The Effect of Online Gaming on Commercial Casino Revenue

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Abstract

This study estimates the effect of the online gaming industry on the commercial casino gaming industry. The findings from this study suggest that during the pre-UIGEA period, online gaming was a moderate substitute good for brick and mortar gaming in the U.S. During this early period in the online gaming market, which was characterized by loose regulation and relatively easy access, online gaming revenue is estimated to have cannibalized commercial casino revenue at a rate of 27 to 30 cents on the dollar. A discussion of this finding's relevance to the current gaming market and the related policy considerations is provided. This study also led to the discovery of a seemingly valid instrumental variable, internet user rates, which can be used to correct internet gaming coefficient estimates for potential bias in future studies.

Keywords: internet gambling, online gaming, instrumental variable, ARIMA

Introduction

The adoption of online gaming in new jurisdictions tends to be touted by proponents as a voluntary source of tax revenue (Legislative Analyst's Office, 2010). By regulating the industry, governments are thought to be able to increase public revenues through an online gaming tax. These taxes are typically levied on operators through a licensing fee and/or an excise tax applied to gross gaming revenue.

If the two industries are substitutes, they should be concerned about cannibalizing their own sales; if the industries are complements, they should explore how to leverage the benefits across the virtual and non-virtual gaming floor.

To date, it has remained unclear what specific effect online gaming has had on traditional brick and mortar (B&M) gaming. In particular, have the two industries been gross-complements (an increase in the demand for industry leads to an increase in the demand for the other), or have they been gross-substitutes (an increase in the demand for one industry leads to a decrease in the demand for the other). This paper seeks to measure the nature of this relationship and the strength of the association.

Significance

An understanding of the relationship between online gaming and brick and mortar gaming is an important concept for both policy makers and private operators. For private industries (or government-owned operators), the importance is clear. If the two industries are substitutes, they should be concerned about cannibalizing their own sales; if the industries are complements, they should explore how to leverage the benefits across the virtual and non-virtual gaming floor.

For policy makers, the distinction is more subtle. Among other considerations, policy makers need to understand how the adoption of online gaming will affect the output and tax revenue generated by existing B&M operations. For example, suppose that online and B&M gaming are perfect substitutes and gross B&M revenue is taxed at 20%. The introduction of online gaming at a 10% tax rate would actually lead to a decrease in tax revenue – for every dollar in online gaming revenue, the government would receive $0.10, but they would lose $0.20 from foregone B&M tax revenue. An argument similar to this

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one has been posited regarding the effect of legal casino adoption on lottery revenue (Walker, 2007a; Walker, 2007b). This argument of cross-industry tax effects is a specific application of the more general argument from the seminal work of Ramsey (1927), which provides a formal argument of the inter-relations between goods and excise taxes.

To date, there has been no published academic research that empirically estimates the relationship between online and B&M gaming demand. As online gaming continues to emerge as an area of interest for business research, understanding the nature of its relationship with B&M gaming will be important for building theoretical and empirical models.

Literature Review

Overview of Online Gaming in the United States

The first recorded online casino to accept a wager was Intertops.com, based and licensed in Antigua, which occurred in January 1996 (Business Wire, 2005). The online gaming industry then grew to roughly 15 casinos by the end of 1996, 650 at the end of 1999, and 1,800 sites by the end of 2002 (Schwartz, 2006). The first online poker room, PlanetPoker, opened in 1998 and was quickly followed by many others (Williams & Woods, 2007).

Online gaming continued to grow in the United States until October 2006, when the Unlawful Internet Gambling Enforcement Act (UIGEA) was passed as an addition to the Security and Accountability for Every Port Act of 2006. This measure effectively made it illegal for any financial transaction provider to transfer funds to online sites that take bets on "outcomes of a contest, sports event or a game of chance" (Smith et al., 2007).[1] [2] Although this act did not make the specific act of betting illegal for the consumer, the increased difficulty of financial transactions, and increasing uncertainty over the legality of online gaming in the average consumer's eyes, had a negative effect on online gaming demand, and caused some foreign operators to exit the U.S. market (Rose, 2010). The largest operator at the time, Party Gaming, was among the companies that left the U.S. market. At the time, the U.S. online gaming industry was estimated to produce roughly 6 billion in revenue per year, while the commercial casino industry generated 32 billion in revenue (Christiansen Capital Advisors, 2007; American Gaming Association, 2007).

Gaming Taxation Policy

The use of gaming regulation to generate tax revenue is often cited as a way to avoid politically dubious tax increases while addressing budget shortfalls (Furlong, 1998; Smith, 1999; Smith, 2000). Although the assumed electoral consequences of fiscal policy changes have become the topic of recent debate (Alesina, Carloni, & Lecce, 2010), the use of a Ramsey taxation framework, which applies excise taxes to generate a specific amount of revenue (as opposed to using taxes to fund the financing of a public good), appears to be a reasonable assumption of general policy practices (Ramsey, 1927).

When cross-effects between goods' demand are ignored, Ramsey (1927) suggests that tax rates be inversely proportional to own-price elasticities of demand. However, the introduction of cross-effects between goods complicates this axiom. Taxation on a good must account for how distortions in demand for that good affect demand for complementary and substitute goods. This concept has been noted by some gaming researchers such as Smith (1999), "Empirical research on elasticity of gaming demand has provided little practical guidance along these lines for taxation policy and design… Estimating gambling demand elasticities is complicated by the extent to which different gambling products are substitutes," but policy applications and research into cross-effects remain limited.

1 The SAFE Port Act had no direct relation to gaming, prior to the late addition of the UIGEA provisions. It is an act designed to address maritime and cargo security.

2 The provisions outlined in the UIGEA did not come into full effect prior to June 1, 2010, though most operators had already fully complied with the act, prior to that date.

Estimates of Gaming Demand Responses

In terms of cross- effects within the gaming industry, Walker and Jackson (2008) use a system of seemingly unrelated regression (probit) models to estimate the volume of casino, dog racing, horse racing, and lottery gaming industries as a function of the other industries' volume, and other control variables. A statistically significant relationship is found with all cross-effects except for dog racing volumes and casino volumes, and Indian casino square footage and dog racing volume. Casino gaming is noted to have a negative relationship with lottery gaming, but a positive relationship with horse racing.

In their review of gaming services in the European Union, the Swiss Institute of Comparative Law (2006) provides a summary table (reproduced in Table 1 below) of the known relationships among gaming industries. The authors provide estimates of the cross-elasticities between some industries, but none for online gaming. The relationships are all noted to be either nil or substitutionary (as opposed to complementary).

Table 1

Relationships between Gaming Sectors – Maximum Reported Empirical Estimates[3]

Gaming Sector From\To	Casino(1)	Gaming Machines	Lottery	Betting Services(2)
Casino	-27%	-27%	-20%	-32%
Gaming Machines	-27%	-27%	-20%	-32%
Lottery	-3% (low-end)	-3% (low-end)	Substitute Magnitude Unknown	-36%
Betting Services	0%	0%	Weak Substitute	-17%

Note: Reproduced from Swiss Institute of Comparative Law (2006)
(1) Results are largely from studies of U.S. venues where slot machines are by far the largest component of casino GGRs. The effects of competition on casinos and gaming machines are assumed to be equal for this analysis.
(2) Assumes that these are predominantly horse and sports betting services.

In his early study of direct gaming demand elasticities, Suits (1979) estimates the elasticity of demand for bookmaking services in Nevada, using data from the reduction of the federal excise tax on bookmaking at the end of 1974. He generates an elastic range from -1.64 to -2.17, indicating that the percent change in demand will be greater than the percentage change in price. He also estimates elastic demand for betting at thoroughbred race tracks from a panel data set of states offering horse racing, ranging from -1.59 to -2.14. Morgan and Vasche (1982) used two multiple regression equations to measure the effect of real disposable income, unemployment, and price of wagering (takeout rate) on pari-mutuel wagering demand. Wagering demand was split into two variables, wagering per attendance and attendance per capita. The authors estimate elasticity of pari-mutuel wagering with respect to price is -1.3. In his study of Illinois casinos, Landers (2008a; 2008b) estimates the price elasticity of casino gaming between -0.8 and -1.0. Landers (2008a) also notes that estimates of price elasticities in prior literature vary between -0.19 (lottery) and -2.81 (betting services). Thalheimer and Ali (2003) compute a log-log model that allowed them to infer elasticities directly from the model coefficients. The authors estimate an elastic (-1.5) price elasticity of demand in 1991, which decreased to an inelastic value (-0.9) by 1998.

Methodology

Overview

This study estimates two time-series regression models to determine the effect of online gaming revenue on brick and mortar gaming revenue. The model seeks to estimate the relationship between real (inflation adjusted) U.S. online gaming revenue and real U.S. commercial casino consumer spending. In order to address potential bias in coefficient estimate of online gaming revenue, an instrumental variable method, two-stage least squares (2SLS), is used to estimate the model coefficients. An ARIMA model is also computed to evaluate the robustness of the findings.

Data

A large portion of online gaming activity takes place on foreign sites, which are operating in countries with dubious regulation and reporting requirements. This makes any analysis of the online gaming industry challenging, and dependent on market estimates. In this study, data on the United States online gaming industry was made available as a result of a trade dispute at the WTO between Antigua and the U.S. (Christiansen Capital Advisors, 2007). The annual online gaming data covers the period from 1999 to 2006, the year the UIGEA came into effect. The use of pre-UIGEA data provides a revealing period to monitor the consumer behavior effects of online gaming, since the lack of significant regulation allowed operators and consumers to interact with fewer market restrictions. Since not all online gaming operators are required to file their revenue values with the government or another institution, the value provided by Christiansen Capital Advisors (2007) are estimates, and not precise audited values. Although the use of estimates may lead to inference issues, it should not bias the parameter estimates. Data for 1998 was coded by applying the 1998 to 1999 World estimates of online gaming by Christiansen Capital Advisors (2007) to the U.S. estimates from 1999. For the period from 1988 to 1998, online gaming revenues were assumed to be insignificant, and were coded as zero. The use of linearly approximated revenue levels from 1995, when online gaming revenues were known to be zero (Business Wire, 2005), and the last Christiansen Capital Advisors (2007) estimate in 1998, did not significantly alter the results. Therefore, the results appear to be robust to the minor estimation errors in 1996 and 1997.

Total commercial gross gaming revenue for the United States was obtained from the American Gaming Association (2010). The nominal values of B&M gaming revenue and online gaming revenue were converted to real values, by applying the U.S. CPI-U consumer price index (U.S. Department of Labor, Bureau of Labor Statistics, 2010).

Real U.S. gross domestic product was obtained from the International Monetary Fund (2010). Commercial casino availability data was obtained from Walker (2007a) and the American Gaming Association (2002, 2003, 2004, 2005, 2006, 2007). Summary statistics for all estimation data is provided in Appendix B.

Omitted Data

The National Indian Gaming Commission (NIGC) was solicited for Indian gaming revenues, however the NIGC was unable to provide data that predated 1998, and therefore Indian gaming revenue was not included as an independent variable. Also missing is a price variable. In empirical studies of the gaming industry, price is typically operationalized as the house advantage for a given game (Eadington, 1999). Since this study examines the U.S. gaming industries as a whole, it is not possible to include price in the model, as there is no index of overall house advantage for the U.S. gaming industry as a whole. The model design addresses potential bias from variable omission through an instrumental variable estimation method. In their study of intrastate industry relationships, Walker and Jackson (2008) previously estimate cross-industry effects without a price variable.

Instrumental Variable Approach

In producing estimates of gaming revenue relationships using long-term time series, the potential for omitted variable bias to enter the model error term becomes an increasing concern, as there is no reliable proxy variable that can address the changes in gamblers' and society's attitudes towards gaming over the 18 year period of this study.

If the model error term, e_t, contains omitted variables, such as attitudes towards gaming or Indian gaming revenue, which are correlated with the independent variables, biased coefficients may be estimated.[3]

In order to address the potentially endogenous online gaming variable, this study uses an instrumental variable approach, two-stage least squares, to obtain a consistent estimate of its effects. Instrumental variable estimation uses an exogenous variable that is uncorrelated with the structural model error term, but correlated with the potentially endogenous variable to obtain consistent coefficient estimates.[4]

Number of internet users per 100 people was used as an instrument for online gaming revenue. The data was obtained from the International Telecommunication Union (2010). The availability of no other potentially valid instruments inhibits the use an overidentification test to measure whether internet user rates and the unexplained variance in B&M gaming are correlated, but it seems intuitively unlikely that there would be a statistically significant relationship between these two variables. The non-zero correlation assumption between internet user rates and online gaming revenue seems intuitively plausible, as it may be the case that as the population of people with access to the internet grows, so will the number of people gambling on the internet. This assumption is tested in the results section.

Estimation Framework

The reduced form (first stage) model that was estimated was specified as follows:

$$OG_t = \Pi_0 + \Pi_1 \cdot IS_{t-1} + \Pi_2 \cdot GDP_t + \Pi_3 \cdot NCC_t + \Pi_4 \cdot BM_{t-1} + \varepsilon_t$$

Where,

OG_t = The inflation adjusted online gaming revenue during period t (in billions of USD)

IS_{t-1} = Internet subscription rates per 100 people during period $t-1$

GDP_t = U.S. real gross domestic product during period t (in billions of USD)

NCC_t = The number of U.S. states with legal and operational commercial casinos in period t

BM_{t-1} = The inflation adjusted total commercial casino gross gaming revenue during period $t-1$ (in billions of USD)

ε = The model error term

[5] See, for example, Wooldridge (2010) for further discussion of instrumental variable methods.

The structural model that was estimated was specified as follows:

$$BM_t = \beta_0 + \beta_1 \cdot OG_t + \beta_2 \cdot GDP_t + \beta_3 \cdot NCC_t + \beta_4 \cdot BM_{t-1} + \varepsilon_t$$

Where,

BM_t = The inflation adjusted total commercial casino gross gaming revenue during period t (in billions of USD)

$\hat{OG}_t$ = The estimate of inflation adjusted online gaming revenue during period t, from the first stage regression (in billions of USD)

GDP_t = U.S. real gross domestic product during period t (in billions of USD)

NCC_t = The number of U.S. states with legal and operational commercial casinos in period t

ε = The model error term

3 As mentioned above, Indian gaming and price are also omitted variables of concern.

4 See, for example, Wooldridge (2010) for further discussion of instrumental variable methods.

Results

First Stage Tests

As shown in Table 2, internet subscription rate is a statistically significant predictor of online gaming revenue; $t_{(11)} = 4.46$, p=.001. The F-stat value for the instrumental variable was $F_{(1, 11)} = 19.92$, greater than the threshold of 10 indicating a good instrument and satisfying the $Cov(IS_t, OG_t) \neq 0$ condition (Sovey and Green, 2011). As expected, the prior years' number of internet users is positively correlated with current year internet gaming revenue

Table 2

Reduced Form Model Summary

	Beta	Robust S.E.	t-stat	p-value
(Constant)	-2.635	3.067	2.77	0.018
LAG Internet Users Per 100	0.122	0.027	4.46	0.001
Real Gross Domestic Product	-0.001	<0.001	-2.57	0.026
Number of Commercial Casino States	0.126	0.117	1.08	0.305
LAG Real B&M Revenue	-0.037	0.103	-0.36	0.722

Two-Stage Least Squares Results

The general model findings are provided in Table 3, below. The structural model, which estimated the effect of online gaming on the commercial casino industry, appeared to explain the variance in the dependent variable well, as the centered R^2 value was 0.996, although the high adjusted R^2 is also a function of the relatively small sample size and the use of an autocorrelative term. An initial test for homoskedasticity indicated non-constant variance $F_{(4, 12)} = 4399.43$, p<0.001.[5] Therefore, standard errors robust to any arbitrary forms of heteroskedasticity were estimated using the robust procedure in Stata (StataCorp LP, 2009). To address small sample issues in the parameter estimates, a finite sample adjustment is used with the robust setting using the small procedure in Stata (StataCorp LP, 2009). The test for autocorrelation failed to show a significant autocorrelative term, t = -2.21, p=0.052, therefore no corrections were made to compute autocorrelation robust standard errors.[6] The Shapiro-Wilks test failed to show a significant departure from normality, z = -1.612, p=0.947.

Table 3

Structural Model Summary

	Beta	Robust S.E.	t-stat	p-value
(Constant)	-6.5331	1.1445	-5.71	<0.001
Real Online Gaming Revenue	-0.2767	0.1247	-2.22	0.049
Real Gross Domestic Product	0.0010	0.0002	5.41	<0.001
Number of Commercial Casino States	0.4379	0.1080	4.05	0.002
LAG Real B&M Revenue	0.4775	0.1129	4.23	0.001

Online gaming is found to be negatively related to commercial casino revenue, indicating the two goods are substitutes. A one dollar increase in online gaming revenue is estimated to coincide with a 28 cent reduction in commercial casino revenue. Real GDP is positively related to commercial casino revenue, suggesting that it is a normal good. Number of commercial casino states and the lagged value of gross commercial casino revenue were positively related to the dependent variable. All control variables' estimate

5 See the procedure outlined on page 535 of Wooldridge (2006).
6 See the procedure outlined on page 537 of Wooldridge (2006).

directions are in line with economic theory and are significant at the 0.05 alpha level.

Income (GDP) Elasticities

As a robustness check, the GDP elasticity from the 2SLS model is compared to estimates of income elasticities from prior literature. An income elasticity value measures the percentage change in gaming revenue given a one percentage change in income. Since observations of internet gaming revenue in early years of the data set were equal to zero, elasticities in the model could not be interpreted directly from a log-log model specification, but instead were computed indirectly from the linear model.[7] The short-run income elasticity computed was 0.74 and the long-run income elasticity was 1.41. Nichols and Tosun (2007) estimated that state long-run income elasticities with respect to casino gaming varied widely. The authors measured a range from 0.22 to 2.29, which includes both the short-run and long-run estimates from this study. Landers' (2008b) study on the demand for casino gaming estimated income elasticities from 1.43 to 1.91, much closer to the long-run elasticity than the short-run. This difference may be due in part to the emergence and rapid growth of internet gaming during the period of this study, as compared to the established casino period studied in Landers (2008b).

ARIMA Modeling

Although the instrumental variable approach addresses potential model endogeneity in the online gaming revenue parameter estimates, it does not address concerns over potential unit root issues in the data. That is, if the variables measured in the model are non-stationary, the coefficient estimates may suffer from spurious correlation, and therefore be biased. To evaluate whether the results from the two-stage model suffer from this issue, this section includes an ARIMA modeling process to render the variables from the 2SLS process stationary and control for unknown model parameters. ARIMA models use autoregressive (AR), integrated (I), and moving average (MA) terms to predict the dependent variable. In this study, variables are first rendered stationary to satisfy the integration term, and then an ARMA model is fitted using the Bayesian Information Criterion (BIC) selection method (Schwarz, 1979).[8]

Trend Stationary Tests

To test whether the variables used in this model are stationary processes, an augmented Dickey-Fuller unit root test is conducted. Non-stationary variables are then differenced and re-tested until a stationary process is revealed. Table 4 summarizes the results of the unit root tests. A second difference of each model variable is noted to produce series that satisfy the unit root test at the 0.05 alpha level. Therefore, second differences of the variables are used in the ARIMA process.

Table 4

Augmented Dickey-Fuller Unit Root Test Statistics

Variable	No Difference	p-value	First Difference	p-value	Second Difference	p-value
Brick & Mortar Revenue	-1.055	.733	-2.568	.100	-2.872	.049
Real Online Gaming Revenue	0.712	.990	-2.046	.267	-4.615	<.001
Real Gross Domestic Product	0.843	.992	-2.304	.171	-3.769	.003
Number of Commercial Casino States	-2.654	.082	-1.542	.513	-5.350	<.001

7 For a proof of the elasticity formulas, see appendix A.

8 Due to the limited number of observations, only ARMA processes up to three are evaluated to minimize the BIC.

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ARIMA Results

As mentioned, ARIMA processes integrated of order two, with up to three autoregressive or moving average terms were estimated and the final model was selected using a BIC minimization procedure. The final specification was an ARIMA (2, 2, 3) process with real online gaming revenue and real gross domestic product as independent variables. Following the criteria for model evaluation, the final model specification dropped the number of states with commercial casinos variable.[9] Results are provided in Table 5.

Table 5
ARIMA Model Output

Variable	Beta
Real Online Gaming Revenue	-0.2959** (0.0305)
Real Gross Domestic Product	0.0018** (0.0005)
AR (1)	0.2317 (0.3213)
AR (2)	-0.3541 (0.3058)
MA (1)	0.1037 (0.2172)
MA (2)	-0.1037 (0.2172)
MA (3)	-1.000** (<0.001)

Heteroskedastically robust standard errors are provided in brackets
*denotes significant at the 0.05 level, **denotes significant at the 0.01 level
n=17, BIC=28.81, Wald $Chi^2(6) = 9.4x10^{11}$, p<0.001.

The model produced an online gaming revenue coefficient estimate of -0.296. This value is the same direction and similar in order of magnitude as the estimate from the 2SLS model, differing in actual effect by only 0.019. A one dollar increase in online gaming revenue is estimated to coincide with a 30 cent reduction in commercial casino revenue under this model's estimation. The real GDP estimate is also significant and the same direction as in the 2SLS model, differing by a value of 0.0008.

Discussion

The findings from this study suggest that online gaming was a gross substitute for commercial casino gaming during the pre-UIGEA period. Although both the 2SLS model and the ARIMA model estimated in this study may suffer from different sources of bias – unit root issues in the 2SLS model and endogeneity issues in the ARIMA model – both produce results that are similar to each other. Both also support the contention of substitution between online and offline gaming. The income elasticities measured in the model also appear to be consistent with the findings from prior gaming literature, further adding to the robustness of the findings. This study therefore provides some evidence that in an online gaming market characterized by loose regulation, and relatively easy access, online gaming will cannibalize some commercial casino revenue at a rate of 27 to 30 cents on the dollar. Policy makers and industry practitioners should consider this effect when evaluating whether or not to enter the online gaming sector.

Despite the robustness of the findings across different models in this study, the short

10 In some ARIMA model specifications, the maximum likelihood function could not be maximized with all explanatory variables. In these cases, reduced form models were estimated.

history of online gaming led to a fairly small data set. Therefore, some caution should be exercised when using these results in decision making processes. As data in more markets and over different time periods becomes available, researchers should explore how robust those estimates are compared to these. Also, given that this study aggregated all online gaming sources, policy makers and industry practitioners should be cautious when using these estimates to evaluate the effect of a policy change to a single product. It may be the case that some online gaming products with purposeful co-marketing, such as online poker (where players can qualify for B&M tournaments through smaller online tournaments) are gross complements, leading to an increase in demand for their brick and mortar counterparts.

The findings from this study suggest that online gaming was a gross substitute for commercial casino gaming during the pre-UIGEA period.

In light of this being a seminal study on the effect of online gaming on offline gaming, many factors remain unclear in terms of the proper interpretation of the long-run effect of online gaming on brick and mortar casinos. First, it seems likely that U.S. consumer behavior has changed in both the post-UIGEA and the post-Black Friday regulatory eras, which differ from the period of this study.[10] The legality of gaming online and the safety of account deposits has become an increasing concern for players as a result of these two market shifts. It is especially unclear how consumers' consumption patterns would respond to the provision of government regulated gaming sites, provided by reputable gaming operators. Case studies of other jurisdictions with legal online gaming, such as Sweden, the UK, or the Canadian provinces of British Columbia and Quebec, may provide some insight in this regard. Regulation of online gaming may simply shift consumption from foreign sites to domestic sites, with little cross-effect on existing brick and mortar casinos, or it may lead to more opportunities for co-marketing between online and offline platforms, and reduce the substitutionary nature of these two products.

The findings from this study also estimated the average effects of the online gaming industry on brick and mortar gaming, while decision makers should focus on the marginal effects from increased activity. In particular, stakeholders should consider how the incremental online casino consumer would patronize brick and mortar casinos. It is worth noting that online gaming remains a small part of the overall U.S. gaming market. In 2006, the year the UIGEA was enacted, online gaming constituted only 6.4% of the total U.S. gaming market (Christiansen Captial Advisors, 2007). If policy changes are made to regulate the industry, the impact on B&M casinos may be modest given the comparative size of the industries, and the expectation that many consumers will simply be shifting consumption from illegal gaming providers to government regulated providers.

Despite the robustness of the findings across different models in this study, the short history of online gaming led to a fairly small data set. Therefore, some caution should be exercised when using these results in decision making processes.

In addition to those policy findings, this study led to the discovery of a seemingly valid instrumental variable, internet user rates, that can be used to correct internet gaming coefficient estimates for potential bias. This instrument may prove useful for other researchers exploring the different cross-effects of sub-industries within online gaming. For example, a similar study could be conducted to determine whether online poker has a positive relationship with brick and mortar poker, as some believe to be the case.

11 Black Friday refers to April 15, 2011, when the three largest online poker sites, Pokerstars, Full Tilt Poker, and Absolute Poker, left the U.S. market in response to indictments by the Southern District of New York.

Appendix A – Proof of Elasticity Estimates

Short-run Elasticity

If,

$$BM_t = \beta_0 + \beta_1 \cdot OG_t + \beta_2 \cdot GDP_t + \beta_3 \cdot BM_{t-1} + \varepsilon$$

Then,

$$\frac{\partial BM_t}{\partial GDP_t} = \beta_2$$

*I*f we multiply both sides by $\frac{GDP_t}{BM_t}$, we have:

$$\frac{\partial BM_t}{\partial GDP_t} \cdot \frac{GDP_t}{BM_t} = \varepsilon_{BM,OG} = \beta_2 \cdot \frac{GDP_t}{BM_t}$$

Mean values of BM, and GDP are used to compute elasticities, therefore estimates are:

$$\frac{\partial BM_t}{\partial GDP_t} \cdot \frac{\overline{GDP}}{\overline{BM}} = \varepsilon_{BM,OG} = \beta_2 \cdot \frac{\overline{GDP}}{\overline{BM}}$$

Long-run Elasticity

If,

$$BM_t = \beta_0 + \beta_1 \cdot OG_t + \beta_2 \cdot GDP_t + \beta_3 \cdot BM_{t-1} + \varepsilon$$

and,

$$BM_t = BM_{t-1}$$

Then,

$$BM_t = \beta_0 + \beta_1 \cdot OG_t + \beta_2 \cdot GDP_t + \beta_3 \cdot BM_t + \varepsilon$$

$$BM_t - \beta_3 \cdot BM_t = \beta_0 + \beta_1 \cdot OG_t + \beta_2 \cdot GDP_t + \varepsilon$$

$$BM_t = \frac{\beta_0 + \beta_1 \cdot OG_t + \beta_2 \cdot GDP_t + \varepsilon}{1 - \beta_3}$$

$$\frac{\partial BM_t}{\partial GDP_t} = \frac{\beta_2}{1 - \beta_3}$$

*I*f we multiply both sides by $\frac{GDP_t}{BM_t}$, we have:

$$\frac{\partial BM_t}{\partial GDP_t} \cdot \frac{GDP_t}{BM_t} = \varepsilon_{BM,OG} = \frac{\beta_2}{1 - \beta_{3\,1}} \cdot \frac{GDP_t}{BM_t}$$

Mean values of BM, and GDP are used to compute elasticities, therefore estimates are:

$$\frac{\partial BM_t}{\partial GDP_t} \cdot \frac{\overline{GDP}}{\overline{BM}} = \varepsilon_{BM,OG} = \frac{\beta_2}{1 - \beta_{3\,1}} \cdot \frac{\overline{GDP}}{\overline{BM}}$$

Appendix B - Summary Statistics

Variable	Observation	Mean	Standard Deviation
Real Brick & Mortar Gaming Revenue	19	13.192	4.3706
Real Internet Gaming Revenue	19	1.085	1.4207
Number of US States with Commercial Gaming	19	8.684	3.1279
US Real GDP	19	10027.39	1767.876
Internet User Rates per 100	17	32.3473	26.9426

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