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8 **Do new gambling products displace old? Evidence from a postcode analysis.**
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Do new gambling products displace old? Evidence from a postcode analysis.

Abstract

In this paper we examine the extent to which new gambling products displace traditional products. In particular, we test whether the introduction of Fixed Odds Betting Terminals (FOBTs) affected the number of traditional gambling machines in Great Britain. We use data from geographical districts based on postcodes within Great Britain between 2001 and 2006. Using a propensity score matching approach, we find little evidence that FOBTs caused any reduction in the number of machines in venues other than licensed betting offices.

JEL classifications: D21, L83, R11.

Keywords: gambling, postcodes, matching.

Do new gambling products displace old? Evidence from a postcode analysis.

1. Introduction and Research Question

There is a well-established literature on the economic impact of the growth of gambling facilities on local and regional economies, an important aspect of which is the effect on existing products of introducing a new gambling product into a region or district. To date most of the published research in this area has focused on the U.S. (e.g. Walker and Jackson, 2011; Kearney, 2005a; Siegel and Anders, 2001, d’Hautesserre, 1998), although there has been some related research in the U.K. at national level (e.g. Paton, Siegel and Vaughan Williams, 2002, 2004; Forrest, Gulley and Simmons, 2010), as well as a detailed study, commissioned by the Department for Culture, Media and Sport, of the options for locating a new regional casino in the U.K. (Casino Advisory Panel, 2007). The findings of these studies are diverse, suggesting that the impact of introducing new gambling facilities on existing gambling products depends on the specific nature of the facilities as well as the economic and regional environment into which they are introduced. The report of the Casino Advisory Panel also details evidence of the positive role that new casinos might play in regional economic development, including notably that arising from the recommended site for a new regional casino in the Manchester area.¹

The evidence is not uncontroversial, however, some authors arguing that new gambling products can, in identified circumstances, cannibalize not only existing gambling products (e.g. Walker and Jackson, 2008) but other local spending as well (e.g. Kearney, 2005b), including investments in physical and human capital. Other authors argue that problem and compulsive gambling (e.g. Ladouceur, Lachance and Fournier, 2009) and other social problems and economic problems, such as bankruptcy and crime, may be aggravated (e.g. Barron, Staten and Wilshusen, 2002; Grinols and Mustard, 2006). In the event, the

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3 proposed new regional casino was in any case blocked in the House of Lords, though
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6 recommendations for the locating of sixteen smaller new casinos are still under consideration.
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8 In this paper, we use a methodology of ‘propensity score matching’ applied to a large
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10 and unique data set of postal districts, to examine in particular the question of displacement
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12 of existing gambling products by new products, this for the first time in Great Britain at a
13
14 local level. Our investigation focuses on the introduction of a highly profitable new type of
15
16 gambling machine into licensed betting offices (LBOs) and the effect this has on the number
17
18 of gambling machines located elsewhere in the local area. The findings have, of course,
19
20 important implications also for the wider policy debate, including that highlighted above,
21
22 around the prevalence of gambling facilities at a national level.
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27 In the next section of the paper, we provide some context to this issue. In section
28
29 three, we describe the propensity score matching methodology in more detail. We discuss
30
31 our data in section four, report the results of our empirical tests in section five and, in the
32
33 final section, make an assessment about the strengths and limitations of our approach.
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39 **2. Background**

40
41 In the U.K., there are well over 8,000 bookmaker outlets on the ‘high street’, in which
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43 customers can place bets on horse racing (fixed-odds and ‘parimutuel’), on sports and current
44
45 events, as well as accessing gambling machines. These outlets are known as licensed betting
46
47 offices (LBOs), and can be opened by anyone subject to obtaining a bookmaking licence.
48
49 LBOs were legalized in 1960 and at their peak in the 1980s around 14,000 were open for
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51 business.
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53

54
55 In addition to LBOs there are widespread opportunities to gamble in the U.K., ranging
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57 from the National Lottery where tickets can be purchased at a wide range of retail outlets, to
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59 bingo halls, casinos, gambling machine ‘arcades’ and ‘entertainment centres’, as well as a
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3 host of online gambling opportunities. There is also a popular culture of betting at the
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5 racetrack itself and the dog track. The regulation and licensing of gambling is overseen by the
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7 Gambling Commission, set up by the Gambling Act of 2005, and the taxation of gambling is
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9 the province of HM Revenue and Customs. Although betting operators are subject to betting
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11 tax, bettors themselves are not subject to such a tax, neither on their stakes nor winnings.
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14
15 In 2001, a new type of gambling machine, a FOBT (Fixed-Odds Betting Terminal),
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17 with much higher maximum stakes and jackpots, was legalized for use in LBOs. LBOs are
18
19 permitted a maximum of four gambling machines, and the FOBTs gradually started to replace
20
21 the traditional machines in these venues. FOBTs are essentially electronic terminals with a
22
23 visual display, which allow players to play a variety of games of chance, including notably
24
25 virtual roulette. An essential difference between FOBTs and most traditional machines is that
26
27 the expected payout on any given play is independent of the outcome of previous plays.
28
29 Indeed, it is notionally possible to win (or lose) on FOBTs on an infinite number of
30
31 successive plays, unlike traditional machines whose payout is linked to the outcome of
32
33 previous plays. More importantly, perhaps, the stakes and potential payout are much higher
34
35 than traditional machines. It is interesting, therefore, to note recent statistics which indicate
36
37 that, while the gambling machines market grew by an estimated 19% between 2008 and 2009
38
39 to reach a total value of £2.42 billion, this growth was driven by the highly profitable FOBT
40
41 machines in betting shops. In contrast, there was an estimated decline of around £100 million
42
43 a year elsewhere in the market (Mintel, 2010). Even so, the U.K. gambling machine market
44
45 cannot compete in overall machine turnover or gross gaming yield (gross win) compared
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47 notably to the U.S., because of strict limits imposed in the U.K. on the number and payout
48
49 size of machines allowed in casinos and bingo outlets, as well as the relatively small size of
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51 the casino market.
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At the time of the introduction of FOBTs, some existing operators of traditional gambling machines in venues other than LBOs (such as arcades, bingo halls and pubs) were opposed to what can be viewed as preferential tax treatment for FOBTs. Key to this opposition was an assumption that FOBTs would have a displacement effect with respect to traditional gambling machines. In Table 1 we report the density of traditional machines in 2001 (i.e. prior to the introduction of FOBTs) at all venues and non-LBO venues. The North East, North West and East Anglia all had machine densities significantly above the mean for the whole country and, as such, were more at risk from any adverse market effects arising from the introduction of FOBTs.

Table 1 to appear about here

Our approach to assessing displacement is based on available data about the number of gambling machines registered for taxation purposes. We would like to be able to measure also the impact of the growth of FOBTs on the money spent on traditional gambling machines, but unfortunately the relevant data are not available.

The data available to us (see below for more details) is at the level of Postcode District (defined below). Her Majesty's Revenue and Customs (HMRC) provided information on the number of traditional gambling machines, broken down by category, between 2001 (before the widespread use of FOBTs) and 2006 (when they were well established). Indeed, by 2006 there were an estimated 20,000 FOBTs in an estimated 8,500 LBOs (Europe Economics, 2006). We also have data on districts which subsequently had FOBTs (as of 2007) and those which did not. In this context, a suitable test of displacement is to test *whether Postcode Districts with at least some FOBTs experienced a bigger or smaller change in the number of other gambling machines between 2001 and 2006, relative to Postcode Districts with no FOBTs*. If the FOBT Postcode Districts experienced a relative

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3 decrease in other machines (compared to non-FOBT districts), this would be evidence in
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6 favour of displacement.

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8 An immediate problem in implementing this test is that non-FOBT districts might be
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10 different from FOBT districts in important ways. If these differences lead to changes in the
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12 number of machines that are unrelated to the growth of FOBTs, our test may lead to invalid
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14 inferences. For this reason, we use a matching estimator that enables us to compare FOBT
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16 districts with non-FOBT districts that are similar in other respects.
17
18

21 22 3. Methodology

23
24 Let $FOBT_{it} \in \{0,1\}$ be an indicator of whether a Postcode District i has at least one FOBT in
25
26 place at time period t , and let y_{it+s}^1 be the outcome variable (in this case, number of other
27
28 machines) at time $t+s$, $s \geq 0$. Also let y_{it+s}^0 be the number of other machines if the district
29
30 had not had any FOBT machines in place. The causal effect of FOBTs for district i on the
31
32 outcome variable at time period $t + s$ is then defined as:
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35

$$36 \quad y_{it+s}^1 - y_{it+s}^0. \quad (1)$$

37
38 The fundamental problem of causal inference is that the quantity y_{it+s}^0 , which is the
39
40 counterfactual, is unobservable. Thus we concentrate on identifying the average effect of
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42 FOBTs in affected areas, i.e. *the average effect of the treatment on the treated* (e.g. Heckman
43
44 et al, 1997, Dehejia and Wahba, 2002 and Smith and Todd, 2005a). Mathematically, the
45
46 average effect of the treatment on the treated is defined as
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$$52 \quad E\{y_{t+s}^1 - y_{t+s}^0 \mid FOBT_{it} = 1\} = E\{y_{t+s}^1 \mid FOBT_{it} = 1\} - E\{y_{t+s}^0 \mid FOBT_{it} = 1\}. \quad (2)$$

53
54 Causal inference relies on the construction of the counterfactual for the last term in
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56 equation (2), which is the outcome districts with FOBTs would have experienced, on average,
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had FOBTs not been installed there. This is estimated by the corresponding average value of the outcome variable for the districts that did not participate in the scheme,

$$E\{y_{it+s}^0 \mid FOBT_{it} = 0\}.$$

We can exploit the fact that we have repeated observations for the same set of districts over time, by basing the policy evaluation analysis on the difference between the variable of interest (viz. y_{it+s}^1) and its pre-treatment value (viz. y_{it-1}^1), that is $\Delta y_{it+s}^1 = y_{it+s}^1 - y_{it-1}^1$ (e.g. Blundell and Costa Dias, 2000). In this case the *average effect of the treatment on the treated* is defined as

$$E\{\Delta y_{it+s}^1 - \Delta y_{it+s}^0 \mid FOBT_{it} = 1\} = E\{\Delta y_{it+s}^1 \mid FOBT_{it} = 1\} - E\{\Delta y_{it+s}^0 \mid FOBT_{it} = 1\} \quad (3)$$

Since the resulting estimator is based on differences, it is known as the *difference-in-differences matching estimator*.

An important feature in the accurate construction of the counterfactual is the selection of a valid control group. The approach we take here is to employ matching techniques. The purpose of matching is to pair each district with FOBTs with a non-FOBT one on the basis of some observable variables, in such a way that the outcome variable of the latter can be studied to generate the counterfactual for the former. This type of matching procedure is preferable to randomly or indiscriminately choosing the comparison group, because it is less likely to induce estimation bias by picking districts with markedly different characteristics.

In practice matching involves comparing FOBT and non-FOBT districts across one or more observable pre-participation characteristics, in particular population density and total number of gambling machines in 2001. Rural and urban districts are likely to be very different in terms of the pattern of gambling activities and, potentially, the impact of FOBTs. The use of population density helps to capture such differences. Similarly, within urban areas, some districts, such as those in seaside resorts, will tend to have particularly high levels of gambling machines. Again, the underlying characteristics of these districts may affect the

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3 impact of FOBTs. Using the number of pre-existing machines in the set of matching
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5 variables ensures that the control and intervention groups are statistically similar in this
6
7 respect.
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10 It is desirable to perform the matching on the basis of a single index that captures all
11 the information in those variables. To this end, we adopt the Rosenbaum and Rubin (1983)
12 method of propensity score matching (see also Lehmer and Moller, 2008; Wenz, 2008). The
13 methodology involves the use of the probability of participating in the scheme conditional on
14 those characteristics, to reduce the dimensionality problem. Accordingly, we first identify
15 the probability (or *propensity score*) of the presence of FOBTs using a probit model
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$$24 \quad P(FOBT_{it} = 1) = F(X_{it-1}) \quad (4)$$

25
26 where X is a vector of covariates observed in the time period before the introduction of
27
28 FOBTs.
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32 Now let p_i denote the predicted probability of having FOBTs for district i amongst
33 all FOBT districts (say group A) and let p_j denote the predicted probability of having FOBTs
34 for district j in the control group of districts (say group C). In general the difference-in-
35 differences matching estimator of the causal effect of FOBTs can be written as
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$$42 \quad \mu = \sum_{i \in A} \left(\Delta y_i - \sum_{j \in C} g(p_i, p_j) \Delta y_i \right) \quad (5)$$

43
44 where $g(\cdot)$ is a function assigning the weights to be placed on the comparison district j used as
45 a match for FOBT district i . The different matching estimators proposed in the literature
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47 (such as the nearest neighbours and kernel estimators) differ from each other in the choice of
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49 the weighting function they employ. However, they share the same property of being
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51 consistent estimators of the treatment effect under consideration.
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Testing the reliability of the propensity score matching method

The propensity score matching method will provide a reliable and robust method for estimating effects of the presence of FOBTs if, conditional on the propensity score, the distribution of the pre-FOBT covariates is independent of the incidence of FOBTs. This can be achieved by choosing a specification of the propensity score model (cf. Equation 4) that ‘balances’ the pre-FOBT variables between the treatment and control groups conditional on the propensity score. We verify that the balancing condition is satisfied by performing several balancing tests suggested in the literature (e.g. Smith and Todd, 2005b).

The first balancing test examines the standardised difference (or bias) for all variables in X (that is the vector of covariates used in the propensity score estimation) as described in Smith and Todd (2005b). For example, the standardised bias for the *density* variable is defined as the difference in means between FOBT districts (group A) and the matched comparison group of districts (group C), scaled by the average variances of the *density* variable for groups A and C. Based on N regions with FOBTs, this is given as

$$SDIFF(density) = \frac{100 \frac{1}{N} \sum_{i \in A} \left[density_i - \sum_{j \in C} g(p_i, p_j) density_j \right]}{\sqrt{\frac{Var_{i \in A}(density) + Var_{j \in C}(density)}{2}}}. \quad (6)$$

Note that the lower the standardised difference, the more balanced or similar the treatment and comparison groups will be in term of the variable under consideration.

Although a formal criterion as to how large a standardised bias should be for it to be considered serious does not exist, we follow Rosenbaum and Rubin (1985) and assume that a value of 20 is large. Furthermore, for each variable entering the propensity score model we perform standard t-tests of equality between treated and control firms to satisfy ourselves that no significant differences exist.

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Whereas the above balancing test considers the cross-sample difference of each variable entering the probit model separately, we also employ the Hotelling's T-squared test that considers whether those differences can be taken as *jointly* significant and which has the flexibility of being based either on all observations or for separate segments of the sample defined by the propensity score estimates. Here we divide the sample into four equal parts (i.e. by propensity score quartile), and conduct the Hotelling's T-squared test within each part.

Throughout we impose the so-called common support condition in the matching algorithm. This involves dropping FOBT districts whose propensity score is higher than the maximum or less than the minimum propensity score of the non-FOBT districts.

4. Data

Our basic unit of observation is the Postcode District. In the U.K. postcodes are the key geographic tool used for postal deliveries. Each address in the country can be identified by a series of letters and numbers. An example might be NG8 1BB. The first part ("NG8") is termed the Outcode and the second ("1BB") the Incode. The letter (or letters) in the Outcode represent the Postcode Area. In our example, the letters NG represent the Nottingham area. In total, there are 124 Postcode Areas in the country. Each area is subdivided into Postcode Districts, represented by the 1 or 2 digit number in the Outcode. On average there are about 20 districts within each area.

Data were supplied to us by HMRC on the total number of gambling machines in each Postcode District between 1996 and 2007. The data between 1996 and 2007 were broken down into the number of machines in each of the five HMRC tax categories A-E, using the definitions in place up to 2006 (these were subsequently replaced by new categories labelled A, B1, B2, B3 and C). As the definition of categories changed significantly in 2001, data up to 2000 are not consistent with the later period. A change to the category definitions

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3 also occurred in 2007 and as a consequence, the data by category in 2007 are not consistent
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5 with the previous period.
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8 For these reasons, we use 2001 as our baseline period when there were no (or virtually
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10 no) FOBT machines in place and 2006 to represent the period when FOBTs are well
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12 established. We test the sensitivity of our results to changing the end-point of our analysis in
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14 some robustness experiments reported below.
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17 Prior to the middle of 2006, FOBTs did not have to be registered with HMRC and so
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19 there are no data on the number of FOBTs up to this point. Although a few districts report
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21 the number of FOBTs in 2006, the first year for which we have complete data on the number
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23 of FOBTs is 2007. Hence, we use 2007 to judge whether or not FOBT machines have been
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25 installed in a district over the sample period. Following discussions with HMRC, we assume
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27 that all machines in LBOs within the new B2 category are FOBTs machines.
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31 Machine information was available for 2,760 Postcode Districts, 1,925 of which had
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33 at least one FOBT in 2007, whilst 835 had no FOBTs in 2007. We matched the machine data
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35 with data on population density by postcode, also supplied to us by HMRC and with claimant
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37 unemployment counts by postcode obtained from NOMIS – the official database of labour
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39 market statistics for Great Britain. Districts with missing data were dropped from the
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41 matching analysis and this reduced the sample size to 2,608 Postcode Districts, 1,905 with
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43 FOBTs and 703 without.
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50 51 **5. Results**

52 53 *Descriptive Statistics*

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55 We report descriptive statistics on the mean numbers of machines (broken down by category)
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57 in both FOBT and non-FOBT districts in Table 2. We report the numbers for 2001 (before
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59 any FOBTs were in place), for 2006, and the percentage change between the two periods. In
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3 Figure 1 we report plots of the annual number of machines per 1000 people for 9 regions of
4
5 Great Britain (including the countries of Wales and Scotland).
6
7

8 *Table 2 to appear about here*
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10 *Figure 1 to appear about here*
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12
13 The machine categories follow the definitions in existence at 2001 and described in
14
15 HM Customs and Excise (2003, p.10). Category A covers non-gaming machines, e.g. video
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17 machines, pinball tables and quiz machines with a cost per play exceeding 50p (cheaper
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19 machines being exempt). Category B covers small-prize gaming machines as well as
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21 medium-prize and jackpot machines with relatively low cost per play. Category C covers
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23 medium-prize gaming machines with higher costs of play. Category D covers higher-prize
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25 jackpot gaming machines with relatively low cost per play while Category E covers higher-
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27 prize jackpot gaming machines. As a guide (see HM Customs and Excise, 2003, p.11), these
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29 machines can be mapped to the following venues: Category A – pubs (93 per cent);
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31
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33 Categories B and C – pubs (38 per cent), seaside arcades (25 per cent), inland arcades (13 per
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35 cent), bingo halls (eight per cent), betting shops (seven per cent) and motorway services (one
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37 per cent); Categories D and E – private members clubs (95 per cent), casinos (three per cent)
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39 and bingo halls (two per cent).
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43
44 Several notable points stand out from the descriptive data. Although the mean
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46 number of total machines (i.e. in both LBOs and other venues) decreased between 2001 and
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48 2006 in both FOBT and non-FOBT districts, the percentage decrease in FOBT districts was
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50 smaller than in non-FOBT districts (11.33% compared to 18.25%). Looking within different
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52 machine categories, the mean number of C and D machines increased in both types of
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54 districts over the period, whilst there were decreases for each of the other categories. The
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56 patterns for the total number and the number in non-LBO venues are quite similar. For
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58 LBOs, however, the decrease in machines was much more marked, reflecting the direct
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3 substitution of FOBTs for traditional gambling machines in betting shops. Note that numbers
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5 of machines in Table 2 do not include FOBTs.
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8 Figure 1 reveals some differences in trends across regions. In particular, in some
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10 regions the number of machines per person was virtually unchanged in 2006 relative to 2001
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12 or (in the case of East Anglia) actually higher in 2006. Of the regions identified earlier as
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14 having a high concentration of machines, only the North West appears to have experienced a
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16 decline in the density of machines since the introduction of FOBTs.
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20 Next, there appear to be significant pre-existing differences between FOBT and non-
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22 FOBT districts in respect of several key variables. First, FOBT districts are characterised by
23
24 a much higher mean number of machines, in terms of total machines and especially within
25
26 LBOs. Second, FOBT districts have a significantly higher unemployment rate and
27
28 population density than non-FOBT districts. This suggests that FOBTs are much more likely
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30 to be in place in urban areas with fairly high numbers of existing gambling machines.
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34 The pre-existing differences between districts with and without FOBTs emphasise the
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36 point made above that simply comparing the relative changes before and after the existence
37
38 of FOBTs may lead to inappropriate inferences. For example, assume that the presence of
39
40 FOBTs actually had caused a relative decrease in the number of other machines between
41
42 2001 and 2006. Assume further that urban districts experienced both more FOBTs being
43
44 installed and an increase in the number of pubs relative to rural districts. The associated
45
46 increase in pub machines in urban districts might lead us to observe a relative increase in the
47
48 total number of machines in FOBT districts, even though FOBTs were actually causing a
49
50 relative decrease. This emphasises the importance of applying the matched difference-in-
51
52 difference estimator whereby we compare FOBT and non-FOBT districts that are similar in
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54 other respects. We now go on to report the results of these estimates
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Matching Difference-in-Difference Estimates

The basic matching estimates are reported in Table 3. We report the estimates for the percentage change in total number of machines (excluding FOBTs) as well as the number of machines in LBOs and non-LBO venues. We also report the estimates for each category of machine.

Table 3 to appear about here

The variables used for the first stage probit model are selected so as to satisfy the various balancing tests discussed in section 2 above. In every case, we cannot reject the null hypothesis that the samples are balanced at even a 10% significance level. The estimates in Table 3 use two variables in the first stage estimates: log of population density and the log of the total number of non-LBO machines in 2001. 479 FOBT districts were found to be outside the region of ‘common support’ (see section 3 above) and these were dropped from the analysis. This left a total of 1426 FOBT districts and 703 non-FOBT districts.

Note that a positive number in the “% Effect” column implies FOBT districts experienced a relative increase in the number of other machines compared to similar non-FOBT districts, whilst a negative number indicates a relative decrease. Asterisks indicate that the percentage change is significantly different from zero at the ten, five or one per cent levels.

The estimates in Table 3 indicate that the total number of other machines in FOBT districts did not change significantly over the period relative to matched non-FOBT districts. For example, the total number of machines in FOBT districts is estimated to have decreased by just 1.44% relative to non-FOBT districts, whilst looking only at machines in venues other than LBOs, there is a relative increase in FOBT districts of 1.85%. Neither these estimates, however, are even close to statistical significance. As expected, the number of LBO machines decreased significantly more in FOBT districts compared to similar non-FOBT

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3 districts. Clearly this represents direct replacement of other gambling machines with FOBTs
4
5 in LBOs.
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8 Looking at the different machine categories, there is no consistent pattern in terms of
9
10 the size of the estimated effect, but in no case do we find a decrease in either total or non-
11
12 LBO machines that is statistically significant at the 5% level.
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15 To summarise, Table 3 provides little or no evidence to suggest that the decrease in
16
17 the number of machines in venues other than LBOs was greater in FOBT districts compared
18
19 to similar non-FOBT districts.
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22 23 24 *Regional Analysis*

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26 In Table 4, we repeat the analysis on each of nine regions or countries in Great Britain. For
27
28 ease of presentation, we do not present the results broken down by machine category. We do,
29
30 however, report the results for total machines and for machines in non-LBOs and in LBOs.
31
32 The regional display greater variation than when the whole sample is used. This is perhaps
33
34 unsurprising given the smaller sample sizes in these cases. However, in none of the regions
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36 identified in Table 1 as being particularly vulnerable to the growth of FOBTs do we find
37
38 evidence of a significantly adverse impact of FOBTs on traditional machines in non-LBO
39
40 venues. In fact, in just one region (East Anglia) is the total number of machines in venues
41
42 other than LBOs found to have decreased in FOBT districts relative to similar non-FOBT
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44 districts. In all other regions the number of non-LBO machines in FOBT districts either
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46 showed no significant change or showed a relative increase compared to non-FOBT districts.
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53 *Table 4 to appear about here*
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Robustness Experiments

In Table 5 we present the results of the experiments that we carried out to test whether the above results were robust to alternative modelling strategies, samples and time periods.

Again, we only report here the results for all machine categories combined.

Table 5 to appear about here

The baseline results (taken from Table 3) are reported in the first row for comparison.

The experiments are reported in the remaining rows of the Table and differ from the baseline in the following ways:

- (i) We use an alternative set of matching variables (unemployment rate and population density) that also satisfy all the balancing tests.
- (ii) We estimate absolute changes in the number of machines, rather than percentage changes.
- (iii) We exclude all London Postcodes Districts. The rationale for this is that London is systematically different to most other areas in Great Britain in several ways. For example, one difference is that the population tends to be particularly mobile across Postcode Districts due to a relatively integrated and extensive public transport network.
- (iv) We use an alternative matching estimator based on the nearest 3-neighbours rather than the nearest-neighbour estimator used for the other estimates.
- (v) We exclude from the control group, those Postcode Districts with no FOBTs themselves but with a high density of FOBTs in the rest of their larger Postcode Area. This is an attempt to control for the possibility that districts in the control group (i.e. with no FOBTs within their boundary) may still be affected by the presence of FOBTs in nearby districts. Note that in this case, the balancing tests are not satisfied using the standard matching variables and, hence, we use just the

1
2
3 natural log of machines to match the groups. The result in Table 5 is based on
4 defining a high density of machines as being in the top half of the distribution.
5
6 However, the key finding is unaltered by changing this definition.
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10 (vi) We exclude from the analysis the districts in the lowest decile based on population
11 density. This is an attempt to control for the possibility that districts with very
12 low population density may be unrepresentative in some systematic way.
13
14 (vii) We examine the change between 2001 and 2005 to test whether our results are
15 sensitive to the selection of sample period.
16
17 (viii) We examine the change between 2001 and 2007, again to test whether our results
18 are sensitive to the selection of sample period. Note that we might expect any
19 impact of FOBTs to be stronger in this test as there is a longer time period for any
20 effect to take place. However, the significant change to the classification of
21 machines in 2007 means that we urge caution in relying on the 2007 comparison.
22
23 (ix) We re-estimate the 2001 to 2007 comparison, but including FOBT machines in
24 the 2007 totals. This experiment is possible due to the change in the treatment of
25 FOBTs by HMRC in this year which meant that all such machines were
26 registered.
27
28 (x) We exclude from control any district in which there are no LBO machines. This
29 allows us to compare districts with LBOs but no FOBTs with districts with both
30 LBOs and FOBTs. In principle, this can help us isolate the impact of FOBTs
31 from effects due to some other, unobserved attribute of LBOs. We should note,
32 however, that the sample size for the control group is reduced very significantly to
33 just 78 Postcode Districts. The balancing test, however, continues to be satisfied.
34
35 (xi) One question with our basic approach is whether FOBT and non-FOBT districts
36 differ systematically in some way which is not captured by our matching
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3 technique. Hence, in the final experiment we restrict the analysis only to those
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5 districts with at least some FOBTs in 2007, but compare those districts in the 25%
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7 highest number of FOBTs per person (“intensive” FOBT districts) to those with
8
9 the 25% lowest number of FOBTs per person (“light” FOBT districts).
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12 The results of the robustness checks are notably consistent with the main results reported
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14 above: there is little or no evidence that the presence of FOBTs resulted in significant
15
16 reduction in machines in non-LBO venues.
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20 One result of note is that when we include registered FOBTs in the totals for 2007
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22 (reported in the 10th row of Table 5) both total machines and LBO machines increase
23
24 significantly in FOBT districts, relative to non-FOBT districts. One interpretation of this
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26 finding is that LBOs installed more FOBTs than the standard machines that they replaced,
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28 thus increasing the total number of machines (FOBTs plus standard machines). However, we
29
30 suggest that this last result be treated with some caution for two reasons. First, it is not as
31
32 robust as the other results to different specifications. Second, 2007 saw a significant change
33
34 in the classification of machines such that the total number of registered machines decreased
35
36 by about a third. Hence, making comparisons between 2007 and 2001 relies on the
37
38 assumption that the structural change in 2007 affected both FOBT and non-FOBT districts in
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40 a similar way. In any case, the increase in non-LBO machines is once again not significantly
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42 different from zero.
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50 **6. Limitations and Conclusions**

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52 The consistent and striking results we report in this paper contribute to the well-established
53
54 literature on the economic impact on existing products of introducing a new gambling
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56 product into a region or district. We are unable to find any evidence that the number of other
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58 gambling machines in Postcode Districts with FOBT machines changed in a significantly
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3 different manner to districts without FOBT machines. In addition to being statistically
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5 insignificant, our point estimates of the effects are generally small in magnitude and have an
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7 inconsistent sign. In contrast, we find clear evidence of displacement of traditional gambling
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9 machines by FOBTs within betting shops. These findings appear to be consistent across most
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11 regions in the country.
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15 Put another way, we have been unable to identify any evidence that the growth of
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17 FOBT machines in LBOs has affected the number of gaming machines in other venues. As
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19 such, this challenges a widely held prior expectation that we would observe an impact.
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21 Indeed, many machine operators lobbied the Government precisely on this point – they
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23 argued that FOBTs would act as direct competition to their products and, indeed, would raise
24
25 into question the viability of many of their operations – for example, BACTA's (British
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27 Amusement Catering Trades Association) submission to the Parliamentary Select Committee
28
29 on Culture, Media and Sport (BACTA, 2008).
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34 This has, of course, important implications for policy concerning the location and
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36 licensing of new gambling facilities. Moreover, the tax advantages enjoyed by FOBTs
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38 compared to that of other gambling machines in the first few years of the new millennium do
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40 not appear, on the basis of this analysis, to have had a negative effect on the number of these
41
42 other machines.
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46 As with any statistical analysis, there are a number of caveats associated with these
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48 findings. Firstly, results are of course dependent on the quality of available data. We have
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50 no reason to doubt the reliability of these data in general. However, the allocation of
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52 machines into LBOs and non-LBOs is unlikely to be perfect. A further assumption we have
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54 made is that all LBO machines classified by HMRC as new category B2 are FOBTs and
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56 similarly that there are no FOBTs in other categories. Although this assumption seems
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3 reasonable, any misclassification of machines is likely to increase the noise associated with
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5 our estimates and to reduce the reliability of our inferences.
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8 In terms of the statistical analysis, we have found no evidence of a statistically
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10 significant impact from FOBTs, but this does not necessarily mean that there is no actual
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12 effect. It could be, for example, that there is an effect, but it is not large enough to be
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14 identified by our statistical tests. That said, our sample size is relatively large and as a result,
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16 we would expect to be able to observe effects that are large enough to be of economic
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18 significance.
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22 We believe that our matching difference-in-difference estimation procedure is both
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24 robust and an appropriate way to analyse this problem. Further, the matching tests indicate
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26 that the FOBT and non-FOBT districts are similar according to specific variables. It may be,
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28 however, that there are other unobservable characteristics which mean that the two groups of
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30 districts differ systematically from each other. That said, we find it reassuring that the final
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32 robustness experiment we carried out (comparing 'intensive' FOBT districts with 'light'
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34 FOBT districts) also led to the conclusion of no effect from FOBTs.
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38 Although these caveats should be taken seriously, the fact that our results are so
39
40 robust to alternative specifications is reassuring. In summary, we find no evidence, using our
41
42 postcode analysis, that the growth of FOBTs in licensed betting offices has had a significant
43
44 impact on the number of gambling machines in other venues or geographical areas.
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49

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51
52 Revenue (HMRC) for his extensive help in organising the data used in this paper and for
53
54 numerous helpful comments points of clarification. We would also like to thank Stephen
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56 Creigh-Tyte and two anonymous referees for their helpful suggestions.
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References

- BACTA (2008) Supplementary memorandum submitted by BACTA, *Written Evidence to the Select Committee on Culture, Media and Sport*, Jan, www.publications.parliament.uk/pa/cm200708/cmselect/cmcomeds/133/133we62.htm, accessed on 22 December, 2010.
- BARRON J., STATEN M. and WILSHUSEN S. (2002) The impact of casino gambling and personal bankruptcy filing rates, *Contemporary Economic Policy*, 20 (4), 440-455.
- BLUNDELL R. and COSTA DIAS M. (2000) Evaluation methods for non-experimental data, *Fiscal Studies*, 21: 427-468.
- D'HAUTESERRE A-M. (1998) Foxwoods Casino Resort: an Unusual Experiment in Economic Development, *Economic Geography*, 74 (March): 112-121.
- EUROPE ECONOMICS (2006) *Fixed Odds Betting Terminals, The Code of Practice and Problem Gambling*, accessed on 23 December, 2010, at: http://www.europe-economics.com/publications/abbl_2006.pdf
- CASINO ADVISOR PANEL (2007), *Final Report of the Casino Advisory Panel*, 30 Jan, http://webarchive.nationalarchives.gov.uk/+http://www.culture.gov.uk/cap/publications/finalreportcap_300107.pdf, accessed on 18 May 2010.
- DEHEJIA R. and WAHBA S. (2002) Propensity score matching methods for non-experimental causal studies, *Review of Economics and Statistics*, 84: 151-161.
- FORREST D., GULLEY O. D. and SIMMONS R. (2010) The relationship between betting and lottery play, *Economic Inquiry*, 48 (1), 26-38.
- GRINOLS E. and MUSTARD D. (2006) Casinos, crime and community costs, *The Review of Economics and Statistics*, 88 (1), 28-45.

- 1
2
3 HECKMAN J., ICHIMURA H., SMITH J. and TODD P. (1997) Matching as an econometric
4
5 evaluation estimator: evidence from evaluating a job training programme, *Review of*
6
7 *Economic Studies*, 64: 605-654.
8
9
- 10 HM CUSTOMS and EXCISE (2003) The modernisation of gambling taxes: consultation on
11
12 the review of amusement machine licence duty, London: HMCE.
13
14
- 15 KEARNEY M. (2005A) The economic winners and losers of legalized gambling, *National*
16
17 *Tax Journal*, 58 (2): 281-302.
18
19
- 20 KEARNEY M. (2005B) State lotteries and consumer behavior, *Journal of Public Economics*,
21
22 89 (11-12): 2269-2299.
23
24
- 25 LADOUCEUR R., LACHANCE S. and FOURNIER P. (2009) Is control a viable goal in the
26
27 treatment of pathological gambling? *Behaviour Research and Therapy*, 47 (3): 189-
28
29 197.
30
31
- 32 LEHMER F. and MOLLER J. (2008) Group-specific effects of intra-regional mobility on
33
34 earnings – a microdata analysis for Germany, *Regional Studies*, 42 (5, June): 657-673.
35
36
- 37 MINTEL (2010) Gaming Machines – U.K., January, London: Mintel International Group Ltd.
38
- 39 PATON D., SIEGEL D. AND VAUGHAN WILLIAMS L. (2002) A policy response to the e-
40
41 commerce revolution: The case of betting taxation in the UK, *Economic Journal*, 112
42
43 (480, June), 296-314.
44
45
- 46 PATON D., SIEGEL D. AND VAUGHAN WILLIAMS L. (2004) Taxation and the demand
47
48 for gambling: New evidence from the United Kingdom, *National Tax Journal*, 57
49
50 (Dec): 847-861.
51
52
- 53 PATON D. and VAUGHAN WILLIAMS L. (2006), *Evaluation of Competition between*
54
55 *Gambling Machines and FOBTs: a Report for HM Revenue and Customs*, London:
56
57 HMRC
58
59
60

1
2
3 PRICEWATERHOUSECOOPERS (2006), *Proposed Regional Casino Development -*
4
5 *Economic and Social Impact assessment*, Newcastle City Council,
6

7
8 www.newcastle.gov.uk/wwwfileroot/cxo/casino/18PWHCproposeddevel.pdf
9

10 downloaded 21st May 2010.
11

12 ROSENBAUM P. and RUBIN D. B. (1983) The central role of the propensity score in
13
14 observational studies for causal effects, *Biometrika*, 70: 41-55.
15

16
17 SIEGEL D. and ANDERS G. (2001) The impact of Indian casinos on state lotteries: A case
18
19 study of Arizona, *Public Finance Review*, 29 (2): 139-147.
20

21
22 SMITH J. and TODD P. (2005a) Does matching overcome Ladonde's critique of
23
24 nonexperimental estimators? *Journal of Econometrics*, 125: 305-353.
25

26
27 SMITH J. and TODD P. (2005b) Rejoinder, *Journal of Econometrics*, 125: 365-375.
28

29
30 WALKER D. and JACKSON J. (2008) Do U.S. gambling industries cannibalize each other?
31
32 *Public Finance Review*, 36 (3): 308-333.
33

34
35 WALKER D. and JACKSON J. (2011) The effect of legalized gambling on state government
36
37 revenue, *Contemporary Economic Policy*, 29 (1): 101-14.
38

39
40 WENZ M. (2008) Matching estimation, casino gambling and the quality of life, *The Annals*
41
42 *of Regional Science*, 42 (1, March): 235-249.
43
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Table 1: Density of gambling machines by region 2001

Machine type	All Machines	Non-LBO machines
All regions	3.80	3.63
East Anglia	4.19	4.08
London	3.04	2.91
Midlands	3.66	3.53
North East	4.54	4.37
North West	4.22	3.97
Scotland	3.79	3.51
South East	3.18	3.07
South West	3.81	3.72
Wales	3.73	3.60

Note: figures are the number of machines per 1000 population.

Table 2: Mean Numbers of Machines per District in 2001 and 2006

Machine type	Non-FOBT districts			FOBT districts		
	2001	2006	% change	2001	2006	% change
All	18.55	15.89	-18.25	113.6	108.4	-14.26
All A	2.35	1.05	-67.15	12.37	11.50	-57.61
All B	3.30	0.93	-85.18	16.65	3.95	-117.0
All C	10.51	11.21	8.94	72.95	75.58	1.87
All D	0.63	0.64	2.63	3.20	3.28	4.58
All E	1.75	1.26	-26.91	8.46	7.72	-25.77
Non-LBO	18.28	15.76	-17.47	106.6	105.7	-10.09
Non-LBO A	2.35	1.06	-67.15	12.3	11.49	-57.57
Non-LBO B	3.25	0.93	-84.88	16.2	3.94	-114.7
Non-LBO C	10.29	11.09	10.06	66.5	72.95	9.47
Non-LBO D	0.63	0.64	2.63	3.20	3.28	4.57
Non-LBO E	1.75	1.26	-24.86	8.44	7.72	-25.48
LBO	0.27	0.13	-11.33	6.98	2.69	-86.36
LBO B	0.04	0.00	-6.17	0.43	0.01	-52.10
LBO C	0.22	0.13	-7.96	6.48	2.63	-80.91
Pop density		3.11			21.00	
Unemployment rate		0.80			1.28	
Number of districts		835			1,925	

Notes:

(i) Machines are the mean number of machine per Postcode District. Pop density is mean number of people per km² in each district in 2001. Unemployment rate is the mean claimant unemployment count divided by total population in 2001.

(ii) % change is the mean percentage change in each Postcode District, excluding districts with zero values in 2001.

(ii) Figures exclude FOBT machines registered in 2006.

Table 3: Matching Estimates of FOBT presence on machines

(nearest neighbour estimates)

Dependent Variable (all in changes 2001-2006)	% Effect	SE
All	-1.44	4.54
A machines	-3.20	15.15
B machines	-1.45	9.35
C machines	0.34	4.65
D machines	-19.15*	10.43
E machines	22.12**	11.01
Non-LBO	1.85	4.91
A machines	-3.16	12.84
B machines	-0.23	9.94
C machines	7.09	5.01
D machines	-19.16*	11.24
E machines	23.29*	12.16
LBO	-42.35***	8.92
B machines	-20.20***	7.23
C machines	-42.59***	11.00
Number controls	703	
Number treated (on support)	1,426	
Number treated (off support)	479	

Notes:

(i) *** indicates t-test is significant at 1% level; ** at 5% level; * at 10 % level.

(i) Data excludes those LBO FOBT machines registered in 2006.

(iii) Observations outside the common support are excluded.

(iv) Standard errors are bootstrapped using 100 replications

(v) Variables used for matching are the log of the number of non-LBO machines in 2001 and the log of population density.

Table 4: Regional analysis of the impact of FOBT presence on machines

	Total		Non-LBO		LBOs		Balancing
	Effect (%)	SE	Effect (%)	SE	Effect (%)	SE	test
							p-value
East Anglia	-28.34*	16.53	-25.73	16.81	-13.18	30.12	0.84
London	-4.71	31.29	2.91	38.36	-141.0***	53.42	0.80
Midlands	0.55	7.35	2.64	7.51	-35.68	27.95	0.74
North East	-0.03	15.21	1.59	15.31	-5.80	22.14	0.75
North West	8.76	10.01	12.50	8,64	-53.25**	20.92	0.75
Scotland	35.56***	13.06	38.20**	15.22	-16.05	22.92	0.98
South East	-13.03	15.35	-9.06	14.01	-80.44***	14.45	0.50
South West	11.95***	4.43	14.36***	5.20	-45.45	29.72	0.88
Wales	16.59	11.94	20.40	14.05	-54.91	35.48	0.72

Notes: see Table 3.

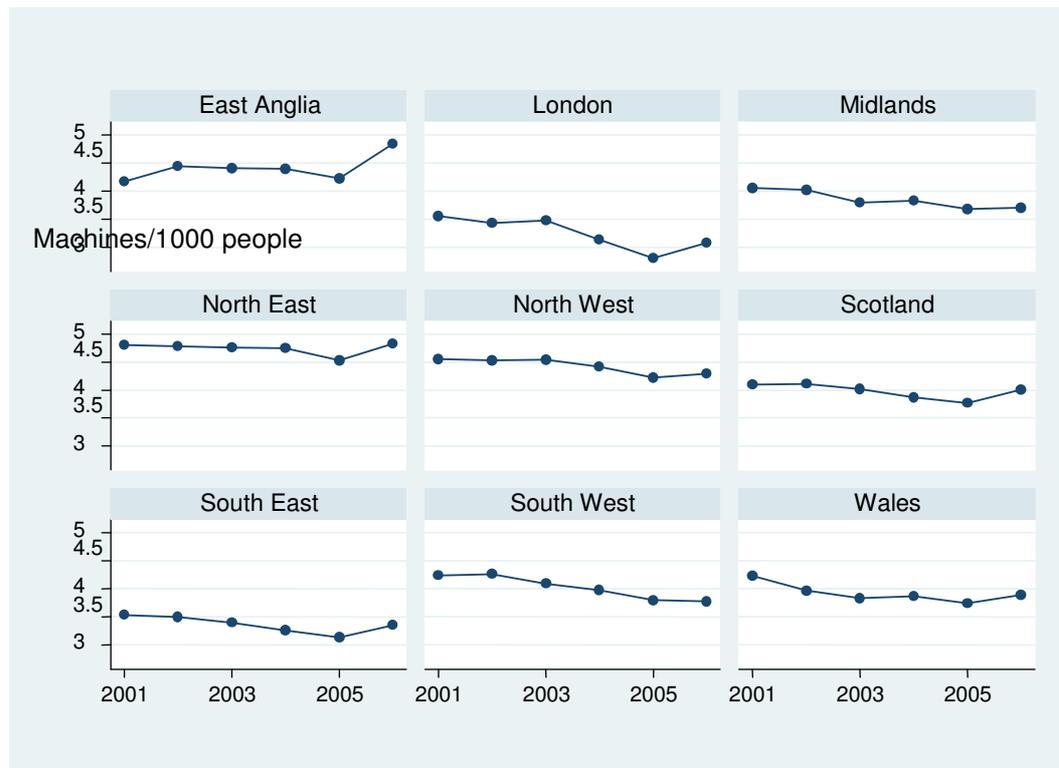
Table 5: Robustness Checks of Matching Estimates of FOBT presence on machines

	Total		Non-LBO		LBOs		Balancing
	Effect (%)	SE	Effect (%)	SE	Effect (%)	SE	test p-value
Baseline (from Table 3)	-1.44	4.54	1.85	4.91	-42.35***	8.92	0.99
Alternative matching variables	-7.68	6.71	-4.95	7.04	-54.96***	7.85	0.33
Absolute Changes	-4.24	4.82	-2.21	4.65	-2.02***	0.24	0.99
Without London	0.56	4.70	3.48	4.95	-41.49***	11.14	0.22
Nearest 3 neighbours	-0.78	5.09	2.52	4.42	-37.89***	13.00	0.87
Bordering postcodes	0.01	0.04	-0.04	0.04	-26.12*	15.66	0.80
Excluding low-density	-2.26	4.79	0.58	4.45	-36.84***	9.32	0.24
Change 2001-2005	-0.21	3.66	2.40	2.74	-32.54***	10.47	0.99
Change 2001-2007	3.94	6.29	8.64	5.89	-104.49***	17.07	0.99
Change 2001-2007 (inc FOBTs)	26.90***	6.33	8.64	5.50	85.09***	16.57	0.99
Only districts with LBOs	9.03	9.31	10.80	9.21	-35.70	23.09	0.79
Intensive vs Light FOBT districts	0.04	0.05	0.09*	0.05	-17.51*	10.06	0.82

Notes:

- (i) Except where otherwise stated, the dependent variable is the percentage change in machines between 2001 and 2006.
- (ii) *** indicates t-test is significant at 1% level; ** at 5% level; * at 10 % level.
- (iii) With the exception of the 10th row, LBO FOBT machines are excluded.
- (iv) Observations outside the common support are excluded.
- (v) Standard errors are bootstrapped using 100 replications
- (vi) Matching variables are as in Table 3. The exceptions are row 2 where the variables are claimant unemployment rate and population density and row 6 where population density alone is used.

Figure 1: Machines per 1000 people by region: 2001-2006



Endnotes

- Several other areas of the UK have consistently argued that gambling can play a central role in regional development, see, for example, PricewaterhouseCoopers (2006).