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Online gambling participation and problem gambling severity: is there a causal relationship?

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Studies of Internet gambling have consistently shown that online gamblers are more likely to report disordered gambling behaviour than offline gamblers. However, little research has focused on whether this is a causal relationship or whether this risk factor is capturing a relationship with one or more missing variables. To address whether there is a strong causal argument for the effect of online gambling participation on problem gambling severity, we use a secondary data method that corrects for potential omitted variable bias. Once this issue is addressed, we find that past-year participation in online gambling is related to a decrease in problem gambling severity, which is the opposite of the popular view in current literature. The estimates in this study are found to be robust to various forms of online gambling, control variables and problem gambling measurement instruments. The findings were also consistent when using a representative sample from the United Kingdom and when using an online research panel from Ontario, Canada. As a primary force against the widespread adoption of Internet gambling has been public health concern over problem gambling, this study provides evidence that such decisions should be more closely considered by policymakers.

Keywords: online gaming; problem gambling; addiction; policy

Introduction

Over the past 20 years, contemporary gambling expansion has been influenced strongly by technology. While the bricks-and-mortar casino landscape has certainly evolved due to advances in technology, the most obvious change in gambling consumption has been for gamblers to access games via the Internet. Online gambling has grown to be a $32 billion industry worldwide ('The Land of eGaming Opportunity', 2012), but in many countries online gambling has been slow to be adopted as a legal form of gaming. This apprehension is commonly attributed to uncertainty over the effects that expansion of the Internet gambling industry will have on public health (e.g. Trynacity, 2011; Vardi, 2013). In particular, public concerns over problem gambling increases have mitigated the legal expansion of online gambling. In many cases, this has facilitated the expansion of unregulated online gambling, with few requirements for player protection, financial reporting or ethical behaviour.

Implications of the unregulated market aside, initial concerns over the harmful effects of this new medium are sensible, as early research in online gambling has established a correlation between problem gambling and online gambling participation. Empirical studies have not been able to advance with the same accelerated pace as the industry, but one

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finding that has been consistently replicated is that online gamblers are more likely to report disordered gambling behaviour when compared to offline gamblers (Griffiths & Barnes, 2008; Griffiths, Parke, Wood, & Rigbye, 2010; Griffiths, Wardle, Orford, Sproston, & Erens, 2009; Ladd & Petry, 2002; McBride & Derevensky, 2009; Petry, 2006; Petry & Weinstock, 2007; Wood & Williams, 2007, 2009, 2011). A primary concern is that the Internet, functioning as a conduit for gambling, has become a causal factor in players developing problems. While this may be valid, empirical evidence to support such assertions is lacking.

Shaffer and colleagues have argued that the Internet is not inherently addictive, contending that it is the interplay of the individual with the activity that determines level of involvement (Shaffer, 1996; Shaffer, Hall, & Bilt, 2000). A large body of empirical research has been conducted on identifying risk and resiliency factors that influence gambling behaviour. These include demographic factors (e.g. age, gender, minority status, education, socio-economic status, marital status), medium factors (e.g. availability, accessibility, exposure, sensory characteristics), cognitive factors (e.g. illusion of control, attributional bias, gambler's fallacy), personality factors (e.g. sensation seeking, impulsivity, arousal), physiological/biological factors (e.g. genetics, heart rate and arousal, transmitter activity) and co-morbid disorders (e.g. substance use, mood disorders, anxiety disorders).

Only a handful of studies have examined variables that may be associated with online gambling. Petry (2006) found that wagering on the Internet was a significant predictor of lower scores on mental and physical health measures, even after controlling for age, gender and pathological gambling status. The frequency of Internet gambling has been found as a predictor of lower scores on mental and physical health measures when controlling for demographics and pathological gambling (Petry & Weinstock, 2007). Griffiths et al. (2009) found that drinking at least twice the recommended amount in one day was a significant predictor of Internet gambling. Internet gamblers who engaged in multiple online activities have been shown to endorse problematic gambling behaviour and have a history of mood disturbance, self-harm and substance misuse (Lloyd et al., 2010). McCormack and Griffiths (2012) observed a sample including 15 online gamblers, finding that the motivation to gamble online was derived from greater opportunity, convenience, value for money, game variety and anonymity. Gainsbury, Russell, Wood, Hing, and Blaszczynski (in press) found problem Internet gamblers more likely to be young, less educated and have greater debts than non-problem Internet gamblers.

Using data from the 2007 British Gambling Prevalence Study, LaPlante, Nelson, LaBrie, and Shaffer (2011) examined the relationship between specific gambling formats and disordered gambling status. They found a general lack of significance, in particular with Internet gambling, between gambling formats and problem gambling when gambling involvement was also included in the model (with gambling involvement being proxied by number of gambling activities played in the past 12 months). Welte, Barnes, Tidwell, and Hoffman (2009) found that among a group of US young people, Internet gamblers had high rates of problem gambling symptoms, but also high rates of overall frequency of gambling and gambling versatility. When problem gambling symptoms were adjusted for other gambling activity, the Internet gambling variable ceased to predict problem gambling. Similarly, Gainsbury, Russell, Hing, Wood, and Blaszczynski (2013) found that their results from comparing Internet and non-Internet gamblers was consistent with a perspective that it was the additive effect of multiple forms of gambling involvement that was impactful on severity, rather specifically engaging in online gambling. Wardle, Moody, Griffiths, Orford, and Volberg (2011) recently identified a sample of Internet-only gamblers and found that none of these gamblers were classified as problem gamblers.

While the aforementioned studies provide some insight into the relationship between online gambling participation and problem gambling, no research to date has controlled for the endogenous participation of online gamblers when attempting to identify a causal relationship with problem gambling severity. That is, it is unclear whether online gambling participation causes an increase in problem gambling severity, or whether observed prevalence rates among online gamblers are a reflection of correlation with variables that cannot be controlled in typical models. In fact, many gambling prevalence studies have tended to focus on the determination of 'risk factors' rather than establish any causal arguments. This approach may be useful for clinical assessment and responsible gambling programme targeting, but is a potentially misleading tool for establishing public policy.

To address whether there is a strong causal argument to be made over the effect of online gambling participation on problem gambling, this study examines a representative sample of gamblers and non-gamblers from a western nation with one of the most liberalized online gambling industries, the United Kingdom (UK). Residents of the UK have access to online gambling options though domestic gambling sites, 'white listed' foreign sites permitted to advertise in the UK, and other foreign sites operating offshore. To address past issues due to omitted variable bias and spurious correlation, modelling methods are used that estimate unbiased relationships between online gambling participation and problem gambling severity, even when not all causal variables are available as controls. In order to test the robustness of the findings, a similar model was estimated on a secondary data set collected from an online research panel in Canada.

Methodology

Secondary data was obtained from the 2010 British Gambling Prevalence Study (Wardle, Moody, Spence, et al., 2011). The data set is a nationally representative survey of 7756 adults aged 16 and older, living in private households in England, Scotland and Wales. Among other aims, the data was collected to measure the prevalence of participation in gambling, estimate the prevalence of problem gambling and explore the socio-demographic factors associated with problem gambling. Respondents were asked about participation in various gambling activities in the past 12 months (in person, online or both) and level of involvement in those activities. Problem gambling was measured with criteria from the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., *DSM-IV*; American Psychiatric Association, 2000) and the Problem Gambling Severity Index (PGSI; Ferris & Wynne, 2001). PGSI scores are categorized into non-gambler/non-problem (92.7% of the sample), low-risk (5.2%), medium-risk (1.5%) and problem gambler (0.6%) categories. The categories are ordinally ranked, with non-problem as the lowest rank and problem gambling as the highest rank. We group non-gamblers with non-problem gamblers for consistency with the reporting in Wardle, Moody, Griffiths, et al. (2011) and because we felt the small probability that a non-gambler would qualify as anything other than a non-problem gambler was outweighed by the increase in power from over 2000 more observations (the majority of PGSI questions would be automatically scored as zero for a non-gambler). However, we recognize that this inclusion may create some small bias towards a more positive estimated coefficient size, and account for this possibility in our interpretation of the results.

Participation in online gambling is defined by participation over the past 12 months in any of online fruit/slots/instant wins (2.6%), online casino games (1.8%), online sports wagering (2.1%) or online bingo (1.7%), resulting in 6.1% overall participation in at least

one form. Each of these category of games is also tested individually. Other measured variables included gender, age, ethnicity, economic status of household (classification of social position based on occupation of the household reference person), level of education, self-reported general health status, smoking status and level of alcohol use. A breakdown of demographic characteristics and gambling participation rates can be found in Wardle, Moody, Griffiths, et al. (2011).

In order to test the robustness of the findings, a similar model was estimated on a secondary data set survey that was conducted in Ontario, Canada. The survey was provided to an online research panel of 3343 respondents that were stratified by age, gender and region to measure gambling behaviour. The survey design was based on Wiebe, Mun, and Kauffman (2006) and measured gambling behaviour (online and offline), participation in online leisure activities (e.g. shopping) and problem gambling severity (PGSI). Despite the data having been stratified on several variables to match census demographic figures, the panel data should not be considered to be representative of the general population as prior research has shown that online research panels have higher levels of problem gambling prevalence (Williams, Volberg, & Stevens, 2012). However, the higher incidence of gambling prevalence does provide a useful amount of variation in the dependent variable to estimate relative impacts of online gambling participation. The participants were categorized into PGSI non-problem/non-gambler (81.1%), low-risk (10.9%), medium-risk (4.6%) and problem gambler (3.5%) categories, while past-year participation in any online gambling totalled 12.8% of the sample.

Empirical estimation technique

Equation 1 defines the ordered regression model for the underlying relationship between online gambling participation and problem gambling:

$$\Pr(\text{outcome}_j = i) = \Pr(K_{i-1} < \beta_1 \cdot OG_j + \beta_2 \cdot x_{2j} + \ \ldots \ + \beta_k \cdot x_{kj} + u_j \leq K_i) \qquad (1)$$

The outcome variable is the ordered level of gambling involvement, non-problem/non-gambler (1), low-risk (2), medium-risk (3) and problem gambler (4). *OGj* is a binary variable indicating past-year participation in online gambling, where '1' indicates having participated and '0' indicates having not participated; x_{2j} … x_{kj} are other explanatory variables indicating problem gambling severity; K_{i-1} and K_i are respectively the lower and upper bound cut-off criteria for a category membership; and u_j is the model error term.

We recognize that we cannot fully identify all $k - 1$ explanatory variables, therefore the effects of these variables will appear in the error term v_j and create bias if $Cov(OG_j, v_j) \neq 0$. To correct this bias, we estimate the following system of equations, which produces a consistent estimate of the effect of online gambling participation (Roodman, 2011; Wooldridge, 2010):

$$\Pr(\text{outcome}_j = i) = \Pr(K_{i-1} < \beta_1 \cdot OG_j + \beta_2 \cdot x_{2j} + \ \ldots \ + \beta_{k-n} \cdot x_{(k-n)j} + v_j \leq K_i) \qquad (2)$$

$$\Pr(OG = 1) = \Phi(\alpha_0 + \alpha_1 \cdot z_{1j} + \alpha_2 \cdot z_{2j} + \alpha_3 \cdot x_{2j} + \ \ldots \ + \alpha_{k-n+1} \cdot x_{(k-n)j} + \varepsilon_j) \qquad (3)$$

Where OG_j is the fitted value from Equation 3, n is the number of missing explanatory variables, and z_{1j} and z_{2j} are exogenous variables that must satisfy the standard requirements of model instruments. In particular, they must satisfy two necessary conditions: (1) have zero correlation with v_j – that is, they provide no more explanatory

power for problem gambling severity than the variables already included in the model; and (2) they must have a non-zero correlation with *OGj*, online gambling participation.

Put succinctly, a probit model to predict online gambling participation is estimated in a first stage, using two instruments. The predicted values of online gambling participation are then used in lieu of the actual values, which produces an unbiased estimate of the model coefficient explaining the relationship between problem gambling severity and online gambling participation.

The challenge in using this method typically centres on finding one or more appropriate instruments. We suggest two variables as potential instruments for online gambling participation, which are represented by z_{1j} and z_{2j}. The variables are two available responses to the survey question, 'In a month, which of the following activities, if any, do you usually do?' One potential response is 'Shop online' and another potential response is 'Browsing the Internet'. Both of these variables are binary, where '1' indicates having participated in the activity as recreation and '0' indicates having not participated in the activity as recreation.

Both of these instruments describe a familiarity and comfort with computers, the Internet, and Internet commerce. Comfort with the Internet is likely to be a characteristic that is important to choosing to gamble online, therefore the instruments should satisfy necessary condition (2), of a non-zero correlation with online gambling participation. These variables have no direct or established empirical relationship to problem gambling, and it seems unlikely that general reporting of leisure behaviour taking place on the Internet would be directly related to problem gambling severity, at the very least in so far as they provide information beyond the other control variables – they should provide no more prediction value of problem gambling severity than online gambling participation does directly, thereby satisfying necessary condition (1). To further support the validity of these necessary conditions, we also employ empirical tests in the next section.

Other independent variables used during the estimation procedure include: past-year number of gambling activities participation (Number of gambling activities), gender (Gender), age group 16 + in 10-year bands (Age), ethnic group (Ethnicity), the main economic activity of the household representative (Economic activity), highest educational qualification (Education), general health response (General Health), smoking status (Smoking) and category of alcohol consumption (Alcohol). Model error terms are clustered by government office region, since these different regions will have different gambling availability and support services. The model standard errors are otherwise robust to arbitrary forms of heteroskedasticity using the Huber/White/sandwich estimate of variance (Rogers, 1994).

Results

The results of the full model are provided in column 5 of Table 1, alongside regression-adjusted models. In all models we observe that the online participation coefficient is negative, suggesting that participation in online gambling is related to a decrease in problem gambling severity (we note that the coefficient in model 3 is not significant, but the significance of the other models suggests this may be an issue of power).[1] Both instruments appear to be statistically significant predictors of online gambling participation, suggesting they may satisfy necessary condition (2).

The online gambling participation variable is noted as being substantially more negative in models where the 'Number of gambling activities' variable is included. This may be the case because inclusion of both variables suggests that one of the counted forms

Table 1. Two-stage least square ordered probit.

PGSI group (second stage)	(Model 1)	(Model 2)	(Model 3)	(Model 4)	(Model 5)
Online gambling past 12 months	−0.353*	−0.938***	−0.0815	−0.848***	−0.833***
	(−2.23)	(−11.06)	(−0.30)	(−6.16)	(−6.88)
Number of gambling activities		0.306***		0.310***	0.311***
		(28.38)		(23.23)	(21.69)
Any online gambling past 12 months (first stage)					
Browsing the Internet	0.277***	0.307***	0.283***	0.296***	0.295***
	(4.52)	(3.61)	(4.67)	(3.52)	(3.57)
Shop online	0.310***	0.316***	0.329***	0.315***	0.313***
	(8.91)	(8.41)	(9.28)	(7.29)	(6.95)
Number of gambling activities		0.317***		0.319***	0.319***
		(28.74)		(29.83)	(33.72)
Gender	Yes	Yes	Yes	Yes	Yes
Age group	Yes	Yes	Yes	Yes	Yes
Ethnicity	No	No	Yes	Yes	Yes
Economic activity	No	No	Yes	Yes	Yes
Education	No	No	Yes	Yes	Yes
General health	No	No	Yes	No	Yes
Smoking	No	No	Yes	No	Yes
Alcohol	No	No	Yes	No	Yes
Observations	7,756	7,750	7,679	7,711	7,674

Note: t statistics in parentheses.
$*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

of gambling from 'Number of gambling activities' is online gambling, and not a more harmful form of gambling such as fruit machines located in pubs. The addition of several demographic variables from model 1 to model 3 causes the online gambling variable to decrease in (absolute) size and become non-significant. This suggests that at least part of the effect size from model 1 may be a factor related to demographic issues or other predispositions. However, the effect sizes in models 2 and 5 are quite similar, suggesting this difference may be statistical noise from an underspecified model. The results from the variables that are indicated instead of fully described were either insignificant or in line with prior research – higher levels of problem gambling severity were associated with being male, younger, a racial minority, in poor self-reported general health, a smoker or a heavier drinker.

Since the coefficient sizes from the ordered probit models are not directly interpretable, we computed the average change in predicted PGSI classification, as a result of participating in online gambling. Based on the results from model 5 of Table 1, participation in online gambling increases the predicted probability of being a non-problem gambler by 4.32%. As a corollary, the average predicted probability of being a low, moderate, or problem gambler decreases by 2.67%, 1.02% and 0.81% respectively. We note that unlike linear regression models, these predictions will differ depending on an individual's other characteristics. To better convey this concept, an illustrative example is provided in Table 2, which compares scenarios for a hypothetical gambler, dependent on whether or not the individual gambles on the Internet.

The results from Table 1 are substantially different from the results shown in Table 3, which does not use a two-stage least squares procedure to correct for model endogeneity. The results from these ordered probit models are representative of the results typically

Table 2. Predicted probabilities of PGSI categorization for illustrative gambler.

	Non-problem	Low risk	Moderate risk	Problem gambler
Predicted probability (Scenario 1)	89.06%	8.18%	2.12%	0.64%
Predicted probability (Scenario 2)	96.01%	3.25%	0.60%	0.13%

Scenario 1: No online gambling participation; three gambling activities.
Scenario 2: Online gambling participation; four gambling activities.
Controls: Age 45–54; male; married; white; east of England; employed in paid work; non-smoker drank 5–9 units on heaviest drinking day in past week; fair self-reported health.

found in prior studies. Online gambling participation is positively related to problem gambling severity, with a weaker result seen in models that include the number of gambling activities. These results highlight the danger of interpreting coefficient sizes in the absence of a correction mechanism for endogenous correlation in the online gambling participation variable.

In Table 4, robustness checks on the general results from the fully model are provided. Model 1 estimates a linear two-stage least squares model on the PGSI score (not PGSI category membership). Importantly, the results are similar for this estimation method that uses a linear probability model in the first stage. The linear model also allows for empirical tests of other model assumptions. The F-test of weak identification = 25.97, well exceeding the benchmark value of 10, suggesting that these variables adequately satisfied necessary condition (2) of strong instruments (Sovey & Green, 2011; Staiger & Stock, 1997). The Sargan test statistic (also known as the Hansen J statistic), $\chi^2 = 0.98$, $p = 0.32$, failed to reject the assumption that 'Shop online' and 'Browsing the Internet' do not belong in the structural equation predicting PGSI membership (Sargan, 1958), supporting the view that necessary condition (1) of the instruments is satisfied. The empirical tests therefore support the theoretical basis for inclusion of these instruments.

The results held for the use of DSM-IV scores in lieu of PGSI scores. This is particularly compelling, since data show limited overlap between the sets of problem gamblers identified by the two screening tools.[2] Only 0.45% of respondents qualified as problem gamblers in both metrics, compared to 0.63% in PGSI-only and 0.83% in

Table 3. Ordered probit – no endogeneity corrections.

PGSI group (dependent var.)	(Model 1)	(Model 2)	(Model 3)	(Model 4)	(Model 5)
Online gambling past 12 months	1.049***	0.331***	1.059***	0.357***	0.365***
	(33.20)	(5.86)	(26.75)	(6.75)	(6.42)
Number of gambling activities		0.225***		0.233***	0.234***
		(17.11)		(17.20)	(16.64)
Gender	Yes	Yes	Yes	Yes	Yes
Age group	Yes	Yes	Yes	Yes	Yes
Ethnicity	No	No	Yes	Yes	Yes
Economic activity	No	No	Yes	Yes	Yes
Education	No	No	Yes	Yes	Yes
General health	No	No	Yes	No	Yes
Smoking	No	No	Yes	No	Yes
Alcohol	No	No	Yes	No	Yes
Observations	7,748	7,745	7,675	7,710	7,673

Note: *t* statistics in parentheses.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Table 4. 2SLS – alternative model specifications.

Dependent variable:	Model 1 PGSI Sc.	Model 2 DSM Pg.	Model 3 PGSI Gr.	Model 4 PGSI Gr.	Model 5 PGSI Gr.	Model 6 PGSI Gr.
Main model (second stage)						
Online gambling past 12 months	−3.336***	−1.632***				
Number of gambling activities	0.370***	0.310***	0.303***	0.293***	0.285***	0.272***
Online slots past 12 months			−1.160***			
Online casino past 12 months				−1.199***		
Online sports bet past 12 months					−1.112***	
Online bingo past 12 months						−0.839*
Online gambling past 12 months (first stage)						
Browsing the Internet		0.284**				
Shop online		0.300***				
Number of gambling activities		0.315***				
Online slots past 12 months (first stage)						
Browsing the Internet			0.256***			
Shop online			0.247**			
Number of gambling activities			0.295***			
Online casino past 12 months (first stage)						
Browsing the Internet				0.144		
Shop online				0.209		
Number of gambling activities				0.274***		
Online sports bet past 12 months (first stage)						
Browsing the Internet					0.355**	
Shop online					0.371***	
Number of gambling activities					0.246***	
Online bingo past 12 months (first stage)						
Browsing the Internet						0.264*
Shop online						0.323**
Number of gambling activities						0.244***
Gender	Yes	Yes	Yes	Yes	Yes	Yes
Age group	Yes	Yes	Yes	Yes	Yes	Yes
Ethnicity	Yes	Yes	Yes	Yes	Yes	Yes
Economic activity	Yes	Yes	Yes	Yes	Yes	Yes
Education	Yes	Yes	Yes	Yes	Yes	Yes
General health	Yes	Yes	Yes	Yes	Yes	Yes
Smoking	Yes	Yes	Yes	Yes	Yes	Yes
Alcohol	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,671	7,674	7,672	7,673	7,672	7,672

Note: Perfectly predicted observations are dropped from the estimation samples; Sc. = Score; Pg. = Problem gambler; Gr. = Group; *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

DSM-IV-only. The results appear to hold for online sports betting, but do not appear to hold for online bingo, as that coefficient is not statistically significant. We note that the maximum likelihood estimation method used here may not be fully efficient, although it is

consistent, which may have reduced some power to detect significant relationship (Roodman, 2011) Although the coefficient on the casino games variable is significant, those results should be interpreted with caution as the instruments appear to be weakly related to online casino game participation. Similar models were estimated using male-only and female-only observations (not shown), also producing similar coefficient sizes.

Model robustness on secondary data set

The secondary data set in Ontario, Canada, is sufficiently similar in question design to be used as a test of robustness, but minor variations in survey response items required use of proxy variables to replicate the analysis. In the Ontario data set, 'Shop online' and 'Personal use of the Internet' leisure activities responses on a Likert scale were used as instruments for online gambling participation, income was used as a proxy for economic activity and no health variables were available for inclusion, though their exclusion in the primary data set did not meaningfully affect the estimation results (see models 4 and 5 in Table 1 as a means of comparison).

As shown in Table 5, the 'Shop online' variable appears to be a valid instrument for Internet gambling but the 'Personal Internet use' categories are not statistically different from one another. The lack of statistical significance appears to be attributable to the online panel survey administration method, where the entire sample was self-selected in choosing an Internet-based method of delivery. It is likely that all participants had a

Table 5. Two-stage least square ordered probit – robustness test.

PGSI group (second-stage)	(Model 1)	(Model 2)	(Model 3)	(Model 4)
Online gambling past 12 months	2.114***	−1.250***	2.161***	−1.308***
	(20.40)	(−15.86)	(20.13)	(−16.12)
Number of gambling activities		0.380***		0.384***
		(46.30)		(42.78)
Any online gambling past 12 months (First-stage)				
Shop online (Base = Daily):				
Weekly	−0.401	0.378**	−0.482	0.314**
Monthly	−0.780**	0.225**	−0.850**	0.215*
Less than monthly	−1.054***	0.287***	−1.124***	0.284***
Never	−0.962**	0.296*	−1.072**	0.278*
Personal Internet use (Base = 1 hour or less):				
1–5 hours	−0.102	0.122	−0.016	0.126
6–10 hours	−0.078	0.226	0.009	0.237
11–20 hours	−0.033	0.233	0.045	0.247
> 20 hours	0.081	0.275	0.173	0.263
Number of gambling activities		0.398***		0.400***
Gender	Yes	Yes	Yes	Yes
Age group	Yes	Yes	Yes	Yes
Ethnicity	No	No	Yes	Yes
Income	No	No	Yes	Yes
Education	No	No	Yes	Yes
Observations	3,041	3,041	3,041	3,041

Note: $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

relatively high comfort level with the Internet (given that they are willing to engage in online surveys on an ongoing basis), causing the 'Personal Internet use' variable to not differentiate between respondents.

While the loss of 'Personal Internet use' as a differentiating factor reduces the number of available instruments, one valid instrument is sufficient to produce a consistent estimate (Wooldridge, 2010) and the UK model established 'Shop online' as a valid instrument. Therefore, the model should still continue to be consistent overall, albeit with weaker power. This weaker power effect is evident when comparing models without 'Number of gambling activities' (Models 1 and 3) to the models where it is included (Models 2 and 4). In the former models, the endogenous correlation remains strong and the results show a positive correlation with problem gambling severity. In the latter models that include the important 'involvement' proxy variable, the estimates are much more in line with the results in Table 1 and further support the robustness of this result. The 'Number of gambling activities' coefficient size is also similar in magnitude (roughly 0.31 in Table 1 as compared to roughly 0.38 in Table 5), though caution should be used when interpreting relative coefficient sizes in ordered probit models.

Discussion

The results from this study provide a strong indication that previous ideas about the relationship between online gambling participation and problem gambling severity may be misguided. When endogenous correlation in online gambling participation is corrected, participation appears to be negatively related to problem gambling severity. This is the opposite of the effect that is observed in less robust models, and is indicative of some sort of spurious relationship. This finding was noted to be robust in another secondary data set from a jurisdiction without regulated online gambling, it was robust to many online gambling variants, and it was robust to use of either the PGSI or *DSM-IV*-based metrics to measure problem gambling.

The absence of a positive causal link between online gambling and problem gambling is an important finding for policymakers. A lack of regulatory standards has perpetuated grey-market business practices and leaves players vulnerable without appropriate consumer protection. A primary force against widespread adoption of Internet gambling has been public health concerns over problem gambling, and this study provides evidence that such behaviour should be reconsidered by policymakers. Legal adoption of online gambling would support economic expansion agendas, reduce the potential for money laundering and improve player security through formal regulation, potentially without the previously assumed public health concerns.

While this study does not provide a clear explanation of how this relationship manifests, some explanations seem plausible. First, the change in the online gambling participation coefficient towards a more negative value when the 'Number of gambling activities' variable is added to the model is informative. Once online gambling participation and 'Number of gambling activities' are both included in the model, the size of the change in the participation variable's coefficient should be indicative of online gambling's risk relative to other forms of gambling. If online gambling is less harmful than other forms of gambling, then the predicted risk from the overall model should decrease, and this is consistent with what was observed. However, the effect of online gambling participation relative to participation in other gambling variants is not the entire explanation, otherwise we would observe an insignificant relationship in our instrumental variable model, rather than a negative relationship. If the model is estimating the relationship as intended, which the

empirical tests support, it is worthwhile to consider how online gambling may be different from offline gambling to explain the remainder of the variable's effect size.

Online games create minimal variable costs to the operator for each additional wager, whereas offline gambling requires significant labour inputs (e.g. slot cashiers, table game dealers, pit bosses). This makes low-denomination games more widely offered online, compared to an offline blackjack game where minimum bet sizes below $5 a hand would effectively be unprofitable for a casino (Lucas & Kilby, 2008). Consider poker, for example. The lowest denomination No Limit Hold'em game typically offered in a casino is $1/$2 blind stakes. Online, 92% of players play below this level, with 47% of players at $0.05/$0.10 blind stakes or less (Fiedler, 2012). Indeed, three of the nine questions that form the PGSI questionnaire directly relate to financial problems, including:

- Have you bet more than you could really afford to lose?
- Have you borrowed money or sold anything to get money to gamble?
- Has your gambling caused any financial problems for you or your household?

The ability to make smaller wagers (or to adjust to smaller wagers after an unfavourable period of losses) may allow players to more easily manage any financial hardship from gambling, while still maintaining similar time-on-device lengths.

The convenience of access to online gambling is often noted as a source of risk, but gambling in the home or another comfortable location may actually cause players to end playing sessions more quickly due to the availability of alternate activities. If a player reaches his/her predetermined money limit early in a session at home, he/she would be able to quickly perform many non-gambling activities at home – surf the Internet, watch TV, cook a meal, talk to family/room-mates, etc. The same convenience of free alternatives is not present at a casino, where amenities are typically provided as profit centres or to encourage further gambling. Eadington (1975) has previously described a phenomenon whereby individuals gambling in a casino allocate a time and money budget to each casino visit. If the consumer loses more than expected, he/she may re-evaluate his/her budget to account for the void of activities to perform in the time period previously allocated to the visit. This effect may be lessened when gambling at home. With many casinos located in remote locations, this 'isolation effect' may be understated in related gambling literature.

The presence of the gambler at an Internet enabled device also implies quick and easy access to a wide range of online help materials for responsible gambling and problem gambling. Gamblers with concerns about their play, or simply seeking to improve their informed decision-making, are typically no more than a couple of clicks away from responsible gambling materials and contact information, which may or may not be easily available (or evident) in a physical gaming location. Online gamblers are also not restricted to accessing the materials provided by the operator, but can also immediately seek out information from non-profit and health providers.

Some limitations of this research are worthwhile to note. The measures of effect size from this study may not be relevant or consistent for all levels of gambling severity. For example, it may be the case that the protective nature of online gambling participation is mostly (or only) effective for certain types of gamblers. The ability to play small stakes online or more easily transition to other recreational activities in the home may enable gamblers in the low-risk categories to avoid accumulating associated financial risks, but it also may trigger binging periods by higher-risk gamblers. However, the Internet may also provide higher-risk gamblers with an opportunity to separate from more isolating and

financially stressful forms of gambling. Even though this study provided epidemiological evidence about the aggregate relationship between online gambling and problem gambling, it certainly does not show that online gambling participation will not increase problem gambling severity for some players. Individual impacts are clearly different from average impacts. A common question posed to gamblers in a clinical environment is to identify the form of gambling that is most problematic, and future epidemiological research could focus on identifying whether Internet gamblers self-report online play as a less pathological form of gambling activity. Clinical treatment and public policy involve very different considerations, and the findings from this study certainly warrant further investigation in terms of its application to each domain.

While this study provides a consistent estimate of the relationship between online gambling participation and problem gambling severity, and provides plausible explanations for this relationship, a full explanation of the causal mechanism is still needed. As more evidence of online and offline gambler behaviour becomes available through longitudinal research, future studies should be able to enlighten this relationship more fully.

Notes

1. Additionally, the correction of potential bias from the interpretation of non-gamblers as non-problem gamblers would only make this negative relationship even larger in absolute value.
2. We thank an anonymous reviewer for pointing out this relationship.

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References

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: American Psychiatric Publishing.

Eadington, W. R. (1975). Economic implications of legalizing casino gambling. *Journal of Behavioral Economics*, *4*, 55–77.

Ferris, J., & Wynne, H. (2001). *The Canadian problem gambling index*. Ottawa.

Fiedler, I. (2012). The online poker database of the university of Hamburg. Presentation for Quebec's Working Group on Online Gambling.

Gainsbury, S. M., Russell, A., Hing, N., Wood, R., & Blaszczynski, A. (2013). The impact of Internet gambling on gambling problems: A comparison of moderate-risk and problem Internet and non-Internet gamblers. *Psychology of Addictive Behaviors*, *27*, 1092–1101. doi:10.1037/a0031475.

Gainsbury, S., Russell, A., Wood, R., Hing, N., & Blaszczynski, A. (in press). How risky is Internet gambling? A comparison of subgroups of Internet gamblers based on problem gambling status. *New Media & Society*. Published OnlineFirst Jan 15, 2014. doi:10.1177/1461444813518185.

Griffiths, M., & Barnes, A. (2008). Internet gambling: An online empirical study among student gamblers. *International Journal of Mental Health and Addiction*, *6*, 194–204.

Griffiths, M., Parke, J., Wood, R., & Rigbye, J. (2010). Online poker gambling in university students: Further findings from an online survey. *International Journal of Mental Health and Addiction*, *8*, 82–89.

Griffiths, M., Wardle, H., Orford, J., Sproston, K., & Erens, B. (2009). Sociodemographic correlates of Internet gambling: Findings from the 2007 British gambling prevalence survey. *CyberPsychology & Behavior*, *12*, 199–202.

Ladd, G. T., & Petry, N. M. (2002). Disordered gambling among university-based medical and dental patients: A focus on Internet gambling. *Psychology of Addictive Behaviors*, *16*, 76–79.

The Land of eGaming Opportunity. (2012). Retrieved from http://www.h2gc.com

LaPlante, D. A., Nelson, S. E., LaBrie, R. A., & Shaffer, H. J. (2011). Disordered gambling, type of gambling and gambling involvement in the British gambling prevalence survey 2007. doi:10.1093/eurpub/ckp177 *The European Journal of Public Health*, *21*, 532–537.

Lloyd, J., Doll, H., Hawton, K., Dutton, W. H., Geddes, J. R., Goodwin, G. M., & Rogers, R. D. (2010). How psychological symptoms relate to different motivations for gambling: An online study of Internet gamblers. *Biological Psychiatry*, *68*, 733–740.

Lucas, A., & Kilby, J. (2008). *Principles of casino marketing*. Escondido, CA: Okie International.

McBride, J., & Derevensky, J. (2009). Internet gambling behavior in a sample of online gamblers. *International Journal of Mental Health and Addiction*, *7*, 149–167.

McCormack, A., & Griffiths, M. D. (2012). Motivating and inhibiting factors in online gambling behaviour: A grounded theory study. *International Journal of Mental Health and Addiction*, *10*, 39–53.

Petry, N. M. (2006). Internet gambling: An emerging concern in family practice medicine? *Family Practice*, *23*, 421–426.

Petry, N. M., & Weinstock, J. (2007). Internet gambling is common in college students and associated with poor mental health. *The American Journal on Addictions*, *16*, 325–330.

Rogers, W. (1994). Regression standard errors in clustered samples. *Stata Technical Bulletin*, *3*, 19–23.

Roodman, D. (2011). Estimating fully observed recursive mixed-process models with cmp. *Stata Journal*, *11*, 159–206.

Sargan, J. D. (1958). The estimation of economic relationships using instrumental variables. *Econometrica*, *26*, 393–415.

Shaffer, H. J. (1996). Understanding the means and objects of addiction: Technology, the Internet, and gambling. *Journal of Gambling Studies*, *12*, 461–469.

Shaffer, H. J., Hall, M. N., & Bilt, J. V. (2000). "Computer addiction": A critical consideration. *American Journal of Orthopsychiatry*, *70*, 162–168.

Sovey, A. J., & Green, D. P. (2011). Instrumental variables estimation in political science: A readers guide. *American Journal of Political Science*, *55*, 188–200.

Staiger, D., & Stock, J. H. (1997). Instrumental variables regression with weak instruments. *Econometrica*, *65*, 557–586.

Trynacity, H. (2011). Alberta hedges bet on online gambling. *CBC News*. Retrieved from http://www.cbc.ca/news/canada/edmonton/alberta-hedges-bet-on-online-gambling-1.1089332

Vardi, N. (2013). Sheldon Adelson says he is 'willing to spend whatever it takes' to stop online gambling. *Forbes*. Retrieved from http://www.forbes.com/sites/nathanvardi/2013/11/22/sheldon-adelson-says-he-is-willing-to-spend-whatever-it-takes-to-stop-online-gambling/

Wardle, H., Moody, A., Griffiths, M., Orford, J., & Volberg, R. (2011). Defining the online gambler and patterns of behaviour integration: Evidence from the British gambling prevalence survey 2010. *International Gambling Studies*, *11*, 339–356.

Wardle, H., Moody, A., Spence, S., Orford, J., Volberg, R., Jotangia, D., & … Dobbie, F. (2011). British gambling prevalence study 2010. Retrieved from http://www.gamblingcommission.gov.uk/researchconsultations/research/bgps.aspx

Welte, J. W., Barnes, G. M., Tidwell, M. O., & Hoffman, J. H. (2009). The association of form of gambling with problem gambling among American youth. *Psychology of Addictive Behaviors*, *23*, 105–112.

Wiebe, J., Mun, P., & Kauffman, N. (2006). *Gambling and problem gambling in Ontario 2005*. Ontario: Responsible Gaming Council.

Williams, R. J., Volberg, R. A., & Stevens, R. M. (2012). *The population prevalence of problem gambling: Methodological influences, standardized rates, jurisdictional differences, and worldwide trends*. Guelph: Ontario Problem Gambling Research Centre.

Wood, R. T., & Williams, R. J. (2007). Problem gambling on the internet: Implications for Internet gambling policy in North America. *New Media & Society*, *9*, 520–542.
Wood, R. T., & Williams, R. J. (2009). *Internet gambling: Prevalence, patterns, problems, and policy options*. Guelph: Ontario Problem Gambling Research Centre.
Wood, R. T., & Williams, R. J. (2011). A comparative profile of the Internet gambler: Demographic characteristics, game-play patterns, and problem gambling status. *New Media & Society*, *13*, 1123–1141. doi:10.1177/1461444810397650. Retrieved from http://nms.sagepub.com/content/13/7/1123.full.pdf+html
Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data*. Cambridge, MA: The MIT Press.