "R" component of R&D than the safer "D" component. This conclusion is similar to HLT's reasoning about overconfident CEOs. This possibility leads us to probe deeper into the incentives of firms to invest more in R&D, which we do in Section 4 below. But before that, we examine the robustness of our results so far and conduct numerous tests addressing identification concerns.

3.2. Robustness checks

Section A.3 of IA provides robustness checks on our main results. In sum, our main results appear robust to alternate empirical measures and specifications.

3.3. Identification tests

Section 3.3.1 examines whether our main results in Section 3.1 survive tests aimed at mitigating a variety of endogeneity concerns. We do this by investigating alternative interpretations of our main empirical results and employing several econometric techniques. Panel A of Table 4 summarizes these results. To save space, we do not tabulate the robustness checks on subsamples partitioned by industry innovativeness, but note that the results are generally stronger in the subsample of innovative industries. We then examine the effects of large changes in a county's religious composition in Section 3.3.2. Panel B in Table 4 summarizes these results. Section 3.3.3 examines the effect on innovation of a plausibly exogenous variation in CPRatio induced by the immigration law of 1965. Table 5 summarizes these results. Finally, section A.6 of IA provides evidence from relocations of corporate headquarters.

3.3.1. Identification of the main results

3.3.1.1. Alternative gambling proxies. To address the possibility that a bias in our main proxy for gambling preference, *LnCPRatio*, is driving our results, we examine two alternate measures of local gambling preferences instead of *LnCPRatio*. First, we gather information on whether each of six types of gambling (charitable, pari-mutuel, state lottery, commercial, tribal and racetrack) is currently legal in each of the 50 US states.[18] We omit charitable gambling, since its purpose is fund-raising for charities rather than gambling for personal gain, and state lottery because almost all of the sample firm-years belong to states where lottery is currently legal, so there is no variation in that measure (later in this sub-section, we consider annual state-level lottery sales, which does have significant variation). Using the remaining four types of gambling, we construct an index of a state's gambling culture by counting the number of types of gambling allowed in the state. This index takes a value of 0 to 4 for a state. This is a time-invariant measure of a state's gambling culture and has a highly significant Pearson correlation coefficient of 0.44 with *LnCPRatio*, consistent with our interpretation of *LnCPRatio* as a measure of local gambling preferences. We then replace *LnCPRatio* by this gambling index in the regressions of Tables 2 and 3. Row (1a) of Table 4, panel A shows that this index positively and significantly explains *R&D/Assets*, *LnPatent* and *LnTechAdjCites*. We do not use this gambling index in our main analysis because it has limited variation (0 to 4), is available only at the state-level and is time-invariant, while *LnCPRatio* is a continuous variable, is measured at the finer country-level and varies over time.

A potential alternate proxy for local gambling preferences may be aggregate expenditures on different types of gambling at a finer geographical level (such as counties or cities) over time. However, to our knowledge, there is no reliable source of such data, except for annual state-level lottery sales. We obtain this data from 1982 to 2006 for each US state where lotteries are legal from LaFleur's 2011 Historical Sales Report. While a state's per capita lottery sales has greater time-series variation than *LnCPRatio*, it is a weaker proxy for the state's overall gambling culture. Empirical evidence shows almost unanimously that most of the spending on state lotteries comes from poorer and less-educated individuals (see, e.g., Blalock et al. (2007); Kumar (2009), and the references therein). So state-level lottery sales are likely to measure the gambling preferences of only poorer demographics. Accordingly, we partition our sample into firm years with below- and above-median state real per capita income. When we repeat our main analysis on the poorer state-years by replacing *LnCPRatio* by the natural log of per capita state lottery sales, the latter

[17] R&D spending and innovation outcomes are jointly determined in response to local gambling preferences. We use a reduced-form specification here and control for R&D as innovation input. Our results are similar if we exclude R&D as a control variable in these regressions.

[18] See the Wikipedia article, Gambling in the United States, http://en.wikipedia.org/wiki/Gambling_in_the_United_States.

Table 4
Robustness and identification tests.
Panel A of the table reports the results of several tests of robustness and identification performed on the regressions of *R&D/Assets*, *LnPatent*, and *LnTechAdjCites*. The main specification is the full sample regression with the complete set of controls, as presented in column 3 of Table 2 and columns 1 and 4 of Table 3 for *R&D/Assets*, and *LnPatent* and *LnTechAdjCites*, respectively. Rows 0 and 2 report the coefficient estimates of *LnCPRatio*. Panel B reports the results of regressions of 10-year changes in R&D explained by large 10-year changes in LnCPRatio. $Large\Delta_{10}CPRatio$ ($Small\Delta_{10}CPRatio$) indicates whether a 10-year change in *LnCPRatio* is in the top (bottom) quintile of the sample during the year, and Δ_{10}*Firm Controls* (Δ_{10}*County Controls*) measures ten-year changes in firm-level (county-level) control variables of Table 2. Standard errors in parentheses are heteroscedasticity robust and double-clustered at *county* × *year* and firm levels. In both panels, all regressions include year and industry dummies, where industry is defined based on 2-digit SIC codes. All continuous variables are winsorized at the 1% level in both tails. *, **, and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Panel A: Main identification tests

Dependent variable	*R&D/Assets*			*LnPatent*			*LnTechAdjCites*		
	Coeff.	S.E.	N	Coeff.	S.E.	N	Coeff.	S.E.	N
0 Main specification	0.006***	0.002	32,424	0.143***	0.037	31,164	0.156***	0.034	31,164
1 Alternative proxies for gambling culture									
1a Gambling Index instead of *LnCPRatio*	0.002**	0.001	32,424	0.050***	0.018	31,164	0.051***	0.016	31,164
1b Per capita lottery sales in poorer state-years	0.005***	0.001	11,848	0.109***	0.028	11,510	0.097***	0.024	11,510
1c Instrumenting Gambling Index with *LnCPRatio*									
First stage: coeff. on *LnCPRatio*	0.820***	0.000	32,424	0.830***	0.000	31,164	0.830***	0.000	31,164
Second stage: coeff. on predicted Gambling Index	0.007***	0.003	32,424	0.173***	0.000	31,164	0.188***	0.000	31,164
2 Tests dealing with omitted variables									
2a Exclude 5 industries with most patents	0.008***	0.002	23,828	0.109***	0.037	22,895	0.125***	0.033	22,895
2b Exclude high-tech industries	0.004**	0.002	25,991	0.144***	0.043	24,892	0.146***	0.039	24,892
2c Exclude counties with 5 most high-tech areas	0.004**	0.002	29,311	0.172***	0.039	28,165	0.187***	0.035	28,165
2d Exclude 5 highest and 5 lowest CPRatio states	0.009***	0.003	24,371	0.191***	0.057	23,445	0.192***	0.052	23,445
2e 2SLS — Instrument: *LnCPRatio1952*	0.006***	0.002	32,160	0.138***	0.045	30,908	0.132***	0.040	30,908
2f Control for CEO overconfidence	0.009***	0.002	5600	0.173***	0.050	5903	0.158***	0.051	5903
3 Test dealing with self-selection of location (PSM)									
Average difference in propensity scores	0.001	0.011	2345	0.000	0.012	2271	0.000	0.012	2271
Average treatment effects	0.021***	0.004	2345	0.263***	0.056	2271	0.262***	0.055	2271

Panel B: Large temporal changes in *LnCPRatio*

	(1)	(2)	(3)
	Δ_{10}[*R&D/Assets*]	Δ_{10}[*R&D/Assets*]	Δ_{10}[*R&D/Assets*]
$Large\Delta_{10}CPRatio$	0.004**		0.004*
	(0.002)		(0.002)
$Small\Delta_{10}CPRatio$		−0.004***	−0.002*
		(0.001)	(0.001)
Δ_{10}*Firm Controls*			Yes
Δ_{10}*County Controls*			Yes
Year/industry FE	Yes	Yes	Yes
Observations	11,508	11,508	11,016
Adjusted R^2	0.008	0.008	0.224
F-statistic [*p*]: Ho: $Large\Delta_{10}CPRatio - Small\Delta_{10}CPRatio = 0$			6.71*** [0.009]

variable positively and significantly predicts each of our innovation input and output variables, as shown in row (1b) of panel A.[19]

Since CPRatio is a noisy proxy for gambling preference, one way to arrive at a better estimate of economic magnitude of gambling preference is by instrumenting the direct gambling proxy with *LnCPRatio*, which we do in row (1c) in panel A.[20] The first stage regression shows that *LnCPRatio* predicts our gambling index with a very high level of economic and statistical significance even after controlling for other county-level and firm-level variables. The second state regression shows that the predicted gambling index positively and significantly predicts all three measures of innovation. The economic magnitudes are comparable to those from the main regressions.

3.3.1.2. Omitted variables. Our baseline regressions of R&D, patents and citations control for many firm and county characteristics likely to be important for innovation. In addition, we conduct several robustness tests aimed at further mitigating a bias coming from potential omitted variables. We do two tests to examine whether our results are driven by a large number of patents generated by firms in a few locations or industries. These tests check for another potential source of endogeneity. Given large cross-sectional variation in R&D expenditures, patents and citations across industries, location-industry matching may be a source of omitted variable bias to the extent that it is not adequately controlled for by county-level control variables and (linear) industry

[19] But do investors in poorer state-years participate enough in the stock market to influence corporate decisions significantly? Well, this subsample contains state-years that are poor only in a relative sense. Moreover, Kumar (2009) finds that poorer investors are more likely to buy lottery-type stocks to complement their purchases of state lottery tickets.

[20] We thank an anonymous referee for suggesting this approach.

Table 5
Difference-in-differences (DiD) estimates using the 1965 immigration law.
The table reports the estimates from difference-in-differences (DiD) around the passage of the 1965 immigration law. $\Delta CPRatio_{(1970-1952)}$ is the change in the average ratio of Catholics and Protestants in the sample counties between the years 1952 and 1970, the two years around 1965 for which survey data on religion is available. $\Delta AvgR\&D/Assets_{(1978,79,80-1963,64,65)}$ and $\Delta AvgPatents_{(1978,79,80-1963,64,65)}$, respectively are the change in average R&D/Asset ratio and change in average number of patent applications among firms located in the sample counties from years 1963, 1964 and 1965 to years 1978, 1979 and 1980. * and ** indicate statistical significance at the 10% and 5% levels, respectively.

Variable	Treatment	Control	DiD	S.E.
$\Delta CPRatio_{(1970-1952)}$	1.2688	0.5744	0.6944**	0.271
$\Delta AvgR\&D/Assets_{(1978,79,80-1963,64,65)}$	0.0117	0.0017	0.01*	0.006
$\Delta AvgPatents_{(1978,79,80-1963,64,65)}$	−3.9130	−6.278	2.365**	1.040

fixed effects. We identify the five industries (defined by 2-digit SIC codes) that generate the largest average number of patents during our sample period, namely transportation equipment (SIC2 = 37), chemicals and allied products (SIC2 = 28), petroleum refining and related industries (SIC2 = 29), paper and allied products (SIC2 = 26), and electronic and other electrical equipment manufacturers (SIC2 = 36). Despite a loss of more than 25% of our sample when we drop them, the results shown in row (2a) remain significant and are in agreement with our main findings. Moreover, our findings are not driven just by firms in high-tech industries. The results in row (2b) are similar when we omit firms in high-tech industries, as defined by Loughran and Ritter (2004).

The next robustness test examines another potential source of endogeneity. The observed positive relation between innovative activities and *LnCPRatio* may be driven by common trends in both variables in some locations without any causal relation, if such trends are not adequately captured by our county-level control variables and year fixed effects. To mitigate this concern, we examine whether our results are driven by clustering of firms in high-tech cities which are also more likely to experience rapid changes in cultural and religious compositions due to immigration. To this end, we exclude the counties that contain the five areas with largest number of high-tech jobs in the US, located in California, Massachusetts, New York, Washington DC and Texas.[21] These counties represent about 10% of our sample of firm-years. Our results in row (2c) do not materially change when we do so. Alternatively, we exclude the five US states with the highest and lowest concentrations of Catholics relative to Protestants in our sample. These states comprise of Massachusetts, New Jersey, New York, New Hampshire and Rhode Island (highest), and Tennessee, Arkansas, North Carolina, South Carolina, and Alabama (lowest). In row (2d), our results from each of the three regressions for R&D, patents and citations remain essentially unchanged. This finding implies that the observed relations are not driven by firms in a few locations with very large or very small concentration of Catholics compared to Protestants.

Next, to further mitigate concerns about an unobserved omitted variables bias, we employ a two-stage least squares (2SLS) model using an instrumental variable for contemporaneous *LnCPRatio*. We calculate the ratio of Catholic to Protestant members in 1952 (*CPRatio1952*), the first year for which ARDA collected data on county-level religiosity. This instrument satisfies the relevance criterion because a county's historical religious composition is likely correlated with its current religious composition because religious beliefs are generally handed down from older to newer generations. Moreover, since our sample starts in 1980 and ends in 2006, this variable represents cross-sectional variation in religious composition from 28 to 54 years ago. This instrument satisfies the exclusion restriction assuming that any correlation between potential omitted variables (such as time-varying growth opportunities, competition or financing) and CPRatio does not persist over time. In row (2e), when we use the natural log of one plus *CPRatio1952* (*LnCPRatio1952*) as an instrument for its contemporaneous *LnCPRatio* in a 2SLS estimation framework, our results remain both economically and statistically significant.

This paper integrates ideas from previous research on two potentially related behavioral attributes, namely gambling preferences and CEO overconfidence. Therefore, a relevant question is how these ideas are conceptually related, and whether *LnCPRatio* has incremental explanatory power over CEO overconfidence. CEO overconfidence and lottery preferences can both affect innovation. Overconfidence is a behavioral bias which makes managers underestimate the variance or overestimate the mean of the payoff distribution, leading them to undertake high-risk projects such as innovation. A preference for skewness, on the other hand, is not necessarily irrational and is justified under a cumulative prospect theory framework. An agent with lottery preferences knows the payoff distribution, but prefers the payoff with greater positive skewness. Since neither of the two attributes precludes the other, they can co-exist and independently influence innovative decisions. So we next investigate whether gambling preferences have incremental explanatory power over the option-based measure of CEO overconfidence. In our subsample of firm-years that belong to S&P 1500 during HLT's (2012) 1993–2003 sample period, we construct their main measure of overconfidence based on CEO option holdings. This subsample is smaller than HLT's sample because our study requires data on additional variables. Our choice of control variables in the R&D, patents and citations regressions largely follows Coles et al. (2006) and HLT (2012). We add *LnCPRatio* as an explanatory variable to each of these regressions. As shown in row (2f), despite a much smaller sample, *LnCPRatio* continues to predict R&D, patents and citations positively and significantly even after controlling for the options-based measure of CEO overconfidence.

[21] See, Geek America: The Top 10 U.S. Cities for Technology Jobs, CIO.com, http://www.cio.com/special/slideshows/top_10_cities_for_tech_jobs/. Specifically, we exclude Silicon Valley (Santa Clara, CA, FIPS = 6085; San Francisco, CA, FIPS = 06075), Suffolk county (Boston, MA, FIPS = 25025), New York metro area, NY (FIPS = 36061, 36047, 36081, 36005), Washington D.C. (FIPS = 11001), and Dallas-Ft. Worth, TX area (FIPS = 48113).

3.3.1.3. Self-selection. Our final test addresses the possibility of self-selection, i.e., firms might choose their location based on their need to innovate, and the factors they consider when locating might be correlated with religious composition. To deal with this issue, we employ a propensity score matching (PSM) analysis. We create two pooled subsamples of firms located in the highest tercile of CPRatio (treatment firms) and firms with the rest of the two terciles (candidate control firms). We then estimate a logit model to predict the probability of a firm's choice to be located in an area in the highest tercile of CPRatio. The validity of a PSM analysis depends on how closely the treatment and control firms are matched. So, in the logit models, we use a large set of explanatory variables as in Table 2 (for the analysis of R&D intensity), or Table 3 (for the analysis of patents and citations). They include 2-digit SIC industry and year fixed effects (and obviously exclude *LnCPRatio*). We then match each firm located in the high CPRatio counties with one firm in the low CPRatio counties using the nearest neighborhood, with a restrictive caliper. As shown by the first line of test 3 in Table 4, this exercise obtains us a very closely matched pool of treatment and control groups with no statistical difference in their average predicted probability of being located in a high CPRatio area. The second line reports the average treatment effect for the treated (ATT), which suggests that the firms located in high CPRatio areas on average have larger R&D expenditure, patents and citations compared to a very similar group of firms located in low CPRatio areas. This result suggests that our main results do not appear to be driven by firms' choice to locate in high or low CPRatio areas.

3.3.2. Evidence from counties with large changes in CPRatio

As an additional attempt to mitigate potential spurious effects of fixed county characteristics on innovation, we next investigate whether firms located in counties that experience large increases (decreases) in CPRatio increase (decrease) their investment in innovation. Since a county's religious composition generally changes slowly, and annual changes tend to be small and noisy, we estimate a regression of the change in R&D compared to ten years earlier on the corresponding change in CPRatio. Moreover, since the changes in CPRatio and R&D both could be driven by contemporaneous changes in firm and county characteristics, we control for ten-year changes in firm level variables (Δ_{10}*Firm Controls*) and time-varying county variables (Δ_{10}*County Controls*) in Table 2 regressions**:**

$$\Delta_{10}(R\&D/Assets) = \mathrm{b_o} + \mathrm{b_1 Large}\Delta_{10}CPRatio + \mathrm{b_2 Small}\Delta_{10}CPRatio + \Delta_{10}\,Firm\ Controls + \Delta_{10}County\ Controls \\ + \text{2-digit SIC industry dummies} + \text{year dummies},$$

where $\Delta_{10}[R\&D/Assets] = [R\&D/Assets]_t - [R\&D/Assets]_{t-10}$; and $Large\Delta_{10}CPRatio$ ($Small\Delta_{10}CPRatio$) = 1, if $[LnCPRatio_t - LnCPRatio_{t-10}]$ is in the top (bottom) quintile of the sample during year *t*, and 0 otherwise. The quintiles are formed every year, starting in 1990, ten years after the beginning year of our sample. The standard errors are robust to heteroscedasticity and double-clustered at *county* × *year* and firm levels. Column 1 of Table 4, panel B shows that large increases in a county's *LnCPRatio* positively predict changes in local firms' R&D expenditures; column (2) shows that small increases, which are mostly decreases, in *LnCPRatio* negatively predict changes in R&D. Finally, in column (3), the coefficient estimate of $Large\Delta_{10}CPRatio$ ($Small\Delta_{10}CPRatio$) is 0.004 (−0.002). The test reported in the last row shows that the difference between the two coefficients ($b_1 - b_2$) is statistically significant ($p < 0.01$). These results imply that, consistent with our baseline results, firms located in counties with large increases in CPRatio significantly increase their R&D spending compared to those in counties with large decreases.

3.3.3. Immigration Act of 1965 as a quasi-natural experiment

The Immigration and Nationality Act of 1965 (also known as Hart–Celler Act) was signed in October 1965 and became effective in June 1968. The law abolished the national origins quota system and replaced it with a system of preferences based on family relationships and skills. Hart–Celler Act was a landmark law, which dramatically changed US demographics in the years to come. As found by Keely (1971) it had an immediate effect on demographics even during the two and half year period from 1966 to mid-1968 over which the quota system had to be phased out. The shock to immigration due to this Act has several desirable features and offers a good setting for testing the causal effect of religious compositions on corporate policies. First, it is a federal law that affects all US states equally. Second, in a major departure from the previous law, the primary criterion for granting a visa under this law is family reunion. That is, applicants are more likely to be granted visas if they already have family members living in the US. This provision of the law mitigates a concern about an immigrant's self-selection of the place to locate because immigrants are likely to move near family members. In addition, this feature, along with data on the demographic compositions of locations, allows us to track where immigrants from different counties are likely to locate in the US, at least in the short-run, and the potential impact on the location's religious composition. For example, an immigrant from India is more likely to move to New Jersey and one from Mexico is more likely to move to Texas. Further, Keely (1971) finds that even though the volume of immigration increased following the new law, the occupational distribution of the immigrant population remained largely unchanged. This finding makes it less likely that these differences are a result of a shift in skill sets, at least in the short run.

From the US Census Bureau, we identify the ten countries that had the largest increase in immigrants to the US immediately after the passage of the law.[22] Five of these countries (Philippines, Mexico, Portugal, Cuba and Dominican Republic) are predominantly Catholic and the other five (India, China, Korea, Jamaica and Japan) are non-Catholic. To identify where these immigrants are most likely to have moved to, we identify 50 cities with the largest concentration of people born in each of these countries

[22] We infer this from "World Region and Country or Area of Birth of the Foreign-Born Population: 1960 to 2000" file available on Census Bureau's website.

from city-data.com (http://www.city-data.com/top2/toplists2.html). We focus our analysis on relatively large cities (population > 20,000) so that these cities likely have a noticeable impact on religious compositions of the counties they belong to. We match these cities to counties. Since multiple cities can be part of the same county, this exercise yields a sample of 26 (22) counties which have cities with the largest concentrations of residents born in Catholic (non-Catholic) countries. The first group serves as our treatment sample and the second serves as the control sample, which we use to do a difference-in-differences (DiD) test. Our strategy is to exploit the differential and plausibly exogenous effect of immigration on the religious compositions of different counties. The idea is that because of the law's family reunification provision, new immigrants are more likely to first move to cities with an already large concentration of immigrants from their countries (who also share their religious affiliation). Since both sets of counties were affected by the new law, comparing these counties allows us to mitigate the concern that the observed effects are because of immigration, not differences in religious compositions. Next, we obtain data on firms' R&D/Asset ratio from Compustat and patent data from Kogan et al.'s (forthcoming) patent database which includes pre-1976 data. We calculate county-level means of R&D/Asset ratio (*AvgR&D/Assets*) and (eventually) successful patent applications of firms in each county (*AvgPatents*) for each year from 1960 to 1980.

First, we check whether the law indeed had differential effects on the religious compositions of the treatment and control counties. The DiD estimates in the first row of Table 5 show that as expected, the treatment counties experience a significantly larger increase in CPRatio ($\Delta CPRatio_{(1970-1952)}$) than the control counties between 1952 and 1970, the two years for which data on religiosity is available from ARDA before and after the law's enactment. Then we test whether public firms in treatment counties subsequently experienced a larger increase in innovation. Demographic changes due to immigration likely affect corporate innovation policies with a significant lag because immigrants may not immediately become a significant part of local investors or workforce, or significantly influence the local culture. Therefore, we allow for 10 years after 1968, the end of the transition period. In particular, for the DiD tests, we compare the change in the R&D/Asset ratio and patents of public firms over the years 1978, 1979 and 1980 and compare it to the average over the three years leading up to the beginning of the transition period, namely years 1963, 1964 and 1965. As shown in the second and third rows of Table 5, the treatment counties subsequently experienced a larger change in average R&D/Asset ratio ($\Delta AvgR\&D/Assets_{(1978,79,80-1963,64,65)}$) and average patenting rates ($\Delta AvgPatents_{(1978,79,80-1963,64,65)}$) compared to the control counties.

To summarize, we use a DiD test around the immigration law of 1965, and find that public firms in counties which experienced a larger increase in CPRatio due to a plausibly exogenous shock to immigration subsequently increased their innovation significantly more compared to a control sample.

Some limitations of this exercise are worth noting. The earlier data on Compustat and patenting activities is thin, which results in a relatively small sample. We make strong assumption about where these immigrants may have moved. We do not have data on immigrants at the individual level, so we cannot separate national origins from religious origins. The law may also have had other effects, which we do not know, that might have affected these two sets of counties differently. While these results support our main findings and a take us a step closer to establishing a causal effect, we should be wary of drawing strong conclusions from them.

4. Incentive for higher R&D

Our results so far are consistent with the hypothesis that local gambling attitudes motivate firms to spend more on R&D and achieve higher levels of innovation in terms of patents and citations. This interpretation of our empirical results hinges on the idea that R&D investments have gamble-like payoff distributions. So in this section we examine whether greater R&D investment makes a stock more lottery-like, which prior studies have found to be a desirable feature for investors inclined to gamble. Kumar (2009) argues that stocks with high idiosyncratic volatility, high idiosyncratic skewness and low price tend to have lottery-like characteristics. Investors with a preference for lotteries find such stocks attractive even if they offer negative expected returns, because these investors expect the extreme positive return events of the past to be repeated in the future.

We begin our analysis by identifying stocks that are more likely to be viewed as lottery-like. Motivated by Kumar (2009), we classify a stock as lottery-type if its returns exhibit above-median idiosyncratic volatility and above-median idiosyncratic skewness in a given year. Since there is no reason to expect R&D expenditures to influence stock price levels per se, we follow KPS (2011) and do not consider price per share in identifying lottery stocks. But we do control for stock price levels in regressions explaining lottery stock characteristics. Idiosyncratic volatility is the standard deviation of the residuals obtained by regressing daily returns on a stock on Fama and French (1993) and Carhart's (1997) four factors over a year. Idiosyncratic skewness is calculated as the skewness of the residuals obtained by regressing daily returns on a stock on excess market return and excess market return squared (see Harvey and Siddique (2000), and Kumar (2009)).

To capture the dynamic role of R&D expenditures in shaping stock return distributions, we estimate a logit model of lottery stock in column 1 of Table 6, after including firm fixed effects.[23] This fixed effect logit model examines the determinants of within-firm variability in the lottery-likeness of a stock. By definition, this regression only includes those firms where the stock switched from being non-lottery type to being lottery type, or *vice-versa*. Since our main explanatory variable of interest here is R&D expenditure, which, unlike *LnCPRatio*, has meaningful time-series variation, the firm fixed-effects model is appropriate for this analysis. Following Kumar (2009, Table II), we control for firm-specific variables (such as firm size, firm age and

[23] We do not include *LnCPRatio* in these regressions because there isn't enough time-series variation in CPRatio within a firm.

Table 6
Motivation for higher R&D expenditures.
The table reports the results of regressions where the dependent variables are 1) an indicator variable for a lottery stock, 2) idiosyncratic volatility of a stock in a given year, and 3) idiosyncratic skewness of a stock in a given year. All the variables are defined in Table A.1 in the Internet Appendix. All independent variables at the firm-level are lagged by one year. County-level control variables (not reported for brevity) are contemporaneous. Model 1 is firm fixed effect logit model where the dependent variable is a dummy variable for a lottery stock. Models 2 and 3 are firm fixed effect panel regressions with idiosyncratic volatility and idiosyncratic skewness as the dependent variable, respectively. Standard errors in parentheses are heteroscedasticity robust and clustered at firm level. *** indicates statistical significance at the and 1% level.

	(1)	(2)	(3)
Dependent variable	Lottery stock	Idio. volatility	Idio. skewness
R&D/Assets	1.153***	0.012***	0.770***
	(0.392)	(0.003)	(0.200)
Firm# and County Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	21,070	32,013	32,009
Adjusted (pseudo) R^2	(0.156)	0.318	0.063

Firm controls are: *LnPatent*, *LnFirmAge*, *LnMarketCap*, Tobin's Q, Amihud illiquidity, dividend payer, turnover, stock return, inst. own, LnAnalysts, price per share, market beta, SMB beta, and HML beta.

market-to-book ratio), variables related to asset pricing (such as market beta, SMB and HML) and market microstructure variables (turnover and illiquidity). We also include all county-level control variables. The model yields a positive coefficient of 1.153 on lagged R&D/Assets which is significant at the 1% level.[24] This finding suggests that higher R&D expenditures significantly increase the probability of a stock being lottery type.

Next, we analyze the effect of R&D expenditures on each of the two lottery factors, a stock's idiosyncratic volatility or idiosyncratic skewness. To better capture the dynamics of R&D expenditures and idiosyncratic volatility, we estimate regressions with firm fixed effects. As shown in columns 2 and 3 of Table 6, R&D expenditure obtains a significantly positive coefficient in regressions of idiosyncratic volatility or idiosyncratic skewness, suggesting a dynamic positive relation between R&D expenditures and individual lottery characteristics.

While the relation between R&D expenditures and firm risk has been documented by prior research (see, e.g., Chan et al. (2001)), it was not in the context of corporate innovation, so it does not include the set of control variables relevant here. To our knowledge, we are the first to document a positive relation between R&D expenditures and idiosyncratic skewness, which suggests that R&D investments are high-risk endeavors that have positively-skewed payoff distributions. While many of these projects fail, a few can yield ground-breaking inventions with very large returns.[25]

5. Supporting evidence

To improve identification, in this section we test for several secondary implications of our main hypotheses. These tests further support the notion that higher R&D expenditures made by firms located in high *CPRatio* areas are partly due to local residents' preference for gambling. We find that: (1) The influence of local gambling preferences on R&D expenditures is stronger among firms for which local investors are more important, (2) the gambling preferences of managers also appear to motivate firms to invest more in innovation activity, and (3) firms in high CPRatio areas tend to be relatively inefficient in generating patents from R&D dollars and obtain patents with higher variance in quality.

5.1. The role of local investors

We find in Section 3.3 that firms located in counties with higher CPRatios invest more in R&D. We argue that firms do so partly because local investors in these areas value lottery-like features in the stock. Our findings in Section 4 are consistent with this argument. This argument also implies that the relation between local gambling preferences and R&D expenditures should be more pronounced in firms for which local investors are economically more important. To test this hypothesis, we use three indicators of such firms. First, Becker et al. (2011) argue that small firms are more likely to be reliant on the local investor base. We create an indicator variable, *SmallFirm*, which equals one if the market value of the firm is less than the median market value of all firms in a given year, and zero otherwise. Second, we identify firms located in counties with fewer

24 For brevity, we only tabulate the coefficient of this variable.
25 We also examine the possibility that greater R&D spending may result in lower risk-increases in large firms than in small firms because a large number of innovative projects can diversify some risk in the former. We repeat the regressions in Table 6 by replacing R&D/Assets by its interaction with large (above median) and small (below median) firms, as measured by sales. The coefficients on both interaction terms are significantly positive in all three regressions. The difference between the two coefficients is significant only in the regression of idiosyncratic skewness, where the coefficient estimate is *larger* for the interaction term with large firms than with small firms, inconsistent with a diversification effect.

investment opportunities relative to local investment demand. Following Hong et al. (2008), we create a variable *BE/PI* which equals the aggregate book equity of all the public companies headquartered in a county in a given year divided by the aggregate personal income of all the residents in the county during the year.[26] The idea is that in the presence of local bias, a firm is likely to get a larger share of local investment if it has to compete with fewer other local firms, which Hong et al. call 'the only-game-in-town effect'. This effect makes local investors economically more important to firms. Specifically, we create a variable, *Low BE/PI*, which equals one if the *BE/PI* associated with a firm is below the median *BE/PI* of all sample firms in a given year, and zero otherwise. Finally, given that individual investors are more likely to be prone to behavioral biases such as gambling preferences (see, e.g., Bailey et al. (2011)) than institutional investors, local gambling preferences should matter more for firms with larger fractions of individual shareholdings. Accordingly, we create a third variable, *High Indiv Invest*, an indicator variable that equals one if a firm has an above-median fraction of individual shareholdings in a year (approximated by below-median fraction of 13F institutional shareholdings), and zero otherwise.

Based on these three indicators of the importance of local investors to a firm, we examine whether the influence of local gambling preferences on innovative endeavors (R&D expenditures) is driven by firms for which local investors are likely to be more important. Accordingly, we re-estimate our regression of R&D expenditures as in column 3 of Table 2, after adding an indicator variable for the importance of local investors (i.e., *SmallFirm or Low BE/PI or High Indiv Invest*) and its interaction with *LnCPRatio*. A positive and significant coefficient on these interaction terms would indicate that R&D expenditure is more sensitive to local investors' preference for gambling if the local investor base is more important for a firm.

Table 7 presents these results. Column 1 shows the results of the regression using *LnCPRatio* and its interaction with the first indicator variable *SmallFirm*. The results support our hypothesis that the influence of local gambling attitudes on innovative input, i.e., R&D spending, should be more pronounced in smaller firms. The point estimate of this interaction term, which measures the incremental effect of gambling preferences in small firms, is 0.006 and is statistically significant at the 1% level, whereas the effect is small and insignificant among large firms, as indicated by the *LnCPRatio* term, with a point estimate of 0.003 (t-value $= 1.50$). The regression in column 2 is similar, except that we now use the next indicator variable, *Low BE/PI* to measure the importance of local investors. Once again, we find a more significant effect of *LnCPRatio* on R&D spending among firms in *Low BE/PI* counties with a point estimate of 0.006 ($t = 2.00$) for the incremental effect, compared to firms in high *BE/PI* counties, which have a point estimate of 0.003 ($t = 1.50$). We arrive at a similar conclusion when we consider *High Indiv Invest* in column 3 as an alternative proxy of the importance of local investors.

To recap, we find that the effect of gambling preferences on innovative input is driven by firms for which the local investor base is more important. In particular, smaller firms, firms in counties with fewer investment opportunities compared to demand, and firms with more individual investors tend to be more influenced by local investors' gambling preferences. Hence, they spend more on R&D.

5.2. The role of managers

We find in Section 3.3 that firms located in high CPRatio areas invest more in R&D. Our findings in Sections 4 and 5.1 suggest that firms do so partly because of local investors' lottery preferences. We next examine whether managers of firms in high CPRatio areas also display a preference for lotteries and if so, whether such preferences play a role in firms' decisions to invest more in R&D. Consistent with the fact that stock options have lottery-type characteristics, such as a positively-skewed payoff distribution, KPS (2011) find that broad-based employee stock option plans are more popular among firms in gambling-tolerant areas. We analyze the stock option holding behavior of the CEO and the top management team, particularly focusing on their exposure to stock volatility (Vega) generated by these holdings.

An analysis of managers' option holdings serves two purposes. First, Spalt's (2013) calibration evidence suggests that stock options are attractive to employees with lottery preferences. So, after controlling for other determinants of Vega, excess Vega at least partially reveals managers' inherent lottery preferences, which can lead them to adopt corporate policies with positively-skewed payoffs. Second, since the value of an option increases with the volatility and skewness of the underlying asset (see, e.g., Boyer and Vorkink (2014)), higher Vega further incentivizes managers to pursue risky polices with positively-skewed payoffs, such as R&D. Consistent with this argument, experimental evidence from Åstebro et al. (2009) shows that subjects make significantly riskier choices when the distribution of payoffs is positively-skewed, and Coles et al. (2006) find that managers with higher Vega invest more in R&D.

For the subsample of our firm-years on Execucomp, we start by examining whether stock option holdings of CEOs and the top management team of firms in high CPRatio areas generate higher sensitivity to stock volatility (Vega). We follow Core and Guay's (2002) approach to compute Vega and option Delta, which measure changes in the values of their option holdings in response to a 1% change in stock volatility and stock price respectively. We then estimate a regression that predicts Vega, where the main explanatory variable of interest is *LnCPRatio*. The control variables are from Mobbs (2013), except for variables related to directors. Additionally, we include HLT's (2012) option-based CEO overconfidence measure (*Holder67*), and the full set of our county-level control variables. A simple regression model with only industry and year fixed effects as controls presented in column 1 of Table 8 shows that consistent with our hypothesis, *LnCPRatio* positively and significantly predicts the Vega of CEO option holdings. The coefficient estimate of *LnCPRatio* remains significant after controlling for CEO overconfidence, option Delta and a number of

[26] We proxy for a county's per capita income by its state per capita income and multiply it by the county's population.

Table 7
Role of local investors.
The table reports the analysis of the effect of our local gambling preference proxy, *LnCPRatio* on an innovation input (R&D expenditure scaled by total assets). All the variables are defined in Table A.1 in the Internet Appendix. *SmallFirm* equals one if the market value of a firm is below the median of all firms in a given year. *Low BE/PI* equals one if the *BE/PI* associated with a firm is below the median *BE/PI* of all sample firms in a given year, and zero otherwise. *BE/PI* equals the total book equity of all public companies headquartered in a county during a year divided by the aggregate personal income of all residents of the county during the year. *High Indiv Invest* is an indicator variable that equals one if a firm has above-median fraction of individual investors in a given year, and zero otherwise. Control variables are the same as in column 3 of Table 2. All the independent variables at the firm-level are lagged by one year. County-level control variables are contemporaneous. Standard errors in parentheses are heteroscedasticity robust and double-clustered at *county* × *year* and firm levels. ** indicates statistical significance at the 5% level.

	(1)	(2)	(3)
Dependent variable	R&D/Assets	R&D/Assets	R&D/Assets
LnCPRatio	0.003	0.003	0.003
	(0.002)	(0.002)	(0.002)
LnCPRatio ∗ *SmallFirm*	0.006**		
	(0.002)		
LnCPRatio ∗ *Low BE/PI*		0.006**	
		(0.003)	
LnCPRatio ∗ *High Indiv Invest*			0.006**
			(0.002)
Firm and County Controls	Yes	Yes	Yes
Year/industry FE	Yes	Yes	Yes
Observations	32,424	32,424	32,424
Adjusted R^2	0.516	0.516	0.516

firm-specific and county-specific variables in column (2). This result implies that consistent with our hypothesis and the findings of KPS (2011) about rank and file employees, CEOs of firms in more gambling-tolerant areas have greater exposure to stock volatility and skewness.

We then add the CEO's Vega as an explanatory variable in our R&D regression in column (3). Even after controlling for additional variables such as CEO overconfidence and option Delta, the coefficient on Vega is significantly positive. This result is consistent with prior findings (see, e.g., Coles et al. (2006)), that incentives from CEOs' option Vega positively predict firms' investments in innovation. However, even after controlling for this Vega effect, the coefficient estimate of *LnCPRatio* remains significantly positive, implying that CEO's Vega does not capture the entire effect of local gambling preferences. We find similar and stronger results in columns 4, 5 and 6 when we repeat the analysis of columns 1, 2, and 3 by replacing the CEO's Vega with the average Vega of a company's top five executives. This result suggests that the gambling preference of the top management team, rather than only the CEO, matters for innovation. While the positive coefficient on Vega represents the influence of managers'

Table 8
Role of managers.
The table reports the analysis of the effect of the local gambling preference proxy, *LnCPRatio* on the option Vega of the CEO and the top management team, and the effect of Vega incentives on R&D. All the variables are defined in Table A.1 in the Internet Appendix. CEO (Mgmt. Team) Vega represents the dollar change in the CEO's (average of top managers') option holdings for a 1% change in stock return volatility, in millions. Untabulated firm-level control variables in columns (2) and (5) are from Mobbs (2013). Untabulated control variables in columns (3) and (6) are as in column 3 of Table 2. All the independent variables at the firm-level are lagged by one year. County-level control variables are contemporaneous. Standard errors in parentheses are heteroscedasticity robust and double-clustered at *county* × *year* and firm levels. ** and *** indicate statistical significance at 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	CEO Vega	CEO Vega	R&D/Assets	Mgmt. Team Vega	Mgmt. Team Vega	R&D/Assets
LnCPRatio	0.032***	0.032***	0.007***	0.013***	0.013***	0.007**
	(0.009)	(0.009)	(0.003)	(0.004)	(0.004)	(0.003)
CEO Vega			0.017***			
			(0.005)			
CEO option Delta			−0.002			
			(0.002)			
Mgmt. Team Vega						0.061***
						(0.013)
Mgmt. Team option Delta						−0.009
						(0.006)
Holder67		0.023***	0.004***		0.011***	0.004***
		(0.006)	(0.002)		(0.002)	(0.002)
Firm and County Controls	No	Yes	Yes	No	Yes	Yes
Year/industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7054	7054	7779	7054	7054	7779
Adjusted R^2	0.128	0.342	0.444	0.131	0.375	0.445

preferences on innovation, the incremental effect of *LnCPRatio* measures the effect of the gambling preferences of both managers and investors.

To summarize we find that managerial gambling preferences can affect a firm's innovative endeavors in at least two ways. The first channel is the higher Vega of managers' stock option holdings in high CPRatio areas, which incentivizes managers to adopt policies that increase stock volatility and skewness. The second channel is the inherent lottery preference of managers in high CPRatio areas that influences corporate innovation even after controlling for their Vega incentives.[27]

5.3. Innovative efficiency and patent quality variance

In section A.7 of IA, we provide two pieces of evidence that support gambling motive of investment in innovation. First, these firms seem to be less efficient in generating patents per dollar of R&D expenditure. Second, firms in high CPRatio areas invest in riskier exploratory research as evidenced by higher variance in the quality of patents they obtain.

6. Firm valuation

We find in Sections 3 and 5.3 that firms in more gambling-tolerant areas invest more in R&D, produce more and higher quality innovation output on average, but produce patents with larger quality variance and are less efficient at generating innovations per dollar of R&D. Thus, our empirical results do not do suggest a clearly positive effect of gambling preferences on overall firm valuation. So we ask a more specific question: Does firm value vary more with local gambling preferences when innovation is critical for a firm's success? More generally, are firms in areas with a greater preference for gambling more adept at transforming industry growth opportunities into firm value?

Theory and empirical evidence by Manso (2011) and Tian and Wang (2014) suggest that innovative activities require extraordinary tolerance for failure and a strong incentive to explore and experiment. We motivated our thesis with the simple premise that gambling preferences of managers and investors, which make them underweight a large probability of losses and overweight a small probability of large gains, closely resemble the culture of failure-tolerance required for innovation to succeed. So we hypothesize that when innovation and rapid growth are critical for a firm's success, gambling preferences of investors and managers should be especially value-relevant because the possibility of very large gains makes them more tolerant of failure, and such tolerance is essential for innovation.

To test this hypothesis, we follow HLT's (2012) framework and estimate the following regression:

$$\begin{aligned}\text{Tobin's Q} = {} & b_o + b_1 \mathit{IndGrowthOpp} + b_2 \mathit{LnCPRatio} + b_3 \mathit{LnCPRatio} * \mathit{IndGrowthOpp} + \text{firm-level controls} \\ & + \text{county-level controls} + \text{2-digit SIC industry dummies} + \text{year dummies},\end{aligned}$$

where Tobin's Q is the ratio of market value of assets to book value of assets and *IndGrowthOpp* is an exogenous, industry-level measure of growth opportunities. We use two alternate measures of *IndGrowthOpp*. First, we use industry innovativeness (*Innovative Ind*) which equals one for 4-digit SIC industries whose citations per patent exceed the median for all industries in a given year; it equals zero for other industries. Hall et al. (2005) findings suggest that firms in innovative industries have greater potential for value creation through innovation. So, *Innovative Ind* is a cross-sectional and time-varying measure of the importance of innovation for firm value. Our second, broader measure of industry growth opportunities is peer firms' average price-to-earnings ratio (*PeerPE*), which we compute as the natural log of total market value of equity divided by total earnings of all other firms in a firm's 2-digit SIC industry. As HLT (2012) point out, PE is a noisy measure of growth opportunities because it is influenced by both growth potential and discount rate changes, biasing our tests against finding a significant result. Firm-level control variables are the same as in HLT (2012). In addition, we control for all the county-level variables used in our earlier analyses.

If firms in areas with a greater preference for gambling are more adept at transforming industry growth opportunities into firm value, we expect b_3 to be positive. However, we do not have a prior on the sign on b_2. Our finding in Section 3.2 that investors in more gambling-tolerant areas produce more and better quality innovation output implies that b_2 should be positive. But our finding in Section 5.3 that firms in high CPRatio areas are less efficient at generating innovations per unit of R&D spending implies that b_2 should be negative.

Table 9 shows estimates of four variants of this regression. For brevity, we do not report estimates of the county-level control variables and the intercept. Models (1) and (3) include alternate measures of industry growth opportunities, without firm-level controls. The coefficient estimates of both measures are positive and highly significant, consistent with the idea that firms in industries with higher growth opportunities command higher valuations. Models (2) and (4) include *LnCPRatio*, a measure of industry growth opportunities, their interaction, and firm and county-level controls. The coefficient estimate of *LnCPRatio* is

[27] In addition, we use Eisfeldt and Kuhnen's (2013) data on exogenous CEO turnover to examine the effect on innovation when a firm switches from a Protestant to Catholic (P → C) CEO or the reverse. We infer CEO religion based on their ethnic origin, identified using Ambekar et al.'s (2009) *Name Ethnicity Classifier* (http://www.textmap.com/ethnicity/). Among the CEO changes in our sample where we could classify the religion of both old and new CEO as either Protestant or Catholic, we compare the change in average R&D to Assets ratio and the proportional change in number of successful patent applications over years (−3, −1) and (+1, +3), where 0 is the turnover year. We find that a P → C (C → P) CEO change leads to an average change of 0.0005 (−0.0012) in the R&D/Asset ratio, and −2.4% (−29.7%) in patents. The estimates of the difference in differences are 0.0017 (S.E. = 0.0020) for R&D/Assets and 0.2727 (S.E. = 0.2116) for patents. These estimates are consistent with our hypothesis, although they are not statistically significant at conventional levels likely due to small sample sizes (average n = 32).

Table 9
CPRatio and firm valuation.
The table reports the results of regressions of Tobin's Q on *LnCPRatio* and two alternate measures of industry growth opportunities, namely industry innovativeness (*Innovative Ind*) or peer firm PE ratio (*PeerPE*), and their interactions. *Innovative Ind* equals one for 4-digit SIC industries whose citations per patent exceed the median for all industries in a given year; it equals zero for other industries. *PeerPE* is the natural log of total market value of equity divided by total earnings of all *other* firms in a firm's 2-digit SIC industry. All other variables are defined in Table A.1 in the Internet Appendix. All firm-level independent variables are lagged by one year. Standard errors in parentheses are heteroscedasticity robust and double-clustered at *county* × *year* and firm levels. ** and *** indicate statistical significance at the 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)
Dependent variable	Tobin's Q	Tobin's Q	Tobin's Q	Tobin's Q
Innovative Ind	0.212***	0.040		
	(0.025)	(0.040)		
PeerPE			0.056***	−0.057***
			(0.016)	(0.022)
LnCPRatio ∗ *Innovative Ind*		0.127***		
		(0.042)		
LnCPRatio ∗ *PeerPE*				0.097***
				(0.026)
LnCPRatio		0.068**		−0.168**
		(0.031)		(0.075)
Firm# and County Controls	Yes	Yes	Yes	Yes
Year/industry FE	Yes	Yes	Yes	Yes
Observations	37,484	35,517	31,912	30,427
Adjusted R^2	0.150	0.247	0.150	0.251

Firm controls are: Ln(PPE/Emp), *LnSales*, stock return, ROA, business segments.

ambiguous: it is positive in model (2) and negative in model (4). But our main interest here is in the interaction term, *LnCPRatio* ∗ *Innovative Ind* or *LnCPRatio* ∗ *PeerPE*, which is positive and highly significant in both models. This result suggests that firms in areas with greater preference for gambling are more successful at converting their potential growth opportunities into realized firm value. This finding parallels HLT's (2012) finding that firms with overconfident CEOs are more adept at translating their potential growth opportunities into firm value. In summary, the findings in this section suggest that when innovation and growth are important for a firm's success, the 'extra push' from gambling attitudes of investors and managers can be value-enhancing.

7. Conclusion

Because innovation is critical for firm value and economic growth, recent academic research and public policy discussion have both focused on identifying factors that lead to more and better innovation. While most prior research investigates rational factors related to firms and financial markets as contributors to innovation, we examine a behavioral determinant of innovation.

We find that local gambling preferences play an important role in promoting firms' innovative activities. In particular, using a county's Catholics-to-Protestants ratio as a measure of local gambling preference, we find that US counties with greater preferences for gambling invest more in R&D, produce more patents and generate more citations. The economic magnitudes of these effects are larger for firms in more innovative industries. Our results are consistent with the view that gambling preferences instill a corporate culture of tolerating failures for the possibility of very large gains, which leads to more spending on exploration and experimentation, and eventually to more innovation. These results are robust to several alternative empirical specifications, alternative measures of gambling preferences, and treatments of endogeneity, both via economic reasoning and econometric techniques. Supporting a gambling motive for higher R&D expenditures, we find that R&D spending makes stocks more lottery-like by increasing both their idiosyncratic volatility and idiosyncratic skewness, features of stocks found by Kumar (2009) to be desired by investors with a preference for gambling.

Next, we empirically confirm four secondary implications of our main hypothesis. First, R&D spending shows greater sensitivity to local gambling preferences in firms that are more reliant on local investors. Second, gambling preferences of managers also appear to matter. In our Execucomp subsample, we find that in high CPRatio areas, top executives create large personal exposures to stock volatility and skewness via higher Vega of their stock option holdings. Third, firms in high CPRatio areas seem to be less efficient in generating patents for a given level of R&D expenditures and their patent quality is more variable, findings consistent with the idea that these firms engage in more exploratory R&D, some of which fails. Finally, we find that local gambling attitudes are important for firm value when innovation and growth are critical for a firm's success.

Our findings suggest that innovative endeavors, like many other financial decisions, are partly a product of human behavior. Our findings are congruent with the rich literature on investor behavior, particularly regarding their preference for local stocks, gambling and skewness. However two caveats are worth noting. First, we do not claim that the influence of religious composition on innovation is *only* through differences in gambling preferences because, despite our extensive checks for robustness and identification, we cannot rule out the potential influence of other differences. However, our many different tests, in totality, pose a high hurdle to alternative stories, and suggest that at least part of the effect is due to local gambling preferences.

The second caveat is regarding a normative interpretation of our results. We examine one consequence of gambling preferences, namely firm innovation. However, we recognize that gambling has many other consequences on individuals and society, and do not argue that gambling is necessarily optimal for a society in an overall sense. But nurturing some aspects of gambling preference such as a tolerance for early failure, a focus on the maximum payoff and perhaps the ability to endure and enjoy some risk might be beneficial for innovation, which is an activity that is crucial for economic growth.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.jcorpfin.2015.12.017.

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