Financial Performance of Internet Gambling Stocks: Empirical Evidence from the UK

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ABSTRACT

The purpose of this study is to examine the financial performance of an online gambling portfolio. The performance of the online gambling portfolio is compared to both the market and a socially responsible portfolio. Additionally, the financial performance is examined during the Great Recession, a period which includes significant financial instability. Financial performance measures designed for periods of negative average returns are utilized. Unconditional and conditional financial performance measures indicate that the online gaming portfolio underperforms the market portfolio. Additionally, the results indicate that relative to the socially responsible portfolio, the online gambling portfolio underperforms as well. Moreover, the results of the modified Sharpe ratios indicate a significant difference compared to the traditional measures. The rankings of all three portfolios changes significantly, with the online gambling portfolio performing the worst out of the three. Finally, the Jobson and Korkie tests showed no significant difference between the traditional performance measures, but this result could be due to the lack of power of the test. This empirical investigation provides insight into the financial performance of online gambling stocks in the UK.

JEL Codes: G00, G11, G15, G19.
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1. INTRODUCTION

The internet boom spawned many new business activities, including online gambling. The online gaming industry has gone from inexistence a couple of decades ago, to millions of people wagering bets every day. According to the UK Gambling Commission, from 2008 to 2009, 68.0 percent of the population engaged in some form of gambling. Moreover, 6.0 percent of UK gamblers used the internet to engage in games of chance. A survey by ICM Research finds that participation in remote gambling (e.g., through a computer, mobile phone or interactive/digital TV) has increased from 7.2 percent in 2006, to 9.9 percent in 2009. More recently, the UK Gambling Commission stated that UK online gambling had overtaken traditional gambling (Barlowe, 2016). Between April of 2015 and March of 2016, online gambling

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operators reported a gross gambling yield of $5.62 billion, which is about 33 percent of the total market yield. According to the Financial Times (Ross, 2017), as of March 2017 shares of the popular online gambling company 888 have risen considerably (about 32% since April of the prior year). According to Casino.org, Colombia recently licensed its first-ever regulated online gambling company (Sheldon, 2017). These reports and news articles provide evidence which indicates that online gambling is gaining acceptance (market share) as a modern form of gambling.

The increased participation in games of chance through the World Wide Web underscores the need for academic examination of publicly listed online gaming companies. However, due to the newness of online gambling, academic finance literature in this area is virtually inexistent. Therefore, many questions remain unanswered for online gambling stocks. For instance, how do online gambling stocks perform relative to the market? Also, how do they perform relative to a set of socially responsible investments? Finally, how do these stocks perform during periods which include great financial instability? These are only a few questions that remain unanswered for online gambling stocks.

This paper contributes to the literature in the following distinct ways. First, we examine the financial performance of an online gambling portfolio and compare it to the market portfolio. Second, we conduct the same analysis, but instead contrast the online portfolio to a socially responsible portfolio.[1] Third, we study the performance of online gambling stocks during a period which includes significant financial instability (The Great Recession); accordingly, we utilize financial performance measures that are specifically designed for periods of negative average returns. These measures include the normalized Sharpe ratio of Scholz and Wilkens (2006), the Israelsen (2003, 2005) Sharpe ratio, and the Ferruz and Sarto (2004) modified Sharpe ratio. Finally, we conduct statistical comparisons of Sharpe ratios using Jobson and Korkie's (1981) test of equal Sharpe ratios, which allows us to test if the Sharpe ratios are statistically different.

This study yields several interesting results. First, when we estimate traditional Sharpe ratio measures, the online gambling portfolio outperforms both the market and socially responsible portfolios. However, the Jobson and Korkie tests showed no significant difference between the traditional performance measures, but this result could be due to the lack of power of the test. However, once we apply performance measures that are specifically designed for periods of *negative average returns* we see observe a complete reversal in the results. Estimating *modified* Sharpe ratios, the rankings of all three portfolios changes significantly, with the online gambling portfolio performing the worst out of the three. That is, the online gambling portfolio has the worst reward-to-risk ratio of all three portfolios. Furthermore, Treynor ratios and Jensen's alpha also show that the online gambling portfolio underperforms the socially responsible portfolio.

The remainder of this paper is organized as follows. Section 2 reviews some of the literature and history of online gambling stocks. Section 3 discusses the measurement and data sources used in the empirics. Section 4 discusses the econometric methods. Finally, Section 5 presents the results of the paper, while Section 6 concludes.

[1]Studies have shown that norm-conforming portfolios perform significantly different than norm-neglect portfolios (Perez Liston and Soydemir, 2010)

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2. BACKGROUND AND LITERATURE REVIEW FOR ONLINE GAMBLING

2.1 Overview of Online Gambling

Miriam Webster's dictionary defines gambling as "the playing of a game of chance for stakes." However, recent technological advances have made it possible for gambling to take place online. Therefore, a potential definition for online gambling could be, using the internet to play a game of chance for stakes. Shaffer (2004) defines online gambling as "…using an Internet connected computer to place a wager on the outcome of a sporting event or game, wager and play a game that has a random number generator associated at its source, or play card or casino type games in real time with other players that are linked by Internet connections" (pp. 5-6). Online Gambling may include the following forms of gambling: (1) fixed odds betting, (2) peer to peer betting, (3) spread betting, (4) gaming, and (5) lottery (Ranade et al., 2006). The UK Gambling Act 2005 defines remote gambling as gambling in which individuals participate by the use of remote communication. [2] This definition is broader than that of online gambling since it encompasses gambling via various remote communication devices, such as internet, telephone, television, radio, and any other electronic device that facilitates communication. This paper focuses on a narrower definition, which only includes online gambling.

Online gambling has its beginnings over two decades ago, when in 1994 Antigua-Barbuda passed the Free Trade and Processing Zone Act, which effectively opened the door for online gambling (see Perez Liston, 2017 for a more detailed, but brief history of online gambling). A decade later the UK parliament passed the Gambling Act 2005, which legalizes all forms of online gambling.

According to Griffiths and Parke (2002), "…Internet gambling is global, accessible, and has 24-hour availability" (p. 313). As a result, these unique characteristics of online gambling create a large potential for sales growth. Over the past two decades, global online gambling grew at an impressive rate. A recent study (KPMG, 2017) places China, the U.S., and Japan as the three largest markets in the world, with annual revenues of USD 24.3, 23.5, and 12.4 billion, respectively. In that same study, they rank the UK's market as the sixth largest, with revenues of USD 3.9 billion. Schopper (2002) estimates that there are 1,400 internet gambling sites around the globe, however, a single company may own several different sites. Possible reasons for the large increase in online gambling are (1) sophisticated gaming software, (2) integrated e-cash systems, (3) multilingual sites, (4) increased realism (e.g., gambling via webcams), and (5) improved customer care systems (Griffiths and Park, 2002). The rapid growth of online gambling underscores the need for academic scrutiny in all disciplines. This growth is sure to have an impact on society, which might manifest itself in different forms.

The emergence of online gambling has invoked distinct reactions from various countries around the globe. Some countries have taken steps to prohibit online gambling, while others have moved to legalize it. For example, China, Japan, South

[2] The UK Gambling Act 2005 made online gambling legal in the UK.

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Korea, Russia, India, Australia, and the United States all prohibit many forms of online gambling. However, the United Kingdom, Antigua and Barbuda, Costa Rica and the Kahnawake Mohawk Territory in Quebec all allow online gambling.

Recently, some significant online gambling trends have developed: (1) increased competition from traditional brick-and-mortar casinos, (2) industry consolidation, and (3) mobile gambling. The last trend has the potential to markedly increase online gambling.

Brick-and-mortar casinos have been, or are now considering, entering the online gaming market. For example, traditional casinos like Harrah's are now seeking to grow their revenues by competing in the online gaming market. However, not all brick-and-mortar gambling businesses support online gambling. In fact, many of them have long supported illegalization of online gambling due to fear of increased competition. Nevertheless, a recent article in the New York Times suggests that this opposition might be fading (Meier, 2010).

The gambling industry is undergoing consolidation and as a result many traditional gambling businesses are acquiring smaller online gaming businesses. For example, in 2005 International Game Technology (IGT), a manufacturer of electronic gaming equipment acquired WagerWorks, a provider of game content for online, mobile and interactive digital television.

Mobile gambling (i.e., gambling using cell phones) has significant potential to increase revenues for online gaming companies. For example, a research report by Juniper Research finds that in Europe over 2 million people now wager over mobile phone devices.[3] The report also suggests that the increased usage of smartphone devices, like the iPhone, have been driving this growth. As a result, many developers of computerized gaming software have been acquiring developers of cell phone gaming technology. For example, in 2008 IGT acquired Million-2-1, a developer of cell phone gaming technology.

Great Britain legalized online gambling with the passage of the Gambling Act 2005. It received Royal Assent in April 7th, 2005 and became law in September of 2007. The passage of the act was a substantial shift for the UK's gambling industry. It sought to make Great Britain one of the trailblazers of the global online gaming industry.[4] The UK has various advantages over other countries (e.g., Antigua and Barbuda): (1) stable political environment, (2) developed capital markets, (3) reliable communications infrastructure, (4) pool of skilled workers, and (5) regulations that should inspire confidence among customers and investors.

2.2 Empirical Findings for Online Gambling

Academic research for online gambling across the various academic disciplines is extremely limited. The majority of the research tends to study (1) trustworthiness of online gambling sites, (2) prevalence rates for online gambling, and (3) the negative social and psychological effects of online gambling (Griffiths, 2001; Ialomiteanu and

[3] Juniper Research (2010, January 9). *Good Odds for Mobile Gambling*. Retrieved January 12, 2011, from http://juniperresearch.com/viewpressrelease.php?pr=208

[4] Labour bids to put UK at heart of online gambling. (2006, October 8). *Sunday Times Business*, p 1.

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Adlaf, 2001; Shelat and Egger, 2002; Griffiths et al., 2009; Griffiths, 2009; Kraiwanit, 2016).[5]

The literature has examined the similarities and distinctions between online gamblers and traditional gamblers. In a small qualitative study, Parke and Griffiths (2001) find that online gamblers differ from traditional gamblers in the following dimensions: (1) financial stability, (2) physiological effects, (3) competitions, (4) need for acknowledgment, and (5) social facilitation. Interestingly, they find that traditional gamblers exhibited greater physiological effects than online gamblers. Traditional gamblers reported more feelings of nausea and dizziness than online gamblers.

To the best of this author's knowledge only a handful of finance papers have been published for online gambling (Bin et al., 2007a; Bin et al., 2007b; Bin et al., 2009; Perez Liston, 2017). Bin et al. (2007a) examined how U.S. federal and state online gambling legislative actions impacted brick and mortar gambling stocks. Their study spans from 1997 to 2003. Their findings suggest that legislative events that seek to prohibit online gambling actually had a positive impact on brick and mortar casino stock prices. These findings maybe interpreted as brick and mortar casinos being direct competitors of online gambling casinos.

Bin et al. (2009) study short- and long-term market movements of six portfolios during and after U.S. online gambling legislative events. Their sample encompasses 17 online gambling events, starting January 1997 to December 2006. Their study uses the Cornett et al. (1996) model to examine short-term price movements and the Fama-French (1993) model for long-term variations. They find that small-cap casino operators respond well (positive stock prices) to illegalization, while large-cap casino operators are not influenced much by increased competition from online casinos. Their paper, however, does not examine the financial performance of online gambling stocks. More recently, Perez Liston (2017) quantified beta for a group of online stocks in the UK. Additionally, he studied the dynamic behavior of this beta. The study shows that UK gambling legislation had an impact on the level of market risk for the online gambling portfolio.

The literature suggests that gambling stocks are neglected by significantly large groups of investors (Hong and Kacperczyk, 2009). For example, many ethical funds (e.g., Aviva UK Ethical Fund, Sustainability Fund) screen out what some deem as unethical businesses, such as online gambling stocks. This neglect suggests that online gambling stocks might have unique financial performance characteristics. It also suggests that online gambling stocks might have distinct financial performance when compared to the market portfolio and a socially responsible portfolio.

To gain some insight on how online gambling equity portfolios might perform, we examined the literature for traditional gambling stocks. The results for traditional online gambling stocks may not carry over for online gambling. Traditional gambling studies find that these stocks have positive risk adjusted returns (Davis and Sikes, 2002; Olsson, 2005; Salaber, 2007; Fabozzi, Ma and Oliphant, 2008). These abnormal returns are typically attributed to the unwillingness of some investors (i.e., norm-conforming

[5]For example, Shelat and Egger (2002) examine on- and off-line factors that influence the perceived trustworthiness of online gambling sites. They find that people base their trustworthiness on the information that is present in the website. For example, information regarding the legal status, fairness of gambling odds, and who owns or operates the casino helps to improve perceived trustworthiness.

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investors) to hold gambling stocks, thus, inducing a risk premium (Hong and Kacperczyk, 2009). Nevertheless, Chen and Bin (2001) find negative alphas for U.S. gaming stocks. These studies, however, do not examine reward-to-risk ratios (e.g., Sharpe, Treynor ratios) for gambling stocks.

In summary, the risk and reward characteristics for online gambling stocks are rather unknown. This paper attempts to fill this gap in the literature.

3. MEASUREMENT AND DATA SOURCES

3.1 Data and Variables

This paper studies online gambling stocks beginning in January of 2001 and ending December 2009.[6] The data is of a monthly frequency and is collected from Datastream.[7] We construct an equally-weighted internet gambling portfolio (*IGAM*), which is the main focus of this study.[8] This portfolio is composed of all online gambling companies listed on the UK stock exchange since 2001. Many leading online gambling companies, such as PartyGaming, Sportingbet, and 32RED are included in the portfolio. The FTSE All-Share index (*MKT*) is used as a proxy for the performance of the UK market. Additionally, we compare the performance of the online gambling portfolio with the FTSE4Good (*FTSE4G*) index, which proxies for socially responsible companies in the UK. The FTSE4Good index has several inclusionary and exclusionary criteria. To be part of the index companies need to show that they are working towards environmental management, climate change mitigation and adaptation, countering bribery, upholding human and labor rights, and supply chain labor standards. More importantly, their exclusionary criterion shuns socially *irresponsible* companies such as tobacco producers and weapons manufacturers (i.e., sin stocks). The 3-month UK t-bill (*Rf*) is used as the risk-free rate.

The returns for all three portfolios (indexes) are estimated by applying the following formula, $R_{p,t} = \ln(P_t/P_{t-1})*100$, where P_t is the price in month t and $R_{p,t}$ is the continuously compounded monthly return of portfolio p at time t. Our sample consists of 108 observations, but one observation is lost when the returns are calculated (so, we have a total of 107 observations). Additionally, the monthly risk-free rate is estimated by dividing the annual interest rate by twelve.

3.2 Highlights from the Data

Table 1 reports the summary statistics for the UK online gambling, market, and socially responsible portfolios and the risk free rate of interest. The average monthly returns over the full sample period are -0.30% for the online gambling portfolio (-3.64% annualized), -0.19% for the socially responsible index (-2.30% annualized), and -0.08% for the market portfolio (-1.01% annualized). When compared to both the market and the FTSE4good portfolios, the online gambling portfolio performed the worst over the observed period. These low returns for the online gambling portfolio are in significant

[6] We start in 2001 because this is when we first obtain data for publicly traded online gambling companies from Datastream.
[7] Monthly, instead of daily or weekly data were selected due to the problem of non-synchronous trading or non-trading problem that occurs when firms are initially listed on the UK stock exchange.
[8] Results are qualitatively the same using value-weighted portfolios.

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contrast to the high average returns observed for sin portfolios (tobacco, alcohol, and gambling) in prior studies (e.g., Hong and Kacperczyk, 2009; Perez Liston and Soydemir, 2010; Perez Liston, 2016). In regards to risk, the monthly standard deviations are 14.31% (49.57% annualized) for the online gambling portfolio, 4.62% (16.02% annualized) for the socially responsible portfolio and 4.61% (15.97% annualized) for the market portfolio. The risk for the online gambling portfolio was about three times larger than that of the market and socially responsible portfolios. The comparatively large standard deviation for the online gambling portfolio is in agreement with the standard deviations found for sin portfolios (Perez Liston, 2016). The mean monthly return for the risk-free rate was 0.34% (4.08% annualized) and the standard deviation was 0.12% (41.57% annualized). The sample covers the Great Recession, so poor financial performance for all three portfolios is to be expected.

Table 1. Descriptive Statistics

	IGAM	*FTSE4G*	*MKT*	*RF*
Mean	-0.303	-0.192	-0.084	0.340
Maximum	39.714	9.222	10.369	0.488
Minimum	-51.021	-14.450	-13.497	0.030
Std. Dev.	14.305	4.616	4.608	0.119
Skewness	-0.235	-0.805	-0.722	-1.519
Kurtosis	4.879	3.561	3.750	4.522
Jarque-Bera	16.726	12.961	11.816	51.460
Probability	0.000	0.002	0.003	0.000
Observations	107	107	107	107

Notes: This table details the descriptive statistics for three portfolios and the risk-free rate. Results are displayed for the full sample. The sample starts in January 2001 and ends in December 2009. *IGAM* represents the monthly return on the equally-weighted online gambling portfolio; *MKT* the monthly return on the value-weighted FTSE All-Share index; *FTSE4G* the monthly return on the FTSE4Good index; and, *RF* is the 3-month UK Treasury bill rate (displayed as a monthly rate).

In Figure 1, we show the monthly returns for the online gambling portfolio. The returns during 2005 were very erratic. A possible explanation for this is the passage of the Gaming Act 2005. A closer look at the figure reveals that there are clusters of volatility, implying heteroskedasticity. Figure 2 plots the monthly returns for the market portfolio. The figure indicates that the returns exhibited a large degree of volatility during the most recent financial crisis. Figure 3 plots the monthly returns for the socially responsible portfolio. The returns for this portfolio also exhibited large degree of volatility during the 2001 and 2008 recessions.

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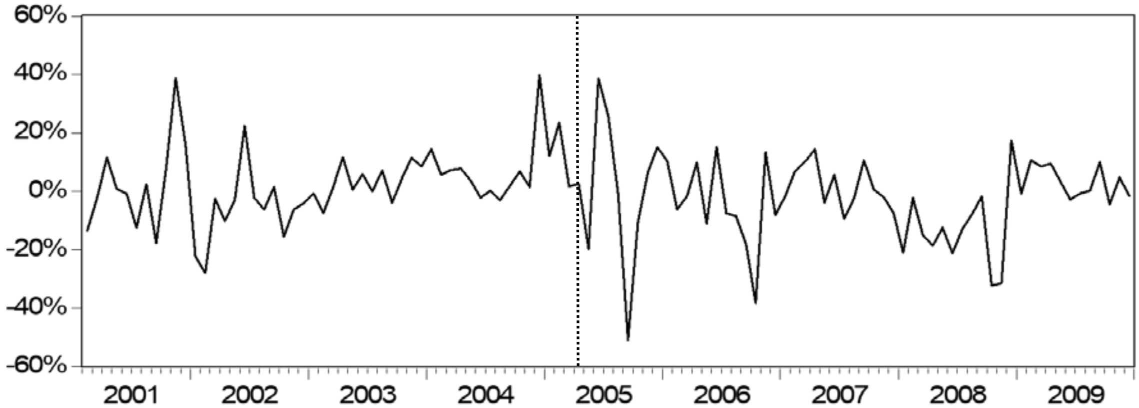
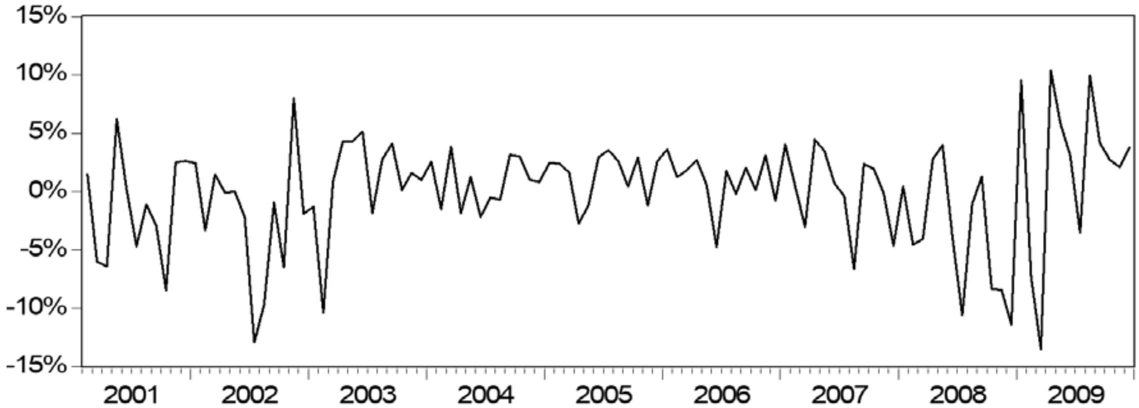
Figure 1. Online Gambling Portfolio Returns



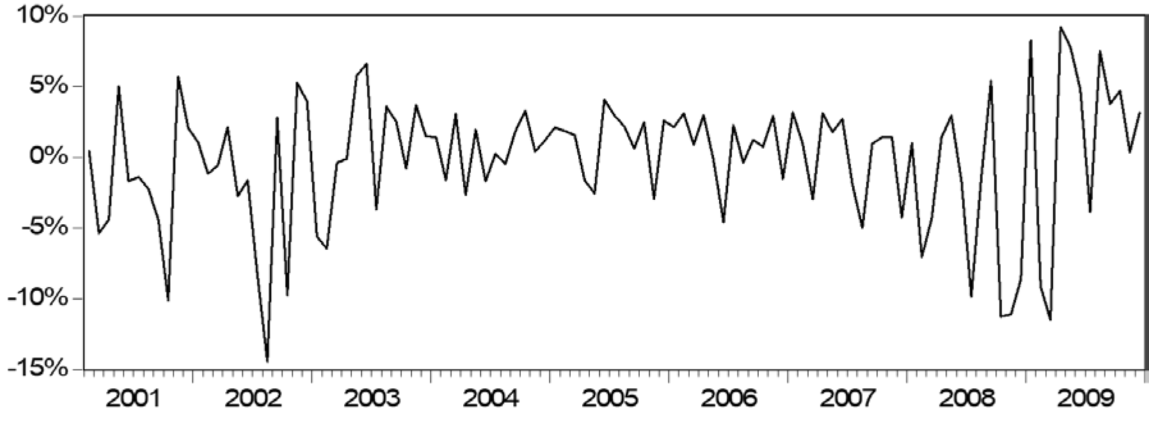
Notes: This graph plots the returns for the online gambling portfolio on the y-axis and time on the x-axis. The sample begins in January 2001 and ends in December 2009. The dashed vertical line indicates the passage of the Gambling Act 2005.

Figure 2. FTSE All-Share Index Returns



Notes: This figure shows the returns for the FTSE All-Share index on the ordinate axis and time on the abscissa axis. The sample spans from January 2001 to December 2009.

Figure 3. FTSE4Good Index Returns



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Notes: This figure shows the returns for the FTSE4Good index on the ordinate axis and time on the abscissa axis. The sample spans from January 2001 to December 2009.

4. METHODOLOGY

This section discusses some of the methods used to estimate the financial performance for the online gambling, socially responsible, and stock market portfolios.

4.1 Conventional Financial Performance Measures

We estimate Jensen's alpha (Jensen, 1968) to determine the financial performance of the online gambling and socially responsible portfolios:

$$\alpha_p = \left(R_{p,t} - R_{f,t}\right) - \beta_p\left(R_{m,t} - R_{f,t}\right) - \varepsilon_{p,t}, \tag{1}$$

where $R_{p,t}$ is the return on the *p*th portfolio at time *t*, $R_{f,t}$ the risk-free rate, $\varepsilon_{p,t}$ the unobservable stochastic white-noise process, β_p is the beta for the *p*th portfolio, and α_p is Jensen's alpha. Of course, a statistically significant and positive Jensen's alpha suggests overperformance for the *p*th portfolio, whereas a statistically significant negative alpha indicates underperformance even after controlling for systematic risk. Furthermore, an alpha of zero is indicative of no under- or overperformance of portfolios, which is consistent with the CAPM.

Sharpe (1966) developed a simple, yet theoretically meaningful ratio which measures a portfolio's excess return relative to total risk.[9] The Sharpe ratio is estimated as follows:

$$Sharpe\ ratio = \frac{(\bar{R}_p - \bar{R}_f)}{var(R_p)}, \tag{2}$$

where $\bar{R}_p$ represents the average return on the *p*th portfolio, $\bar{R}_f$ the average risk-free rate, and $var\left(R_p\right)$ the variance of the *p*th portfolio. The interpretation of the Sharpe ratio is straight forward. Portfolios with larger Sharpe ratios are considered more desirable by investors because they reward investors with more return for a given level of risk. A major benefit of the Sharpe ratio is that it can be estimated without assuming any equilibrium model (e.g., CAPM), whereas the Treynor ratio and Jensen's alpha necessitate such a model (Ferruz and Sarto, 2004).

To examine *statistical differences* in financial performance, we use the Jobson and Korkie (1981) test of equal Sharpe ratios. The Jobson and Korkie test is as follows:

$$z = \frac{\sigma_a(\mu_b - Rf) - \sigma_b(\mu_a - Rf)}{\sqrt{\theta}}, \tag{3}$$

$$\theta = \frac{1}{T}\left[2\sigma_a^2\sigma_b^2 - 2\sigma_a\sigma_b\sigma_{ab} + \frac{1}{2}\mu_a\sigma_b^2 + \frac{1}{2}\mu_b\sigma_a^2 - \frac{\mu_a\mu_b}{2\sigma_a\sigma_b}\left(\sigma_{ab}^2 + \sigma_a^2\sigma_b^2\right)\right], \tag{4}$$

[9] The Sharpe ratio is sometimes called the reward-to-variability ratio.

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where μ_j is the mean return of the jth portfolio, σ_j is the standard deviation of portfolio j, σ_{ij} is the covariance between portfolios i and j, and T is the number of observations. Under the null hypothesis, Sharpe ratios are statistically equal. A rejection of the null indicates a distinct reward-to-risk relationship between portfolio i and j. The hypotheses are:

$$H_0\text{: Portfolio } i - \text{Portfolio } j = 0 \text{ and} \tag{5}$$

$$H_1\text{: Portfolio } i - \text{Portfolio } j \neq 0,\ i \neq j. \tag{6}$$

Using Monte Carlo methods, Jobson and Korkie (1981) find that the z statistic is well behaved in small samples. However, they also find that the test lacks power in detecting typical differences in Sharpe ratios when monthly data is used.

The Sharpe ratio has been criticized because it measures excess return relative to total risk, not market risk (beta). Portfolio theory suggests that diversification eliminates idiosyncratic risk and that only non-diversifiable risk should be rewarded. Treynor (1965) developed a measure of financial performance, the Treynor ratio, which measures excess return relative to non-diversifiable risk. According to Sharpe (1966), the Treynor ratio might be a better predictor of future performance because it ignores transitory effects and focuses on more permanent relationships, such as systematic risk. The Treynor ratio is estimated as follows:

$$Treynor\ ratio = \frac{(\bar{R}_p - \bar{R}_f)}{\beta_p}, \tag{7}$$

where $\bar{R}_p$ represents the average return on the pth portfolio, $\bar{R}_f$ the average risk-free rate, and β_p the market beta of the portfolio. For the Treynor ratio, a larger value is indicative of better financial performance relative to systematic risk. Sharpe (1966) suggests that the Treynor ratio is an inferior measure of past performance, because it cannot capture the nonsystematic component of variability. This weakness is particularly important in non-diversified portfolios, which tend to exhibit larger idiosyncratic risk.

4.2 Modified Financial Performance Measures

There is an ongoing discussion on whether Sharpe ratios are appropriate when average excess returns are negative (Scholz and Wilkens, 2006). Since the sample period (2001 to 2009) we use in this study encompasses the Great Recession, the returns for the online gambling, market, and socially responsible portfolio are on average negative. This leads us to estimate three additional performance measures that account for periods where excess returns are negative; Israelson (2003, 2005) modified Sharpe ratio, Ferruz and Sarto (2004) modified Sharpe ratio, and Scholz and Wilkens (2006) normalized Sharpe ratio. Israelsen (2005) develops the modified Sharpe ratio and tests it as a ranking criterion using 25 U.S. equity mutual funds over the period of 1999-2003. The interesting feature of his sample is that over the sampled period all 25 funds had negative excess returns. When compared to the regular Sharpe ratio, he finds that the modified Sharpe ratio is much better at ranking funds in periods of negative excess returns. The Sharpe ratio developed by Israelsen (2003, 2005) is as follows:

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$$mSR_p^{IS} = \frac{\bar{R}_p - \bar{R}_f}{var(R_p)^{\left(\frac{\bar{R}_p - \bar{R}_f}{abs\left(\bar{R}_p - \bar{R}_f\right)}\right)}}, \tag{8}$$

where mSR_p^{IS} is the modified Sharpe ratio for the *p*th portfolio, $\bar{R}_p$ and $var(R_p)$ are the average return and variance on the *p*th portfolio, respectably. $\bar{R}_f$ the average risk-free rate and $abs()$ is the absolute value operator. Modified Sharpe ratios that are less negative are indicative of better financial performance. For example, a modified Sharpe ratio of -0.49 is more desirable than that of -8.94. According to Israelson (2005), the value of the modified Sharpe ratio is as a ranking criterion.

Ferruz and Sarto (2004) modify the Sharpe ratio by treating the premium on returns as relative rather than absolute. Their contribution involves dividing the returns by the risk-free rate in the numerator of the Sharpe ratio. The Ferruz and Sarto (2004) modified Sharpe ratio is estimated as follows:

$$mSR_p^{FS} = \frac{\frac{\bar{R}_p}{\bar{R}_f}}{var(R_p)}, \tag{9}$$

where mSR_p^{FS} is the modified Sharpe ratio for the *p*th portfolio. A larger ratio represents a more favorable reward-to-risk relationship. A weakness in this ratio is that it does not provide consistent rankings when mean returns are negative, $\bar{R}_p < 0$ (Ferruz and Vicente, 2005).

Scholz and Wilkens (2006) developed a normalized Sharpe ratio that separates the impact of the market climate and fund management performance on fund excess returns. The normalized Sharpe ratio of Scholz and Wilkens (2006) is:

$$nSR_p = \frac{JA_p + \beta_p(\bar{R}_{lm} - \bar{R}_{lf})}{\sqrt{\beta_p^2 var(R_{lm})^2 + var(R_p)^2}}, \tag{10}$$

where the numerator is the excess return and is obtained from the following regression:

$$R_{p,t} - R_{f,t} = JA_p + \beta_p(R_{m,t} - R_{f,t}) + \varepsilon_{p,t}, \tag{11}$$

where $R_{p,t}$ is the return on the *p*th portfolio, $R_{lf,t}$ is the return for the long risk-free rate, JA_p is Jensen's alpha, $R_{lm,t}$ is the long return for the market, β_p is beta, and $\varepsilon_{p,t}$ is the Gaussian disturbance term. The numerator (excess return of the fund) of the normalized Sharpe ratio is influence by fund specific variables $(JA_p,\ \beta_p)$ and market variables $(\bar{R}_{lm}, \bar{R}_{lf})$. The denominator (variance of the fund) is also composed of fund specific variables $(\beta_p^2, var(R_p)^2)$ and market variables $(var(R_{lm})^2)$. Scholz and Wilkens (2006) estimate the variance and mean of both the market and risk-free rate using a "long" window. This calculation avoids the market climate bias. Thus, the normalized Sharpe ratio represents a measure of risk-adjusted performance for an "average" market period based on fund-specific characteristics. Therefore, it is not affected by random market climates and yields a more accurate appraisal of fund management performance.

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A potential weakness of this approach is that it is based on a single factor model and assumes stability of the estimated parameters (i.e., intercept, slope, and error variance).

4.3 Conditional Performance Measures

In the previous section, the financial performance measures where unconditional and did not allow for time-varying parameters (e.g., variances, intercepts, and betas). Evidence suggests that the assumption of homoscedasticity in financial returns is not always realistic and that parameters might be time-varying. Various authors propose econometric models that account for the unequal variances sometimes found in financial returns (Engle, 1982; Bollerslev, 1986; Glosten, Jagannathan, and Runkle, 1993). In this section we modify the unconditional financial performance measures (Sharpe and Treynor ratios) and allow for time-varying parameters.

First, the unconditional Sharpe ratio from equation (2) is modified by assuming that the variance of the portfolio, denominator, is time-varying. To estimate this ratio we now need the estimated time-varying variance. Various researchers have developed econometric models that generate these time-varying variances (Engle, 1982; Bollerslev, 1986; Glosten, Jagannathan, and Runkle, 1993). An advantage of the GJR model (Glosten, Jagannathan, and Runkle, 1993) over the ARCH and GARCH models of Engle and Bollerslev is that a dummy variable separates the impact of past negative (positive) shocks on volatility. We estimate the following GJR model:

$$R_{p,t} = \mu + \varepsilon_t, \ \sim N(0, h_t), \tag{12}$$

$$h_t = \gamma + \alpha\varepsilon_{t-1}^2 + \beta h_{t-1} + \omega\varepsilon_{t-1}^2 S_{t-1}^-, \tag{13}$$

where in the mean equation $R_{p,t}$ represents the return on portfolio p at time t, μ the constant, ε_t the unobservable error. In the variance equation, h_t represents the conditional variance, ε^2_{t-1} the lagged error term, S_{t-1}^- = 1 for $\varepsilon_{t-1} < 0$ and 0 otherwise, and subject to $\gamma > 0$, $\alpha, \beta \geq 0$, $\alpha + \omega \geq 0$, $\alpha + \beta + \omega < 1$. Volatility asymmetry is captured through ω. Accordingly, we take the volatility generated by the GJR GARCH and use it as an input in the denominator of the Sharpe ratio, where the Sharpe ratio now becomes:

$$Sharpe\ ratio_t = \frac{(\bar{R}_{p,t} - \bar{R}_{f,t})}{var(R_{p,t})}, \tag{14}$$

where time subscripts have been added to the variables to denote the time-varying nature of the ratio.

Second, the unconditional Treynor ratio from equation (7) is modified by assuming that the beta of the portfolio (i.e., denominator) is time-varying. Thus, the Treynor ratio becomes:

$$Treynor\ ratio = \frac{(\bar{R}_{p,t} - \bar{R}_{f,t})}{\beta_{p,t}}, \tag{15}$$

where time subscripts are added to denote that beta is time-varying. To estimate this ratio we now need the estimated time-varying beta. The conditional beta is estimated

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using the conditional variances and co-variances obtained from Engle's (2002) dynamic conditional correlation (DCC) model.[10] Many authors have used these multivariate GARCH models to estimate time-varying parameters (Ledoit, Santa-Clara, and Wolf, 2003; Jostova and Philipov, 2005; Chong, Her, and Phillips, 2006; Perez Liston, 2017).

5. EMPIRICAL RESULTS

5.1 Unconditional, Conditional and Modified Sharpe Ratios

Table 2 reports the results for the *unconditional* Sharpe ratios. The unconditional Sharpe ratios are -0.04, -0.12, and -0.09 for IGAM, FTSE4G, and MKT, respectively. Notice that IGAM has the better reward-to-variability ratio (i.e., less negative) and FTSE4G has the worst Sharpe ratio. Table 3 shows the results of calculating the Jobson and Korkie test of equal Sharpe ratios. The test's null hypothesis is that the Sharpe ratios are equal, or that both portfolios have similar reward-to-variability ratios. A rejection of the null would indicate that one of the portfolios has a superior reward-to-variability ratio. For all three pair-wise comparisons, we fail to reject the null of equal Sharpe ratios, indicating that all three portfolios have statistically similar reward-to-variability ratios. However, the failure to reject the null might be due to the low power of the test. Jobson and Korkie (1981) and Jorion (1985) indicate that due to the lower power of the test, large differences in Sharpe ratios need to be observed before rejecting the null.

Table 2. Unconditional and Conditional Performance Measures and Betas

	IGAM	*FTSE4G*	*MKT*
Unconditional Sharpe ratio	-0.044	-0.115	-0.092
Conditional Sharpe ratio	-0.045	-0.125	-0.100
Unconditional Treynor ratio	-1.040	-0.578	
Conditional Treynor ratio	-0.767	-0.599	
Jensen's alpha	-0.381	-0.142*	
t-stat	-0.258	-1.762	
Beta	0.618***	0.919***	
t-stat	2.275	24.628	
Conditional beta average	0.839***	0.888***	
t-stat	20.056	84.332	

Notes: This table reports the unconditional and conditional Sharpe ratios for the equally-weighted internet gambling portfolio (*IGAM*), the FTSE4Good index (*FTSE4G*) and the value-weighted FTSE All-Share index (*MKT*). In addition, the unconditional and conditional Treynor ratios for the equally-weighted internet gambling portfolio (*IGAM*) and FTSE4Good index (*FTSE4G*). Jensen's alpha and beta—the intercept and

[10] Tsay (2005) suggests that conditional (time-varying) beta may be estimated using multivariate volatility models.

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slope from a CAPM time-series regression—are shown for *IGAM* and *FTSE4G*. Furthermore, the conditional beta average for *IGAM* and *FTSE4G* is shown. Results are shown for the entire sample period, which spans from January 2001 to December 2009. *** 1%; ** 5%; * 10% significance.

Table 3. Jobson and Korkie Tests

	(*IGAM, MKT*)	(*FTSE4G, MKT*)	(*IGAM, FTSE4G*)
Test statistic	-0.384	0.605	-0.589

Notes: This table reports the *z* test statistic of pair-wise comparisons of Sharpe ratios using the Jobson and Korkie test. Under the null hypothesis of the test, Sharpe ratios are statistically equal. (*IGAM, MKT*) is the pair-wise comparison of Sharpe ratios between the equally-weighted internet gambling portfolio (*IGAM*) and the value-weighted FTSE All-Share index (*MKT*). (*FTSE4G, MKT*) is the pair-wise comparison of Sharpe ratios between the FTSE4Good index (*FTSE4G*) and the value-weighted FTSE All-Share index (*MKT*). (*IGAM, FTSE4G*) is the pair-wise comparison of Sharpe ratios between the equally-weighted internet gambling portfolio (*IGAM*) and the FTSE4Good index (*FTSE4G*). Results are shown for the entire sample period. The sample spans from January 2001 to December 2009. *** 1%; ** 5%; * 10% significance.

Table 2 also reports the results for the *conditional* Sharpe ratios. The conditional Sharpe ratios are -0.05, -0.13, and -0.10 for IGAM, FTSE4G, and MKT, respectively. The conditional versions of the ratios reveal a slight worsening in the reward-to-variability relationship for all three portfolios. However, the rankings between the three portfolios remain intact.

Table 4 reports the results for the modified and normalized Sharpe ratios. The Israelson (2003, 2005) modified Sharpe ratios are -0.053 for FTSE4G, -9.211 for IGAM, and -1.950 for MKT. The Ferruz and Sarto (2004) modified Sharpe ratios are -0.122 for FTSE4G, -0.062 for IGAM, and -0.053 for MKT. Scholz and Wilkens (2006) normalized Sharpe ratios are 0.003 for FTSE4G and -0.019 for IGAM. After estimating reward-to-variability measures that account for periods when average excess returns are negative, the results reveal a different story. Out of the three measures only in one does IGAM outperform both the FTSE4G and market portfolios. These results are in contrast to the unconditional and conditional Sharpe ratios measures presented earlier. Thus, over the 2001 to 2009 period IGAM underperformed relative to the FTSE4G and the market portfolios.

Table 4. Alternative Sharpe Ratios

	Ferruz and Sarto Sharpe ratio	Israelsen Sharpe ratio	Normalized Sharpe ratio
FTSE4G	-0.122	-0.053	0.003
IGAM	-0.062	-9.211	-0.019
MKT	-0.053	-1.950	

Notes: This table reports the alternative Sharpe ratios for the equally-weighted internet gambling portfolio (*IGAM*), the FTSE4Good index (*FTSE4G*) and the value-weighted FTSE All-Share index (*MKT*). Results are shown for the entire sample period. The sample spans from January 2001 to December 2009

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5.2 Treynor Ratios

Table 2 reports the unconditional Treynor ratio for IGAM and FTSE4G. The Treynor ratios are -1.04 and -0.58 for IGAM and FTSE4G, respectively. Accounting only for systematic risk, FTSE4G outperforms the online gaming portfolio. The table also reports the conditional Treynor ratio for IGAM and FTSE4G. The estimated conditional Treynor ratios are -0.78 and -0.60 for IGAM and FTSE4G, respectively. Again, FTSE4G outperforms IGAM, however, by a smaller margin, when compared to unconditional measures.

5.3 Jensen's Alpha

The results for estimating the CAPM for IGAM and FTSE4G are presented in Table 2. For IGAM, the CAPM yields a Jensen's alpha of -0.381, which is statistically indistinguishable from zero. In contrast to previous sin studies, there is no overperformance for the online gambling portfolio (Fabozzi, Ma, and Oliphant, 2008; Lobe and Roithmeier, 2008; Hong and Kacperczyk, 2009). This implies that online gambling investors do not receive a risk premium for investing in socially irresponsible firms. For FTSE4G, alpha is -0.142 (or 14 basis points per month) and statistically significant at the 10% level. Consistent with previous studies, the negative estimated alpha implies that socially responsible investors bear a cost for investing in responsible companies (Geczy, Stambaugh, and Levin, 2003; Renneboog, Horst, Zhang, 2008).

5.4 Summary of Results

The results from the three different financial performance measures—modified Sharpe ratios, Treynor ratios, and Jensen's alpha—suggest that the online gambling portfolio underperformed both the FTSE4G and market portfolios over the 2001 to 2009 period. These results are in contrast to those found in the sin stock literature (Lobe and Roithmeier, 2008; Fabozzi, Ma, and Oliphant, 2008; Hong and Kacperczyk, 2009; Perez Liston and Soydemir, 2010). Specifically, the results from the various Sharpe ratios—unconditional, conditional, modified, and normalized—suggest that, once we account for negative excess returns, the online gambling portfolio has the lowest ranking relative to the other two portfolios. The unconditional and conditional Treynor ratios also rank the online gambling portfolio below the FTSE4G. Although, not statistically significant, Jensen's alpha for the online gambling portfolio is considerably lower than that of FTSE4G portfolio.

6. CONCLUSION

The internet and mobile technology have spawned a new form of gambling. Many companies have emerged over the last couple of decades that address the growing demand in this new industry. Some of these firms have grown rather quickly and have become listed on major stock exchanges, such as the London Stock Exchange.

As a result, this study seeks to further our understanding of the financial performance of a portfolio composed of publicly traded online gambling stocks in the UK. The results of this study provide important and interesting findings for practitioners and academics alike. First, financial performance measures, which account for periods where excess returns are negative, indicate that the online gambling portfolio

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underperforms relative to the market portfolio. Thus, it appears that there is a financial cost, in the form of inferior risk-adjusted returns, to reducing the investable universe to online gambling stocks. This finding contrasts to those in the sin stock literature, where the sin portfolio (which includes brick-and-mortar gambling stocks) outperforms the market (Fabozzi, Ma, and Oliphant, 2008; Lobe and Roithmeier, 2008; Hong and Kacperczyk, 2009; Perez Liston and Soydemir, 2010). Second, financial performance measures also show that the socially responsible portfolio outperforms the online gambling portfolio. Lastly, the Jobson and Korkie tests showed no significant difference between the online gambling portfolio and both the market and socially responsible portfolios. However, these results should be interpreted with caution due to the lack of power of the test and because the test only included *traditional* performance measures (that is, this result does not include the Israelson, 2003, 2005 modified Sharpe ratio; Ferruz and Sarto, 2004 modified Sharpe ratio; and Scholz and Wilkens, 2006 normalized Sharpe ratio, all of which account for long periods of negative returns).

The study is not without its limitations. First, the period of study is relatively short, given that online gambling companies have just recently listed on public stock exchanges. Second, the number of companies in the portfolio is rather limited, again, due to the newness of this type of publicly listed company. Lastly, the study does not take into account the potential role of investor sentiment on the financial performance of these stocks. These are just a small number of areas that could be addressed by future studies.

Overall, this study suggests that online gambling stocks do not significantly improve the risk-adjusted returns for norm-neglect investors (those who ignore social and religious norms). The practical implications of these findings suggest that if values-based investors exclude online gambling stocks from their portfolios (portfolios that might be similar to the FTSE4Good index) they are not sacrificing financial performance due to their values-based investment strategy.

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