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Gambling activity and stock price volatility: A cross-country analysis

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ABSTRACT

Shiller (2000) contends that gambling activity might promote risk-taking by individuals in other areas, such as firm decision making or in financial markets. In this study, we test the hypothesis that favorable attitudes towards gambling impact country-level stock price volatility. Using American Depositary Receipts (ADRs) to control for differing market structures, we find that countries with more gaming institutions, higher gambling losses per adult, and legalized online gambling have less stable stock prices. These results are robust to different measures of volatility and controls for both firm-specific characteristics and macroeconomic conditions. These findings support the idea that a country's culture toward gambling might generate greater levels of volatility in the country's financial markets.

1. Introduction

A growing body of both theoretical and empirical research suggests that gambling preferences by investors can influence asset prices in financial markets (Scheinkman and Xiong, 2003; Hong et al., 2006; Barberis and Huang, 2008; Kumar et al., 2011; Patton and Sheppard, 2015; Blau et al., 2016). Shiller (2000) argues that increases in gambling activity affect culture and can "change attitudes towards risk-taking (pp. 41)", which could affect the behavior of prices in the stock market. Shiller (2000) writes that from 1929 to 1933, volatility in the stock market corresponded with a "gambling craze", suggesting that attitudes toward gambling might be associated with higher levels of volatility in financial markets. Several explanations for this association exist. One explanation is that in cultures with favorable attitudes toward gambling, managers of firms are likely to take greater risks. Companies that take on greater risk will have more variability in their financial performance, which will likely result in less stable stock prices. Another explanation could stem from the findings in Dorn and Sengmueller (2009) that show that investors with stronger preferences for gambling tend to trade stocks more frequently. Numerous studies have documented a positive relationship between trading activity and volatility (Schwert, 1989; Gallant et al., 1992; Karpoff, 1987; Jones et al., 1994). Perhaps excessive trading by investors in places with favorable gambling cultures contributes to the link between gambling activity and volatility. Following these ideas, this study formally tests the assertion in Shiller (2000) that gambling attitudes and activity will lead to greater volatility in financial markets. In particular, we test whether or not countries with favorable gambling cultures have less stable stock prices.

Identifying determinants of volatility has important implications for several reasons. Beginning with Shiller (1979, 1981), several studies have shown that stock prices are more volatile than expected according to standard asset pricing models (LeRoy and Porter, 1981; Singleton, 1980; Grossman and Shiller, 1981; Blanchard and Watson, 1982; Flavin, 1983). Given the abnormally high levels of volatility, testing whether or not gambling activity leads to higher volatility in stock prices could help identify, in part, factors that lead to excess volatility. Furthermore, the abnormal levels of volatility suggest either incomplete models or deviations from traditional explanations, which might stem from cultural characteristics, such as gambling preferences.

Moreover, the implications of our tests may contribute more broadly to our understanding of economic and financial activity. Endogenous growth theory suggests that economic output is a function of aggregate capital stock in the economy. However, the level of capital depends on the level of financial development (Goldsmith, 1969; McKinnon, 1973; Shaw, 1973; and Pagano,

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1993). In equilibrium, gross savings in the economy funnels into gross investment, which leads to higher levels of aggregate capital. In the steady-state, economic growth becomes a function of the quality of financial markets. When these markets are excessively volatile, the fraction of gross savings that flow into gross investment might decrease because risk-averse savers are less inclined to invest in capital markets. In that case, unusual volatility in financial markets might reduce gross investment, aggregate capital stock, and ultimately, economic output. Thus, understanding the factors that lead to the instability of asset prices has important implications that are not only important for financial markets but also relate to other economic outcomes.

One of the challenges associated with testing whether cultural factors influence cross-country differences in stock market volatility is the heterogeneity of market structures around the world. Given the role that market structure and economic development play in the volatility of stock markets (see Arestis et al. (2001)), controlling for country-specific factors is critical. To alleviate these issues, we examine the volatility of American Depositary Receipts (ADRs), which are securities that are traded on U.S. stock exchanges but represent shares of foreign companies. The use of ADRs allows us to control for the possibility that the volatility of financial markets in a particular country is endogenously determined by the quality of gambling markets in that country. Additionally, the use of ADRs accounts for the different market structures while at the same time capturing differences in volatility that could be related to cultural preferences. Because ADR prices and the prices of foreign stocks are inherently linked through arbitrage (Kato et al., 1990; Karolyi, 2004), the use of ADRs allows us to examine the volatility of securities while holding the market structure constant but also allows us to exploit the variation in gambling attitudes across ADR home countries. Admittedly, we are not the first to use this research design. For example, Eleswarapu and Venkataraman (2006) find that the strength of political and legal institutions in an ADR home country leads to greater ADR liquidity in U.S. equity markets.

Attitudes toward gambling vary dramatically around the world. At one extreme, countries like many of those in Europe, have very liberal attitudes toward gambling. At the other extreme, countries like Qatar, have very strict laws that attempt to restrict gambling. These types of differences make our tests more compelling. To measure the attitudes toward gambling in an ADR home country, we first gather data on the number of gaming institutions and calculate the ratio of gaming institutions to the population. We also obtain data on gambling losses per adult in countries ranked in the top 10 in the world. Finally, we approximate gambling cultures by determining whether or not a particular home country allows for legalized online gambling.

Results from our univariate tests show a strong and positive relationship between these three measures of gambling and the volatility of ADRs. These results are robust to various measures of volatility. Of the three measures used in our analysis, gambling losses per adult seem to be most strongly associated with increased volatility. However, we find that our results are still robust to the number of gaming institutions and whether or not online gambling has been legalized in the ADR home country.

Our results also hold in both univariate and multivariate settings. Holding constant a variety of ADR-specific and home country-specific characteristics, results from these tests show gambling in the home country is directly associated with the volatility of ADRs. The results from our multivariate tests are not only statistically significant but the findings are also economically meaningful. For instance, a unit increase in the number of gaming institutions in the home country is associated with an increase in volatility that ranges from 5.4% to 7.9% depending on how volatility is measured. When examining the relationship between gambling losses per adult in the home country and the volatility of ADRs, we find that a unit increase in gambling losses increases volatility by more than 20%. Additionally, home countries that allow legal online gambling have ADR volatility that is about 8% higher than home countries that do not allow legal online gambling. These results are consistent with our hypothesis and suggest that countries with more favorable attitudes toward gambling have less stable stock prices. More importantly, these findings contribute to the existing literature by providing support for the assertion in Shiller (2000) that gambling cultures can lead to greater risk-taking and, eventually, affect the volatility of asset prices.

Combined, the results of this study provide an important contribution to our understanding of how gambling cultures influence the volatility of stock prices. Aside from finding support for Shiller's (2000) argument, our results also contribute to the broad literature that attempts to identify factors that influence volatility (Black, 1976; Christie, 1982; Schwert, 1989; Chan and Lakonishok, 1995; Bekaert and Wu, 2000; Wu, 2001). While this literature generally focuses on the determinants of volatility that are more traditionally firm-specific, the results in our study suggest that more non-traditional factors, such as culture, can influence the stability of stock prices.

A detailed description of our analysis follows. Section 2 provides a discussion of the data used throughout the analysis. Section 3 presents our empirical tests and results. Finally, Section 4 provides some concluding remarks.

2. Data description

The data used in this analysis come from several common sources. First, we obtain the universe of ADRs from the Center for Research on Security Prices (CRSP) using share codes. We then cross-check the ADRs with information from Bloomberg and find the home country for each ADR. From CRSP, we obtain share prices, stock returns, shares outstanding, trading volume, and bid–ask spreads from daily closing ask and bid prices. From this information, we can estimate market capitalization and Amihud's (2002) measure of illiquidity, which is the ratio of daily returns (in absolute value) scaled by volume (in 100,000s). We recognize the need to control for macroeconomic conditions in the ADR home countries so, from the World Bank, we obtain GDP per capita and unemployment rates. Finally, we obtain information regarding gambling attitudes from several different sources. From CasinoCity.com's worldwide gaming directory, we obtain the number of gaming institutions in each country.[1] From H2 Gambling Capital, we gather information about gambling losses per adult for the top 10 countries as of 2010. Finally, from several different sources that are cross-checked, we determine whether or not the ADR home country legally allowed online gambling as of 2010. The ADR and macroeconomic data is obtained from 2010 to 2012 and averaged so that our final sample consists of 211 ADRs from 32 home countries.

Table 1 provides a summary of the ADR home countries. We first list the number of ADRs for each home country and include the average volatility across ADRs. Throughout the analysis, we use three measures of volatility. First, we estimate the standard deviation of daily returns for ADRs from 2010 to 2012. The standard deviation represents the total volatility ($Volt$). Next, we estimate residual returns from the following four-factor model.

$$R_{i,t} - R_{f,t} = \alpha + \beta 1 MRP_t + \beta_2 SMB_t + \beta_3 HML_t + \beta_4 UMD_t + \varepsilon_{i,t} \quad (1)$$

[1] CasinoCity.com constantly updates the worldwide directory of gaming institutions so we are unable to determine the number of institutions as of 2010 but feel that this information, which was obtained in early 2014 is a good approximation of 2010's number of gaming properties.

Table 1
Financial market volatility and gambling attitudes by ADR home country. The table reports some summary statistics regarding the volatility of the ADRs in each home country and different proxies for gambling attitudes. Column [1] shows the number of ADRs included in the sample. *Volt* is the total volatility of the ADR. *IdioVolt* is the idiosyncratic volatility of each ADR. *Garch(1,1)* is the conditional expected volatility obtained from fitting daily ADR returns to a Garch(1,1) model. These measures of volatility are estimated using daily returns and average annual volatility from 2010 to 2012. *Gaming* is the ratio of the number of gaming institutions to country population (in billions). *Top10* determines whether or not the ADR home country is listed in the top 10 countries with the most gambling losses per adult. *GambLoss* is the number of gambling losses per adult for the countries that ranked in the top 10. *Online* shows whether or not online gambling is allowed in the ADR home country.

	No. ADRs [1]	*Volt* [2]	*IdioVolt* [3]	*Garch(1,1)* [4]	*Gaming* [5]	*Top10* [6]	*GambLoss* [7]	*Online* [8]
Australia	5	0.0438	0.0383	0.0416	2.8261	Yes	1288	Yes
Belgium	1	0.0183	0.0145	0.0186	0.6351	No	0	Yes
Brazil	8	0.0215	0.0157	0.0224	0.0024	No	0	No
Chile	14	0.0226	0.0191	0.0232	0.1934	No	0	No
China	27	0.0266	0.0229	0.0295	0.0002	No	0	No
Denmark	2	0.0383	0.0353	0.0370	0.3217	No	0	No
Finland	2	0.0311	0.0267	0.0304	0.6274	Yes	553	No
France	10	0.0292	0.0230	0.0329	0.7661	No	0	Yes
Germany	7	0.0176	0.0130	0.0176	0.3944	No	0	Yes
Greece	3	0.0362	0.0318	0.0352	0.0946	Yes	420	No
Hungary	1	0.0238	0.0180	0.0231	0.0484	No	0	Yes
India	10	0.0306	0.0262	0.0314	0.0020	No	0	No
Indonesia	2	0.0185	0.0167	0.0197	0.0000	No	0	No
Ireland	9	0.0353	0.0328	0.0374	1.5918	Yes	588	Yes
Israel	4	0.0206	0.0172	0.0215	0.1050	No	0	No
Italy	5	0.0262	0.0208	0.0253	0.0295	Yes	517	Yes
Japan	18	0.0188	0.0161	0.0196	0.0217	No	0	No
Luxemberg	1	0.0238	0.0142	0.0238	0.2368	No	0	No
Mexico	15	0.0249	0.0207	0.0251	0.1403	No	0	No
Netherlands	7	0.0242	0.0165	0.0247	0.7290	No	0	No
NewZealand	1	0.0180	0.0143	0.0177	1.6675	No	0	Yes
Norway	1	0.0191	0.0111	0.0194	0.0452	Yes	448	No
Peru	1	0.0220	0.0205	0.0234	0.2534	No	0	No
Phillipines	1	0.0129	0.0116	0.0147	0.0489	No	0	Yes
Portugal	1	0.0222	0.0173	0.0219	0.1079	No	0	No
Russia	5	0.0265	0.0205	0.0272	0.0041	No	0	Yes
South Africa	7	0.0234	0.0202	0.0250	0.1170	No	0	No
South Korea	7	0.0228	0.0183	0.0234	0.0467	No	0	No
Spain	3	0.0253	0.0166	0.0243	0.2177	Yes	418	Yes
Sweden	1	0.0241	0.0177	0.0246	0.3528	No	0	No
Switzerland	5	0.0203	0.0159	0.0213	0.4400	No	0	Yes
U.K.	27	0.0195	0.0136	0.0194	0.7048	No	0	No
All Obs.	211	0.0246	0.0201	0.0255	0.3717	N/A	87.1327	N/A

The dependent variable is the daily excess return (the difference between the CRSP raw return and the daily risk-free rate) for each ADR i on day t. The independent variables include the Fama and French (1996) three factors (market risk premium MRP, small-minus-big risk factor SMB, and the high-minus-low risk factor HML) along with the up-minus-down factor UMD. These factors are obtained from Wharton Research Data Services. After estimating this four-factor model for each ADR, we then calculate the standard deviation of residual returns ($\varepsilon_{i,t}$) to provide an approximation for idiosyncratic volatility (*IdioVolt*). For our third measure of volatility, we fit daily ADR returns to a Garch(1,1) model:

$$\sigma_t{}^2 = \eta V_L + \alpha \mu_{t-1}{}^2 + \beta \sigma_{t-1}{}^2 \quad (2)$$

where V_L is the long-run variance, $\sigma_{t-1}{}^2$ is the prior day's volatility of returns, and $\mu_{t-1}{}^2$ is the volatility of residual returns. To obtain the long-run forecasted variance $\sigma_t{}^2$, we estimate the following equation:

$$\sigma_t{}^2 = \omega + \alpha \mu_{t-1}{}^2 + \beta \sigma_{t-1}{}^2 \quad (3)$$

Here, we can estimate parameters for ω, α, and β and back out the long-run variance and the parameter η since $\eta = 1 - \alpha - \beta$ and $\omega = \eta V_L$. The square root of this third measure of volatility is denoted as Garch(1,1) volatility (*Garch(1,1)*). Table 1 also reports the ratio of the number of gaming institutions per country relative to the country's population in billions (*Gaming*), whether or not the country is listed among the top 10 countries in the world in gambling losses per adult (*Top10*), the number of gambling losses per adult (*GambLoss*), and whether or not online gambling is legally allowed (*Online*). As seen in Table 1, both China and the U.K. have the largest number of ADRs (27) while several countries only have one ADR. The table reports the average ADR volatility for each country according to each of our measures of volatility. Additionally, the table reports our approximations for gambling attitudes. Column [5] shows that Australia has the most gaming institutions (relative to population in billions) and the highest gambling losses per adult. Furthermore, Australia has legalized online gambling. It appears that China has the least favorable attitude towards gambling as the number of gaming institutions is the lowest in the sample of ADR home countries and China does not allow online gambling. Aggregated results for the entire sample are reported in the last row of Table 1.

3. Empirical tests and results

In this section of the paper, we present some results from univariate tests. We then report the findings from our multivariate analysis, where we control for ADR specific characteristics and macroeconomic variables. Here, we test whether or not gambling attitudes and gambling activity in the ADR home country affect the volatility of ADRs.

3.1. Univariate tests

In this subsection, we conduct some univariate tests to determine the relationship between gambling attitudes and our three

Table 2
Univariate correlation. The table reports Pearson correlation coefficients for two continuous proxies for gambling attitudes and our three measures of ADR volatility. *Gaming* is the ratio of the number of gaming institutions to country population (in billions). *GambLoss* is the number of gambling losses per adult for the ADR home countries that ranked in the top 10. *Volt* is the total volatility of the ADR. *IdioVolt* is the idiosyncratic volatility of each ADR. *Garch(1,1)* is the conditional expected volatility obtained from fitting daily ADR returns to a Garch(1,1) model. In brackets, we report p-values that provide the results from tests that coefficients are different than zero.

	Gaming [1]	*GambLoss* [2]	*Volt* [3]	*IdioVolt* [4]	*Garch(1,1)* [5]
Gaming	1.0000	0.7255*** [<.0001]	0.2542*** [0.0002]	0.2221*** [0.0012]	0.2166*** [0.0016]
GambLoss		1.0000	0.3558*** [<.0001]	0.3385*** [<.0001]	0.2987*** [<.0001]
Volt			1.0000	0.9662*** [<.0001]	0.9487*** [<.0001]
IdioVolt				1.0000	0.9257*** [<.0001]
Garch(1,1)					1.0000

measures of ADR volatility. Table 2 reports the correlation matrix for the following variables: the number of gaming institutions relative to the home country population in billions (*Gaming*); the gambling losses per adult for those countries that are listed in the top 10 — zero otherwise (*GambLoss*); the total ADR volatility (*Volt*); the idiosyncratic volatility (*IdioVolt*); and Garch(1,1) volatility (*Garch(1,1)*). We also report *p*-values in brackets underneath each of the correlation coefficients. As seen in Table 2, we first find that *Gaming* and *GambLoss* are highly correlated (correlation = 0.7255, *p*-value = <.0001). Second, we show in the first row that *Gaming* is directly correlated with *Volt*, *IdioVolt*, and *Garch(1,1)*. Each of these correlation coefficients is significant at the 1% level according to the reported *p*-values. These findings suggest that the number of gaming institutions in the home country is associated with higher volatility in the ADR regardless of how volatility is constructed. Third, when focusing on the correlation between *GambLoss* and our measures of volatility, we again find positive and significant correlations. We note that these coefficients are larger in magnitude than the corresponding coefficients in the first row suggesting that, if anything, the direct relation between *GambLoss* and ADR volatility is stronger than the direct relation between G*aming* and ADR volatility. We also note that our measures of volatility are highly correlated, which is expected given their construction.

Table 3 provides some additional univariate tests. Here, we examine mean volatility across discrete variables that attempt to capture the favorability of gambling attitudes in ADR home countries. Panel A reports mean volatility for ADRs with home countries ranked in the top 10 in gambling losses per adult (*Top10*). Each of our measures of volatility produces qualitatively similar results, so for brevity, we only discuss our findings in column [1]. In the home countries that are ranked in the top 10, we find that the average ADR has total volatility of 0.0333. In unranked home countries, the average ADR has total volatility of only 0.0232. The difference, which is reported in the third row, is statistically different from zero (t-statistic = 4.74). This difference is also economically meaningful as a top 10 ranking is associated with nearly 44% higher volatility.

Panel B shows the results when we report mean ADR volatility for those home countries with legalized online gambling and those with laws restricting online gambling. Again, the results are similar across measures of volatility, so we only discuss our findings in column [1]. The average ADR with home countries that allow online gambling has volatility of 2.77% compared to the average ADR with home countries with online gambling restrictions of 2.36%. In the third row of Panel B, the difference is 0.41% and is reliably different from zero (t-statistic = 2.37). Additionally, this difference is economically significant as ADRs with home countries with legal online gambling have volatility that is more than 17% higher than ADRs with home countries that do not. Taken together, results from our univariate tests in Tables 2 and 3 suggest that a favorable culture toward gambling in the home country is an important determinant, or at least an important correlate, of ADR volatility.

3.2. Multivariate tests

The results from the previous section suggest that the level of home country gambling attitudes is directly associated with the volatility of ADRs. We recognize, however, that other factors may be influencing our results. In this section, we attempt to control for both ADR-specific and country-specific characteristics in several different multivariate tests. We begin by estimating the following equation using cross-sectional data made up of 211 ADRs.

$$\begin{aligned} VOLATILITY_{i,j} = {} & \beta_0 + \beta_1 Gaming_j + \beta_2 ln(GDP/Cap)_j \\ & + \beta_3 ln(Unemp)_j + \beta_4 NASD_i + \beta_5 ln(MktCap)_{i,j} \\ & + \beta_6 ln(Price)_{i,j} + \beta_7 Turn_{i,j} + \beta_8 Spread_{i,j} \\ & + \beta_9 ln(Illiq)_{i,j} + \varepsilon_{i,j} \end{aligned} \quad (4)$$

The dependent variable *VOLATILITY* is measured in different three ways. $Ln(Volt_{i,j})$ is the natural log of total volatility for ADR i in country j. $Ln(IdioVolt_{i,j})$ is the natural log of idiosyncratic volatility for ADR i in country j. $Ln(Garch(1,1)_{i,j})$ is the natural log of Garch(1,1) volatility for ADR i in country j. We include as control variables the following: *ln(GDP)* is the natural log of GDP per capita in country j; *ln(Unemp)* is the natural log of the unemployment rate in percent in each country j; *NASD* is an indicator variable capturing whether ADR i is listed on NASDAQ — zero otherwise; *ln(MktCap)* is the natural log of average market capitalization (from 2010 to 2012) for each ADR on the last trading day of the year; *ln(Price)* is the natural log of the average closing price (from 2010 to 2012) for each stock at the end of each year; *Turn* is the ratio of total trading volume scaled by shares outstanding; *Spread* is the relative bid–ask spread in percent for each ADR; *ln(Illiq)* is the natural log of Amihud's (2002) measure of illiquidity, which is the ratio of the absolute value of daily returns to trading volume (in 100,000s). The independent variable of interest is *Gaming*, which is the ratio of the number of gaming institutions to the country population (in billions). To the extent that the level of home country gambling affects the volatility of ADRs, we expect a positive and significant coefficient on *Gaming*. We report t-statistics that are obtained from standard errors that are clustered across ADRs.

Results from estimating Eq. (4) are reported in Table 4. The format of this table, and the three that follow, report the results

Table 3
ADR volatility and gambling attitudes. This table reports volatility for countries with more and with less favorable attitudes towards gambling. *Top10* is an indicator variable capturing whether or not the ADR home country is listed in the top 10 countries with the most gambling losses per adult. *Online* is an indicator variable that captures whether or not online gambling is allowed in the ADR home country. *Volt* is the total volatility of the ADR. *IdioVolt* is the idiosyncratic volatility of each ADR. *Garch(1,1)* is the conditional expected volatility obtained from fitting daily ADR returns to a Garch(1,1) model. At the bottom of each panel, we report the difference between volatility in ADRs in home countries with the most favorable attitudes towards gambling and volatility in ADRs in home countries with the least. We also report t-statistics testing whether the differences are statistically different from zero.

	Volt [1]	*IdioVolt* [2]	*Garch(1,1)* [3]
Panel A. Gambling losses per adult			
Top10	0.0333	0.0286	0.0332
Non-Top10	0.0232	0.0187	0.0243
Difference	0.0101***	0.0098***	0.0089***
	(4.74)	(4.46)	(3.94)
Panel B. Online gambling			
Online	0.0277	0.0227	0.0285
Non-Online	0.0236	0.0192	0.0244
Difference	0.0041**	0.0035**	0.0041**
	(2.37)	(1.96)	(2.27)

Table 4
Cross-sectional regression analysis. The table reports the results from estimating the following equation using pooled ADR-year data.

$$VOLATILITY_{i,j} = \beta_0 + \beta_1 Gaming_j + \beta_2 ln(GDP/Cap)_j + \beta_3 ln(Unemp)_j + \beta_4 NASD_i + \beta_5 ln(MktCap)_{i,j} + \beta_6 ln(Price)_{i,j} + \beta_7 Turn_{i,j} + \beta_8 Spread_{i,j} + \beta_9 ln(Illiq)_{i,j} + \varepsilon_{i,j}$$

The dependent variable *VOLATILITY* is measured in three ways. $Ln(Volt_{i,j})$ is the natural log of total volatility for ADR i in country j. $Ln(IdioVolt_{i,j})$ is the natural log of idiosyncratic volatility for ADR i in country j. $Ln(Garch(1,1)_{i,j})$ is the natural log of Garch(1,1) volatility for ADR i in country j. We include as independent variables the following: *Gaming* is the ratio of the number of gaming institutions to country population (in billions); *ln(GDP)* is the natural log of GDP per capita in country j; *ln(Unemp)* is the natural log of the unemployment rate in percent in each country j; *NASD* is an indicator variable capturing whether ADR i is listed on NASDAQ — zero otherwise; *ln(MktCap)* is the natural log of average market capitalization (from 2010 to 2012) for each ADR on the last trading day of the year; *ln(Price)* is the natural log of the average closing price (from 2010 to 2012) for each stock at the end of each year; *Turn* is the ratio of total trading volume scaled by the shares outstanding; *Spread* is the relative bid–ask spread in percent for each ADR; *ln(Illiq)* is the natural log of Amihud's (2002) measure of illiquidity, which is the ratio of the absolute value of daily returns to trading volume (in 100,000s). We report t-statistics that are obtained from standard errors that are clustered across ADRs. *,** denote statistical significance at the 0.05, and the 0.01 levels, respectively.

	$Ln(Volt_{i,j,t})$		$Ln(IdioVolt_{i,j,t})$		$Ln(Garch(1,1)_{i,j,t})$	
	[1]	[2]	[3]	[4]	[5]	[6]
Intercept	−3.0595***	−2.7386***	−2.9131***	−2.5676***	−2.8561***	−2.5184***
	(−11.87)	(−10.36)	(−9.77)	(−9.63)	(−11.41)	(−9.47)
Gaming	0.2038***	0.0728**	0.2159**	0.0535*	0.2100***	0.0793***
	(2.89)	(2.38)	(2.43)	(1.74)	(3.16)	(2.80)
Ln(GDP)	−0.0968***	−0.0472***	−0.1354***	−0.0734***	−0.1122***	−0.0624***
	(−3.77)	(−2.77)	(−4.66)	(−4.58)	(−4.50)	(−3.69)
Ln(UnEmp)	0.0603	0.0203	0.0688	0.0413	0.0518	0.0123
	(1.19)	(0.59)	(1.17)	(1.06)	(1.06)	(0.38)
NASD		0.0334		0.1268**		0.1100**
		(0.67)		(2.50)		(2.53)
Ln(MktCap)		−0.0199		−0.0203		−0.0221
		(−0.77)		(−0.75)		(−0.89)
Ln(Price)		−0.1756***		−0.2077***		−0.1723***
		(−6.08)		(−7.06)		(−6.23)
Turn		0.0006*		0.0004		0.0005
		(1.89)		(0.63)		(1.38)
Spread		0.1147***		0.1260***		0.0842***
		(3.40)		(3.45)		(2.60)
Ln(Illiq)		−0.0099		0.0055		−0.0093
		(−0.51)		(0.27)		(−0.50)
Adj. R^2	0.0883	0.5888	0.1023	0.6888	0.1043	0.5869
N	211	211	211	211	211	211
Robust SEs	Yes	Yes	Yes	Yes	Yes	Yes

for each of our measures of volatility. We also show the results from two specifications. First, we only include the home country characteristics as independent variables. Second, we present the results for the entire specification. We note, however, that in unreported results, we estimate a variety of different specifications including different combinations of control variables and find the results to be qualitatively similar to those reported in this study.

Columns [1] and [2] present the results when the dependent variable is *Ln(Volt)*. We find in both columns that the estimate for *Ln(GDP)* is negative and reliably different from zero suggesting that home countries with lower GDP per capita have higher ADR volatility. Focusing on the other control variables in column [2], we find that lower-priced ADRs with higher turnover and larger bid–ask spreads tend to be more volatile. After controlling for these variables, we find that *Gaming* produces a positive and significant coefficient (estimate 0.0728, t-statistic = 2.38). Qualitatively similar results are found in column [1]. Furthermore, these findings are economically meaningful as a unit increase in *Gaming* is associated with a 7.3% increase in ADR volatility. The economic magnitude of these results is even greater in column [1]. These findings support our results from our earlier univariate tests and suggest that the level of gambling in the ADR home country is associated with higher levels of volatility.

Table 5
Cross-sectional regression analysis. The table reports the results from estimating the following equation using pooled ADR-year data.

$$VOLATILITY_{i,j} = \beta_0 + \beta_1 GambLoss_j + \beta_2 ln(GDP/Cap)_j + \beta_3 ln(Unemp)_j + \beta_4 NASD_i + \beta_5 ln(MktCap)_{i,j} + \beta_6 ln(Price)_{i,j} + \beta_7 Turn_{i,j} + \beta_8 Spread_{i,j} + \beta_9 ln(Illiq)_{i,j} + \varepsilon_{i,j}$$

The dependent variable *VOLATILITY* is measured in three ways. *Ln(Volt$_{i,j}$)* is the natural log of total volatility for ADR *i* in country *j*. *Ln(IdioVolt$_{i,j}$)* is the natural log of idiosyncratic volatility for ADR *i* in country *j*. *Ln(Garch(1,1)$_{i,j}$)* is the natural log of Garch(1,1) volatility for ADR *i* in country *j*. We include as independent variables the following: *GambLoss* is the number of gambling losses per adult for the ADR home countries that ranked in the top 10; *ln(GDP)* is the natural log of GDP per capita in country *j*; *ln(Unemp)* is the natural log of the unemployment rate in percent in each country *j*; *NASD* is an indicator variable capturing whether ADR *i* is listed on NASDAQ — zero otherwise; *ln(MktCap)* is the natural log of average market capitalization (from 2010 to 2012) for each ADR on the last trading day of the year; *ln(Price)* is the natural log of the average closing price (from 2010 to 2012) for each stock at the end of each year; *Turn* is the ratio of total trading volume scaled by the shares outstanding; *Spread* is the relative bid–ask spread in percent for each ADR; *ln(Illiq)* is the natural log of Amihud's (2002) measure of illiquidity, which is the ratio of the absolute value of daily returns to trading volume (in 100,000s). We report *t*-statistics that are obtained from standard errors that are clustered across ADRs. *,** denote statistical significance at the 0.05, and the 0.01 levels, respectively.

	Ln(Volt$_{i,j,t}$)		*Ln(IdioVolt$_{i,j,t}$)*		*Ln(Garch(1,1)$_{i,j,t}$)*	
	[1]	[2]	[3]	[4]	[5]	[6]
Intercept	−3.1699***	−2.7821***	−3.0006***	−2.5717***	−2.9888***	−2.5830***
	(−13.32)	(−10.82)	(−11.24)	(−10.05)	(−12.75)	(−9.99)
GambLoss	0.5467***	0.2313***	0.6306***	0.2286***	0.54302***	0.2157***
	(3.88)	(4.51)	(3.42)	(3.48)	(3.89)	(4.14)
Ln(GDP)	−0.0777***	−0.0427***	−0.1177***	−0.0733***	−0.0909***	−0.0556***
	(−3.37)	(−2.62)	(−4.65)	(−4.72)	(−4.00)	(−3.41)
Ln(UnEmp)	0.0366	0.0084	0.0385	0.0271	0.0307	0.0026
	(0.75)	(0.25)	(0.65)	(0.70)	(0.64)	(0.08)
NASD		0.0327		0.1242**		0.1106**
		(0.66)		(2.49)		(2.55)
Ln(MktCap)		−0.0201		−0.0204		−0.0222
		(−0.79)		(−0.78)		(−0.91)
Ln(Price)		−0.1693***		−0.2008***		−0.1668***
		(−5.85)		(−6.88)		(−5.97)
Turn		0.0007*		0.0004		0.0005
		(1.92)		(0.64)		(1.40)
Spread		0.1180***		0.1269***		0.0886***
		(3.67)		(3.67)		(2.79)
Ln(Illiq)		−0.0124		0.0035		−0.0119
		(−0.64)		(0.17)		(−0.64)
Adj. R^2	0.1367	0.5996	0.1612	0.6993	0.1426	0.5940
N	211	211	211	211	211	211
Robust SEs	Yes	Yes	Yes	Yes	Yes	Yes

Columns [3] through [6] present the results when we look at idiosyncratic volatility and Garch(1,1) volatility as dependent variables. In general, the control variables produce estimates that are similar in sign and magnitude to the corresponding coefficients in columns [1] and [2]. However, there are a few differences worth noting. First, we find that the indicator variable *NASD* produces a positive estimate that is reliably different than zero in columns [4] and [6] suggesting that NASDAQ-listed stocks have higher volatility than stocks listed on other exchanges, such as the NYSE. Second, we do not find that share turnover produces reliable coefficients in either columns [4] or [6]. Despite these differences, the coefficient on *Gaming* is positive and significant in each of the columns. In economic terms, results in columns [4] and [6] suggest that a unit increase in *Gaming* results in an increase in ADR volatility of 5.4% and 7.9%, respectively. These findings again indicate that the preferences for gambling in the home country are directly related to the volatility of ADRs.

Next, we replicate our analysis but use a different proxy for favorable gambling attitudes in the ADR home country. In particular, we estimate the following equation.

$$\begin{aligned} VOLATILITY_{i,j} &= \beta_0 + \beta_1 GambLoss_j + \beta_2 ln(GDP/Cap)_j \\ &+ \beta_3 ln(Unemp)_j + \beta_4 NASD_i \\ &+ \beta_5 ln(MktCap)_{i,j} + \beta_6 ln(Price)_{i,j} + \beta_7 Turn_{i,j} + \beta_8 Spread_{i,j} \\ &+ \beta_9 ln(Illiq)_{i,j} + \varepsilon_{i,j} \end{aligned} \quad (5)$$

The dependent variable and independent variables are similar to those in Eq. (4). The only difference is that the independent variable of interest is *GambLoss*, which is the number of gambling losses per adult in the ADR home country. Recall that *GambLoss* is equal to the number of gambling losses only for those home countries that are ranked in the top 10 — zero otherwise.[2] As before, we estimate this cross-sectional regression using OLS and account for clustered standard errors.

Table 5 presents the regression results. The control variables produce estimates that are very similar to the corresponding estimates in the previous table. When focusing on the variable of interest, we find that *GambLoss* provides positive and significant coefficients across columns. Focusing on the full specification in column [2], a unit increase in gambling losses is associated with a 23.1% increase in total ADR volatility. The economic magnitude of the estimates for *GambLoss* in columns [4] and [6] are similar. These results corroborate the findings in Tables 2 and 3 and again suggest that the level of gambling in the home country directly affects the stability of ADR prices.

We recognize that the discontinuity (or truncation) in the variable *GambLoss* might present issues when trying to make inferences. Therefore, instead of including *GambLoss* as the independent variable of interest, we include an indicator variable *Top10*, which captures those home countries that are ranked in the top 10 in gambling losses per adult. In particular, we estimate the following equation using cross-sectional data and report the results in Table 6.

$$\begin{aligned} VOLATILITY_{i,j} = \beta_0 + \beta_1 Top10_j + \beta_2 ln(GDP/Cap)_j + \beta_3 ln(Unemp)_j \\ + \beta_4 NASD_i + \beta_5 ln(MktCap)_{i,j} \\ + \beta_6 ln(Price)_{i,j} + \beta_7 Turn_{i,j} + \beta_8 Spread_{i,j} \\ + \beta_9 ln(Illiq)_{i,j} + \varepsilon_{i,j} \end{aligned} \quad (6)$$

2 H2 Gambling Capital only makes the Top 10 rankings publically available. The entire ranking is proprietary.

Table 6

Cross-sectional regression analysis. The table reports the results from estimating the following equation using pooled ADR-year data.

$$VOLATILITY_{i,j} = \beta_0 + \beta_1 Top10_j + \beta_2 ln(GDP/Cap)_j + \beta_3 ln(Unemp)_j + \beta_4 NASD_i + \beta_5 ln(MktCap)_{i,j} + \beta_6 ln(Price)_{i,j} + \beta_7 Turn_{i,j} + \beta_8 Spread_{i,j} + \beta_9 ln(Illiq)_{i,j} + \varepsilon_{i,j}$$

The dependent variable *VOLATILITY* is measured in three ways. $Ln(Volt_{i,j})$ is the natural log of total volatility for ADR i in country j. $Ln(IdioVolt_{i,j})$ is the natural log of idiosyncratic volatility for ADR i in country j. $Ln(Garch(1,1)_{i,j})$ is the natural log of Garch(1,1) volatility for ADR i in country j. We include as independent variables the following: *Top10* is an indicator variable capturing whether or not the ADR home country is listed in the top 10 countries with the most gambling losses per adult; *ln(GDP)* is the natural log of GDP per capita in country j; *ln(Unemp)* is the natural log of the unemployment rate in percent in each country j; *NASD* is an indicator variable capturing whether ADR i is listed on NASDAQ — zero otherwise; *ln(MktCap)* is the natural log of average market capitalization (from 2010 to 2012) for each ADR on the last trading day of the year; *ln(Price)* is the natural log of the average closing price (from 2010 to 2012) for each stock at the end of each year; *Turn* is the ratio of total trading volume scaled by the shares outstanding; *Spread* is the relative bid–ask spread in percent for each ADR; *ln(Illiq)* is the natural log of Amihud's (2002) measure of illiquidity, which is the ratio of the absolute value of daily returns to trading volume (in 100,000s). We report t-statistics that are obtained from standard errors that are clustered across ADRs. *,** denote statistical significance at the 0.05, and the 0.01 levels, respectively.

	$Ln(Volt_{i,j,t})$		$Ln(IdioVolt_{i,j,t})$		$Ln(Garch(1,1)_{i,j,t})$	
	[1]	[2]	[3]	[4]	[5]	[6]
Intercept	−3.1104***	−2.7584***	−2.9221***	−2.5306***	−2.9288***	−2.5603***
	(−12.92)	(−10.68)	(−10.85)	(−9.90)	(−12.29)	(−9.83)
Top10	0.4034***	0.1695***	0.4760***	0.1901***	0.3936***	0.1588***
	(4.15)	(3.36)	(3.95)	(3.21)	(4.22)	(3.18)
Ln(GDP)	−0.0750***	−0.0416***	−0.1152***	−0.0737***	−0.0885***	−0.0547***
	(−3.24)	(−2.55)	(−4.51)	(−4.74)	(−3.87)	(−3.33)
Ln(UnEmp)	−0.0121	−0.0099	−0.0205	0.0038	−0.0172	−0.0146
	(−0.24)	(−0.29)	(−0.32)	(0.09)	(−0.33)	(−0.43)
NASD		0.0327		0.1230**		0.1105**
		(0.66)		(2.49)		(2.55)
Ln(MktCap)		−0.0220		−0.0225		−0.0241
		(−0.87)		(−0.86)		(−0.98)
Ln(Price)		−0.1644***		−0.1942***		−0.1623***
		(−5.61)		(−6.59)		(5.71)
Turn		0.0006*		0.0003		0.0005
		(1.86)		(0.59)		(1.35)
Spread		0.1279***		0.1374***		0.0979***
		(3.86)		(3.95)		(3.08)
Ln(Illiq)		−0.0137		0.0020		−0.0131
		(−0.71)		(0.10)		(−0.70)
Adj. R^2	0.1264	0.5977	0.1556	0.7014	0.1341	0.5924
N	211	211	211	211	211	211
Robust SEs	Yes	Yes	Yes	Yes	Yes	Yes

The control variables again produce coefficients that are similar in sign and magnitude to those in the previous table. Consistent with our findings in Table 5, we find those home countries that are ranked in the top 10 in gambling losses per adult have more volatile ADRs than home countries that do not. In economic terms, a home country that is ranked in the top 10 has total ADR volatility that is nearly 17% higher than the ADR volatility of home countries that are not ranked in the top 10. Columns [4] and [6] suggest that ranked home countries have ADR volatility that is 19% and 15.9%, respectively, higher than home countries that are not ranked.

In our final test in this subsection, we examine the effect of legalized online gambling on ADR volatility by estimating the following regression.

$$\begin{aligned} VOLATILITY_{i,j} = \beta_0 + \beta_1 Online_j + \beta_2 ln(GDP/Cap)_j + \beta_3 ln(Unemp)_j \\ + \beta_4 NASD_i + \beta_5 ln(MktCap)_{i,j} \\ + \beta_6 ln(Price)_{i,j} + \beta_7 Turn_{i,j} + \beta_8 Spread_{i,j} \\ + \beta_9 ln(Illiq)_{i,j} + \varepsilon_{i,j} \qquad (7) \end{aligned}$$

The dependent and independent variables are similar to those in previous tables. The only exception is the variable *Online*, which is equal to one if the ADR home country has legalized online gambling and zero otherwise. The results of this analysis are presented in Table 7. Again, the control variables produce coefficients that are similar to corresponding coefficients in previous tables. Consistent with our expectation, the estimates for *Online* are positive and generally significant. We note, however, that the coefficients on *Online* are only significant at the 10% level in columns [2] and [4]. Given that we only have 211 observations, significance at the 10% level is relatively reliable. Not only are these results statistically significant, but the coefficients are also economically meaningful. For instance, in column [2], the coefficients suggest that home countries that legally allow online gambling have ADRs with volatility that is approximately 8% higher than ADR volatility in home countries with restrictions on online gambling. Similar results are found in columns [4] and [6]. Taken together, Tables 3 through 7 support our contention that the favorability of gambling attitudes affects the stability of stock prices. These results support the assertion in Shiller (2000) that suggests that societies that cultivate strong gambling cultures might also experience unusual levels of volatility in financial markets.

4. Conclusion

A growing consensus in prior research suggests that volatility in financial markets is greater than expected according to traditional asset pricing models (Shiller, 1979; Singleton, 1980; Grossman and Shiller, 1981; LeRoy and Porter, 1981; Shiller, 1981; Blanchard and Watson, 1982; Flavin, 1983). Given these results, a considerable portion of the literature has been devoted to identifying determinants, or at least correlates, of volatility (Black, 1976; Christie, 1982; Schwert, 1989; Chan and Lakonishok, 1995; Bekaert and Wu, 2000; Wu, 2001). These studies, however, focus on firm-specific or macroeconomic characteristics. We deviate from these more traditional determinants of volatility and test the hypothesis that cultures with favorable attitudes toward gambling will exhibit less stable stock prices. Shiller (2000) argues that gambling activity can influence culture and change individual attitudes toward risk-taking in other areas, such as financial decision making. To the extent that this is true, in places with more favorable gambling cultures, firms may be less risk-averse which might be reflected in greater volatility in stock prices. The main objective of this study is to test this hypothesis.

Table 7
Cross-sectional regression analysis. The table reports the results from estimating the following equation using pooled ADR-year data.

$$VOLATILITY_{i,j} = \beta_0 + \beta_1 Online_j + \beta_2 ln(GDP/Cap)_j + \beta_3 ln(Unemp)_j + \beta_4 NASD_i + \beta_5 ln(MktCap)_{i,j} + \beta_6 ln(Price)_{i,j} + \beta_7 Turn_{i,j} + \beta_8 Spread_{i,j} + \beta_9 ln(Illiq)_{i,j} + \varepsilon_{i,j}$$

The dependent variable *VOLATILITY* is measured in three ways. $Ln(Volt_{i,j})$ is the natural log of total volatility for ADR *i* in country *j*. $Ln(IdioVolt_{i,j})$ is the natural log of idiosyncratic volatility for ADR *i* in country *j*. $Ln(Garch(1,1)_{i,j})$ is the natural log of Garch(1,1) volatility for ADR *i* in country *j*. We include as independent variables the following: *Online* is an indicator variable that captures whether or not online gambling is allowed in the ADR home country; *ln(GDP)* is the natural log of GDP per capita in country *j*; *ln(Unemp)* is the natural log of the unemployment rate in percent in each country *j*; *NASD* is an indicator variable capturing whether ADR *i* is listed on NASDAQ — zero otherwise; *ln(MktCap)* is the natural log of average market capitalization (from 2010 to 2012) for each ADR on the last trading day of the year; *ln(Price)* is the natural log of the average closing price (from 2010 to 2012) for each stock at the end of each year; *Turn* is the ratio of total trading volume scaled by the shares outstanding; *Spread* is the relative bid–ask spread in percent for each ADR; *ln(Illiq)* is the natural log of Amihud's (2002) measure of illiquidity, which is the ratio of the absolute value of daily returns to trading volume (in 100,000s). We report *t*-statistics that are obtained from standard errors that are clustered across ADRs. *,** denote statistical significance at the 0.05, and the 0.01 levels, respectively.

	$Ln(Volt_{i,j,t})$		$Ln(IdioVolt_{i,j,t})$		$Ln(Garch(1,1)_{i,j,t})$	
	[1]	[2]	[3]	[4]	[5]	[6]
Intercept	−3.2734***	−2.7566***	−3.1432***	−2.5500***	−3.0785***	−2.5345***
	(−12.91)	(−10.00)	(−11.43)	(−9.39)	(−12.59)	(−9.27)
Online	0.1732**	0.0806*	0.1806**	0.0776*	0.1768**	0.0899**
	(2.27)	(1.81)	(2.06)	(1.75)	(2.36)	(2.07)
Ln(GDP)	−0.0696***	−0.0395**	−0.1063***	−0.0699***	−0.0841***	−0.0544***
	(−2.79)	(−2.27)	(−4.02)	(−4.37)	(−3.49)	(−3.23)
Ln(UnEmp)	0.0528	0.0139	0.0615	0.0330	0.0444	0.0049
	(0.99)	(0.40)	(0.98)	(0.82)	(0.85)	(0.15)
NASD		0.0449		0.1361***		0.1226***
		(0.89)		(2.69)		(2.81)
Ln(MktCap)		−0.0271		−0.0272		−0.0301
		(−1.03)		(−0.99)		(−1.18)
Ln(Price)		−0.1675***		−0.1993***		−0.1632***
		(−5.80)		(−6.84)		(−5.96)
Turn		0.0006*		0.0003		0.0005
		(1.79)		(0.56)		(1.29)
Spread		0.1269***		0.1356***		0.0975***
		(3.69)		(3.70)		(3.03)
Ln(Illiq)		−0.0160		0.0001		−0.0160
		(−0.80)		(0.01)		(−0.83)
Adj. R^2	0.0573	0.5878	0.0749	0.6903	0.0703	0.5860
N	211	211	211	211	211	211
Robust SEs	Yes	Yes	Yes	Yes	Yes	Yes

Following Eleswarapu and Venkataraman (2006), we use a research design that accounts for the possibility that the structure of the market is endogenously determined by the strength of the gambling culture in a particular country. More specifically, we examine the volatility of ADRs while conditioning on the level of gambling attitudes in the home country. Doing so allows us to hold constant the structure of the market while testing whether gambling culture determines the stability of stock prices. Results show a statistically significant and economically meaningful relationship between gambling attitudes in the home country and ADR volatility. This relation is robust to a variety of controls for ADR-specific and macroeconomic-specific characteristics as well as various measures of volatility.

Combined, our findings contribute to the literature by (i) providing support for the assertion in Shiller (2000) and (ii) identifying a non-traditional determinant of volatility (gambling culture). Moreover, the results of this study have broad and important implications relating to economic outcomes. Endogenous growth theory suggesting that economic output is, in part, driven by the quality of financial markets. When capital markets are more volatile, risk-averse savers are less likely to invest, which can lower the level of aggregate capital stock and subsequently economic growth. In the framework of our study, countries with more favorable gambling cultures may have a more difficult time converting gross savings to gross investment.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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