Rensselaer

Working Papers in Economics

Department of Economics, Rensselaer Polytechnic Institute, 110 8th Street, Troy, NY, 12180-3590, USA. Tel: +1-518-276-6387; Fax: +1-518-276-2235; URL: http://www.rpi.edu/dept/economics/; E-Mail: keenak@rpi.edu

Taxation and the Demand for Gambling: New Evidence from the United Kingdom

David Paton
University of Nottingham

Donald Siegel
Rensselaer Polytechnic Institute

Leighton Vaughan Williams
Nottingham Trent University

Number 0306

October 2003

TAXATION AND THE DEMAND FOR GAMBLING: NEW EVIDENCE FROM THE UNITED KINGDOM

August 2003

Dr. David Paton
Senior Lecturer in Industrial Economics
Nottingham University Business School
Wollaton Road
Nottingham NG8 1BB
United Kingdom
Tel: +44 115 846 6601
Fax: +44 115 846 6667
Email: David.Paton@Nottingham.ac.uk

Professor Donald S. Siegel
Professor of Economics
Department of Economics
Sage Building-Room 3502
Rensselaer Polytechnic Institute
110 8th Street
Troy, NY 12180-3590
Tel: (518) 276-2049
Fax: (518) 276-2035
Email: sieged@rpi.edu

Professor Leighton Vaughan Williams
Professor of Economics and Finance
Nottingham Trent University
Burton Street
Nottingham NG1 4BU
United Kingdom
Tel: +44 115 848 5516
Fax: +44 115 848 6829
Email: Leighton.Vaughan-Williams@ntu.ac.uk

TAXATION AND THE DEMAND FOR GAMBLING: NEW EVIDENCE FROM THE UNITED KINGDOM

Abstract

In October 2001, the U.K. government implemented a dramatic shift in the taxation of gambling, resulting in a substantial decline in taxes levied on U.K. bookmakers. Using data before and after this event, we present econometric evidence on the demand response to this tax reduction. Our results suggest that the demand for bookmaker gambling is highly sensitive to taxation rates and that the decline in the rate of taxation led to a large increase in the demand for on-shore betting. We also find some evidence of price-induced substitution across different segments of the gambling industry. The U.K. policy initiative may provide useful information for policy makers in other countries who are contemplating changes in gambling taxation.

Taxation and the Demand for Gambling: New Evidence from the United Kingdom

1. Introduction

Gambling is relatively socially acceptable in the U.K. and has rarely engendered any concerted religious opposition, in contrast to the U.S. Indeed, much of the gambling activity in the U.K. occurs at street corner betting shops, often in the most fashionable sections of British cities.[1] Two recent events were alleged to have had a deleterious effect on such gambling establishments: (a) the introduction of the U.K. National Lottery in 1996 and (b) the rise of off-shore Internet bookmakers, who are not subject to betting taxes and thus can seriously undermine the competitive position of traditional bookmakers.

These environmental changes stimulated an important public policy debate in the U.K. regarding optimal levels of taxation for different types of gambling. Similar issues have arisen in the U.S., as states become increasingly dependent on lottery revenues to fund educational programs (Clotfelter and Cook (1989)), while also viewing casinos as a tool for economic development (Sauer (2001)).

In order to determine an appropriate response to recent changes in the gambling industry, the U.K. Government commissioned a comprehensive review of betting taxation in 2000 (see Paton, Siegel and Vaughan Williams, 2002) which led to a dramatic change in the taxation of bookmaking establishments. Specifically, the government announced that 'General Betting Duty' (henceforth, GBD), levied as a percentage of betting stakes, would be replaced by a 'Gross Profits Tax' (henceforth, GPT), based on the net revenue of bookmakers. The change from GBD to GPT

[1] See Sauer (2001) for a trenchant analysis of the political economy of gambling regulation in the U.S. For issues relating specifically to Indian gaming, see Anders et al. (1998).

significantly reduced the effective incidence of taxation on bookmakers and ended the direct tax levied on bettors.

The purpose of this study is to examine the effects of these changes on the demand for betting. The remainder of the paper is organized as follows. Section II provides a brief discussion of recent adjustments to the structure of betting taxation in the U.K. The following section outlines the econometric model that we use to assess the impact of these tax changes on betting demand. Section IV describes the data and Section V presents our empirical findings. The final section consists of preliminary conclusions and suggestions for additional research.

II. Gambling Taxation Reform in the U.K.

Betting taxation was introduced in the U.K. in 1966, at a rate of 2.5%, and was increased to 5% eighteen months later. Although this was reduced by a percentage point in 1972, it continued to climb until it reached a peak of 8% before being trimmed back to 7.75% in 1992 and to 6.75% in 1996. The 1996 reduction was in response to the introduction of the National Lottery, which was viewed as a danger to the street-corner betting establishments. Another critical change occurred in 1987, when the tax on wagers placed at the racetrack was abolished.

Deductions faced by bettors were generally levied by bookmakers at a higher rate than the betting tax rate, specifically at 10% when the general rate was 8%, and 9% when it was 6.75%. The bookmaking establishments asserted that this premium was charged to cover payments to the Levy Board for managing the horse-racing segment and also handling charges, such as non-recoverable sales taxes, in the form of VAT ('Value Added Tax').

The threat to the U.K. bookmaking sector from the National Lottery was exacerbated in the late 1990s by the widespread diffusion of the Internet and the concomitant rise in the use of home

personal computers for entertainment. The new technology led to the rise of on-line gambling, which posed a serious threat to the competitive position of "bricks and mortar" gambling establishments.

In response to these pressures, the U.K. government instituted a radical reform of the taxation structure of U.K. bookmaking, switching from a tax on turnover (revenue) to a tax on gross profits. This reform was accompanied by a commitment from the major U.K. bookmakers to close down and repatriate to the U.K. all of their offshore operations, and to abolish deductions on bets placed with them. Specifically, the reform involved a switch from a tax on revenue (General Betting Duty), of 6.75 per cent, to a tax on the gross profits of bookmakers (i.e., their gross revenue minus what they pay out to winners) of 15 per cent. Prior to the switch, data supplied to the authors by HM Customs and Excise (the arm of the U.K. government that regulates the betting industry) suggests that bookmakers' gross profits were approximately 22 per cent of revenue. Thus, the switch represented a halving of the effective rate of taxation faced by bookmakers.

Paton, Siegel and Vaughan Williams (2001b; 2002) demonstrate that the key economic rationale for the policy change is that a GPT is allocatively more efficient than a revenue tax. The former is levied on price, whereas a revenue tax is levied on quantity. Consequently, a GPT provides firms with an incentive to reduce their margins and to concentrate on a low-price, high-revenue strategy, instead of a high-price, low-revenue strategy.

Another point in favor of the GPT is that it encourages firms to focus on margins. Economic theory predicts that this will result in a lower tax burden in sectors such as online betting, which are extremely competitive and thus have low profit low margins. Thus, a shift from GBD to GPT is expected to enhance the ability of British bookmakers to compete in a rapidly changing technological and global environment. A corollary of this is that a greater burden of risk

is borne by the government under a GPT. The reason is that in a climate of increasing competition, government tax revenue, which is based on profit margins, may be less stable and predictable.

The U.K. government expected that a gross profits tax may actually generate more tax revenue in the long run. That is because they were convinced that reducing risk for the industry and reducing tax rates would enhance industry competitiveness,

To summarize, the British government identified several challenges to the onshore British bookmaking industry, and therefore its own medium and long-term betting tax revenue base, from untaxed offshore competition and technological change. In response to this, a radical new betting tax structure (based on margins rather than revenue) was introduced in October 2001, designed to allow onshore bookmakers to compete more effectively with offshore rivals.

III Econometric Model and Estimation Techniques

As noted earlier, we wish to estimate the impact of the reduction in gambling taxation on betting demand. The purpose of this section is to outline the methodology used to achieve this objective. We also consider several econometric issues that are relevant to this type of study. [2]

We estimate variants of the following $Q_t = \varphi + \sum_{r=1}^{k} \gamma_r Q_{t-r} + \sum_{r=0}^{l} \alpha_r P_{t-r} + \sum_{j;r=0}^{m} \beta_j P_{t-r}^{j} + \grave{\mathbf{o}}\mathbf{Z}_t + Trend + \mu_t$ equation for betting demand:

(1)

[2] We do not provide a comprehensive review of the literature on the demand for gambling. For such a review, see Paton, Vaughan Williams and Siegel (2003).

where

Q_t = demand for betting during time period t
P_t = average price for betting during period t.
P^j_t = average price in gambling sector j during period t.
$\mathbf{Z}_t$ = a vector of additional factors that influence demand in period t.
Trend = time trend.
μ_t = a stochastic error or classical disturbance term.

If the demand function is specified in logarithms, α_0 constitutes a direct estimate of the short run own price elasticity, which is hypothesized to be negative. β_j represents the short run cross price elasticity of demand for betting with respect to the price of sector j. $\beta_j < 0$ denotes that betting and sector j are complements; $\beta_j > 0$ indicates that they are substitutes.

The vector **Z** includes real average annual earnings (wages) and the unemployment rate, since these factors have been shown in previous studies to influence the demand for gambling (e.g. Tuckwell (1984) Thalheimer and Ali (1995), Paton, Siegel and Vaughan Williams (2001a)). **Z** also contains two dummy variables that allow us to control for two significant events. The first is a dummy for the month of Princess Diana's death, in the immediate aftermath of which gambling activity throughout the U.K declined sharply. The second is a dummy variable for October 2001, the month when the gambling tax changes were fully implemented. This takes account of the publicity that surrounded the tax reduction and which may have provided a temporary boost to demand. Given that the tax change was announced in April 2001 and that many betting companies reduced their rate of deductions (though did not repatriate their overseas operations) in advance of the change, the temporary effect may be evident prior to October of this year. We allow for this by including up to 5 'leads' of this variable, although for reasons of space we report only the estimates of the aggregate effect.

The inclusion of lagged terms allows us to analyze dynamic factors. For example, if gambling is 'addictive', its long run price elasticity may exceed its short run value. In the simplest

case in which only one lag of the dependent variable is included and there is no lagged price term, the long run elasticity will be equal to $\alpha_0/(1 - \gamma_1)$.

An econometric concern associated with estimation of equation (1) is that the price variables are unlikely to be exogenous. If the exogeneity assumption is violated, ordinary least squares (OLS) yields parameter estimates that are biased and inefficient. Several alternative estimators are available that could provide us with unbiased and efficient econometric estimates of the key parameters. These estimators can be divided between single equation methods such as two-stage least squares (2SLS), and system estimators such as three stage least squares (3SLS), full information maximum likelihood (FIML) and the generalized method of moments (GMM).[3] For a correctly specified model, system estimators are likely to be the most efficient. However, a disadvantage of the system approach is that mis-specification in one equation (for example, due to serial correlation) can affect parameter estimates of other equations. We prefer to risk the loss of some efficiency in return for greater reliability, so we report 2SLS estimates. In a footnote to the table reporting regression results, we identify each variable that is instrumented and the set of instruments used. In cases in which the number of additional instruments exceeds the number of endogenous variables, we report the Sargan test for the validity of the overidentifying restrictions. For each variant of the regression model, we also report White standard errors that are robust to heteroscedasticity.

Some other econometric/measurement issues also need to be considered. These include our choice of a functional form for the demand equation, the measurement of price, specification of the time trend, and the set of arguments included in the demand equation. We now consider each of these in turn.

[3] A detailed discussion of alternative estimators can be found in, for example, Greene (2000).

We have chosen a log-linear specification for equation (1), since this allows the coefficients to be interpreted as elasticities. As it turns out, our key findings are robust to the use of a linear specification.

The convention in the academic literature on gambling (see, for example, Farrell et al, 1999; Forrest, Gulley, and Simmons, 2000a; 2000b; 2002) is to measure 'price' as the expected value of a bet. This is typically computed as the percentage of a unit bet that, on average, is not returned to bettors. In some instances, however, we have selected instruments for price. In particular, the price of the main National Lottery draw is instrumented by the value of rollover and additional draws in that month. When the appropriate data are not available, several alternative approaches are possible. For example, in the case of betting price, data are available only on the tax rate, which is a significant determinant of price. This allows us to directly estimate the elasticity of betting demand with respect to the tax rate. Another advantage of using the tax rate is that this variable is exogenous and does not require the use of instruments. For bingo, Lottery Scratchcards, the Lottery Thunderball draw, and the Lottery Extra draw we have no data relating directly to price changes. For various Lottery products, we use dummy variables to denote time periods when such products have been available on the market. These events are clearly exogenous and can be used to determine substitution or complementarity in the demand equations for other sectors. In the case of bingo, we use demand in place of price in the demand equations for other sectors. As bingo demand may be endogenous, we instrument this variable by lagged demand. Although bingo demand is correlated across time periods, it is not clear that this variable is a valid instrument. Thus, we view our results regarding substitution from bingo to betting as somewhat speculative.

We consider several approaches to control for time effects. The first is to include a standard linear time trend. This approach, however, is somewhat restrictive in that it is based on the assumption that the trend is constant throughout the sample period. To some extent, this problem may be mitigated by the inclusion of a quadratic term. A more general approach, though, is to use a piecewise linear 'spline'. This approach involves dividing the time period into a pre-specified number (n) of sub-periods and then constructing a linear function for each sub-period. The linear functions are restricted so that they join together at certain threshold values or 'knots' (see Greene, 2000, 322-5). Below, we use the Akaike Information Criteria (AIC) to choose the appropriate specification of the time trend (including the value of n where appropriate) for each gambling sector. Accordingly, we only report results from the best specification. In general, however, the specification of the time trend had only a marginal impact on our results.

The final econometric issue concerns the specification of the demand equation. We follow the 'general-to specific' approach. That is, for each dependent variable, we begin by estimating a model with <u>all</u> potential explanatory variables. This includes up to four lags for the price variables and the lagged dependent variable. Next, we eliminate variables that have little or no explanatory power, which results in a more parsimonious final model. Specifically, we drop variables sequentially on the basis of the t-value associated with each coefficient, ceasing only when all t-values are significantly different to zero at the 10% level or better. At each stage, we test for specification problems: autocorrelation, ARCH effects, normality and heteroscedasticity. If the omission of an insignificant variable results in the diagnosis of specification problems, we retain

the insignificant variable in the model. We will present estimates of the most general specification[4] and the final, parsimonious specification.

Before discussing our econometric results, we present an overview of the data used in our empirical analysis in the following section. We also provide some descriptive information on the impact of the 2001 changes to general betting duty on various types of gambling activity.

IV. Data Description

Data on betting revenue were derived from the monthly tax reports provided by HM Customs and Excise. Until October 2001, the tax on betting was levied as a proportion of revenue. Consequently, data on tax receipts, along with knowledge of tax rates, allow us to derive total off-course betting revenue for each month from April 1987 to September 2001. Note that prior to April 1987, tax was payable on bets placed on-course and so figures are not comparable. After October 2001, HM Customs and Excise provided us with total revenue figures for betting directly. Revenue is deflated by the monthly retail price index, using January 2002 as our base month. We also test for seasonal effects and adjust betting revenue by running preliminary regressions of revenue on month dummies. Controls are also included in the econometric model for the number of Saturdays in each month and for the month of the Grand National, an iconic horse rate that attracts easily more betting interest than any other event in the year.[5]

The Lottery price is calculated as the mean expected value of a lottery ticket in draws taking place in that month. The expected value is calculated following, for example, Forrest et al (2000a). Prices from the other important gambling sectors, amusement machines and casinos, are

[4] For reasons of space, we only report results including the lagged variables where these have significant explanatory power.

more problematic. Duty on amusement machines is levied as a license fee per machine. Thus, we construct a series of the mean license rate per machine. Similarly, the duty on casino gambling is levied via a license fee on establishments, where the size of the fee is related to total turnover. This duty is payable over a 6-month accounting period with some interim payments also being due. Since 1987, the license rates changed in October 1991 and then again in April of 1998, 1999, 2000 and 2001. Most of these changes were fairly modest in nature and basically, adjustments for inflation. An exception was the change in April 1998, which represented a significant reduction in the overall rate of duty. In the econometric work below, we construct a dummy variable for this change and use this to estimate substitution effects.

As discussed above, the available data do not permit us to construct a meaningful measure of the price for bingo so, instead we use bingo revenue (instrumented by its lagged values) in the econometric model. Data on bingo revenue subject to duty are derived from information provided by HM Customs and Excise.[6]

Figures 1-4 present monthly data for January 1999 through August 2002 in four segments of the gambling industry: betting, lottery draws, scratchcards and bingo. Data on revenue from National Lottery draws and scratchcards were provided to us by Camelot, the organization that manages the National Lottery for the U.K. Government. Analysis of data from this period allows us to examine the impact of the October 2001 reduction in General Betting Duty on the demand for gambling. Figure 5 shows monthly tax receipts from betting. The vertical line on each graph refers to the tax reduction in October 2001.

---

[5] Patterson (2000) contains a good discussion of the seasonality issue. Note we also run standard stationarity tests, finding little evidence that any of the turnover series are non-stationary.

[6] Certain categories of 'small-scale' bingo games are exempt from duty (for example, games with prize money below certain amounts promoted by private clubs and organizations). These games are excluded from our analysis.

As expected, Figure 1 suggests that the tax reduction had a significant impact of the tax reduction on betting revenue. The upward trend in the series appears to commence some time prior to the actual change in tax. There is anecdotal evidence that some smaller bookmakers anticipated the change, and reduced betting deductions in advance of the tax reduction. There is no evidence, however, that any of the established bookmakers began repatriating their operations before the tax changes were formally announced. We will explore this issue econometrically in the next section of the paper.

Evidence presented in the other figures is inconsistent with the notion that there have been substantial declines in revenue in other segments of the gambling industry. Finally, in Figure 5, we report monthly tax receipts from betting. The reduction in the effective tax rate had a significant impact on receipts, reducing them by about one third on the previous year. This immediate impact on tax revenues was fully anticipated, although tax revenues were expected to recover in the medium to longer-term.

In the next section of the paper, we construct multivariate models of the turnover series to analyze the impact of the tax reduction more fully.

V. Empirical Results

Parameter estimates of the demand equation (equation (1)) are presented in Table 1. A description of the variables used in our regression analysis is contained in the Data Appendix.

Several points should be made about the results presented in Table 1. The first is that the empirical analysis is based on monthly data, although figures for September, October, and November 2001 are approximate (due to aggregation by Customs and Excise). A second point is that the model was estimated for the entire sample period (April 1987 to January 2002) and then

just for the period during which U.K. National Lottery tickets have been sold (November 1994 to January 2002). Columns (1) and (2) present findings for the entire sample period, while columns (3) and (4) contain results for the "Lottery Period." Another stylized fact is that there was an absence of any significant differences between long run and short run effects, which could be due to our use of monthly data. Finally, we note that each variant of the model fits quite well, as the R^2 values range from 0.7133 to 0.8722.

As expected, the coefficient on the betting tax variable is negative and highly statistically significant in each of the four specifications of the model. Our estimates of the tax elasticity are –0.502 and –0.555. These results suggest that a 50% reduction in the tax rate on betting will result in a 25% increase in the demand for betting. The elasticity estimates imply an absolute price elasticity for betting that is significantly higher than unity. For example, based on the mean price and duty levels over the sample period, the betting price elasticity estimates are -1.59 and -1.62.

Another key finding is that the coefficients on the October 2001 dummy variable are positive and statistically significant in each variant of the model. This implies that the tax change announced in October 2001 induced an increase in demand for on-shore betting, and that this event began to register five months before the actual implementation of the tax changes.

A caveat to this result should be noted. It is conceivable that some of the increase in on-shore betting experienced by domestic booking establishments consists of betting activity that had been transacted by off-shore branches of these same bookmaking firms. To the extent that this is occurring, a non-negligible percentage of the increase in betting may reflect not 'new' demand, but rather this transfer from off-shore to on-shore betting outlets. Unfortunately, it is not possible to separate out such effects in the data that were provided to us.

The other parameter estimates are generally consistent with our expectations. That is, for the entire sample period, there appears to be an inverse relationship between unemployment and demand and a positive relationship between wages and demand. The coefficients on the National Lottery dummy variables provide only weak evidence that the introduction of the Lottery reduced betting revenues. Only the introduction of Wednesday draws appears to be associated with a statistically significant decline in the demand for betting. On the other, we find strong evidence of a response in the demand for betting to price changes in the National Lottery, as evidenced by the fact that the coefficients on Lottery Price are positive and statistically significant. Specifically, estimates of the cross price elasticity of betting with respect to the National Lottery are +0.355 and +0.396. This result is consistent with U.S.-based evidence of substitution between the lottery and other forms of gambling (Siegel and Anders (2001). While we find no evidence of substitution from machines or casino gambling to betting, there is strong evidence of substitution from bingo, although not during the Lottery period. Lastly, as expected, gambling activity was significantly lower in the month of Princess Diana's death.

In assessing our results, it is important to note that what we are only estimating the demand for on-shore betting in the UK. Given that the betting tax changes implemented in October 2001 were at least partially the result of agreement on the part of major UK bookmakers to repatriate their off-shore operations in the wake of the tax changes, this caveat is especially critical. Also, UK bookmakers agreed to end deductions on bettors, so that the GPT was covered entirely by the operators themselves. The impact of enhanced market competition must also be considered as a key factor influencing bookmaker's profit margins, with consequent effects on the elasticity of demand for betting.

VI. Conclusions

A rapid rise in gambling has heightened interest in identifying demand characteristics and optimal levels of taxation. In this paper, we present some preliminary econometric evidence on the demand response of betting activities in the U.K. to recent changes in the structure of betting taxation. A key result is that the demand for betting appears to be highly sensitive to changes in tax rates. In particular, the reduction in the rate of betting tax in October 2001 appears to have induced a fairly large increase in the demand for on-shore betting.

Our findings also imply that betting in street-corner gambling establishments and the lottery are strong substitutes, at least in the short-run. The results also suggest that amusement machines and casino gambling are strong substitutes for the lottery. Unfortunately, given our somewhat short "post-event" window, it is difficult for us to project long-term impacts.

The issues discussed in this paper may be even more important in the U.S. than in the U.K. That is because issues regarding gambling are typically resolved at the state level, since state legislatures have jurisdiction over most aspects of gambling. The last two decades have seen intense competition among the states to internalize gambling revenues, using riverboat and Native American casinos, lotteries, and video poker games to attract gambling patrons. This has probably resulted in stronger substitution effects, since motorists can easily patronize gambling establishments or play the lottery in neighboring states. Furthermore, there is likely to be greater interest in estimating such impacts in the U.S., due to the recent fairly severe recession. This economic downturn has heightened concerns (at the state level) regarding tax revenue and the possibility that there may be displacement effects associated with the growth of gambling. These displacement effects are a major concern, as many U.S. states have become increasingly dependent on lotteries to fund educational programs and other off-budget items.

Finally, it is interesting to note that tax revenue from gambling pales in comparison to revenue that is generated from alcohol, gasoline, and tobacco. Thus, in determining optimal tax policies, it would be useful to extend our model to include these commodities. This would allow us to determine whether alcohol, gasoline, and tobacco are substitutes or complements for betting.

References

Anders, Gary, Donald Siegel, and Munther Yacoub. (1998), 'Does Indian Casino Gambling Reduce State Revenues?: Evidence From Arizona,' Contemporary Economic Policy, 16(3): 347-355.

Clotfelter, Charles T. and Philip J. Cook. (1989). Selling Hope: State Lotteries in America, Cambridge, MA: Harvard University Press

Farrell, Lisa, Edgar Morgenroth, and Ian Walker (1999), 'A Time Series Analysis of U.K. Lottery Sales: Long and Short Run Price Elasticities', Oxford Bulletin of Economics and Statistics, 61(4): 513-526.

Forrest, David, O. David Gulley, and Robert Simmons (2000a), 'Elasticity of Demand for UK National Lottery Tickets', National Tax Journal, 53 (4): 852-63.

Forrest, David, O. David Gulley and Robert Simmons (2000b), 'Testing for Rational Expectations in the UK National Lottery', Applied Economics, 32: 315-326.

Forrest, David, Robert Simmons and Neil Chesters (2002), 'Buying a Dream: Alternative Models of Lotto Demand', Economic Inquiry, July, 40, 3: 485-96.

Greene, William H. (2000), Econometric Analysis, 4th Edition, New Jersey: Prentice-Hall.

Paton, David, Donald S. Siegel, and Leighton Vaughan Williams (2001a), 'A Time Series Analysis of the Demand for Gambling in the United Kingdom', Nottingham University Business School Working Paper Series, 2001.

Paton, David, Donald S. Siegel, and Leighton Vaughan Williams (2001b), 'Gambling Taxation: A Comment', Australian Economic Review, 34(4): 427-440.

Paton, David, Donald S. Siegel, and Leighton Vaughan Williams (2002), 'A Policy Response to the E-Commerce Revolution: The Case of Betting Taxation in the U.K.', Economic Journal, 111(480): F296-F314.

Paton, David, Donald S. Siegel and Leighton Vaughan Williams (2003), 'The Demand for Gambling: a review,' in: The Economics of Gambling, ed. Leighton Vaughan Williams, London: Routledge.

Patterson, Kerry (2000), An Introduction to Applied Econometrics: a Time Series Approach, Basingstoke: Macmillan.

Sauer, Raymond D. (2001), 'The Political Economy of Gambling Regulation,' Managerial and Decision Economics, 22(1): 5-15.

Siegel, Donald S. and Gary Anders (2001), 'The Impact of Indian Casinos on State Lotteries: A Case Study of Arizona', Public Finance Review, 29(2): 139-147.

Thalheimer, Richard and Mukhtar Ali (1995), 'The Demand for Pari-mutuel Horserace Wagering and Attendance with Special Reference to Racing Quality and Competition from State Lottery and Professional Sports', Management Science, 45(1): 129-143.

Tuckwell, R.H. (1984) 'Determinants of Betting Turnover', Australian Journal of Management, December.

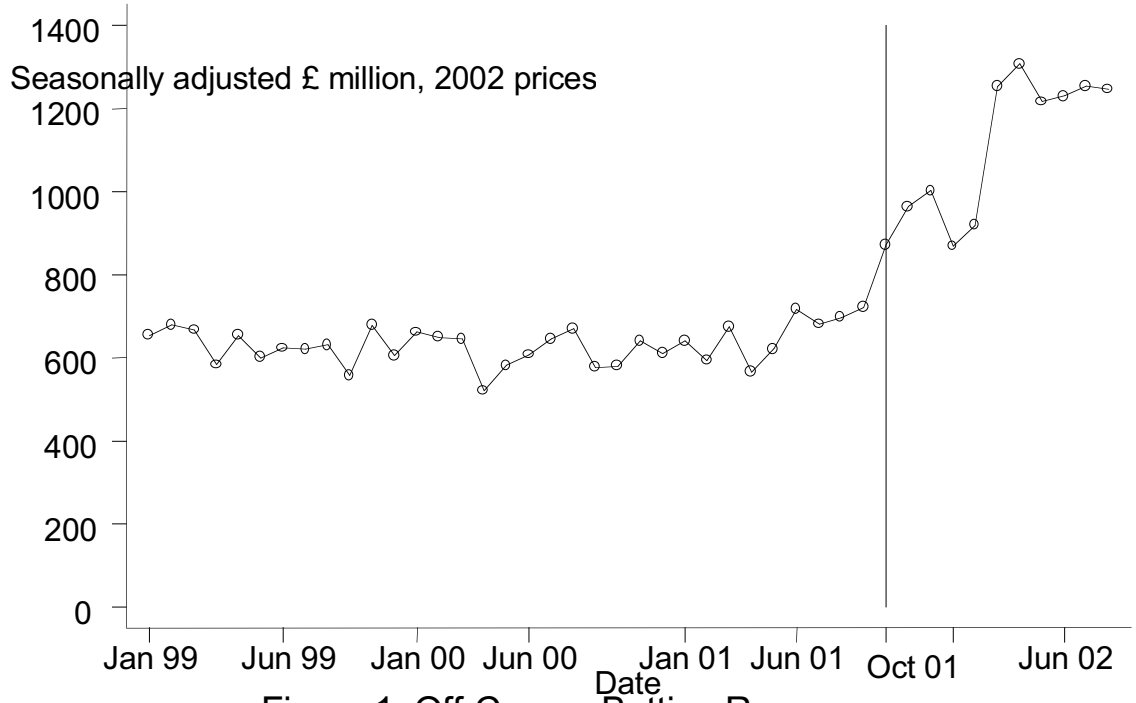

Figure 1: Off-Course Betting Revenue

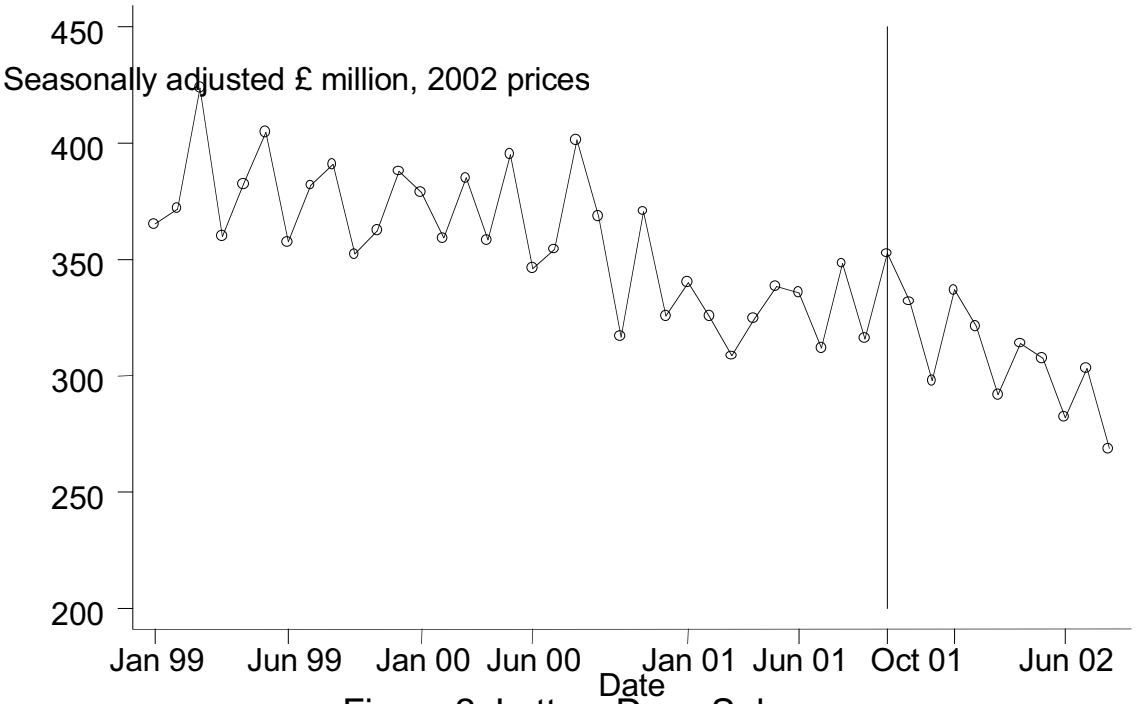

Figure 2: Lottery Draw Sales

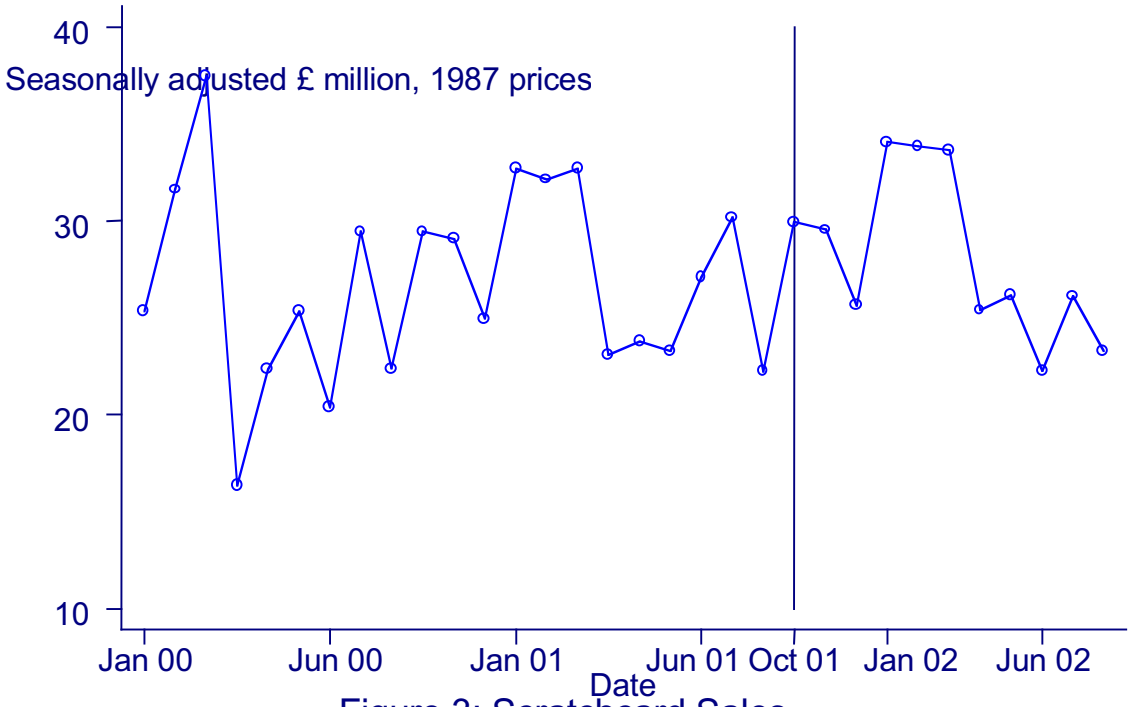

Figure 3: Scratchcard Sales

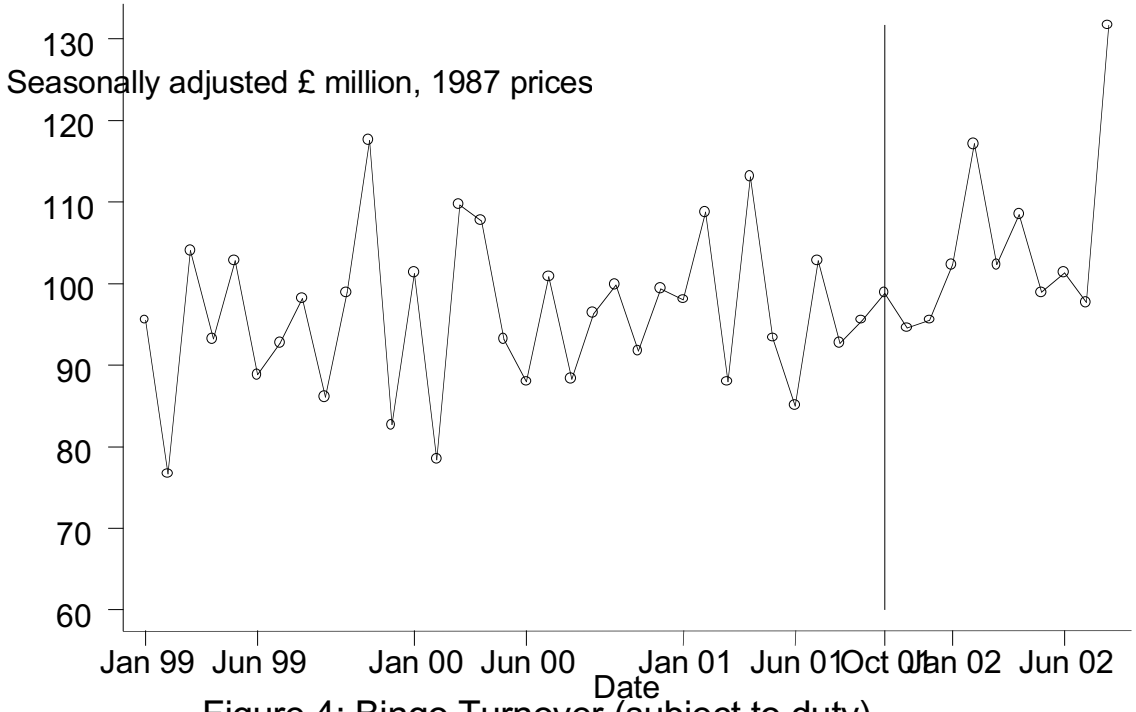

Figure 4: Bingo Turnover (subject to duty)

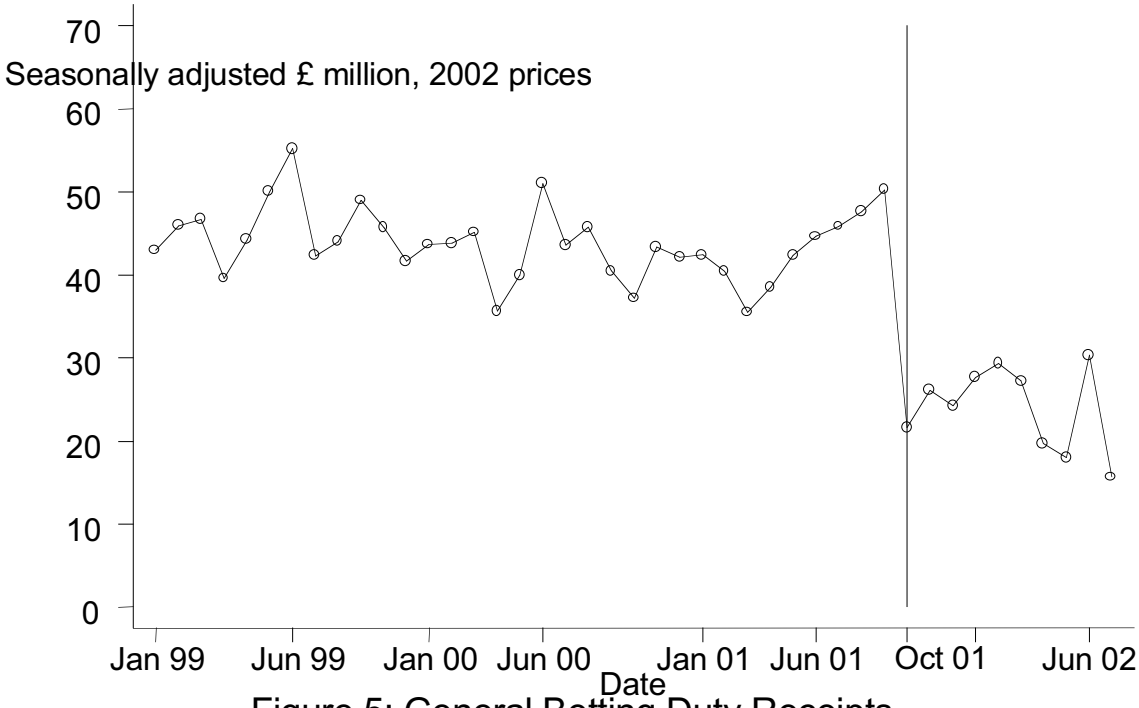

Figure 5: General Betting Duty Receipts

Table 1

Dependent Variable: The Demand for Betting in the U.K.

	1	2	3	4
	Entire Period		**Lottery Period**	
Demand (t-1)	-0.039 (0.087)	-	-	-
Betting Tax	-0.523*** (0.077)	-0.555*** (0.051)	-0.502*** (0.025)	-0.516*** (0.031)
Wages	1.657** (0.823)	-	1.725 (1.496)	-
Unemployment	-0.433*** (0.165)	-0.447*** (0.151)	-0.365 (0.351)	-
Lottery Price	n/a	n/a	0.355** (0.157)	0.396** (0.174)
Bingo	0.243** (0.096)	0.275*** (0.100)	0.258 (0.247)	-
Amusement Machine Tax	0.002 (0.102)	-	-0.413 (0.296)	-
Casino Gambling Tax Down	-0.040 (0.049)	-	0.072 (0.068)	-
National Lottery	-0.055 (0.054)	-	n/a	n/a
Scratchcards	-0.008 (0.054)	-	0.040 (0.055)	-
Wednesday	-0.119** (0.055)	-0.099** (0.047)	-0.053 (0.098)	-
Thunder	-0.086* (0.045)	-	-0.098* (0.058)	-
Extra	-0.084 (0.058)	-	-0.066 (0.061)	-
October 2001	0.569** (0.262)	0.548*** (0.171)	0.576** (0.280)	0.489*** (0.079)
Diana	-0.078*** (0.021)	-0.077*** (0.019)	-0.058** (0.027)	-0.056*** (0.017)
Constant	7.720 (3.601)	13.998*** (0.601)	8.436 (6.448)	12.539*** (0.684)
Time	5-pt spline	5-pt spline	2-pt spline	2-pt spline
N	183	184	93	93
R^2	0.7416	0.7133	0.8595	0.8722
Sargan test	n/a	n/a	1.981	1.292
AR test	1.051	0.634	0.446	0.564
ARCH test	0.173	2.453	0.192	0.024
Normality	0.299	1.653	0.994	0.092
Heteroscedasticity	0.928	1.526	5.587***	1.091

Notes:

(i) Dependent variable is log of seasonally adjusted monthly, real expenditure (1987 prices) on betting.

(ii) All continuous variables are measured in logs.

(iii) Figures in brackets are robust standard errors.

(iv) Betting Tax rate is calculated as proportion of turnover taken in General Betting Duty/Gross Profit Tax.

(v) Lottery Price is instrumented by size of rollover draws and additional draws in that month. Bingo turnover is instrumented by its own lagged value.

(vi) *** indicates significance at the 1% level; ** at the 5% level; * 10% level.

Data Appendix: Description of Variables Used in the Econometric Analysis

Betting Demand	Seasonally adjusted monthly real expenditure (1987 prices) on off-course betting. *Source: HM Customs and Excise.*
Lottery Demand	Weekly real expenditure (1987 prices) on National Lottery Saturday and Wednesday draws. *Source: Camelot.*
Scratchcard Demand	Weekly, real expenditure (1987 prices) on the National Lottery Scratchcards. *Source: Camelot.*
Bingo Demand	Seasonally adjusted monthly, real expenditure (1987 prices) on bingo subject to duty. *Source: HM Customs and Excise.*
Betting Tax	Rate of GBD up to 6th October 2001. From 6th October, it is bookmaker gross profits as a percentage of total turnover. *Source: derived from information supplied by HM Customs & Excise.*
Lottery Price	Expected value of a lottery ticket, calculated following, for example, Forrest, Gulley & Simmons (2000a) *Source: derived from information supplied by Camelot.*
GPT in Place	Dummy for period in which GPT has been in place: =1 from on; = 0 otherwise.
Wages	Seasonally adjusted average earnings index in the UK, 1987 prices. *Source: Office of National Statistics*
Unemployment	Claimant count unemployment rate in the UK *Source: Office of National Statistics*
Amusement Machine Tax	Mean rate of tax per amusement machine. *Source: HM Customs & Excise.*
Casino Gambling Tax Down	Dummy for significant reduction in casino gambling tax in 1998: = 1 from 1st April 1998 on; = 0 otherwise.
National Lottery	Dummy for start of National Lottery: = 1 from Nov 1994 on; = 0 otherwise.
Scratchcards	Dummy for Lottery Scratchcards: = 1 from 25th March 1995; = 0 otherwise
Wednesday	Dummy for Lottery Wednesday draw: = 1 from 25th Feb 1997; = 0 otherwise
Thunder	Dummy for Thunderball draw: = 1 from 6th Dec 1999; = 0 otherwise
Extra	Dummy for Lottery Extra draw: = 1 from 15th Nov 1999; = 0 otherwise
GPT in Place	Dummy for the period in which GPT has been in place: =1 from on; = 0 otherwise.
October 2001	Dummy for the introduction of GPT: = 1 for week (month) of 6th Oct, 2001; = 0 otherwise.
Diana	Dummy for the death of Princess Diana: =1 for week (month) of 7th Sept 1999; = 0 otherwise.