FOB-Ts in British betting shops: Further analysis of machine data to examine the impact of the £50 Regulations

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January, 2017

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EXECUTIVE SUMMARY

1. Our brief was to evaluate the impact of the introduction of the *£50 Regulations*, which were introduced in April, 2015, and which changed the conditions of use of Fixed Odds Betting Terminals (FOB-Ts) (gaming machines provided in British bookmaker shops). Analysis was to be based on data provided by the machine manufacturers. Particular attention was to be paid to identifying any changes in how players used the machines that might be indicative of either mitigation or aggravation of gambling-related harm.

2. For several years, concern has been expressed about the relatively high staking limit of £100 on FOB-Ts. This feature is said to present an opportunity to lose significant sums of money in a short time. The Gambling Commission noted at one stage that about 6% of all sessions on a FOB-T ended in the player losing more than £100.

3. The £50 Regulations were a response to these concerns. While the maximum stake was left at £100, those who wished to place a bet of more than £50 would in future have to do so within a 'verified account' or by obtaining 'over-the-counter-authorisation'.

4. This is an example of 'Nudge' policy. Individuals are nudged towards modifying their behaviour by the non-coercive means of placing a small obstacle in the way of making a risky choice. The literature includes many examples of parallels outside gambling. Some of these measures have been successful in achieving their goals but others have failed because individuals varied other, related decisions in ways which meant that, overall, their level of risk was unchanged (and it could even be raised).

5. The data made available for analysis consisted of weekly summaries of FOB-T activity between February, 2014 and October, 2016. The unit of observation was the player session (one use of the machine by one anonymous player). Thus we had, or could calculate, statistics such as number of plays per session, average session duration, and numbers of sessions ending in a player win or loss within specified ranges. We paid particular attention to the metrics where it was plausible to regard the statistics as likely correlated with harm, for example the number of sessions ending in a player loss of more than £500.

6. We found that nearly all data series analysed were subject to influence by seasonal factors and therefore deseasonalised the data prior to modelling using standard statistical procedures.

7. Many data series exhibited a strong upward or downward trend prior to the Intervention. This makes it harder to evaluate the effects of the Intervention. For example, the end of our data period was October, 2016. One way of estimating the effect of the Intervention would be to compare the value of a statistic in October, 2016 with its value immediately pre-Intervention. The implied counter-factual behind such a comparison is that the World would have stayed exactly where it had been at the beginning of April, 2016 but for the Intervention. An alternative is to compare the value in October, 2016 with a value for October, 2016 projected from a trend observed up to the point of Intervention. The implied counter-factual in this case is that statistical indicators would simply have continued to change in accordance with previous trends if the

Intervention had not taken place. Typically we quote findings based on each of these two alternative counter-factuals. Sometimes this makes findings imprecise but we are able to draw confident conclusions in most cases.

8. The data show that the policy had an immediate and substantial impact on players who had previously placed bets above £50. The weekly number of plays with a stake of more than £50 *and* the total money value of stakes spent on such plays both declined precipitously at the precise point of Intervention. There was a further decline in each data series during the following months. However, staking above £50 revived somewhat during 2016 as more players used verified accounts. Even so, in October, 2016, the weekly amount wagered on stakes above £50 was still less than half of what it had been before the £50 Regulations.

9. Thus the 'nudge' was conspicuously successful in terms of its immediate objective of deterring players from placing bets of more than £50 on individual plays. Previous research has suggested that a majority of high stakes players experience gambling problems. However, whether there would be mitigation of harm among those players would depend on where the money previously used for high stakes went. For example, the players might have continued with their previous behaviour online instead of at FOB-Ts, or switched to playing B3 slots games (low stakes games available on the same machines, where greater permitted speed of play and higher volatility of returns could expose them to new risks).

10. We found that, following a period of adaptation, the fall in total stakes from bets above £50 was close to being exactly offset by an increase in total stakes from bets just within the new 'soft cap' of £50. This is consistent with players preferring not to opt into tracked play but rather deciding to spend similar stakes as before but spread across more lower-denomination plays. It is not consistent with funds being transferred to play in other gambling channels or in alternative games on the machines themselves. The latter point was confirmed by our finding that the (upward) trend in slots play on FOB-Ts was barely disturbed by the Intervention.

11. Placing a similar amount of stakes but split across more spins implies either more frequent or longer sessions or both. We found no strong evidence of an impact on total number of sessions. We did find strong evidence that the mean duration of sessions and the mean number of plays per session both increased. Typical sessions on machines are short (below 10 minutes). The number of such sessions continued to decline in line with the previous trend. But there was a significant increase in the number of sessions in each duration band above 45 minutes. Substitution between stakes above £50 and stakes in the band immediately below appears to have led to many already long sessions becoming longer.

12. If the effect of the Intervention was to lead to a pool of players (likely to include many problem gamblers) changing behaviour but still spending the same amount of money as before and extending the time spent at the machines, it seems unlikely that the Intervention achieved its ultimate goal of harm mitigation.

13. Average speed of play had been increasing over time. This trend continued after the Intervention, apparently little disturbed by the new rules. There is therefore no evidence that players adopted a more considered way of playing as a result of the Intervention.

14. It is possible for 'nudges' to be counter-productive. In this case, while we found that money staked in high stakes play appears simply to have been diverted into slightly lower stakes play, there was the risk that the players concerned would adopt riskier strategy in their roulette games. For example, a £50 spin might not be as exciting as a £100 spin, so a less conservative set of sub-bets may be placed to maintain suspense. This would make for greater volatility in returns and an increased frequency of very high losses over a session. This could increase harm.

15. We examined the weekly number of sessions ending in various ranges of financial outcome. High losses occur most often in roulette-only sessions but the number arising from slots sessions is still significant. We found that the frequency of losses in the hundreds of pounds was appreciably higher after the Intervention. However, the frequency had been increasing strongly before the Intervention and so the increase after the Intervention could be interpreted as just a continuation of trend. Therefore we found no strong evidence that the Intervention was actually counter-productive in terms of its effect on the incidence of very high sessional losses.

16. Generally, our findings do not support the proposition that nudging players towards lower stakes mitigated harm or made play more responsible.

17. The £50 Regulations could be regarded as an experiment in lowering maximum stake because most players appear to have treated the £50 limit as if it were a hard cap. At the time of writing, many propose further reductions in maximum stake. The disappointing findings about what seems to have been the ineffectiveness of the last change do not necessarily imply that a future reduction would fail to mitigate harm. A lower cap would affect a new group of players who might respond differently from those who favoured the highest staking levels. Nevertheless our findings indicate that it may be optimistic to focus just on one element in the choice architecture of players (the stake) while neglecting others (such as speed of play or mechanisms for paying).

INTRODUCTION

1.1 Background

Fixed odds betting terminals (FOB-Ts) are gaming machines found in British bookmaker offices. They began to appear in significant numbers from 2001 following a change in the structure of gambling taxes which made it more attractive for operators to provide low-margin products, such as simulated roulette, the most popular game played on the machines. At first their legal status, as to whether they were subject to regulatory control, was ambiguous. In 2003, to avoid legal process, the regulatory authority of the time agreed with the Association of British Bookmakers that the machines could stay but subject to a new Code of Practice which limited the number of gaming machines (including FOB-Ts) to four per shop; it was also determined that there would be restrictions on stake size per play (£100 maximum), prize level (£500 maximum) and speed of play (20 seconds between plays).[1]

Subsequently these restrictions were enshrined in the new framework for the regulation of gaming machines in Great Britain, introduced by the Gambling Act (2005). The Act defined new machine categories, each with a maximum stake, a maximum prize and a minimum gap between consecutive plays. Each category is limited to specified types of establishment. For example, sub-category B1 machines are restricted to casinos and the regulatory rules are that the maximum stake on one spin is £5 and the maximum prize £10,000 (£20,000 on single-premises linked jackpots); speed of play is controlled by specifying a game cycle of 2.5 seconds (i.e. the minimum gap between spins is 2.5 seconds).

FOB-Ts fell within the sub-category B2, where the restrictions were to be the same as in the ad hoc agreement made in 2003: *maximum stake £100, maximum prize £500, game cycle 20 seconds*. B2 gaming was permitted only in betting premises and in casinos. B2 users typically play simulated roulette though slots games are also offered.

In addition to being used for B2 play, FOB-Ts could also be used to play as B3 machines.[2] If used for B3 play, which offers slots games, the maximum stake is only £2 but the maximum prize is still £500 and the speed of play can be faster (minimum of 2.5 seconds between consecutive spins).

[1] Further detail on the history of FOB-Ts is provided in J. Woodhouse, *Fixed Odds Betting Terminals*, Briefing Paper 06946, House of Commons Library, April, 2016.

[2] B3 machines are permitted in bingo halls and adult gaming centres as well as in betting shops and casinos.

At the most recent official count, there were 34,684 FOB-Ts in licensed betting offices in Great Britain[3] (a slight decline on the previous year, in line with a slight fall in the number of betting shops). They accounted for nearly two-thirds of the gross gaming yield of all gaming machines regulated by the Gambling Commission and more than 55% of the gross gaming yield generated in off-course betting premises (that is, they generated significantly more revenue in betting shops than betting itself).[4]

While they therefore provide a successful commercial product, the presence of FOB-Ts in betting shops has been very controversial. Critics have focused on the much higher maximum stake size compared with that set for other gaming machines[5] and the consequence that there is a potential for players to lose substantial sums of money in a short space of time. Moreover, the density of the betting shop estate in relatively deprived areas makes the machines highly accessible to vulnerable populations which may be particularly susceptible to gambling-related harm.

The bookmaker industry responded to concern over potential harm by initiating player protection programmes.[6] It has now also initiated a Player Awareness Scheme. This is a framework for using algorithms to detect when account-based customers display potentially problematic patterns of play, with a view to delivering an intervention intended to encourage more responsible gambling. Evaluation of this relatively recent initiative is ongoing.

There has also been regulatory response to concern over potential harm linked with FOB-Ts, for example mandating multi-operator self-exclusion schemes. Another regulatory initiative, and one directed specifically at the issue of high-stakes play, was to use secondary legislation to

[3] There were also 200 B2 machines located in casinos.

[4] *Industry Statistics, April 2013 to March 2016*, Gambling Commission, 2016, http://www.gamblingcommission.gov.uk/pdf/Gambling-industry-statistics-April-2013-to-March-2016.pdf

[5] The next-highest stake size is £5, for B1 machines, which account for most machines found in casinos. However, it should be borne in mind that the maximum speed of play permitted on B1 machines is eight times faster than the maximum allowed on B2.

[6] For example, mandatory alerts were introduced in March, 2014. These warn players when they have spent £250 or have been playing for 30 minutes. Subsequently another measure gave players the facility to set a money or time limit when they commence a session. An early evaluation of the programme showed no strong impact on player behaviour: see S. Salis, H. Wardle, S. Morris & D. Excell, *ABB Code for Responsible Gambling and Player Protection: Evaluation of early impact among machine gamblers*, NatCen Social Research for The Responsible Gambling Trust, 2015.

introduce the Gaming Machines (Circumstances of Use) (Amendment) Regulations, 2015. Commonly known as 'the £50 Regulations', this intervention took legal effect on April 6, 2015. The purpose of our Report is to investigate the effect of the £50 Regulations.

1.2 The £50 Regulations

The new rules left intact the maximum staking limit of £100 attached to gaming on a B2 machine. However, conditions were imposed on those who wished to wager more than £50 on a single play. They would have to either place the stake within account-based play (through a *verified account*) or obtain over-the-counter authorisation from shop staff.[7]

According to an ex post review by the Department for Culture, Media and Sport, the new provision had been intended to address the concern that FOB-Ts "present a combination of high stakes and natural game volatility that can generate significant losses in a short space of time". It noted that the Gambling Commission had advised that "a small but significant proportion of sessions on B2 machines result in high losses, with approximately 6% of sessions resulting in a loss of more than £100".[8]

Given this rationale for the policy intervention, we shall pay particular attention to changes in the incidence of high losses since the Regulations were introduced. But how were the new rules expected to have the desired outcome?

1.3 Expected effect of the £50 Regulations

Discouraging the placing of high stakes by requiring registration or authorisation appears to be a classic "nudge" policy. The idea of public policy relying on such indirect means of inducing behavioural change was popularised in behavioural economics by Richard Thaler and Cass Sunstein, who defined a nudge as a modification of "any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly

[7] On the first occasion that a customer seeks to stake more than £50, authorisation must be through a staff member loading cash at the counter. Subsequent authorisations may be made at the machine.

[8] Department for Culture, Media and Sport, *Evaluation of Gaming Machine (Circumstances of Use) (Amendment) Regulations 2015*, January, 2016.

changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid".[9]

An example of a proposal, not in fact implemented, to "improve" behaviour by such a non-coercive measure was that advanced by Julian Le Grand, a Professor at the London School of Economics and Chairman of Health England. In 2008, he advocated that smokers should have to apply annually for a government permit which would be required for purchasing cigarettes. This would be a relatively small cost in terms of time and trouble but the idea was that it could still induce many smokers to give up. Perhaps the need to fill in a form would trigger individuals to make a reassessment of their long-term costs and benefits from smoking.[10]

The parallel with the £50 Regulations introduced in 2015 is fairly close. High stakes play could be damaging to users of FOB-T machines. Facing them with what seems to be a small bureaucratic barrier might still induce some of them to eschew high stakes play. Harm should be reduced since some of those who stake high get into trouble.

In the case of the £50 Regulations, there was the additional potential benefit that even those who *were* willing to register for a player account or seek authorisation over the counter might subsequently behave in a more considered and responsible way. Interaction with staff at the counter might provide a reality check. Account holders might make better informed decisions because they can be shown data on the screen of the machine about how much they have spent. In the future, they may become better protected as player awareness schemes and the algorithms on which they depend are refined to allow effective monitoring of problematic play and useful follow-up interventions.

From previous studies to be summarised below, and as confirmed by our own analysis to be presented in this Report, it is clear that the policy had its planned effect in that there was an immediate, sustained and very steep fall in the frequency with which users of FOB-Ts placed stakes of more than £50.[11] Take-up of verified accounts proved to be relatively low and the

[9] R. Thaler & C. Sunstein, *Nudge: Improving Decisions about Health, Wealth and Happiness*, Yale University Press, 2008.

[10] https://www.theguardian.com/uk/2008/feb/15/smoking.health

[11] There are several parallel examples in the nudge literature where a small barrier to repeating previous behaviour curtailed that behaviour significantly, for instance placing unhealthy food in a position where it is slightly more effort to reach reduced purchases substantially. See P. Rozin (and 5 others), 'Nudge to nobesity I', *Judgement and Decision Making*, 6: 323-332, 2011.

number of over-the-counter authorisations still lower. This suggests that previously high-staking players typically evaluated the psychic cost of registration or authorisation as high (the cost could be embarrassment or fear of loss of privacy, for example). Effectively, they treated the £50 limit as binding, as if the maximum stake for them had been lowered from £100 to £50.[12]

However, while the propensity to play for high stakes was reduced dramatically, this will not have guaranteed the achievement of the *ultimate* goal of the policy, which was harm reduction. Critics of nudge theory argue that individuals are not as easily manipulated as its advocates claim. Individuals may face a new constraint in their decision making but they retain freedom to adjust other variables which remain under their control. Modifying behaviour using these other variables may frustrate the achievement of the ultimate policy goal or even render the policy counter-productive.[13]

In the case of individuals treating the new machines regime as if it had imposed a £50 stake limit, they had the freedom to adjust their behaviour in a number of ways in response to the intervention. They could decide to play more often or to play at faster speed or to extend the length of each session or to choose riskier bets.[14] All of these options have the *potential* to expose players to at least as much risk as if the £50 Regulations had not been introduced.

To illustrate, consider the choices open to players of roulette, the most popular game on FOB-Ts. On any single play, it is normal to make a number of sub-bets. All have the same expected return but they have different variance (or volatility). For example, a bet on red will win *nearly* half the time but a winning bet gives a profit equal only to the amount staked. By contrast, a bet on a single number is very much less likely to win but the pay-off is correspondingly greater. Although the expected return of these two bets is identical, the volatility of return (referred to as

[12] To this extent, for most players, the new policy could be regarded as a trial of lowering stake limits.

[13] The policy may also be frustrated by a response from suppliers. A large-scale evaluation of a regulation in New York which required calorific content of each dish to be included in the menus of chain restaurants found that the goal of reducing the energy content of meals purchased was achieved at some chains. However, at Subway, mean calorific content of meals increased. The authors noted that, following the new regulation, Subway had promoted new super-sized sandwiches at an attractive price. While our narrative in the text below focuses on choice on the demand side, it should be noted that outcomes may also have been modified by bookmaker responses to regulations. For details of the calorie intake study, see: T. Dumanovsky and 5 others, 'Changes in energy content of lunchtime purchases from fast food restaurants after introduction of calorie labelling: cross sectional customer surveys', *British Medical Journal*, 343:d4464, 2011.

[14] They could even decide to play online instead of in shops. Then they would face no limits on stakes except those imposed by operators for commercial reasons.

risk in the finance literature) on the second bet is much higher. As such, on a single spin, players can effectively construct a portfolio of sub-bets in line with their own risk-reward preferences.

Consider a simple if highly stylised example which does not describe the behaviour of the typical player[15] but does capture the essence of how the £50 limit could lead to riskier play. To make the game sufficiently suspenseful, a particular player needs to have the chance to collect £200 on the spin of the wheel. For him, given his particular circumstances, that is the pay-out the prospect of which is sufficiently exciting to make participating in a spin worthwhile. Allowed to stake £100, he bets on the outcome being an even number. There is a probability of .513 that he will lose his £100.

Given a new £50 stake limit, he now determines to buy two spins instead of one, to allocate the same £100 budget as before. But it is no longer possible to achieve a pay-out of £200 on a single spin by betting on an even number because the odds on that sort of bet are only 1:1. A successful £50 bet would collect only £100. Adequate suspense would be lacking. Therefore he splits each £50 between nine sub-bets of £5.55 on single numbers (given the long odds, £5.55 is the stake required to collect his desired £200). The probability that he will lose all of his £100 is now .573 instead of .513.

If forcing lower stakes typically induces players to adopt riskier portfolios of sub-bets (for some of them effectively replacing high stakes with volatility as a source of excitement), there is therefore a *possibility* that frequency of 'high' losses will increase instead of decrease following the introduction of a lower limit on stakes.[16] The same possibility would arise if players switched some of their play from B2 to B3 games.[17] In either case, adaptation to the new regime might then lead to gambling-related harm increasing instead of decreasing.

Whether the policy achieved its goal of harm reduction or whether it had no or even perverse consequences is of course an empirical matter. It cannot be settled by *a priori* reasoning. One

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[15] who may include, for example, lines of numbers or else cover areas of the board.

[16] There is a correspondingly increased probability of a high-winning session (our player in the stylised example could win on each £50 spin) but this might not lead to significant mitigation of harm if winnings are typically reinvested and returned to the machine as 'house money'.

[17] Customers can choose between different B3 games with different risk-reward profiles. However, given that the maximum stake is only £2 and the maximum prize is £500, they are typically designed such that they exhibit high volatility of returns compared with the volatility associated with common styles of play in roulette.

could construct alternative scenarios where a player responded to the new limit by decreasing risk. It is necessary to examine the data.

The purpose of this Report is to interrogate the data to establish whether it is plausible that the policy did or did not mitigate harm. Unfortunately it is not possible to observe harm directly. However, like previous studies of the £50 Regulations, we will be able to analyse metrics which are likely to be proxies for harm, at least to an extent.

1.4 Previous studies

Study by the Department for Culture, Media and Sport (DCMS)

In January, 2016, DCMS published an early Evaluation of the impact of the £50 Regulations.[18] It analysed key metrics derived from aggregated weekly data supplied by the industry and covering a period of 93 weeks. The £50 Regulations were in place from week 66 of the data set.

Some of the analysis presented in the DCMS Report consists of taking a given metric, for example total amount staked on B2 roulette, and graphing the time series before and after the Intervention.[19] A trend line is fitted to the pre-Intervention time series and is shown projected into the post-Intervention period. At the end point of the graph, it is therefore possible to compare where the time series actually was with where it would have been had the old trend continued (as it was assumed it would have done absent the Intervention).

There are also tables summarising quarterly data, for example the amount of revenue deriving from different sizes of stake (below £40, £40-£50, above £50). These tables allow the reader to compare figures for the two quarters after Intervention with the same quarters in the previous year.

While these charts and tables are informative, their value is limited by the brevity of the post-Intervention period available for analysis. At Intervention, players were confronted with new rules for play. It would surely be normal for individuals to take time to adapt to new circumstances. For example, it would not be hard to imagine a player (who used to make some stakes above £50) initially just playing in exactly the same way as before and for the same length of time as before except that he would now stake £50 instead of a greater sum whenever a point

[18] For the reference, see Footnote 8 above.

[19] Whenever we discuss or present statistical analysis on the impact of the introduction of the £50 Regulations, we shall refer to it (for the sake of brevity) as "the Intervention".

in the session was reached where he wanted to make a high stake. However, over time he could explore new styles of play, different durations of session, etc. As he adopted these, it might be that, although his expenditure fell precipitously at first, it would gradually increase back to the old level. If the post-Intervention period for analysis is too short, it might be that, at the end of the period, he is showing an upward trend in expenditure but it has not yet reached its old level. It would not then be possible to say for this hypothetical player (and therefore for the aggregate of players) whether expenditure had been reduced compared with initially because it would be unknown whether the period of adaptation was over.

With that caveat, the Report can be said to have revealed a number of interesting stylised facts of how players collectively responded to the Intervention:

- Take-up of verified accounts was low and take-up of over-the-counter authorisation very low. Hence most players who may sometimes have staked above £50 before appear to have accepted a new constraint of having to stay within a £50 limit. As a result, there was a large decrease, about two-thirds, in the amount staked in bets over £50.

- Comparing the two quarters post-Intervention with the same two quarters in the preceding year, the amount staked in bets over £50 fell by £6.2b.

- There was a substantial increase, about four-fold, in the amount staked in the range £40-£50. Comparing the two quarters post-Intervention with the same two quarters in the previous year, the amount staked in bets £40-£50 rose by £5.1b.

- The amount staked in bets below £40 increased slightly in the first quarter of the new regime compared with the corresponding quarter of the preceding year and by rather more, if still modestly, in the following quarter.

- To a large extent therefore, the effect on the total amount staked in B2 play at the highest stake levels was offset by a corresponding change in the amount staked at lower levels. Overall, total stakes in B2 play were 3.7% lower in the first quarter post- Intervention compared with the same quarter in the previous year and 0.7% lower in the second quarter post-Intervention compared with the same quarter in the previous year.

- Week-by-week comparisons with the previous year (which controls for seasonality) suggests that, by the end of the study period, total B2 stakes were getting close to what they had been before Intervention. The gap would be a little greater if the comparison were with the volume of stakes projected from the pre-Intervention upward trend.

- There was some indication of increased growth in stakes placed on B3 games played on the machines.

- Mean session duration, as measured weekly, increased such that, across all weeks post-Intervention, the average was 6% higher (compared with the pre-Intervention period).[20]

- Though not part of the data set analysed, separate figures from industry sources were reported to show that the difference in speed of play between two periods either side of Intervention was tiny.

A possible and, to us, plausible interpretation of these various findings is that the *broad* effect of the £50 Regulations was to induce players to replace bets of more than £50 with bets of close to £50 while (at the end of a period of adaptation) not in fact spending a very different amount than before. The changes in their pattern of play involved spending somewhat more time per FOB-T session.

These general findings are an interesting starting point but do not take us very far towards being able even to speculate on the impact of the Intervention on gambling-related harm. For example, total staked on its own is not very informative in this regard. It *could* be that, collectively, a similar amount of money was staked (and a similar amount of money lost) by players as before but that there was a change in the distribution of losses (more cases of high loss in a single session) because of a switch towards bets with greater volatility of returns.

Similarly, there is not much to be inferred directly from the data on *mean* duration of session. Gambling-related harm is indeed associated with 'excessive' time spent gambling. However, when the mean is only of the order of 10 minutes, an increase of 6% would scarcely be likely to have strong consequences for the individual. As very often in gambling data, the behaviour of concern is not in fact captured at the mean but rather at the extreme of the distribution (of session duration in this case). Presumably because the authors were not supplied with the relevant data, the DCMS Report does not discuss any impact the Intervention may have had on the frequency of very long sessions (for example, more than four hours).

Compared with the DCMS Evaluation, our analysis will be able to document the evolution (pre- and post-Intervention) of the number of sessions ending in various amounts of player loss (e.g. more than £200) and in the number of sessions lasting various amounts of time (e.g. duration of more than three hours). The range of data available to us will also permit analysis of speed of play, which is relevant to the extent that part of the rationale for the Intervention was to nudge users of FOB-Ts towards more considered play.

[20] The figure refers to sessions which included B2 play. The increase in duration was larger for B2-*only* sessions.

In addition to the benefit of being able to employ data series which could be argued plausibly to be more closely related to harm, we will also have the advantage of observing data extending for a much longer period post-Intervention. This will remove ambiguity concerning whether behaviour was still adapting at the end of the study period and indeed we will be able to attempt to estimate the length of the adaptation period for each data series.

Data review by the Gambling Commission[21]

As with the DCMS study (and as with ours), the data review by the Gambling Commission employs weekly sessional data from the industry, aggregated across all machines. The unit of observation in the *underlying* data is a session by an (anonymous) player.

The review presents results in tables comparing one year of pre-Intervention data (February, 2014-January, 2015) with one year of post-Intervention data (July, 2015-June, 2016). By comparing two full years, it is able to avoid complications arising from month-to-month seasonality since each month appears in each period. By omitting the months between February and June, 2015, the review avoids any distraction from turbulence in the data around the time of the Intervention and implicitly allows for a period of adaptation by players (albeit with a length the determination of which is not stated and which is constrained to be the same for all data series).

We judge the review's basis for comparing pre- and post-Intervention data to be fair but add a cautionary note. Some data series will have exhibited a trend pre-Intervention. For example, to preview our own analysis, mean stake-per-play was increasing fairly steadily prior to the Intervention. Perhaps it could be argued that there was no reason to suppose that this trend would not have continued in the absence of the Intervention. Then the change associated with Intervention would be better captured by comparing the data for July, 2015- June, 2016 with projected data for that year rather than with actual data from the previous year. Of course there is no definitive 'right' answer as to how to proceed since the true counter-factual (what would have happened absent the Intervention) is unknown.

Some of the key findings from the Gambling Commission review of the data are as follows:

- The number of sessions including at least one play with a stake above £50 has fallen substantially. This is another illustration that many players were reluctant to register or seek authorisation.

[21] The Review of data from the Gambling Commission is expected to be published in early 2017.

- The number of B2-only sessions declined by 11% but the number of B3-only sessions increased by 17% and the number of 'mixed' sessions by 3%. This appears to indicate that B3 play was substituted for B2 play. [We noted above that B3 games tend to be characterised by relatively high volatility of returns and note in addition that they have a lower percentage return-to-player than B2 roulette.]

- Mean and median session durations have increased.

- The number of short sessions (below 30 minutes) has fallen; the number of long sessions, particularly very long sessions (more than two hours), has increased sharply.

- Sessions are divided into ranges of player loss: in all ranges above £100 and up to £1,000, there was a significant increase in frequency of occurrence. That this was matched by a similar increase in the frequency of large player wins (which occur less often than equivalent player losses) is consistent with a shift towards styles of play/ products with greater volatility of returns.

Again, while no direct indicators of harm are observed, none of these findings are suggestive of harm reduction following the introduction of the £50 Regulations. Indeed, increasing session duration and greater frequency of high-loss sessions are findings which might be argued to indicate that greater harm was present in the post- compared with the pre-Intervention period.

Our analysis will use a data set which extends further, to October, 2016. It will examine similar metrics as are covered in the data review from the Gambling Commission, with additions such as speed of play. It will also take into account trend. And, by modelling week-by-week data (which will necessitate seasonal adjustment) rather than comparing two twelve-month periods, it will be possible to trace how player behaviour adapted and evolved in the period following the Intervention.

1.5 Our brief from GambleAware

We were commissioned by GambleAware[22] to analyse data to shed further light on the impact of the £50 Regulations. GambleAware was particularly interested in whether it was possible to distinguish between different interpretations of findings in the DCMS Report. In particular, it

[22] GambleAware is the charity formerly known as the Responsible Gambling Trust. In this Report, we have used the name Responsible Gambling Trust when referring to earlier work published under that title. All those Reports are available on the GambleAware website.

noted that some changes in player behaviour identified by DCMS could either represent simple circumvention of the new rules or signal that users were in fact better controlling their play.

GambleAware required the comparison of sessional data[23] for periods before and after the Intervention to capture the impact on metrics such as aggregate spending on FOB-Ts, duration of sessions, size of player loss in a session and number of sessions. Statistical modelling was to take account of any trends in the data before the Regulations took effect and the presence of seasonality in the data. So far as is possible given the constraint of what data are retained by the industry, the aim of the modelling should be to disentangle pre-existing trends from changes in behaviour that can be attributed with confidence to the Intervention.

GambleAware asked that, in this modelling, "particular attention should be paid to impacts on the frequency of sessions where the size of loss or the duration of play is much higher than the typical amount".[24]

In the next chapter, we describe the *Data* set supplied by the industry to enable us to execute the modelling and discuss its strengths and limitations. Chapter 3 sets out details of our *Methods* including how we identified trends and how we accounted for seasonality. Chapter 4 is our *Results* chapter where we include an emphasis on the frequency of large loss/ long duration sessions. Chapter 5 offers *Reflections* on the results of the exercise.

Most of the data we analysed were weekly data covering January, 2014 to October, 2016. We were also supplied with a longer run of data (going back to 2012) but these were only monthly and, more importantly, they were restricted to a narrow range of metrics.[25] Since none of the results from modelling monthly data were inconsistent with the conclusions to be drawn from our analysis of weekly data, we report the 'monthly data' results in an Appendix.

[23] Sessional data relate to records of metrics describing each session played on a machine (from a single anonymous individual commencing play to that same user finishing play).

[24] The quotation and our summary of the requirements for the Report are drawn from the Invitation to Tender document, http://about.gambleaware.org/media/1323/further-analysis-of-machine-data-to-examine-the-impact-of-the-50-regulations-itt.pdf

[25] This limitation reflects industry practices on for how long various items of data are stored.

DATA

1.7 Nature of the data

In 2013, as part of its Machines Research Programme, the Responsible Gambling Trust commissioned NatCen to carry out a scoping study to explore what data from the gambling industry might be available to enable research into gambling-related harm. The resulting Report[26] noted that, in many respects, the data from bookmakers had greater potential than that from other types of operator offering play on Category B machines.

Types of data included *tracked data* where use by particular individuals could be observed over time because they were enrolled in a loyalty card scheme. Subsequently the Trust commissioned several research projects[27] to analyse FOB-T play in which loyalty cards had been used (though none of these studies used data from the period after the introduction of the £50 Regulations).

Following the tracked activity of individual players has obvious advantages, such as the ability to link behaviour to demographics, but carries the disadvantage that only a small proportion of players are sampled and the sample is self-selected and is therefore possibly unrepresentative (if, for example, only the most committed players signed up for account-based play). The other possibility is to analyse *proxy session data*, which is based on observing all activity on FOB-Ts, divided into player sessions. The universality of the coverage is the advantage here but the anonymity of sessions imposes limitations. For example, one could detect any increase in the frequency with which a session ended in a loss of more than £100 but could not know whether this was linked to the same players making a big loss repeatedly or whether, alternatively, a large number of users were experiencing the occasional very bad session.

Our data set had been produced from proxy session data which had in turn been derived from *transactional data*. These are financial accounting data recorded by each machine and extracted and stored by the machine manufacturer to allow the operator to meet tax and regulatory reporting requirements. Every financial transaction between a player and the machine is in the record produced by the system. For example, a customer stakes £100. At that point, his credit on the machine meter is debited. That £100 debit is recorded. The 'spin' then takes place. He wins and is eligible to collect £150. This amount is then credited to the machine meter and is recorded. Thus what the NatCen Report terms the 'atomic data' on the machine have the amount staked and the amount won or lost on every single play (and also include which game was played).

[26] H. Wardle, C. Seabury, H. Ahmed & C. Coshall, *Scoping the Use of Industry Data on Category B Machines*, NatCen Social Research for the Responsible Gambling Trust, December, 2013.

[27] For example, D. Excell & P. Grudzien, *Secondary Analysis of Machines Data*, Responsible Gambling Trust, 2014.

However, the non-financial data- what sub-bets are made within the spin (for example, £50 on red *and* £50 on an even number)- are logged only in the 'game cycle' part of the machine and they are not extracted and recorded. The NatCen Report points out that there would be strong technical obstacles to extracting these latter data systematically. Thus, a full set of transactional data would allow observation of stake sizes and player wins and losses but not what lies behind any variation in these parameters in terms of staking patterns. Suppose players collectively were observed to reduce average stake. It would not be possible to observe directly whether this was accompanied by a change in the risk-profile of portfolios of sub-bets contained within each wager on a spin since only the total stake on a spin is recorded, not its components.[28]

But in any case we did not have access to the full set of transactional data. Our data were much more highly aggregated.

The machine manufacturers aggregate the atomic transactional data from each machine into *proxy sessions*. Each proxy sessions is a chunk of the transactional data which is supposed to represent a sequence of plays by a single user. Algorithms (agreed by the Association of British bookmakers (ABB)) divide the stream of transactional data generated by a machine into player sessions, where a session beginning or ending is determined by 'ABB session markers'. For example, if there is no player activity for one minute from the end of the last play and zero or below 20 pence of credit remains *or* if there is no input from a player for four minutes irrespective of the amount of credit, then the session is deemed to have ended (the next play will then be attributed to a new session). The document setting out the conventions governing the delineation of sessions contains eleven such rules.

Many of our conclusions will rest on data which describe sessional outcomes (for example, the number of sessions ending in a player loss of more than £100). Our analysis therefore depends on the efficacy of the ABB session markers. It would be unrealistic to expect 100% accuracy and indeed the process is incapable of handling some circumstances (for example, a customer playing on two terminals simultaneously would generate two different and unlinked sessional records). However, it was reported to us that both of the machine manufacturers which supply licensed betting offices had compared sessions delineated by the algorithms with sessions which could confidently be attributed because a player was using a loyalty card and found a high degree of accuracy. Further, one operator had confirmed the accuracy of the system in a small-scale trial where the sessions identified by the markers had been compared with activity at the machine as recorded by CCTV. While there might be a case for larger-scale and transparent testing, we have no reason to doubt the usefulness of the sessional data and we know of no argument for believing

[28] There might be an indirect indication. For example, if wins became less common and average amount won per winning spin increased, this would be suggestive of players choosing riskier strategies.

that the £50 Regulations would have systematically changed the accuracy of the system such as to bias the before- and after-comparisons we make.

1.8 Data available

The two machine manufacturers, Inspired Gaming and Scientific Games, with the agreement of the operators (who own the data), supplied us with two data sets each of which combined records based on sessional data from their respective machines.[29] Together these two companies are responsible for nearly all gaming machines in licensed betting offices in Great Britain.

The combined data sets supplied to us did not consist of records of each session played but rather of aggregated data *based on* these records. Thus many metrics were based on aggregating across all sessions and all machines to give weekly or monthly totals or summary statistics. For example, the weekly data series includes metrics such as "total stakes on B2 roulette", "total number of plays on B2 slots" and "average stake per B3 play". Other metrics related to the number of sessions (for example the number of sessions in a week across the whole bookmaker estate) or to characteristics of sessions (such as the number of sessions ending in a player loss in a given range or the average duration of a session).

Note that the raw data captured in machines had been aggregated at multiple levels to produce the data sets which we subject to analysis. At the betting terminal itself, items such as the amount staked and won or lost on a single play are recorded. Subsequently, the stream of observations of single plays on a machine, was divided into 'player sessions' by the application of algorithms. All player sessions from all machines in a given week/ month were then pooled together to produce the statistics with which we were supplied.

It is typically the case in statistics that aggregation leads to loss of information and in the present case some of this could potentially have been useful in answering relevant research questions. For example, aggregating across plays to the level of a player session suppresses information on the sequence of events in a session. Aggregating across machines leads to loss of the ability to distinguish between changes in behaviour in different sub-sets of machines in different geographical locations with different socio-economic profiles. The levels of aggregation already built into the data sets we received precluded us therefore from pursuing potentially interesting lines of inquiry. We draw attention to this issue only to illustrate that the data held by the industry have the potential to deliver richer analysis in the future if made available to researchers in less aggregated form.

[29] We are grateful to Roderick Grafton (Inspired Gaming) and Chris Wilkinson (Scientific Games) for marshalling and delivering the data sets and for answering our questions and points of clarification.

Nevertheless, the data sets provided were fit for the purpose of answering the questions we were invited to address by GambleAware.

Weekly Data

Box 2.1 lists the data series we were able to use from the weekly data set.[30] The weeks in question are defined as running from Sunday to Saturday. The data period begins on Sunday, February 2, 2014 and ends on Saturday, October 8, 2016. This gives 140 time points. The Intervention (introduction of the £50 Regulations) occurred at the start (strictly on the Monday) of the 62nd week in the data set and we therefore have 61 weeks where the Regulations were not yet in place and 79 weeks when they applied.

A complication is that the machines had to be adjusted to be ready for April 6, 2015 and this will have necessitated fixing them earlier and therefore imposing the new restrictions on some players earlier. We were advised by industry sources that the roll-out took two weeks. However, when we inspected data series where there had been a step change at the time of the Intervention, we found that, for week 60, the figure tended in fact to be about where it had been before; but an adjustment towards a new level was already evident in week 61. For example, consider *total stakes derived from £100 roulette plays*. The weekly values around the time of the Intervention are displayed in Table 2.1. As with other series, week 60 appears to be quite 'normal'; but week 61 presents a figure which suggests that there is an extent to which some players are already facing the new restrictions. All do so in week 62, the first week of the new regime. In view of the presence of this pattern (some of the shift in behaviour being evident in week 61), we will treat week 61 as a 'special' week. In statistical models of the time series, we will always include a dummy variable, *roll-out*, which takes the value of 1 in week 61 and zero in all other weeks. This is a common device to prevent model results from being distorted by a single anomalous observation.

Table 2.1. Weekly stakes from £100 roulette plays

March 15- March 21, 2015	week 59	£129.9m
March 22- March 28, 2015	week 60	£132.1m
March 29- April 4, 2015	week 61	£96.5m
April 5- April 11, 2015	week 62	£49.4m
April 12- April 18, 2015	week 63	£51.9m

[30] The organisation of data series under different headings in Box 2.1 reflects the organisation of the data in the separate spreadsheets supplied to us by the machine manufacturers. In addition, we were able to create new variables for analysis by aggregating across series included in separate spreadsheets.

Weekly data series sometimes related to all play on bookmaker machines and sometimes to play with particular products. Our analysis will focus on B2 roulette and B3 slots as these were the products which accounted for most FOB-T play. To allow the reader to gauge the relative importance of the four product categories represented in the data, Table 2.2 shows the average weekly stakes on each over the whole study period.

Table 2.2 Average amount staked per week by product category

product	average weekly stakes	percentage of total staked
B2 roulette	704,828,367	78.46
B2 slots	32,715,135	3.64
B2 other	49,741,801	5.54
B3 slots*	111,046,573	12.36

* the total for B3 slots includes relatively very small amounts relating to play on B4 and C play

BOX 2.1. WEEKLY DATA SERIES USED IN THE REPORT

sessions

number of sessions; average amount staked per session; average plays per session; average player loss per session; average session duration; average duration of sessions including a £50 play; average duration of B2/ mixed sessions; average duration of B2-only sessions

roulette stake size

number of roulette plays in each of eleven stake ranges from "below £10" to "exactly £100"; total stakes derived from plays within each of these eleven stake ranges

duration of roulette-only sessions

number of sessions in each of eleven session length ranges from "below 5 minutes" to "more than 4 hours"

total stakes on FOB-Ts

total weekly stakes for each of four product categories; aggregate weekly stakes

outcomes of roulette-only sessions

number of roulette-only sessions ending in each of 23 ranges of outcome from "player loss of more than £5,000" to "player win of more than £5,000"[31]

outcomes of slots-only sessions

number of slots-only sessions (B2 or B3 or mixed) ending in each of 23 ranges of outcome from "player loss of more than £5,000" to "player win of more than £5,000".[32]

[31] Across the whole 140 weeks, the proportion of sessions in each of the two extreme categories was very small indeed. Nevertheless, the absolute number was not trivial in either case. There were 1,077 sessions where the player lost in excess of £5,000 while 1,809 sessions delivered a player profit of more than £5,000.

Monthly data

We were also provided with a file of monthly data which contained information on the *number of* plays and the *total amount staked* on each product group (B2 roulette; B2 slots; other B2 games; B3 slots; other B3, B4 and category C games).[33] From these we could of course calculate average stake per play. Still, this is a much more restricted set of variables than was available in the weekly data set (for example, there is no information on session duration or player losses). However, the information does go back for a longer period. The monthly data begin in January, 2012 and end in October, 2016. This will enable us to compare events post-Intervention with a pre-Intervention trend estimated over a longer period. In the monthly data set, there are 39 observations pre-Intervention and 19 observations post-Intervention (if April, 2015 is allocated to the post-Intervention period; the Regulations came into legal force on the 6th but some machines will have been adjusted earlier).

[32] Across the whole 140 weeks, there were only 8 cases of a player losing more than £5,000 and 7 cases of the player winning more than £5,000.

[33] Of these product types, the last is of little interest as, over the whole period, it accounted for only 0.1% of the amount staked. Of the total amount staked, 80.0% was on roulette and 11.4% on B3 slots games.

METHODS

1.9 Event studies

Essentially our brief was to carry out an 'event study', the name for analyses which examine the impact of an event, in our case the Intervention (introduction of the £50 Regulations), by comparing the behaviour of relevant time-series before and after. The approach was first developed in the academic study of finance where the event was typically something like the take-over of a firm and the time-series of interest was the share price of the acquiring firm. The idea was to discover whether the take-over shifted up the value of the shares, which would indicate that the market view was that the take-over would lead to higher profits.

The potential weakness of any event study is that it may not be possible confidently to attribute a change in the behaviour of the time series to the event itself. There may have been *confounding factors* which became relevant at about the time of the event and which would have shifted the time-series even if the event had not occurred. For our event study, we therefore needed to consider whether there were any significant changes at around the time of the Intervention which could compromise the comparison between the behaviour of key time-series before and after.

Close to the Intervention, there was one significant change on the *supply side* of the market. Five weeks before the £50 Regulations took effect, there was an increase in the rate of machine games duty charged on the gross profits [34] from FOB-Ts, from 20% to 25%.[35]

Economic theory suggests that the appropriate operator response to an increase in the tax charged on the net amount won from gamblers is to make no change to the product offer. If a product offer is maximising operator win before a tax, it must also maximise after-tax operator win once the tax is in place, because after-tax win is just a fixed proportion of the pre-tax win. Indeed this is the whole point of UK gambling taxes being based now on the taxation of 'gross profits': as

[34] The term 'gross profits' refers to the net amount won by operators from gamblers, i.e. it is stakes minus prizes. Note that the word 'profits' in the context of the rules for this tax has a different meaning from in general usage since it takes no account of the cost of renting the machines and premises, paying staff wages, etc.

[35] This increase applied only to FOB-Ts as it was a new higher-rate applicable only to machines where it is possible to stake more than £5. The higher rate is charged on all games played on the machine even where the player chooses a game type with a lower maximum stake. Thus the new rate applied to all FOB-T activity, including B3 play where the maximum stake is only £2.

demonstrated in a paper by Paton, Siegel and Vaughan Williams,[36] the tax should *not* affect the price of gambling or the products offered.[37] It should not therefore affect consumption decisions.

For this reason, we are highly sceptical that the introduction of a higher rate of gaming duty applicable to FOB-Ts will have generated turbulence in the data which would undermine our assessment of the impact of the £50 Regulations. However, we acknowledge that some commentators might think that, given the market structure of the industry, bookmakers tend to take a more ad hoc approach to decision taking. Thus bookmakers *may* have sought to compensate for profits lost to the Exchequer through the tax change by promoting B3 play (offering new slots games, for instance) since B3 is more profitable, it carries a lower return-to-player than B2 content. In this case, any shift towards B3 play observed in the following months might not be wholly attributable to the Intervention which is the focus of our study.

The £50 Regulations were intended to work through the *demand side*, by directly constraining players from placing high stakes (if they chose anonymous play) or by inducing them to consider their decisions more carefully (if they chose to use a verified account). The Regulations, if successful, should therefore have been followed by a shift to more 'responsible' behaviour. However, over the whole study period, there were other initiatives to promote responsible gambling. None of these were introduced at a date very close to the Intervention we study, for example mandatory alerts about time and money spent were put in place thirteen months before. However, they may have burned slowly and have had effects which would confuse the before and after comparisons on which evaluation of the £50 Regulations depends.

On the whole, we are inclined to the view that the legitimacy of the comparisons we make is not in fact significantly compromised by the presence of other responsible gambling initiatives. For many of the time series we study, the data are marked by a sharp step change at the precise time of the Intervention (weeks 61-62), followed by a limited period of adaptation before behaviour stabilises. Such a pattern is unlikely to be explained by other ongoing programmes where there was no particular reason to anticipate a *concentration* of effects at and in the weeks immediately following April 6, 2015.

[36] D. Paton, D. Siegel & L. Vaughan Williams, 'A policy response to the e-commerce revolution: The case of betting taxation in the UK', *Economic Journal*, 112: F296-314, 2002.

[37] The exception would be if the after-tax win from players were driven so low by the new rate of tax that it could not cover associated staffing and premises costs. Increases in the tax rate therefore have the potential to induce withdrawal of the product (e.g closure of shops) even if they should not change the product price and specification so long as the product is still offered.

It may also be noted that there is an extent to which the proper degree of concern about the influence of confounding factors will depend on what the results of the study are. For example, suppose, following the Intervention, there were no 'improvement' in indicators thought to be correlated with responsible gambling or with gambling-related harm. In this case, if there had been no positive behavioural change after the Intervention, *notwithstanding* the presence of other measures intended to achieve similar effects, it could be concluded with confidence that the Intervention had failed to achieve its objective. If instead there were a steady trend towards responsible gambling after the Intervention, that would lead one to believe that it had been successful; but the degree of confidence in this case would be less because other programmes may have pushed things in the same direction regardless of the Intervention.

1.10 Seasonality and trends

A simple event study might compare periods before and after the event in question by reference simply to the totals or means of relevant series. For example, one might compare the number of player sessions or the mean stake per session in the two quarters before Intervention and the two quarters after Intervention. But this procedure would be flawed if the data were characterised by seasonal variation. One might then be comparing, say, a busy time of year with a slack time of year and there would be the danger that differences observed were due to time-of-year effects rather than to the Intervention itself. It would therefore be better to compare, say, two quarters after Intervention with the corresponding quarters from twelve months earlier. This would purge the comparison of any distortions due to seasonal variation. However, this advantage would come at the cost of losing information from the quarters in between. The new comparison might, for example, overestimate the impact of the Intervention because the series of interest had been on an increasing trend and using data from a full year ago would be misrepresenting the situation immediately before the new policy took effect.

Our first-best choice was therefore to model *seasonally-adjusted* weekly data and to incorporate into the model trends in the data both before and after the Intervention. We did test for seasonality in each time-series before using seasonally-adjusted rather than raw data and indeed seasonality was present in most statistics studied. For example, the number of player sessions tended to be depressed in the weeks around Christmas and elevated in the Spring.

We have referred to pre- and post-Intervention periods but in fact, for examining the behaviour of each time-series, we conceptually divided the study period into three sub-periods rather than two. We thought it plausible that, following Intervention, there might be a jump in a series, then a period of adaptation where behaviour was changing, then a settling-down to a new equilibrium trend. To apply this conceptual idea, we proceeded as follows when studying each statistic Y in which we were interested:

(i) We took the raw data for *Y* and tested for seasonality. If present, we adjusted the raw data to make them a seasonally-adjusted series, using standard statistical methods.[38]

(ii) We then estimated a 'best fitting line' to the data, split into three segments. First a linear trend was fitted to the pre-Intervention data on *Y*. Then a linear trend was fitted to the adaptation period beginning at the point of Intervention. There was provision for a discontinuity (i.e the level of the statistic at the start of the second trend line could be different from its level at the end of the pre-Intervention period if this is what the data suggested- i.e. there could be a jump in the fitted value of *Y* at the point of Intervention). Finally, a fresh linear trend was fitted to the final sub-period. Here there was no provision for a discontinuity as there is no reason to suppose that adaptation would end in a jump rather than in convergence to a new equilibrium path.

(iii) The length of the middle sub-period, the adaptation period, was left to be determined (separately for each statistic) by the data themselves. We estimated the whole model seventy times, each time with a different adaptation period, from one week up to seventy weeks. From these estimates, we selected the final model to be presented, based on standard statistical criteria of model goodness of fit.

This has been a basic account of our approach which we illustrate in more concrete fashion in the following section. For those well-versed in statistical methods, Box 3.1 presents a short technical account of what we did. Other readers may skip Box 3.1 and proceed through the text without loss of continuity.

[38] Seasonal adjustment of the weekly data with which we worked should be regarded as somewhat imprecise for some observations. The reason is that any week in the year is observed only three times (and for some weeks only twice) within the data set. This could lead to distortion of the size of the appropriate seasonal adjustment if one of the observations of a particular week had a wholly exceptional value for the statistic, due to unknown shocks such as from weather. Inspection of the data suggested that only a relatively small number of weeks were affected by this sort of scenario. Thus the position of estimated trend lines is unlikely to be affected significantly.

BOX 3.1. TECHNICAL NOTE ON METHODS USED

To account for seasonality in the data we use the seasonal decomposition method first proposed by Cleveland et al[39] known as STL, which stands for "seasonal trend decomposition using loess". The STL methodology is a versatile and robust method for removing seasonality and trend from a time series. In analysing the FOB-T data, this is necessary as the likely impact of the Intervention is not on the seasonal characteristics of play, but rather on the subtle variations in the time series that remain after any seasonality has been accounted for.

The STL method has several key advantages that have made it a popular decomposition method. In addition to being able to handle any period of seasonality (not just monthly or quarterly), it is robust to outliers, and can even allow for the seasonal and trend components to vary over time.

The algorithm relies on iteratively smoothing the data using locally weighted polynomial regression (as first presented by Cleveland[40]) to identify the trend component of a time series followed by another round of smoothing to identify the seasonal component.

Here, we do not want to use the estimated trend component from the STL algorithm as we want to model the trend directly to gauge exactly how it has been affected by the Intervention. As such, we use the STL algorithm to remove the seasonal component of the time series, and then model the remaining time series including our own specification that deals with trend.

Our models allow for trend in the following way. In the period before the Intervention (w/c April 5, 2015), a linear trend is permitted. This can identify an increasing or decreasing linear trend. We then allow for a 'jump' in the level of the time series, and a change in gradient (i.e. a change in the growth, or decline, rate) of the trend. We call the second period the "adaptation period", and we estimate its duration from the data. For example, it may be that the adjustment period lasts 6 weeks or several months. We fit models allowing for all length adjustment periods (from 1 week to 70 weeks) and select the model providing the best fit to the data according to the Akaike Information Criterion. After the adjustment period, we allow another change in the gradient of the trend. However, we do not allow for a second jump in the level as it does not seem likely that there should be a shift change in the time series at the end of a period of adjustment.

[39] R.B. Cleveland, W.S. Cleveland, J.E. McRae, & I. Trepanning, 'STL: A seasonal-trend decomposition procedure based on loess'. *Journal of Official Statistics*, 6: 3-73, 1979.

[40] W.S. Cleveland, 'Robust locally weighted regression and smoothing scatterplots', *Journal of the American Statistical Association*, 74:829–836, 1979.

1.11 Illustration of methodology

In this section, we explain the steps which generated our results for one particular time-series. The same steps were followed in analysing *each* measure of behaviour to be considered in the Results chapter; but, in that chapter 4, we will show results only from the final step in each application of our procedures, which will capture our estimates of what changes followed the Intervention. Too much detail at that stage would be repetitive and detract from the presentation of the findings. So, in this section 3.3, we aim to satisfy the curiosity of the reader by demonstrating the intermediate steps for just one of the statistics we will analyse in chapter 4.[41]

To illustrate the methods, we use the time-series for *total stakes*. This figure relates to all activity on FOB-Ts in a week, regardless of game type or whether it was B2 or B3 content. Across the whole period, the mean of weekly stakes was £898.3m

The top panel in Figure 3.1 presents a graph of the time series included in the data set supplied to us by the machine manufacturers: these are the *raw data*. At the first observation, week commencing, February 2, 2014, total stakes in FOB-Ts were £893.9m; two weeks before the Intervention, in the week of March 22-28, 2015, total stakes were £953.6m; at the last observation, at the beginning of October 2016, total stakes were £932.4m.

But just comparing each of these three observations could produce misleading impressions. The three dates are from Winter, Spring and Autumn. Differences could in principle be explained just by seasonal variation in demand. Alternatively, larger underlying changes could be being masked by seasonal factors. Moreover all data points including these three will be affected by "noise", which is to say that there will be some apparently random variation from week-to-week, caused by unknown factors.[42] By deseasonalising the data and then fitting trend lines, we are able to abstract from the influences of both season and "noise" to reveal the underlying evolution of behaviour with respect to the amount staked in FOB-Ts.

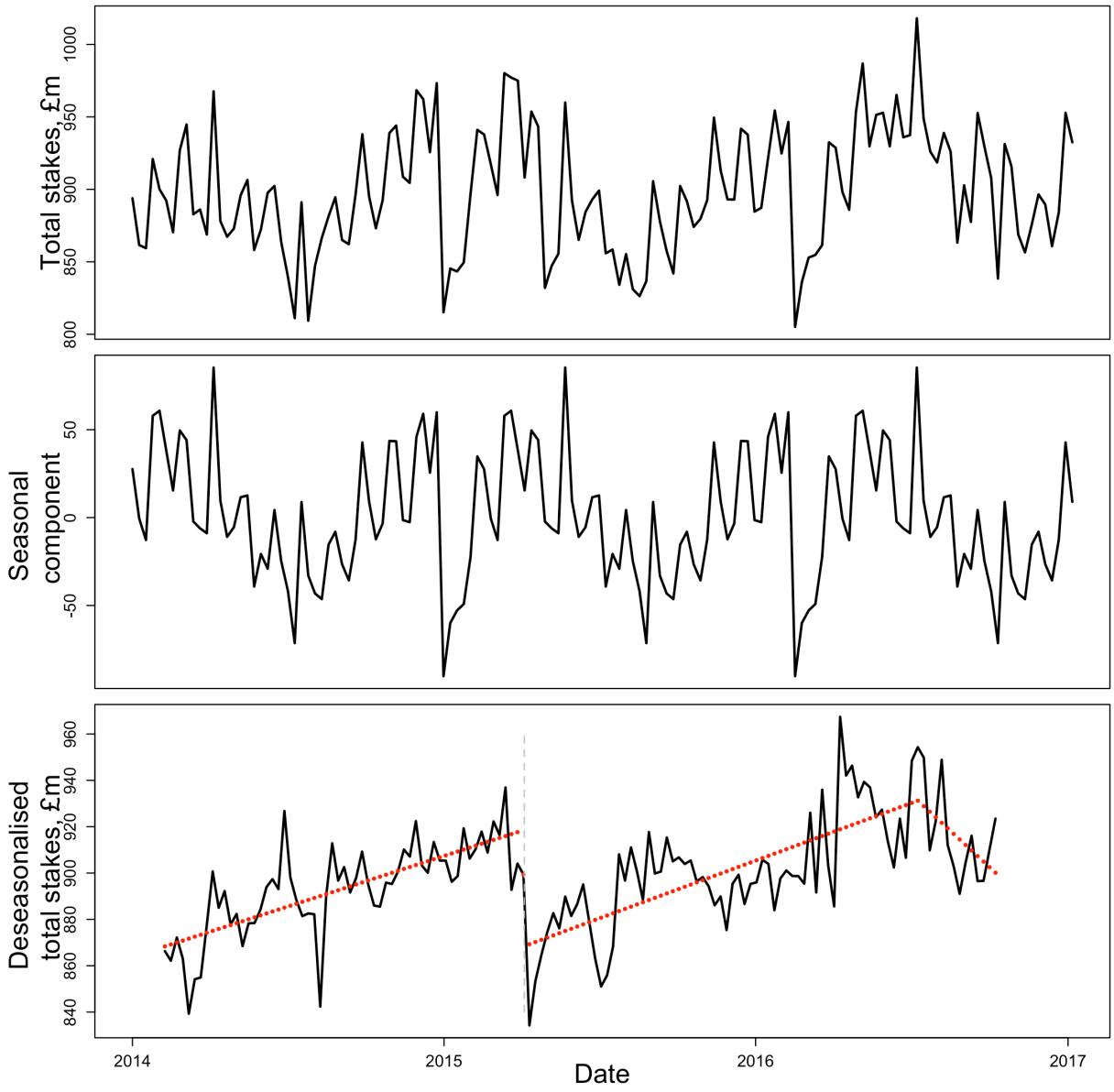
The first step was to deseasonalise the data. The second panel in Figure 3.1 presents estimates of the seasonal component of total stakes from applying a statistical procedure referenced in the technical exposition (Box 3.1). For example, in the first observation, the seasonal component can

[41] Readers without a strong interest in the methodology behind our findings might consider skipping to chapter 4.

[42] One could imagine examples of sources of variation including such as bad weather keeping customers at home or a major sports (betting) event increasing footfall in the shops.

be seen to be above zero, reflecting that that week in the year typically sees total stakes which are above average. The largest dips in the graph shown in the second panel reflect strongly negative seasonal effects during weeks in December.

Figure 3.1. Total amount staked in FOB-Ts (all games)



For each observation in the raw data (top panel), the estimated seasonal component (middle panel), positive or negative, is removed to produce the *seasonally-adjusted data series* shown by the black line in the bottom panel.

The red line superimposed on the bottom panel graphs the trend lines from a *regression model*. This line may be understood as showing for each week a 'standardised' or 'fitted' value for total stakes. This is where our focus lies. As noted, it should illustrate how the value of total stakes evolved over time, abstracting from the effects of "noise" (as well as from seasonal influences).

It will be observed that total stakes showed a general upward trend through the pre-Intervention period though with a lot of variation around the trend during the first half of 2014. Then there was an abrupt and sharp drop in total stakes at the point of Intervention. Recovery then began and the rate of growth was similar to or a little more than that in the first period. Although, as will prove to be the case in the analysis of several other series, the picture is confused by an apparent moderation of behaviour very late in the study period, the broad story is therefore that the Regulations imposed a once-and-for-all fall in total stakes but did not disrupt underlying growth. This growth was sufficiently rapid to take total stakes at the end of the study period to a higher level than immediately before the Intervention; but total stakes were still reduced compared with where they would have been *had the initial trend continued in the absence of the Intervention*.

This general story is evident from visual inspection of the chart in the bottom panel of Figure 3.1 and we will use such charts in chapter 4 below to present results on many other data series. However, for more detail, it is necessary to use the results from the statistical model which generates the red line in the chart. The model was a regression model which, given the specification determined by the researchers, produces an equation which describes the plot which best fits the data (the red line in the chart). The specification of the equation in our case was:

$$\hat{Y} = \text{constant} + \text{b}_1(week\ number) + b_2(roll\ out) + b_3(post\ Intervention) + b_4(weeks\ since\ Intervention) + b_5(weeks\ since\ end\ of\ adaptation\ period)$$

Here:

$\hat{Y}$ is the fitted value of the statistic of interest (total stakes in the present case).

week number is the week number in the data set, where the first week is numbered 1 and the following weeks are numbered consecutively till the final week, which is week number 140.

roll out is a 'dummy variable' which has the value zero in every week except in week 61 (the week before the Intervention) when it has the value 1.

post Intervention is a 'dummy variable' which has the value zero for each week pre-Intervention and the value 1 in each week when the new Regulations were in effect, i.e. in each week from week 62 in the data set to the end of the data set.

weeks since Intervention is a variable set equal to zero up to and including the week of the Intervention; thereafter, it is equal to 1 in week 63, 2 in week 64, and so on.

Similarly, *weeks since end of adaptation period* has the value zero till the end of the adaptation period (identified as described in Box 3.1); subsequently it is equal to the number of weeks since the first week of the post-adaptation period. In the case of total stakes, the modelling revealed that the best fit to the data was found by treating the adaptation period as lasting for 65 weeks. The last sub-period is therefore from week 127 in the data set. Until week 127, *weeks since adaptation period* is set equal to zero. In week 128, it is equal to 1; in week 129, it is equal to 2; and so on.

The results of the statistical model yielded *coefficient estimates*, which are the values of the constant and of b_1, b_2, b_3, b_4 and b_5. Plugging these values into the equation, it becomes the basis for plot of the red line summarising the evolution of total stakes:

standardised values of total stakes (£m)= 867.514+ 0.835(week number)- 19.089(roll-out)- 50.040(post-Intervention) + 0.118(weeks since Intervention)- 3.346(weeks since end of adaptation period)

For any week number, we can then use the equation to find the standardised value at that point in time.

In week 1 of the data set, this is 867.514 + (0.835 *times* 1) = 868.349 (million pounds).

Standardised stakes then increase at a rate of £0.835m per week such that by week 62, the first week of the new regime, we would have expected the level to have reached 867.514+ (0.835 *times* 62) = £919.284 (million pounds).

This figure of **£919.284m** is calculated without taking account of the effect of the Intervention now just occurring. It is our **baseline figure for standardised total stakes at the point of Intervention and without the Intervention yet having had an effect**.

In fact, in week 62, the new Regulations *were* in place (for the first time). The standardised value of stakes with the effect of the Intervention taken into account was:

867.514+ (0.835 times 62) - (50.040 times 1)= 869.244 (million pounds).

Thus the ***immediate*** **impact** of the Regulations is estimated to have been to depress weekly total stakes by £50.040m. Note that this estimate of the immediate impact could be read directly from the model results as it is the coefficient estimate on the variable *post-Intervention.* **Relative to the benchmark figure for standardised total stakes at the point of Intervention, this represents a contraction of 5.4%.**

However, weekly stakes then recovered, growing on average week-by-week by (0.835 + 0.118)=0.953 million pounds. Note that the coefficient estimate on *weeks since Intervention* shows the *change* (+0.118) in the gradient of the relationship between total stakes and time. Thus the Intervention was associated with a one-off drop in stakes but, from this lower level, the series increased week-by-week and at a faster rate than before.

The statistical analysis revealed that there was another structural break in the series and this was estimated as occurring at July 3, 2016. Thus, when calculating the standardised value, the final term in the equation comes into play from week 128 on. For example, the value at week 140 (the end of the data set) is:

867.514 + (0.835 *times* 140) - (50.040 *times* 1) + (0.118 *times* 78) - (3.346 *times* 13)

where 13 is the number of weeks since the structural break (which we term the end of the adaptation period though the cause of the break might be some other unknown factor).

The standardised value at week 140 is then £900.080 (million pounds).

Thus, at the end of the study period**, standardised weekly stakes had recovered considerably from the shock of the Intervention but were still marginally lower by £17.162m (2.1%) compared with their level pre-Intervention.** The long-run effect of the Regulations (if one can use ‘long-run’ for a time frame of 78 weeks after the policy was introduced) therefore appears modest. And even this modest effect depends on the downward trend identified in the final sub-period, which may not be sustained and whose estimated steep slope derived from only a small number of observations in late, 2016.

However, this finding of close to no effect on total stakes in the long-run is based on assuming the counter-factual to be that, absent the Intervention, total stakes would have remained frozen at their level at the beginning of April, 2015. This is implausible because the value of total stakes had been increasing over time and indeed there was little fluctuation around the upward linear trend in the months leading up to April, 2015. Thus the trend looked well-set and there was no reason to think that it would end abruptly. Ideally, we would like to compare stakes at the end of the study period with where stakes would have been without the new Regulations. We don't know for how long the upward trend would have continued but the very presence of an upward trend is suggestive that the estimate of a -2.1% effect, derived from a straightforward comparison between data from weeks 61 and 140, is an under-estimate.

Let us make a very strong alternative assumption: in the absence of the Intervention, total stakes would have continued to increase by £0.805m per week all the way through to week 140, the end of the study period. Projected standardised total stakes at week 140 would then be 867.514 + (0.835 *times* 140)= 984.414 (million pounds). This would imply that **total stakes by October, 2016 were running £65.130m (7.1%) per week lower than they would have been without the Intervention**.

This estimate of the effect of the £50 Regulations is probably an over-estimate. The longer the pre-existing trend is projected into the future, the less plausible the counter-factual becomes. Most series which trend upwards begin to level off eventually and indeed the data suggest that the growth of total stakes post-Intervention came to an end in the late Summer of 2016 (though there are insufficient data points to be sure that this represented more than a transient phenomenon). Whatever they were, the same factors which caused the change in the late Summer of 2016 might still have been at work in an imagined world with no £50 Regulations. In this case, the true shortfall in total stakes at October, 2016 would have been be less than the quoted 7.1%.

In this case, our results are somewhat inconclusive. What can be said with confidence is that the Intervention produced an immediate drop in stakes of the order of 5% but that stakes then resumed upward growth. By the latest date for which data were available to us, total stakes were close to where they had been at the time of the Intervention. But they may by then still have been depressed compared with where they would have been, by up to about 7% depending on for how long the upward trend would have continued in the absence of the Intervention.

Bookmaker win is closely related to total stakes. It can therefore be concluded that there was a business cost from the Regulations and that, though the impact was not in the end as severe as it first appeared, revenue was still lower than it would have been at about a year and a half after they were introduced.

Of course our brief is not to assess the business cost of the Intervention but rather the welfare cost as proxied in data series believed to be related to gambling harm. We attach no particular welfare significance to what happened to total stakes but the exercise here has been included to illustrate the steps that lie behind our (we think more interesting) estimates of the impact on key series, to be presented now in chapter 4.

RESULTS

1.12 Preliminaries

In this chapter we set out our empirical findings across a range of variables included in our data set. In a section on 'totals and averages', we will look at estimates of the impact of the Intervention on variables such as the number of sessions played and the average duration of a session. Then, in a section entitled 'Extremes', we will consider variables such as the number of very long sessions, the number of sessions ending in high player losses and the frequency of playing for high stakes. It will be here that the main interest will be found because serious gambling harm is likely to occur *more often* in unusually heavy play than at the modest levels of typical play.

First though, before presenting results from modelling, we put on record facts about the take-up of 'authorised' play. These data were available from the commencement of the £50 Regulations.

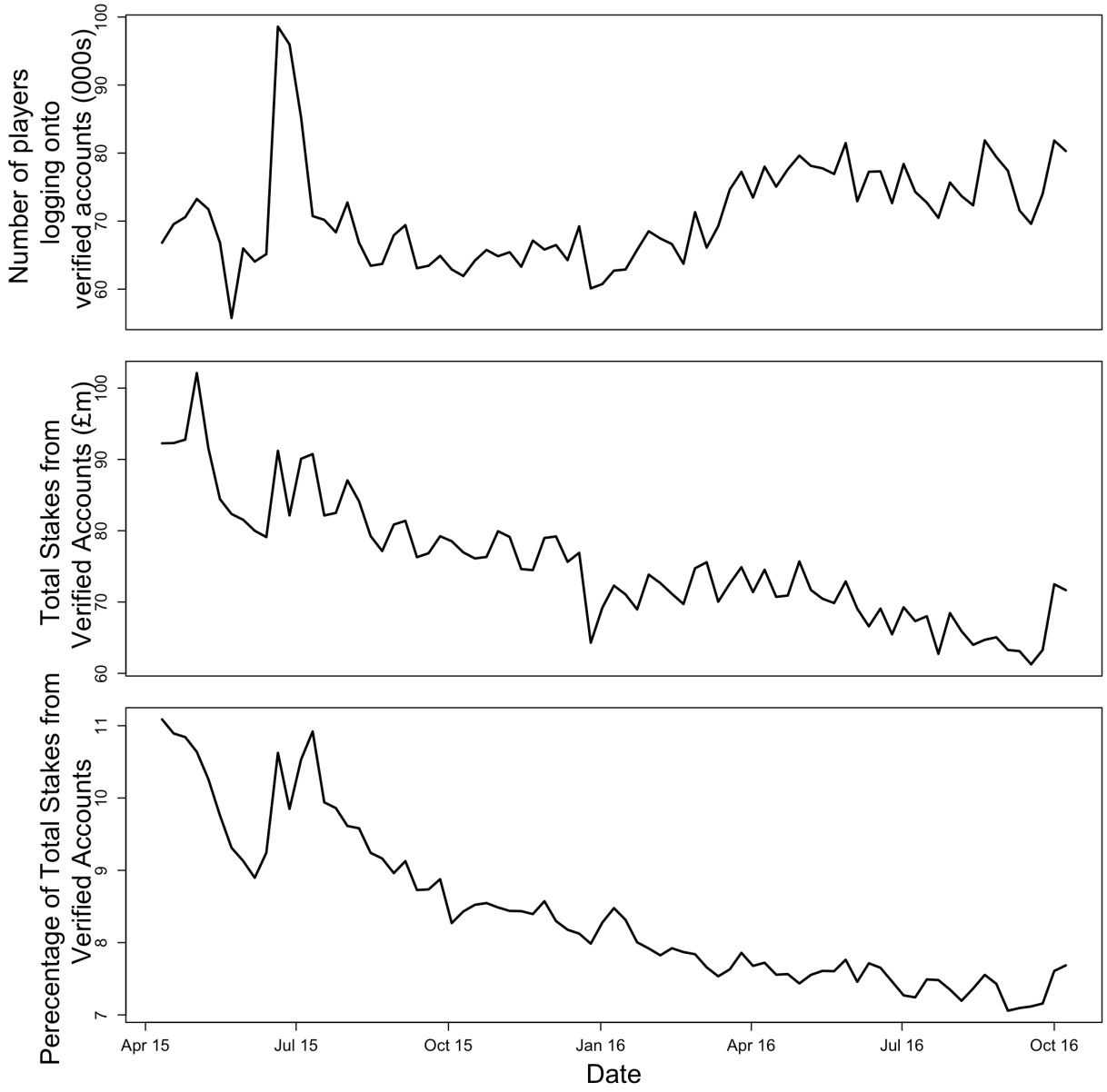
They confirm the findings of previous Reports on the £50 Regulations: take-up and use of the new verified accounts have been limited. Nevertheless, there are trends to note in the period since verified accounts were required for high stakes play. The three panels of Figure 4.1 graph relevant statistics.

The number of unique players logging on to an account (top panel) showed strong variation in the early part of the period; the very strong peak in June, 2015 is thought to have been driven by marketing campaigns (with incentives offered to play via an account). The effects of this marketing were not sustained though and, during the rest of 2015, there was a falling away in the number of those who chose to use an account facility for at least some of their play. However, **from the beginning of 2016, there was a clear trend towards more individuals using accounts until the number of individual players using accounts in any given week stabilised in the range 70,000- 80,000.** It should be understood that, while playing through an account gives a player the option to stake more than £50 on a play, he or she may in fact choose not to do so. Nevertheless we shall see below that during the period in 2016 when the number of players using accounts was increasing, a revival in the number of plays at a stake of more than £50 is also observed.

In the second panel of Figure 4.1, the value of stakes placed during sessions where the player was using a verified account is seen to have fallen substantially during the post-Intervention period to date (though the rate of change varied over time). It will be recalled, from chapter 3,

that the aggregate of all stakes in FOB-Ts was *increasing* slightly over most of the period. It follows therefore that the percentage of all stakes accounted for by verified account play declined (third panel of Figure 4.1) and in fact it was below 8% for all observations after January, 2016. In a Report on a survey carried out in 2014, i.e. pre-Intervention, Wardle et

Figure 4.1. Use of verified accounts



al.[43] noted that the proportion of machine play attributable to loyalty card holders was about 10%. Thus it does not seem that much progress has been made in encouraging tracked play.

This seems to limit the potential for what Government had hoped would be a significant gain from the policy. In a House of Lords debate on the £50 Regulations, the official Government spokesman, Baroness Jolly, had argued that "account-based play allows players access to up-to-date and accurate information about their session of play, which can help players maintain control".[44] **Post-Intervention, it is still the case that relatively little play is tracked play**.[45]

The likely proximate reason for the low take-up is evident from other data: many players who were accustomed to placing high stakes before April, 2015 probably chose not to open/ use a verified account because they were willing to accept a £50 limit on their own play rather than give up anonymity. In any event, there was a very marked decline in staking over £50 immediately on introduction of the £50 Regulations.

The black line in Figure 4.2 shows the seasonally-adjusted number of roulette plays made each week where the stake was in the range £50-£100. The red line plots trends that smooth out "noise" in the data.[46] At the beginning of the study period, the standardised figure for the weekly number of plays was 3.71m and this declined gently to 3.54m at the point of Intervention. There was then an immediate impact from the Regulations: a drop in the standardised number of plays to 1.49m. Thus **the immediate consequence of introducing obstacles to placing a stake of more than £50 was to reduce the frequency of such plays by 45.1%**. Subsequently, frequency fell further and, by mid-December, 2015, the cumulative decline in the standardised weekly number of high stakes plays since the point of Intervention had reached 76.6%. During 2016, frequency increased back up again though did not reach even the level observed in the immediate aftermath of the Intervention: at the end of the study period, the standardised number of plays was still 57.9% lower than at the point of Intervention.

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[43] H. Wardle, D. Excell, E. Ireland, N. Ilic & S. Sharman, *Identifying Problem Gambling: Findings from a Survey of Loyalty Card Customers*, NatCen Social Research for the Responsible Gambling Trust, 2016.

[44] Full text at: https://www.theyworkforyou.com/lords/?id=2015-03-23a.1295.0

[45] Of course, the need for authorisation does imply that sessions containing high stakes *are* now typically played within the framework of an account. However, according to a study of 4,001 loyalty card holders, many problem gamblers play at low staking levels. It follows that gambling harm is likely also to be significant in non-account play; and non-account play is still more than 90% of all activity measured by stake volume. Reference: see footnote 43 above.

[46] Here, and in all cases below where model results are shown in a chart, the results of the underlying regression are provided in Appendix B.

Figure 4.2. Weekly number of roulette plays with stake in the range £50-£100

Even if the counter-factual were taken as that the rate of decline observed in the first sub-period would have continued to October, 2016 (absent the Intervention), such that the standardised number of plays would then have been 3.34m in the final week, the actually observed number would still have been 55.2% below that projected figure. Either way, **following the Intervention, the frequency of placing of stakes in the range £50-£100 fell to less than half its previous level (as measured 78 weeks after the Intervention)**.

In section 4.3, we will look at staking levels in more detail and across the whole range. Here the chart is provided simply to demonstrate that, if the aim of the policy was to reduce high stakes play, the nudge in that direction was strikingly successful.[47]

However, as noted in the discussion in chapter 1, achievement of the proximate goal of discouraging high stakes play does not necessarily imply that the ultimate goal of harm reduction will be achieved. Players may be willing to give up high stakes but may make other behavioural changes (such as in style of play) in response to the new perceived constraints. Hence we need

[47] There has been no formal study of motives for player decisions when confronted with the £50 Regulations. However, the substantial change in behaviour indicates that the barriers to being able to play for high stakes were regarded by many as non-trivial. This might indicate that British gamblers place a high value on anonymity and that many would be antipathetic to any future proposal that would make account-based play compulsory.

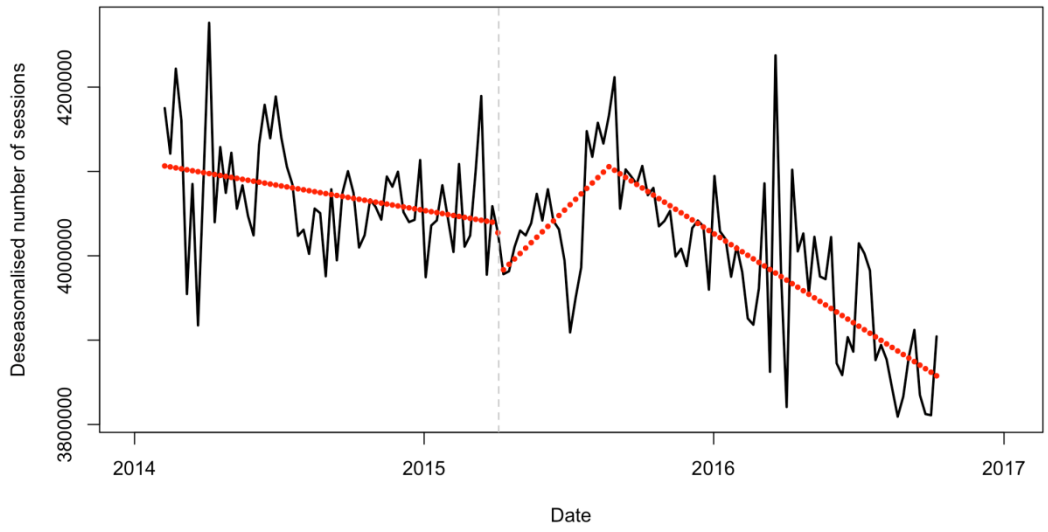
to look at a wide range of indicators to allow a view to be formed about the broad effects of the Intervention.

1.13 Totals and averages

Number of sessions

Figure 4.3 shows the number of FOB-T sessions for each week of the study period. Over time, the total number of sessions tended to fall. At the start of the study period, the standardised number is 4.11m per week. There is then a very gentle (but statistically significant) downward trend and, by the point of Intervention, the value is down to 4.04m per week. There is then turbulence in the data around Intervention. The initial effect seems to be to lower the number of sessions but the estimate on the relevant variable is not in fact statistically significant at the conventional 5% level. In the following 19 weeks, the downward trend is reversed and players collectively tend to play more rather than fewer sessions with each passing week. However, eventually, around mid-August, the previous downward trend is resumed. At the end of the study period, the standardised number of sessions is 3.858m. This is 0.18m (4.5%) lower than the number of sessions at the point of Intervention and 0.09m (2.3%) lower than a projection of the

Figure 4.3. Number of FOB-T player sessions each week



trend estimated for the pre-Intervention period. Whichever counter factual scenario is considered, **it is difficult to argue that the Intervention had any *substantial* lasting effect on the number of player sessions per week**. Essentially, over time, this statistic can just be said to have continued to fall.

Duration of sessions

The four panels of Figure 4.4 show deseasonalised data series for the average duration of (a) all sessions including at least one play over £50, (b) all sessions including some B2 play, (c) all B2-only sessions and (d) all sessions on Fob-Ts (regardless of session content). Average duration is of the order of 9-11 minutes in each case, except for case (a), the set of sessions which included high stakes play. In that case, average duration is very much longer, of the order of 21-26 minutes. Those who place high stakes therefore have a tendency to play for much longer than typical players.

In high staking sessions (the first panel), there is a very significant increase in mean session duration at the point of Intervention and further increases in the mean up to about late January, 2016. Then the mean stabilises at around 25.5 minutes. Prior to the Intervention there had actually been a downward trend and the standardised mean at the point of Intervention had been only 21.48 minutes. The increase in duration post-Intervention is therefore very striking. However, it is difficult to infer anything about behavioural change because selection effects will be present. From the point of Intervention, those staking more than £50 had to self-select for eligibility for high stakes by registering or by obtaining authorisation at the counter. Those willing to pay this psychic cost may well have been the most committed players who might also have been those who tended to play for longest. Thus the composition of players represented in the first panel will have changed at the point of Intervention, quite probably towards a higher share of high duration players. So, despite the strong increase in the mean, it cannot be sure from this that any *individual* players lengthened session duration.

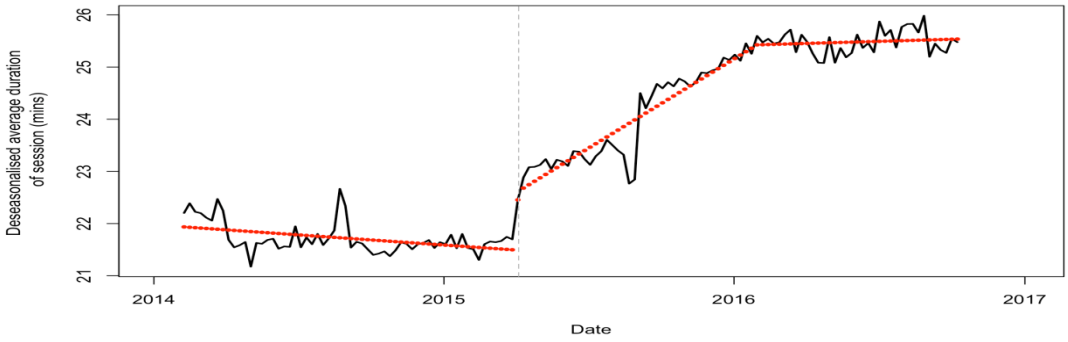
This complication does not arise in interpreting the other three panels in Figure 4.4. They show a similar pattern in each case, except that, in the bottom panel, there is no sign of a significant change in the gradient of trend late in the study period. Since the bottom panel includes B3 sessions, this suggests that the change was confined to B2 sessions and not strong enough to be picked up in more aggregated data. But, given that the three graphs tell a broadly similar story, we comment in detail only on the bottom panel, average duration across all FOB-T sessions.

At the start of the study period, standardised mean duration was 9.56 minutes and an upward trend took this to 9.77 minutes at the point of Intervention.

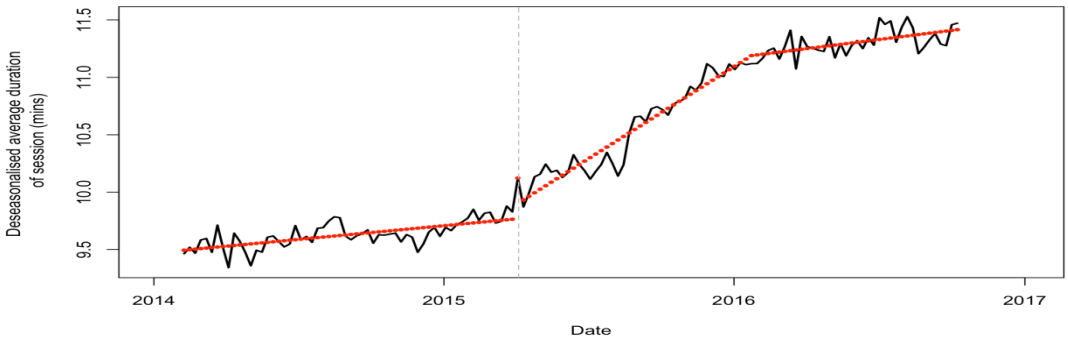
The model estimates suggest a step change upwards by 0.10 minutes at the point of intervention. There is then a period of adjustment lasting just two weeks where further lengthening of the mean duration occurs. Then the old upward trend resumes but at about twice the rate.

Figure 4.4. Average session duration

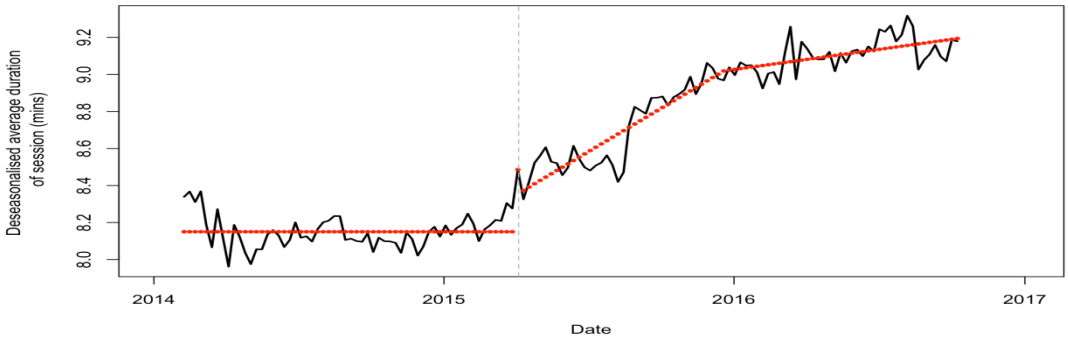
(a) *sessions with at least one play >£50*



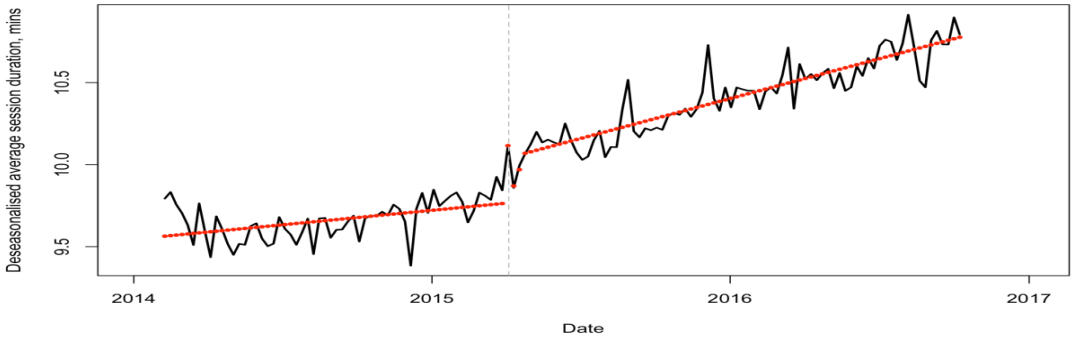
(b) *sessions including B2 play*



(c) B2-only sessions



(d) all sessio



ns

By the end of the study period, standardised mean duration was 10.78 minutes. Sessions were therefore, on average 10.3% longer. Compared with a hypothetical figure for the final week extrapolated from the pre-Intervention trend, the increase is 4.3%. The interest in these estimates of the effect of the Intervention is probably in the sign rather than the magnitude. **Session length *increased* whereas a policy to reduce harm might have been expected to have shifted mean duration in the opposite direction** (unless increased duration was associated with a slower pace of play- which it was not, as we shall see below).

In interpreting this finding, the degree to which there is cause for concern should depend on whether the change in mean is being driven by changes in players who engage in the longest sessions. At the mean, an increase of one minute or so on a session of ten minutes might not be so significant.[48] However, if the mean is increasing because a relatively small number of players are significantly lengthening already long sessions, then this would be worrying as long duration of machine play is strongly correlated with problem gambling.[49] We investigate the frequency of long duration sessions in the 'Extremes' section below.

Plays per session

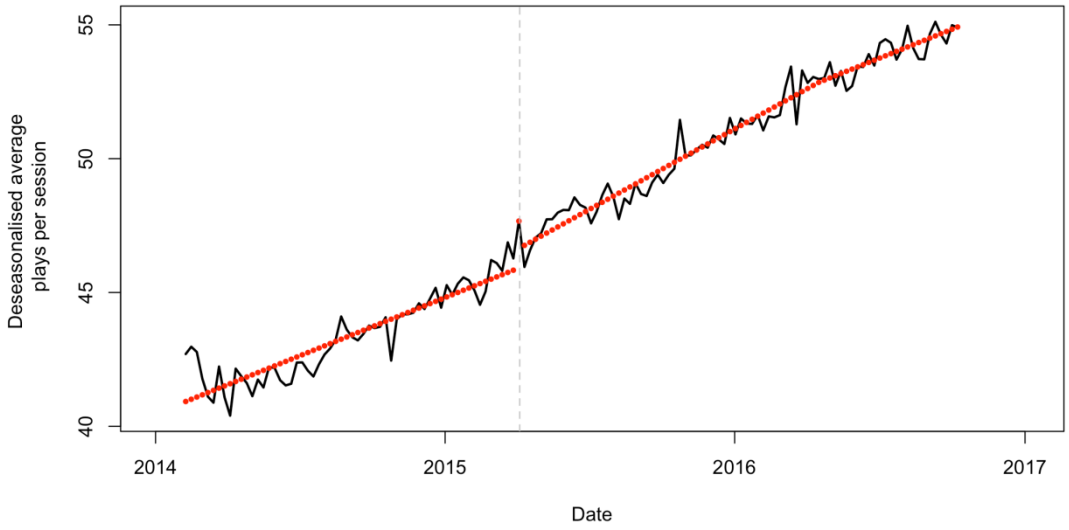
Figure 4.5 tracks the mean number of plays per session. There is an increasing trend throughout the study period with a small jump at the point of Intrervention and a slight slow down in the rate of increase from April, 2016.

At the end of the study period, the standardised figure for mean number of plays per session was 54.92, up from 46.00 at the point of Intervention: an increase of 19.4%. However, this is likely to be an overestimate of the impact of the policy since a steady upward trend had been evident right up to Intervention and would likely have continued for some time. If we compare the actual figure at the end of the study period with the figure projected from the pre-Intervention trend, the increase is only 2.44%. Broadly, the behaviour of average session duration measured by the number of plays mirrors that of average session duration measured by time.

[48] The level of aggregation of the data with which we were supplied did not permit precise calculation of *median* session length.

[49] See, for example, T. Schellinck & T. Schrans, 'Identifying problem gamblers at the gambling venue: Finding combinations of high confidence indicators', *Gambling Research*, 16:1:18-24, 2004.

Figure 4.5. Average number of plays per session



Speed of play

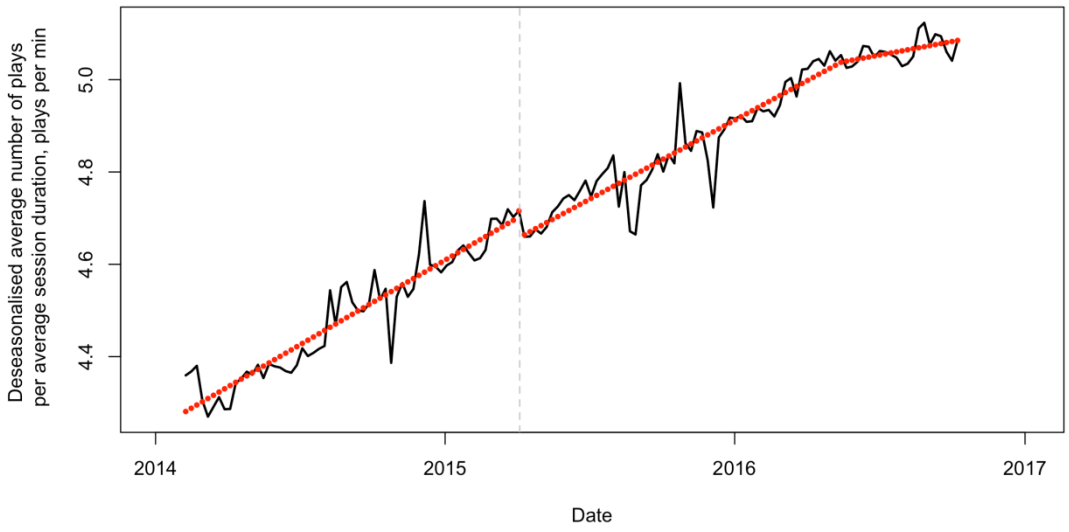
Mean speed of play, which we measure by the number of plays per minute, is calculated as the average number of plays per session divided by the average duration of a session. The averaging is therefore over all session minutes.[50]

This metric is of particularly interest because an important stated objective of the Intervention was to induce FOB-T users to play in a more considered way. This could mean that they should think more about whether to play at all; but it could also be understood to imply that, when they play, they should play more slowly. It might therefore be hoped that the Intervention would have been followed by a lower mean speed of play. This would be suggestive of players taking more time over decision-taking and so being more "in control" of their actions.

Figure 4.6 shows that speed of play was generally faster after than before the Intervention. At the srart of the period, and using, as usual, the standardised measure, the average minute on a FOB-T contained 4.27 plays. By the point of Intervention, this had increased to 4.71 plays. By the end of the study period, the figure was up to 5.26. From the point of Intervention to the last week in the data set, 78 weeks later, speed of play therefore increased by around one play per minute, an increase in speed of 8.1%.

[50] It is perhaps worth pointing out that this measure is not the same as the average speed across players. For example, players who spend an abnormally long time on machines may play faster or slower than other users. These players will have a high weighting in the calculation of mean speed across minutes because they account for a relatively high share of total minutes. Because sessions are anonymous, we cannot measure average speed across players.

Figure 4.6. Average speed of play



Thus, **a before-and-after comparison indicates that average play became *faster* under the £50 Regulations, which is contrary to what would be consistent with the Intervention having achieved its objective of inducing more considered play**.

One could, however, evaluate the Intervention against the alternative counter-factual that, without the £50 Regulations, speed would just have continued to trend upwards at the rate observed up to week 62. With this scenario, speed would have reached 5.26 plays per minute by the end of the study period. This figure is 3.2% *greater* than the actual figure in the last week of the data set. This alternative comparison would be consistent with the Intervention having had some small 'favourable' effect. However, we would have relatively little confidence in drawing such a conclusion. In part, it depends on the model estimates having identified a flattening of the trend after Intervention; but the estimate on the change in slope was not in fact statistically significantly different from zero.

The safest conclusion would therefore be that **the Intervention appears not to have disrupted to any great extent a trend for the speed of play on FOB-T play to increase over time. This is likely disappointing for those who supported the new Regulations because speed of play is a plausible correlate of the degree of self-control among players**.

Of course it would be interesting to know the cause of the upward drift in speed of play independent of whether this may or may not have been moderated by the introduction of the £50 Regulations. Possible candidates as factors to explain the trend include a shift in the extent to which players use the 'repeat bet' button and a shift in the balance of play between B2 and B3

content (where the regulated maximum speed is eight times faster in the latter case). We had no data on use of the repeat facility but below we are able to offer information on the split between B2 and B3 games.

Player loss per session

Considered at the level of the individual session, the typical cost of playing a FOB-T is modest. For example, in the data set we have aggregated data from more than 370m roulette-only sessions over 140 weeks. 28% of these ended in a win for the player and another 24.7% ended with the player losing less than £5. Thus more than half of all sessions "cost" the customer below £5 (or actually gave him or her money). Although the median (or typical) loss was below £5, the mean is pulled up by sessions with very high losses. Even so, the mean is significantly below £10. These are costs that may reasonably be compared with the costs of alternative entertainments such as visits to a coffee shop.

On the other hand, while an 'average' session loss would not be likely to cause undue harm to many players, it should be borne in mind that some gamblers, and perhaps especially those who have problems with their gambling, will play multiple sessions per week. For example in a sample of 4,001 loyalty card holders[51], 10% played "every or almost every day" and some of them did so twice a day. Even if they played only "average" sessions with "average outcomes", such frequent engagement would be damaging for many. In that context, it may be reasonable to hope that the Intervention will have reduced player loss per session.

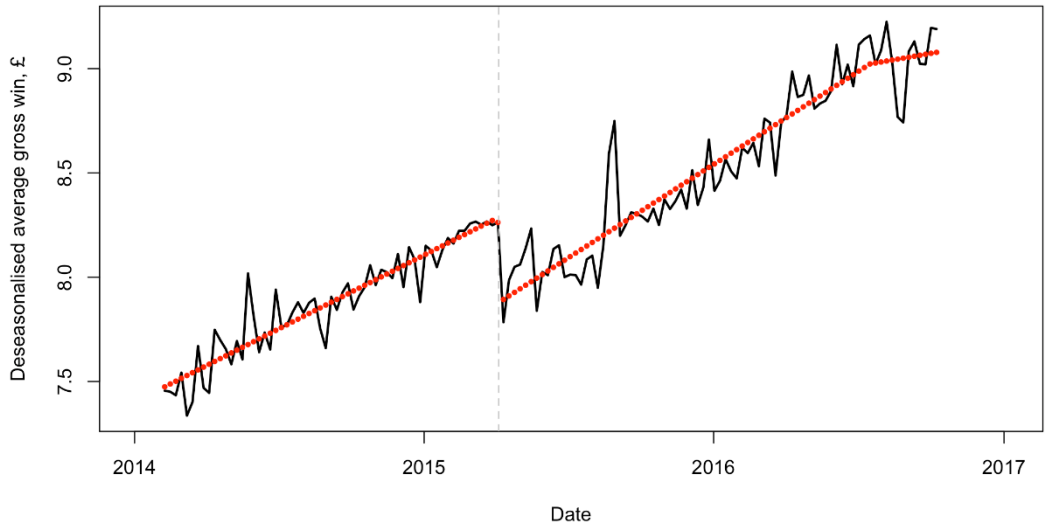
Figure 4.7 shows the evolution of average loss per session. It shows the trend to have been towards a higher sessional loss both before and after the Intervention, but with a once-and-for all downward adjustment at the point of Intervention. Thus, the starting (standardised) value of mean loss was £7.46. This trended upwards to £8.30 over the first 62 weeks of the data set and then took a step down by £0.41 on the £50 Regulations being introduced. Even with this negative "shock", average loss was still higher than it had been one year earlier. Moreover, the upward trend was immediately renewed at a slightly faster rate than before and this continued for much more than a year, before the break in trend detected in July, 2016. At the end of the study period, mean loss was £9.08, which was 9.4% higher than at the point of Intervention but 2.9% lower than the figure obtained by simply extrapolating the pre-Intervention trend.

One can never know the true counter-factual. The reason for the end of the long upward trend in July, 2016 is not known. The change in behaviour around that time may have occurred regardless of the introduction of the £50 Regulations. Therefore it could be more realistic to compare the actual with the projected standardised value as at week 128. In this case, the discrepancy was only 1.8%. A balanced conclusion might therefore be that **the Intervention had a transient**

[51] For the reference, see footnote 43 above.

impact on average player loss but any effect was substantially eroded over the following fifteen months.

Figure 4.7. Average player loss per session



Intensity of play

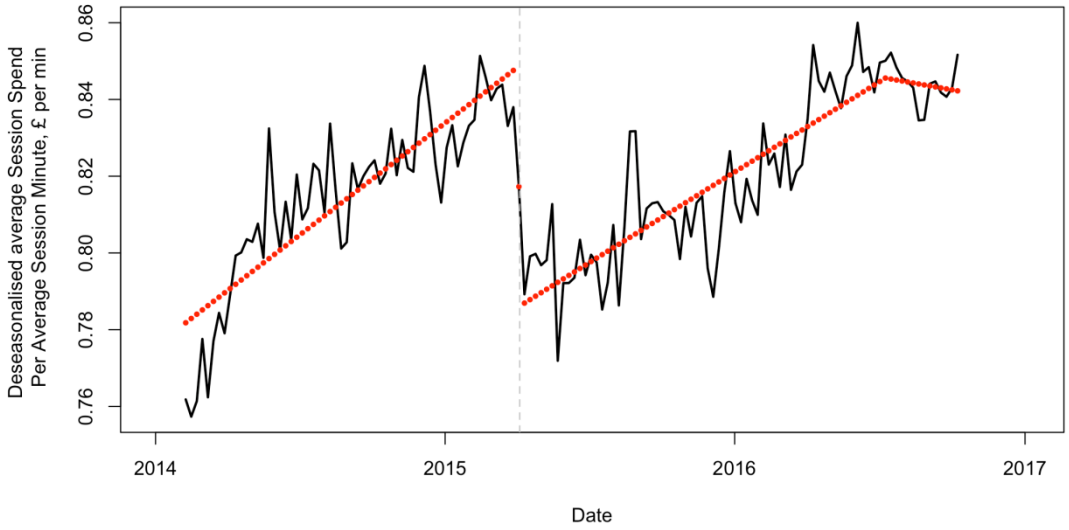
Intensity of play refers to the average loss per minute of play. It is calculated from two series in the data set, which show, for each week, average session loss and average session duration.[52]

This is another statistic where a fall would indicate moderation of behaviour. But it is also another which in fact, *increased* over time. It is plausible that, if anything, this will have increased gambling-related harm.

However, it is hard to blame the £50 Regulations. Loss per minute had increased before they were introduced (Figure 4.8). And their immediate impact was to lower the loss per minute by 7.4%, from the 85.0 pence it had reached down to 78.7 pence. It is true that an immediate recovery began but (taking standardised values, as is our custom) the mean loss per minute never quite reached its level at the point of Intervention. In the final week of the data set, it was still (just less than) 1% lower than then. So**, if the counter-factual scenario is that the statistic would have remained at the same value it had had at the point of Intervention, then the conclusion would be that the Intervention immediately reduced intensity of play but made no material difference once the market had adapted. Things went back to close to the way they had been.**

[52] Note that, in the calculation of average session loss, a session win for a player is treated as a negative loss.

Figure 4.8. Average intensity of play



Our alternative scenario is that the trend evident in the data up to week 62 would simply have continued to the final week (140) had the Intervention not been made. **Making this alternative assumption about the counter-factual leads to an alternative conclusion, that there was a lasting moderating effect from the regulatory nudge**. At week 140, standardised mean loss per hour was 84.2 pence compared with a projected 93.7 pence (a variation of -10.1%).

These are alternative assumptions and either could be regarded as unreasonably strong. The truth may lie in between: the Intervention immediately curbed and diminished average intensity of play and, although it then resumed its old upward path, there was still a modest longer-term moderating influence on behaviour. However, if session length is longer, this may not be much of a gain- we have shown already that any impact on average session loss was very limited.

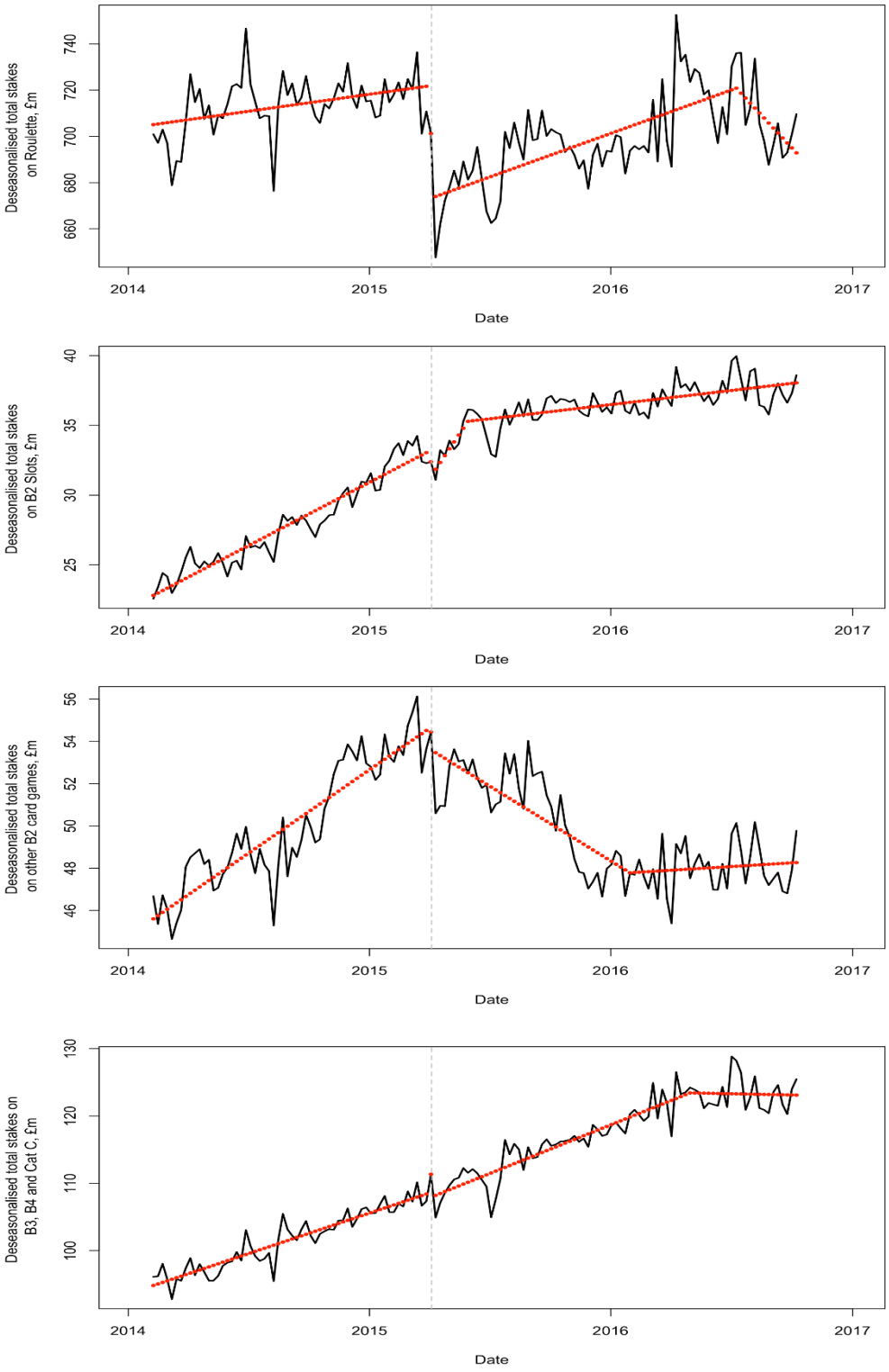
B2 versus B3 play

In chapter 3 we considered the evolution of the data series showing weekly stakes in FOB-T machines. Now we consider the break-down of total stakes by product category. In Figure 4.9 the foci of interest are the top and bottom panels, for B2 roulette and B3 games[53] respectively. For completeness, we exhibit also stakes placed on B2 slots and card games. But consideration of the numbers on the vertical axes will confirm that these products contribute only a small proportion

[53] The data for B3 games include also stakes placed on categories B4 and C but these are a tiny proportion of the total.

of FOB-T activity (see also Table 2.2 above). Hence our commentary considers just the top and bottom charts in Figure 4.9.

Figure 4.9. Stakes in four product categories



For the B2 roulette series, disruption around Intervention is very much more evident than is the case for the B3 series. This is to be expected because no new constraints had been introduced on B3 plays where the maximum stake is just £2. However, there might be have been some potential for some B2 stakes to be switched into B3 games by B2 players.

In the 61 weeks we observe prior to Intervention, stakes in both product categories increased steadily. Our estimate of the gradients of the fitted trends suggest that the average weekly increase was £0.281m for roulette and £0.230m for B3. Thus the growth in each market was similar in absolute terms. But, because the roulette market is much bigger, this represented faster proportionate growth and increasing market share for B3.

At the point of Intervention, stakes on roulette fell abruptly. The standardised figure for amount of stakes fell by 6.7% or £48.26m. However, there was a strong and sustained rebound which lasted until the beginning of July in the following year. Then the series turned downwards again. At the end of the study period, amount staked was £29.38m (4.1%) below the figure at the point of Intervention. But for the turn down in the second half of 2016, one might reasonably have expected that total stakes on roulette would soon have reached their pre-Intervention level.

There was therefore "a lot going on" in the roulette market after the Intervention. But the same cannot be said of the B3 market as represented in the bottom panel of Figure 4.9. In the model results underpinning the chart, the dip post-Intervention was not statistically significant and the increase in the gradient of the trend line at the Intervention was only small. Growth continued at close to the old rate until early July, 2016 when the series flattened out (the point estimate on the weekly change of stakes is negative but close to zero over the final 13 weeks of the data set).

Visual inspection of the charts therefore gives little support for the proposition that the Intervention shifted play, in terms of amount staked, from B2 to B3. This conclusion is reinforced by considering the numbers. In chapter 3 we reported on modelling of the impact of the Intervention on total stakes across all products combined. Our estimate of the immediate impact of the Intervention was that total weekly stakes fell by £50.04m. In this section, the estimate for the immediate fall in roulette stakes was £48.26m. Given how close these *estimates* are to each other, it would be fair to conclude that, in the immediate aftermath of Intervention, there was no or very low leakage of 'lost' roulette stakes into B3 games.

Again, consider where stakes on each product would have been had there been no Intervention and had the pre-Intervention trends continued in each case until the end of April, 2016. This was when we place the break in trend for stakes on B3 games which saw the series flatten. Later,

growth in B2 stakes was also curtailed and indeed reversed. We consider it speculative to relate these changes, more than a year after the event, to the Intervention and so compare actual stakes at the end of April, 2016 with stakes projected from pre-Intervention trends.

At the end of April, 2016, standardised weekly roulette stakes were £713.65m, which was £24.04m below the projection. Standardised weekly B3 stakes were £123.42m, which was £1.89m more than would have been expected from this particular counter-factual scenario. This would imply that, arithmetically, 7.9% of the 'shortfall' in roulette stakes could be accounted for by increased B3 stakes.

Whichever comparison is preferred, **evidence of large-scale migration of stakes from roulette to B3 is limited. It is true to say that the ratio of roulette stakes to B3 stakes is lower now than it was before the Intervention. However, much of the change observed is consistent with continuation of trends already evident in the data prior to April, 2015**.

A key argument in our discussion of the possibility that the objectives of the Intervention might not be achieved is that players might be drawn into B3 play, which is faster and has both a lower and a more volatile return-to-player. From our analysis, this has not been so important a factor. However, it should be noted that players may have exposed themselves to greater volatility in an alternative way by playing roulette less conservatively than before. We are not able to observe style of play but some inference about it may be possible from analysis of session outcomes below.

Totals and averages- overview

One reason why several of our conclusions are expressed somewhat tentatively is that matters have been made less clear-cut by changes which were detected in the last part of the data, in Summer, 2016. This was more than a year after the Intervention. It cannot be sure whether these changes were unrelated to or else part of any train of events set in motion by the introduction of the £50 Regulations. As the time since the Intervention becomes greater, it becomes increasingly less safe to assume that trends identified between February, 2014 and April, 2015 would simply have continued to the present. On the other hand, it could be that changes in response to the Intervention could take a very long time to work themselves out. The pool of players is not constant over time. Players quit the field and are replaced by new recruits. The short-run response to a regulatory change will be driven by how existing players react. In the longer-run, the behaviour of new players will have a substantial influence on totals and averages. Those who never experienced the old regime may regard the current constraints in a different way from the original players. So long-run impacts may differ from short-run impacts.

Some ambiguity is therefore inevitable. Nevertheless, we can draw some conclusions about the behaviour of key series following the Intervention:

- the frequency with which high stakes (as defined by the £50 limit) were placed fell precipitously immediately the Regulations came into force; although there was a recovery (and a probably-associated increase in the number of players using verified accounts in 2016), frequency at the end of the study period was still much less than half what it had been

- the total number of player sessions continued to fall, after as well as before the Intervention

- average session length whether measured in minutes or by number of plays increased somewhat

- there is no convincing evidence that the Intervention arrested a trend to faster play, hence no reason to believe that there was more considered decision-taking

- average per-session losses had been on an increasing trend; the Intervention immediately shifted the level of average loss lower but the upward trend was not arrested; and any impact was not evident for much beyond a year

- intensity of play (player loss per minute) was reduced initially but the lasting effect was modest and reflective just of increased duration

- evidence of a switch from B2 to B3 play as a result of the Intervention is weak

The first point illustrates the potential of a 'nudge' to modify behaviour. But, while many players did change something of what they did because of an obstacle put in their way, the remaining points show that there was little material effect on final outcomes. This is consistent with individuals using the flexibility given by the presence of choice variables not covered by new rules effectively to carry on as before after a period of adaptation.

However, these conclusions are drawn from consideration of data to which 'typical' players contribute heavily. 'Typical' players had no need to modify behaviour since they did not play for high stakes anyway. This gives an inherent inertia to most of the data series we have examined. This may mask significant variation of behaviour by a minority of players. Change in the behaviour of atypical players therefore merits more attention. It is among those players that the new 'soft cap' of £50 on stakes was relevant. Further, it is among those engaging in extreme play that harm from gambling is most often found. Harm is ultimately what the Intervention targeted.

1.14 Extremes

High stakes

We have noted already that the number of high stake plays fell substantially on Intervention and remained much lower than before, at least as far as the end of the study period. Now we provide more detail on staking patterns. The reason for focusing on the use of high stakes is that it is unusual behaviour[54] and it has high specificity (though low sensitivity) as a marker for problem gambling, i.e. there is a high proportion of problem gamblers among those who use high stakes, according to a study of loyalty card holders .[55] Indeed this study suggested that, literally, a *majority* of those who placed stakes above £50 were PGSI problem gamblers

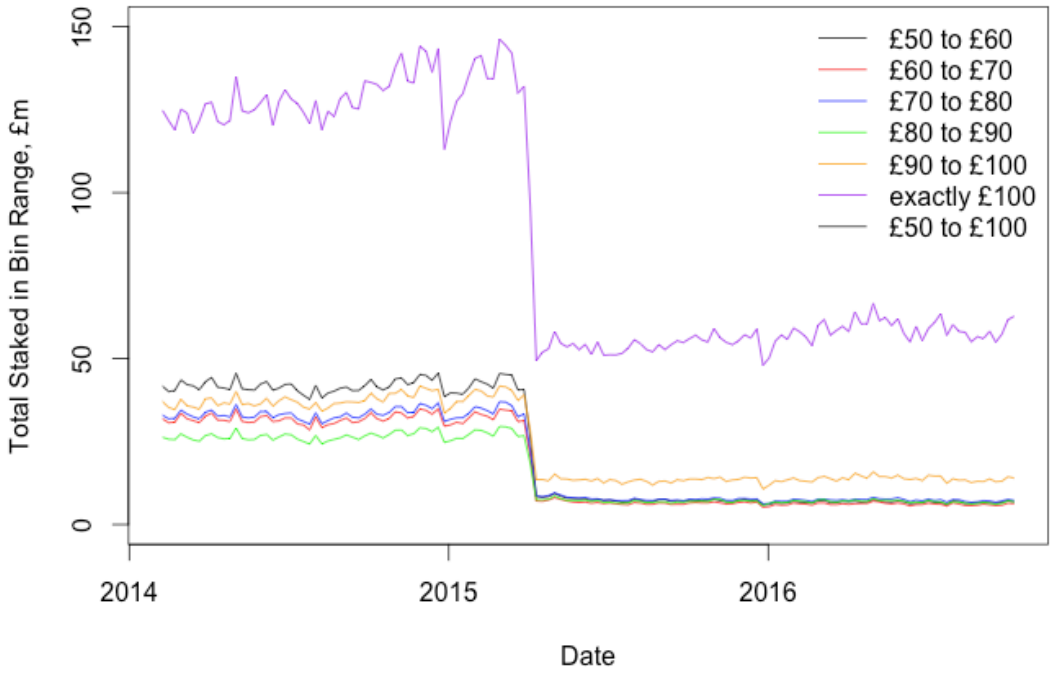
Figure 4.2 above showed the data series for *number* of roulette plays above £50. Now we show the *money value* of high stake roulette plays. Figure 4.10 illustrates the evolution of the raw data series for various stake ranges above £50 (top panel) and up to £50 (bottom panel). In these raw data, the fall, at the exact point of Intervention, in the total staked in each of the stake ranges above £50 is very obvious. In the bottom panel, there is a simultaneous step increase in the value of stakes from plays in the range £40.01-£50. It is harder to detect any significant changes in amounts staked in lower stake ranges (below £40). This leads to the working hypothesis that the principal impact of the Intervention was that it led to replacement of bookmaker *revenue from the highest stake bets* by *revenue from bets just within the £50 limit*.

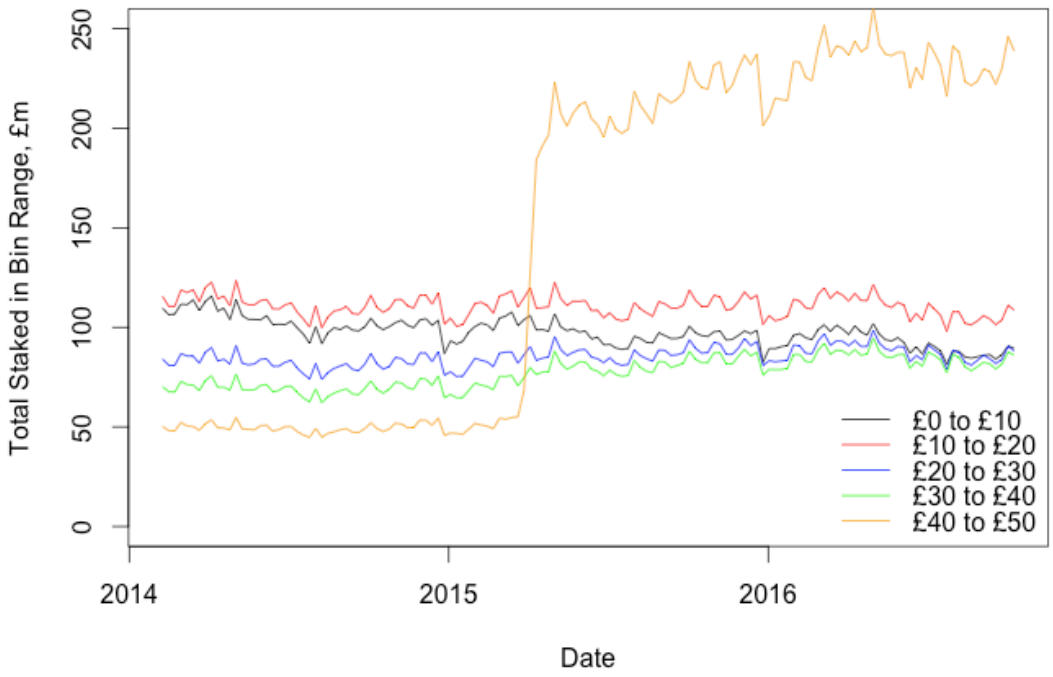
To judge the significance of this shift of money, more detailed analysis is needed where numbers are evaluated to measure the extent of the displacement. So we turn to consideration of the seasonally adjusted data.

[54] Across our data period, the proportion of roulette plays to which a stake of over £50 was attached was 5.8%.

[55] See, for example, Table 4.2 in H. Wardle, *People who Play Machines in Bookmakers: Secondary Analysis of Loyalty Card Survey Data*, NatCen Social Research for the Responsible Gambling Trust, 2016.

Figure 4.10. Total amounts staked in various stake ranges

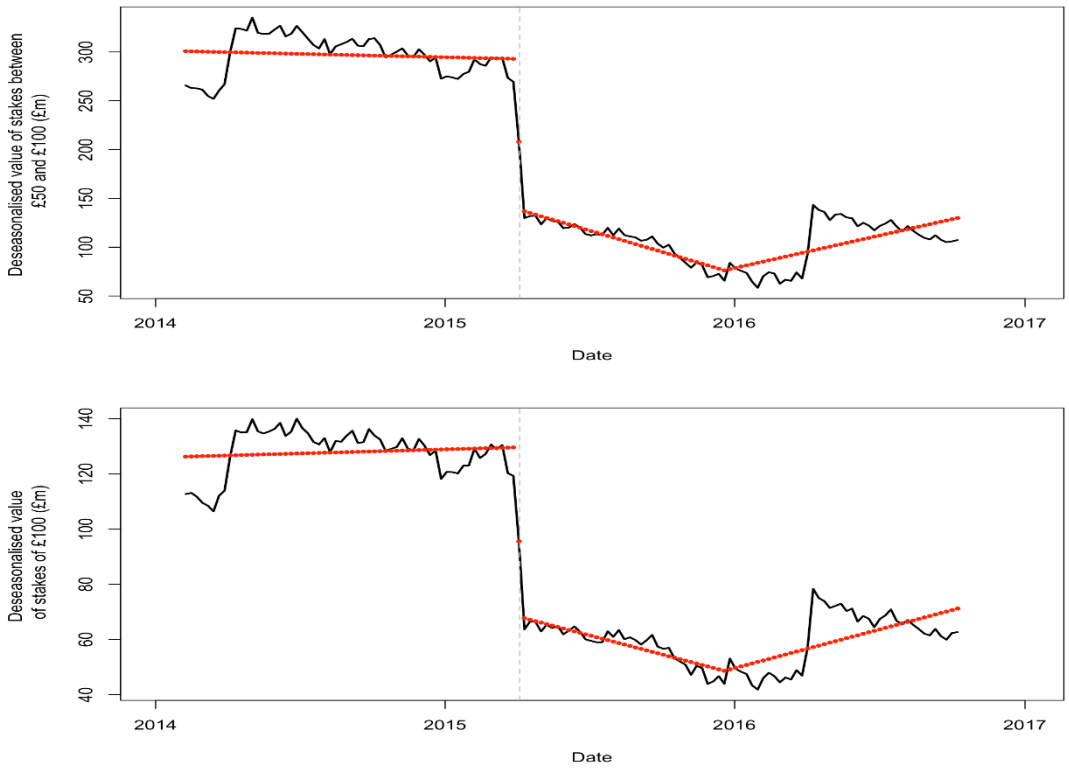




Our conclusions are drawn from modelling whose results are shown in Figures 4.11 and 4.12. Figure 4.11 presents the trends in the value of stakes of more than £50 (and, for interest, shows also the data for plays at exactly £100). Figure 4.12 focuses on each stake band (£0.01 to £10, £10.01-£20, etc) *below* the new soft cap.

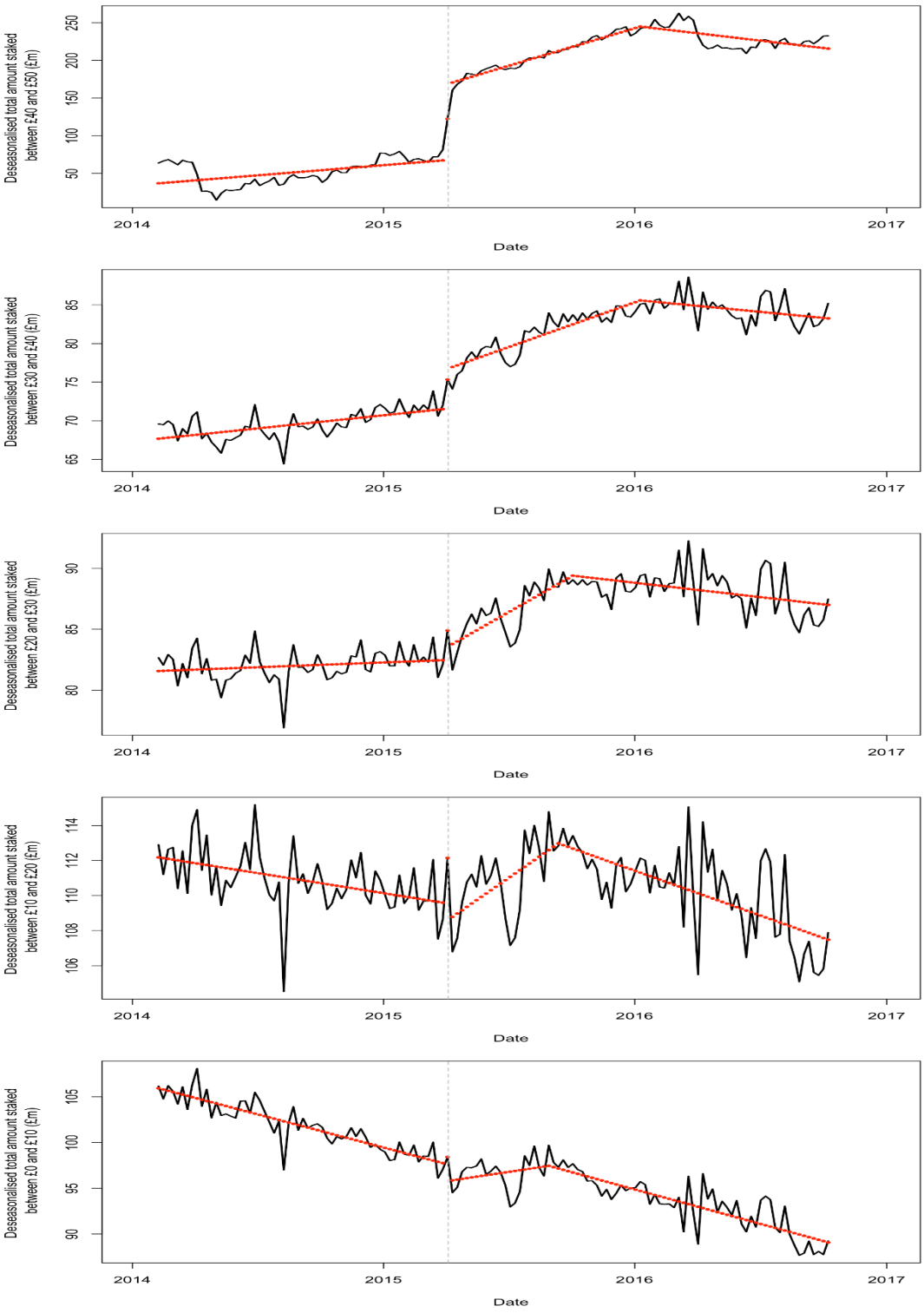
Consider first the immediate impact of the Intervention. The standardised value of weekly total amount staked in plays over £50 fell by £156.04m (the jump shown in the top panel of Figure 4.11). The standardised value of weekly total amount staked in the range £40.01-£50 increased by £102.36m (the jump shown in the top panel of Figure 4.12). There was also a step increase in the value of £30.01-£40 stakes (+£5.33m) and of £20,01-£30 stakes (+£1.29m).[56] **Thus, very close to 70% of the "lost" stakes from high stakes play at the point of Intervention was simply replaced by revenue from lower stakes bets.**

Figure 4.11. Total amounts staked in high stake roulette plays



[56] The change in the range £10.01-£20 was statistically insignificant; the value of stakes below £10 actually fell but by only 1.6%.

Figure 4.12. Total amounts staked in roulette plays with stakes in ranges up to £50



Following the Intervention the series for stakes over £50 and £40.01-£50 continue to mirror each other, the one showing further decline, and the latter a trend increase, until about the beginning of 2016. Then the trends reverse as more players opt into registered play (recall the increase in 2016 in the number of unique players logging in to registered accounts). Again this is consistent with many players reacting and adapting to the new environment mainly by just switching money between the two stake levels.

Consider now where things had reached by the end of the study period, the beginning of October, 2016. The standardised weekly value of stakes in the above £50 range was now £140.19m. This was *£152.55m below its level at the point of Intervention*. The standardised weekly value of stakes in the range £40.01-£50 was £ 215.77m. This was *£147.40m above its pre-Intervention level*. Moreover stakes in the range £30.01-£40 were contributing £11.64m more than pre-Intervention.

Putting all these numbers together, **the impact of the Intervention seen from the end of the study period was minimal: roughly, the fall in the value of roulette stakes derived from bets over £50 was simply cancelled out by a corresponding increase in the money value of stakes just within the £50 limit**.

This is interesting for a number of reasons.

First, since roulette is the dominant game in the FOB-Ts market, it explains why we could detect little effect from the Intervention on aggregate stakes across all games.

Second, there is always the possibility that individuals will respond to an intervention on one gambling product by using others instead. Thus players who were not happy about registering for an account could have migrated to online play, where there are no regulatory restrictions on stakes. Alternatively they could have decided that the structure of the roulette game made playing it unattractive without the excitement of high stakes and moved money to B3 games, played at the same machines at low stakes but with high volatility. But there is no evidence of such substitution having taken place (this is consistent with our finding no serious impact on trends in B3 play, section 4.2 above). The substitution was *within* the roulette game.

Third, the success of the nudge in dramatically reducing the number of plays above £50 seems less significant once it is appreciated that the money spent on those ‘lost’ plays has simply been diverted into extra plays at close to the £50 limit.

On the face of it, the Intervention may therefore seem likely to have had little effect on wellbeing given that it left the amount of money staked by formerly high stakes players more or less at the same level as before. However, it cannot in fact be presumed that there is no implication for the level of gambling-related harm.

On the one hand, if players substituted two £50 plays for one £100 play, and *they played in exactly the same style as before* (i.e. they made the same sub-bets within each play but at half the stakes), they would still have the same expected rate of return but with less volatility. To take an extremely stylised example for the sake of illustration, suppose the player used to split £100 between £50 on red and £50 on an odd number outcome. There is a 0.237 probability of a £100 gain for the player and a 0.264 probability of a £100 loss. Now the player makes two plays, each time staking £25 on red and £25 on odd. Now the chance of a £100 gain (across the two plays) is 0.056 and the chance of a £100 loss is 0.069. Extreme outcomes from gambling therefore become less likely (and intermediate outcomes more likely) and the harm associated with a big loss less likely.

On the other hand, players are unlikely to keep the same style of play. Similar to the literature on financial markets, studies on lotteries and horse betting find that gamblers' behaviour is consistent with their taking into account the mean, variance and skewness of returns.[57] Here, their chance of turning £100 into £200 has shrunk considerably because the £100 has had to be divided into two £50 bets. The player is predicted to try to push back up the chance of that £100 gain but this necessitates accepting more risk. For example, splitting each £50 bet into a series of bets on single numbers would increase the chance of gaining £100 but also considerably increase the chance of losing £100. This style of play would produce more "high loss" sessions and perhaps therefore more harm even though the amount wagered has stayed the same.

We are not able to observe style of play. Data on the records of each play have not yet been made available to researchers. The machines tell us only the stake on each play, not what the sub-bets were within that play. Therefore we cannot directly test the prediction that styles of play will have changed following the Intervention. However, we were provided with information on session outcomes in terms of player losses or gains. If the style of play changed in a risky direction, we would expect to see an increase in extreme outcomes and a decrease in moderate outcomes from the (roughly) given level of total stakes.

[57] See, for example, J. Golec & M. Tamarkin, 'Bettors love skewness not risk at the racetrack', *Journal of Political Economy*, 106:205-225, 1998.

High losses

The case against FOB-Ts has mainly been made on the grounds that they present an opportunity to lose a lot of money in a short time. For example, the DCMS Report expressed concern over the Gambling Commission finding that about 6% of sessions ended in a player loss in excess of £100. While a small proportion of sessions, this would still represent a large absolute number of visits to bookmaker shops which ended very badly for the player.

It is plausible that losses in the hundreds of pounds will often generate harm. Particularly given that areas close to betting shops "tend towards higher levels of crime events, and resident deprivation, unemployment, and ethnic diversity",[58] there is likely to be a high proportion of customers for whom hundreds of pounds would be very significant, potentially triggering a crisis for themselves and their families.[59]

It seems, then, fair to assume that the Intervention was intended to reduce the frequency of high-loss events. We therefore judge that, among all the data series supplied to us, this is the most important metric for evaluating the effectiveness of the £50 Regulations.

We were provided with summaries of sessional outcomes in 23 different ranges from "player loss of more than £5,000" at one extreme to "player win of more than £5,000" at the other. The data came in two files, one covering roulette-only sessions and the other slots-only sessions (be they B2, B3 or mixed B2-B3). Therefore the data below do not include mixed roulette-slots sessions.

For conciseness, we choose to present information on session losses which add together the numbers from the roulette-only and slots-only spreadsheets. The analysis does not cover sessions where there was gambling on *both* roulette and slots. Nevertheless it does cover about 90% of all sessions played and we have no reason to believe that findings would be altered by consideration of the missing data.[60]

[58] G. Astbury & M. Thurstain-*Goodwin*, *Contextualising Machine Gambling Characteristics by Location-Final Report*, Geofutures for the Responsible Gambling Trust, 2015.

[59] Further, a study of loyalty card holders (reference as in footnote 55 above) found that players who incurred high per-period losses did not have, on average, higher incomes than other machine users. It seemed not to be true that those who lost the most were those who could afford it.

[60] Resource constraints prevented the machine manufacturers from producing the additional data. It was reported to us that extraction of information from the data banks is costly.

Table 4.1 illustrates the average number (across the whole study period) of sessions per week ending in losses of magnitudes from £100 up. The data underline that, although a small proportion of all activity, the absolute number of high loss incidents make them almost commonplace, an average of nearly 2,000 instances per week when player losses exceed £100. Of course these are national numbers. In an average shop, large losses would still be rare. Note that most high loss sessions involve roulette rather than slots play.

Table 4.1 confirms that losses beyond £5,000 are rare. In modelling, we do not analyse the frequency of sessional losses in excess of £5,000 as it is unrealistic to derive reliable estimates of trend in the occurrence of such rare events.

Table 4.1. Average weekly number of sessions with player losses above £100

player loss	roulette-only sessions	slots-only sessions	total
£100.01-£200	90,549.3	32,633.6	123,182.9
£200.01-£500	49,583.5	12,965.3	62, 548.8
£500.01-£1,000	9,948.7	1,445.2	11,393.9
£ 1,000.01-£5,000	2,707.6	154.2	2,861.2
>£5,000	7.7	0.1	7.8

Modelling results are displayed in the form of the charts in the four panels of Figure 4.13.

In all high loss categories, there is a steady upward trend in frequency during the 61 weeks prior to the Intervention. In all cases, the increase is more than 10% and in the case of the £200.01-£500 band, it is very close to 15%. The total number of FOB-T sessions was *falling* over this period, so this rate of *increase* in the number of sessions ending in high losses could be regarded as surprising.

At the point of Intervention, there is an immediate drop in the standardised number of sessions in every high loss grouping. The fall is 8.1% for each of the two highest loss bands but marginal over £100-£500. Only in the case of the very top band is the fall big enough to wipe out the increase in frequency over the prior 61 weeks.

In all four cases, incidence of high loss sessions resumes its growth though with now familiar signs of moderation setting in in 2016.

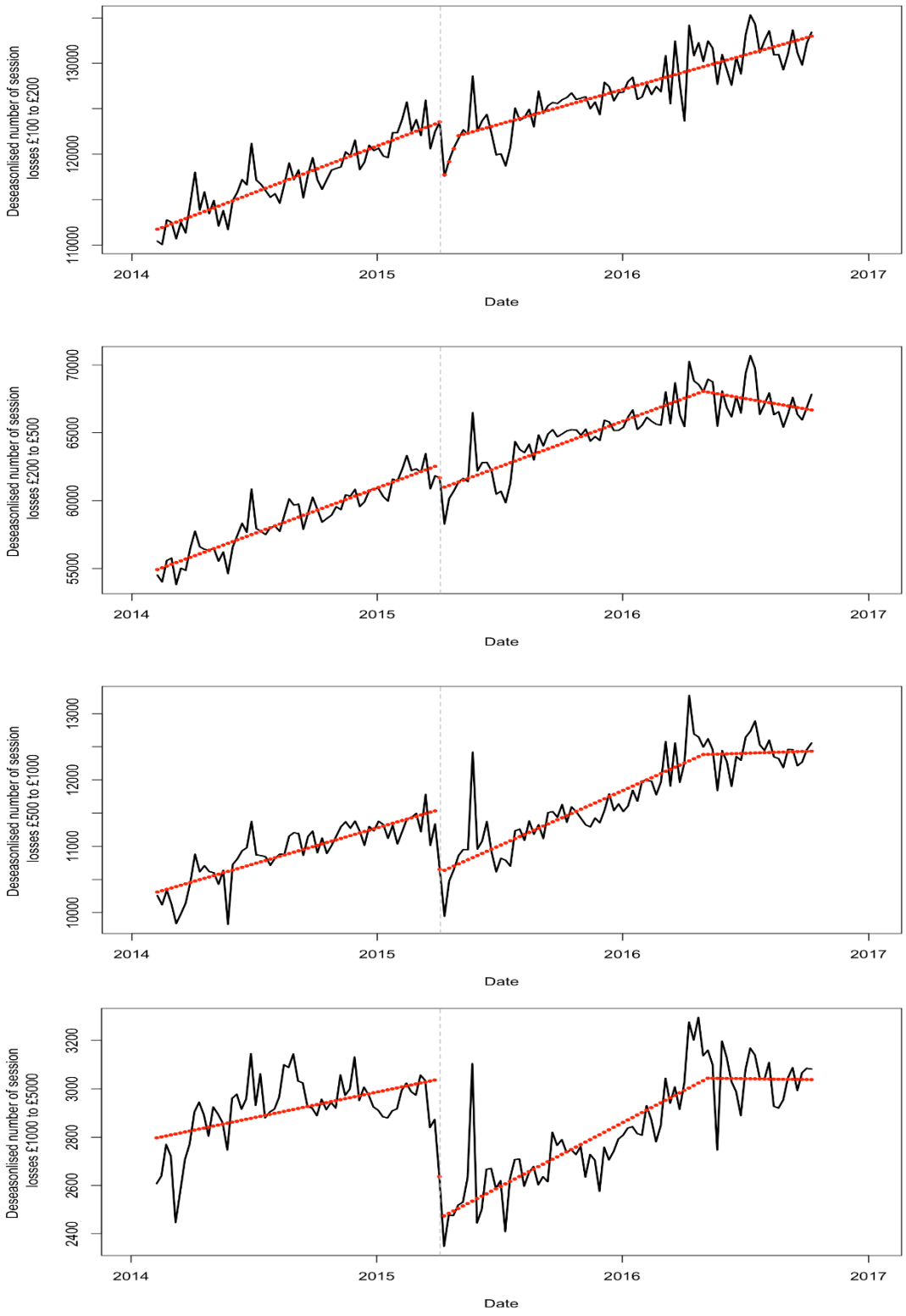
Comparing values in the final week of the study period with the corresponding values immediately before the Intervention, incidence of losses in the £1,000-£5,000 range is virtually unchanged; in the three ranges corresponding to losses in the hundreds of pounds, incidence is *higher* by 6.2%-7.5%. This suggests that the effects of the Intervention might indeed have been counter-productive. One possible explanation for an unintended negative consequence is that the shift from spending a similar amount on stakes but broken down into plays at (say) £50 rather than (say) £100 results in riskier styles of play which will be more likely to end in heavy sessional losses (or indeed wins).[61]

A kinder verdict on the efficacy of the Intervention would be drawn if the comparison were instead between the end-values of the standardised series and a counter-factual where the rates of growth observed pre-Intervention would simply have continued had the Intervention not occurred. On this basis, the Intervention would be credited with having led to lower frequency as measured at the beginning of October, 2016. The proportionate effects would be from -4.3% to -9.6%. However, these estimated impacts look optimistic because they assume that the moderation of trends in 2016 would not have occurred in a World without the £50 Regulations.

Again the conclusion cannot be wholly conclusive because we cannot know the true counter-factual. But there are grounds again for questioning the difference made by the £50 Regulations: taking the mid-points between the estimated final impacts on frequency of heavy losses under the alternative counter-factual scenarios puts the impacts in the region of zero.

[61] For conciseness, we do not present analysis for frequency of high wins but they also became more common.

Figure 4.13. Weekly number of sessions with a player loss more than £100



Long duration sessions

For many people, it is intuitive to be concerned about individuals who sit for hours at a gaming machine. To be sure, this may reflect cultural prejudices against leisure preferences different from their own.[62] Nevertheless there is research evidence that long duration is a leading predictive indicator that a user has problems.[63] And indeed part of their problem may be that so much time is spent gambling that it impinges on family and work responsibilities. We would therefore regard a finding that the Intervention was associated with an increase in the incidence of very long sessions as suggesting that harm may have been caused.

At this stage we expected to find such an increase. All the data series we consider are likely to be related to each other (even if our data set does not allow us to link sessions across headings[64]). Thus, if the money value of stakes stays roughly the same but there is a shift in the composition of the total such that more now is derived from £50 rather than £100 individual bets, it follows that there will be more plays on the machines. This is likely to mean individuals having to spend more time at the machine. And indeed we have already noted a significant increase in mean duration of sessions following the Intervention.

Figure 4.14 graphs the raw data series for the weekly number of roulette-only sessions[65] by session duration. There are eleven bands, ranging from "0-5 minutes" to "more than four hours". Short sessions are very much the norm and long sessions definitely atypical. For example, over the whole data set, the weekly average number of sessions lasting less than ten minutes was more than 2.1m whereas the average number lasting for more than two hours was 3,527.

Visual inspection of Figure 4.14 suggests that the number of short sessions (bottom panel) tended to fall over time and this is consistent with the fall in total sessions already reported above. By contrast, in the top panel, frequency of very long sessions appears generally to be greater late in the study period. Modelling of trends using deseasonalised data is needed to have a chance of distinguishing any Intervention effect from that of any pre-existing trend.

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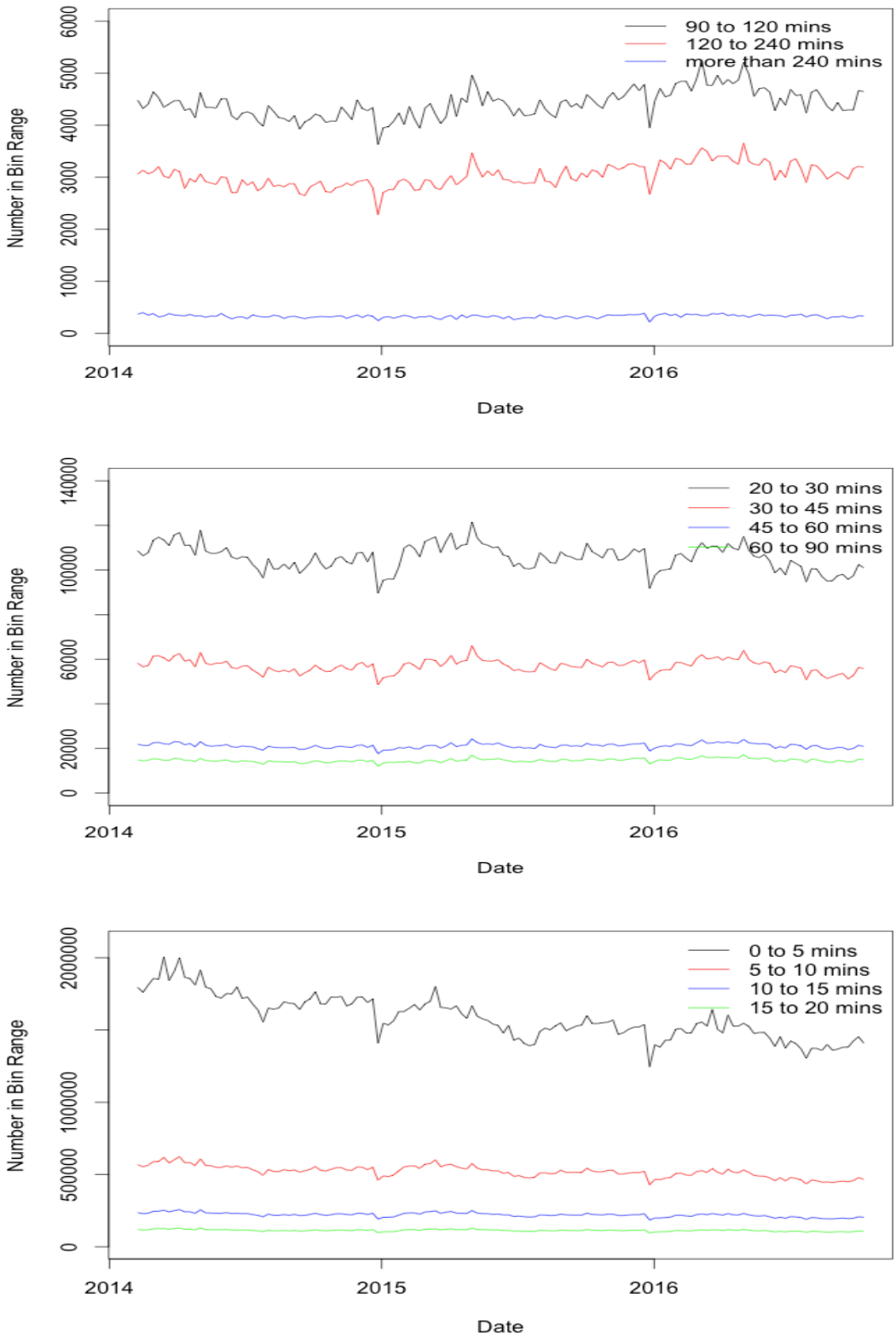
[62] Others, for example, choose to devote whole days every week for playing cricket or golf.

[63] See footnote 49 above.

[64] To illustrate, we know the number of sessions ending in a high player loss and the number of sessions lasting a long time. But we cannot examine whether and to what extent these tend to be the same sessions.

[65] Again we were constrained by the data series with which we were provided. In the data set, the information on the number of sessions in different bands of duration related just to roulette-only sessions. However, these account for the majority of sessions. Further the constraint on stake size was not binding in the case of B3 and we have found little evidence of diversion of roulette player funds into B3. Thus we would expect any tendency towards an increase in the number of lengthy sessions to be concentrated in roulette-only play.

Figure 4.14. Weekly number of roulette-only sessions by session duration



Figures 4.15 and Figure 4.16 present charts representing the modelling results for each of the eleven duration bands, from longest to shortest. Figure 4.15 groups together results for "long" sessions, defined as all bands from 45 minutes up; this grouping is suggested by the great similarity in the evolution of each of the bands. Figure 4.16 has results for bands representing durations up to 45 minutes.

For all long duration bands (Figure 4.15), the pattern is always the same. Prior to the Intervention, there is always a downward trend in the number of sessions. This always comes to an abrupt end at the point of Intervention and then there is a sharp jump to a higher number of sessions. In every case, there is an upward trend from this higher level such that the number of sessions reaches a peak in early 2016. However, during 2016, the trend reverses. The number of sessions in each "long" category declines. However, at the end of the study period, the figure in each case is still higher than pre-Intervention and (given the initial downward trend) also higher than a figure extrapolated from the behaviour of the series pre-Intervention.

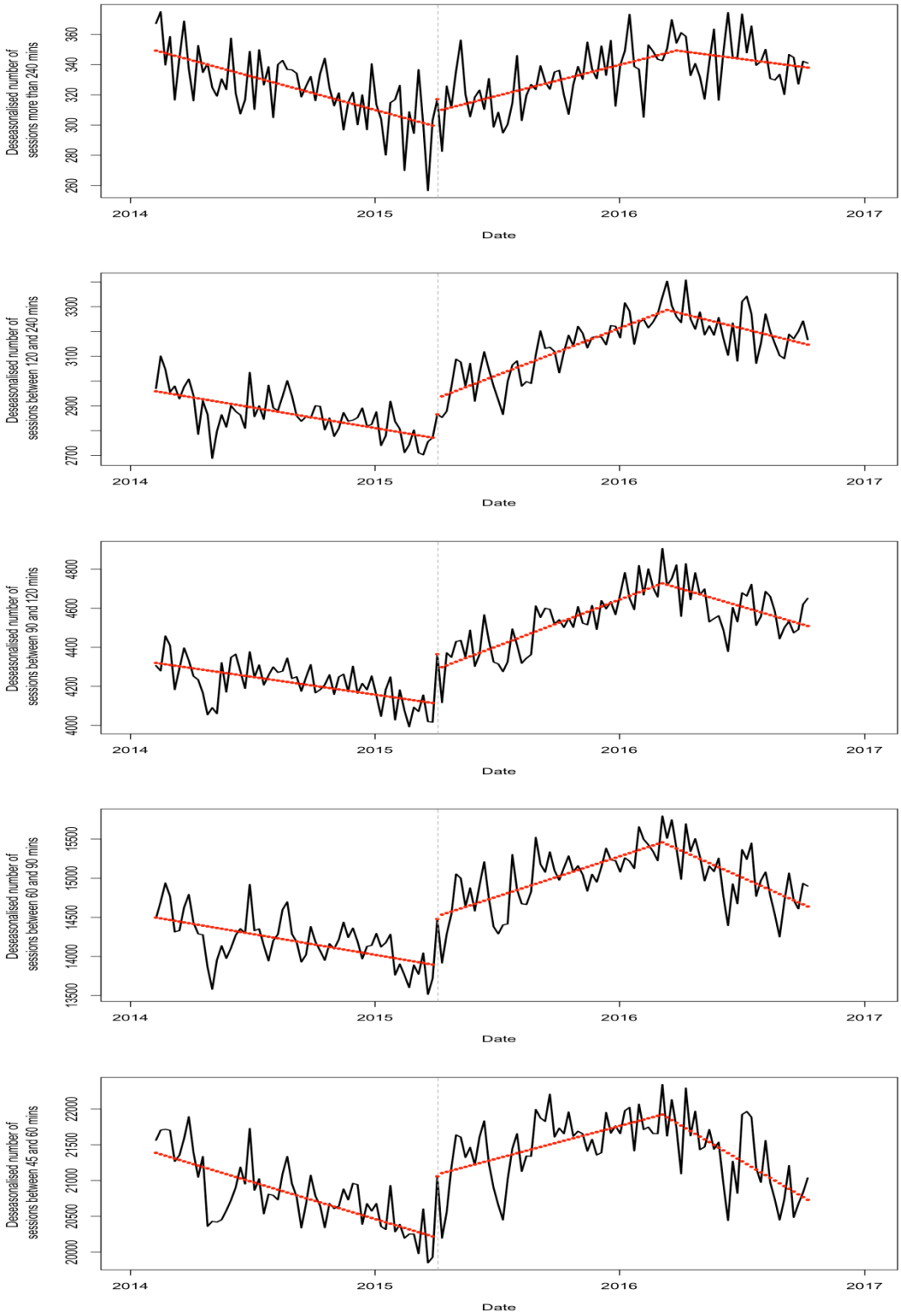
It would be repetitive to put numbers to each case. We consider the duration 45-60 minutes because such sessions are relatively common. Pre-Intervention, the standardised weekly number of sessions is 20,178.7. At the point of Intervention, this jumps by 4.4% to 21,104.0. The abrupt departure from trend suggests a causal impact from the regulatory shock.

After the Intervention week, the standardised value continues to rise and reaches 21,922.0 at the end of February. The trend is then reversed. By the end of the study period, the figure is 18,633.5 per week. This is 2.7% higher than the level immediately prior to the Intervention and 11.2% higher than an estimate generated from simple projection of the trend in the first sub-period.

A before and after comparison which takes into account both trends and variability in the data therefore indicates that the Intervention led to more long duration sessions being played. This result holds for all thresholds for defining "long sessions" from 45 minutes upwards.

Note that the findings for each band are not independent of each other. Overall, the total number of sessions (all durations) is actually falling. If one band is expanding, it must be that it is gaining more from migration from the band below than it is losing membership to the band above. As one goes to lower and lower duration sessions, eventually one expects to reach a band which is shrinking in size, Figure 4.16 shows that Intervention produces an increase in number of sessions as far down the chain as 30-45 minutes. But, in modelling, the 'Intervention shock" was statistically insignificant at 20-30 minutes and is actually negative for the bottom two bands (below 10 minutes).

Figure 4.15. Weekly number of sessions in duration bands above 45 minutes



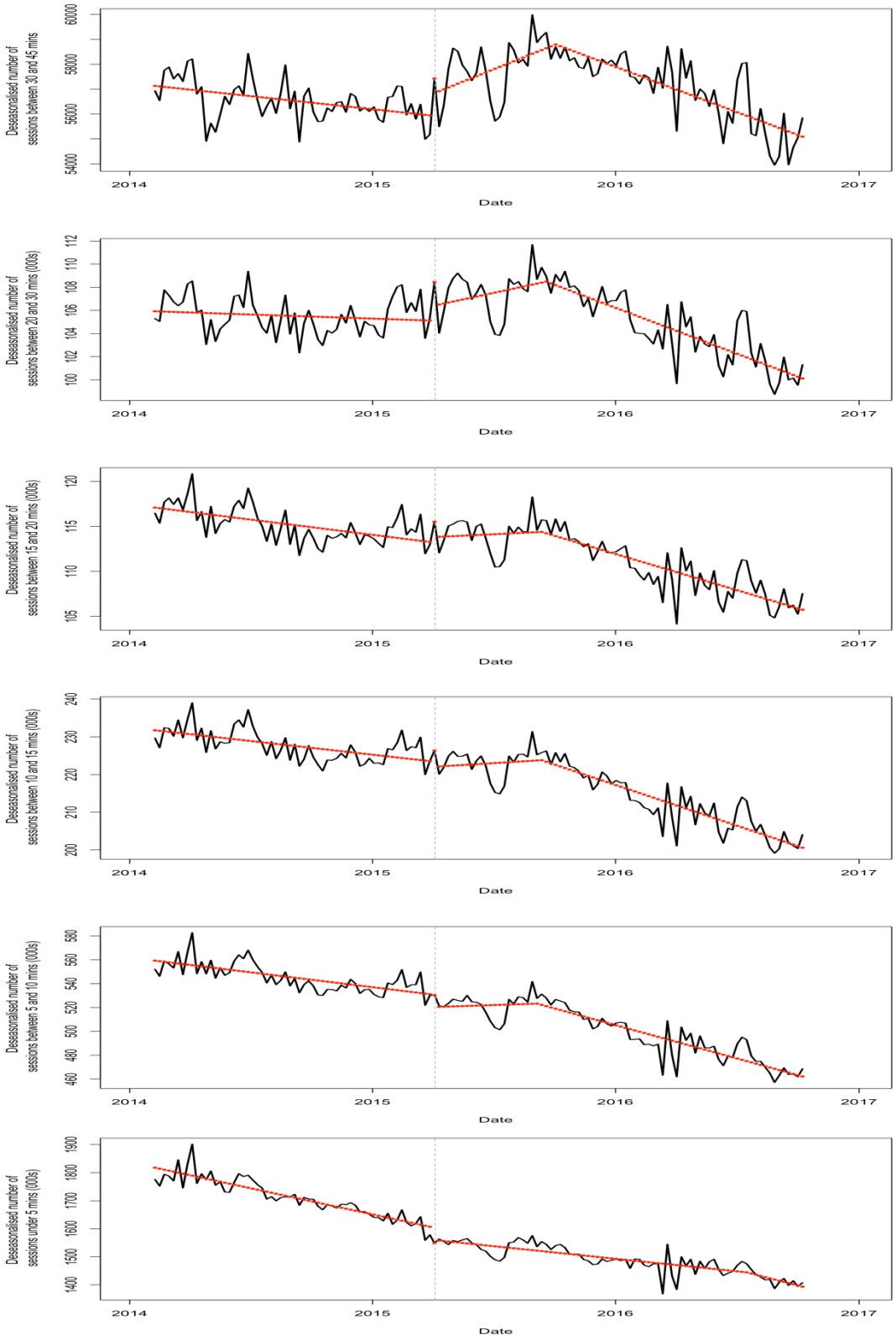
This overall pattern suggests that the effects of the Intervention worked by increasing average duration across much of the spectrum of session lengths. Some sessions below 10 minutes were extended and drifted into the 10-15 minutes band. This decreased the number of very short sessions. It increased the number in the 15-20 minutes range even though 15-20 minutes will have lost some sessions to the next band up. In this case, the out-migration upwards is more than cancelled out by the in-migration from below. This will typically be the case because population sizes are higher further down the structure. Thus the numbers of sessions in all "long" duration categories were able to increase simultaneously.

The story suggests that the Intervention did not create new "very long" sessions from nowhere. They were typically "long" sessions which would have been played anyway but which changed length to pass the threshold for "very long" sessions once the new Regulations were in place. It is to be expected that such transitions will occur because (to put things in a stylised way) stakes which had been £100 in one play were now split into two £50 stakes. Two plays take longer than one play. Average duration will increase and some individual sessions will qualify to be considered long.

The reversal of trends in 2016 is consistent with the story. Earlier we documented and quantified a move back to play above £50 in 2016, representing not an increase in total staked but a change in the split between bets above £50 and bets in the £40-£50 range. As more individuals moved back to high stakes without spending more in total, some sessions naturally became shorter. As a result, the number of sessions in each of the long duration bands edged down again.

Overall, **though the Intervention may not have *created* new very long sessions, it does seem to have pushed up the mean duration of sessions which were already lengthy. Some of these sessions then cross a band threshold and thus indicators such as "number of sessions longer than four hours" were higher after (and probably as a result of) the Intervention. This is an unambiguous result of our analysis and is no doubt related to high stakes players spending a similar amount as before but split into more plays**. This may signal harm being caused. On the margin, small extensions of session length could be damaging to players who are already allocating undue amounts of time to the machines.

Figure 4.16. Weekly number of sessions in duration bands below 45 minutes



Extremes- overview

Putting together the various strands of analysis in this section, we regard the principal points to be captured by the following:

- from loyalty card studies, a high proportion of those who played at the highest stake levels were problem gamblers and this justifies policy makers having targeted those players

- the Intervention successfully lowered the frequency of high stake plays and by a dramatic amount (albeit there was a very partial recovery in 2016)

- however, to a large extent, money used in stakes of more than £50 was simply moved to plays at stake levels just within the new soft cap

- by the year after the Intervention, total stakes were similar to where they would be expected to have been without the Intervention; this suggests that harm may not have been reduced by nudging players away from placing a large sum on a single play of the machine

- because many who would have played with high stakes switched the funds in question to purchasing plays with a lower stake, session duration would be expected to increase

- some already long sessions were lengthened as a result and the evidence is strong that the Intervention led to some increase in the frequency of sessions measured in hours rather than minutes

- this might be considered, for policy makers, an unwanted consequence of the new Regulations

- ex ante, there was also a risk that players who felt constrained to keep their bets below £50 would respond to the Intervention by adopting a less conservative playing style, which would lead to more cases of players losing hundreds of pounds in a single session

- but, while frequency of high loss sessions indeed increased in the period after the Intervention, there had been a strong trend towards more frequent high loss sessions even before then; consequently evidence that the Intervention made things worse is weak.

It would go too far to say that these findings were suggestive that the Intervention proved counter-productive in its effects on gambling-related harm. There is no evidence that behavioural change included migration of funds to other and potentially more risky forms of gambling, such as online roulette. Rather behavioural change was confined to the reallocation of funds used by high stake B2 players into a different staking pattern within roulette. This did lead to an increase

in session durations. However, only with a strong assumption about the counter-factual could the Intervention be evaluated as having increased the number of high loss sessions in FOB-T play. **We judge it possible to say that the Intervention proved disappointing in its (lack of) effects but not possible to argue convincingly that it was actually counter-productive**.

REFLECTIONS

As a demonstration of the efficacy of the 'Nudge' approach to mitigation of harm among consumers of risky products, the £50 Regulations (so far as one can tell) proved a failure. The episode did demonstrate and confirm that introducing a non-coercive obstacle to risky behaviour can indeed serve as a deterrent to that behaviour. But, if individuals can make ready adjustments to other choices, the adapted pattern of behaviour may still lead to similar harm as before. In this case, many were indeed deterred from making high stakes bets. But they could still choose to stake the same amount of money, spread across a greater number of plays, and collectively this is what they chose to do. Consequently, in the end, none of the indicators we considered (for example, speed of play, session duration, frequency of losses in the hundred pounds) had been moved in a direction consistent with more responsible or more considered play. This was true whether we were analysing indicators about average behaviour (where our findings for each indicator are summarised in bullet-point form on p. 58) or about behaviour at the extremes of stakes, losses and duration (findings summarised by bullet points on p. 71).

Thus this Report contributes, through a case study, to the general debate on 'Nudge' as a policy approach. It underlines the limitations of nudge policies which target specific, narrowly defined behaviours. But does this Report also contribute to the more specific debate on whether the Government, following its Review of gambling policy (in progress at the time of writing), should reduce the maximum stake on B2 gaming machines to a lower level than now, for example £30 or even £2 (as argued by one group of MPs[66])?

The £50 Regulations could be considered a trial of lower maximum stakes in that the sheer scale of the reduction in the use of stakes over £50 suggests that a large proportion of players affected by the limit chose to treat it as binding on themselves, i.e. they responded as if it were a new definite and lower limit rather than just a soft cap that could be circumvented by registering for account-based play.

Considered as a trial, the results were disappointing. Those affected- i.e. the players who used to stake at high levels, the majority of whom were likely to have been problem gamblers[67]- appear to have adapted their behaviour in a way such that they ended up spending *about as much money* and *more time* than before. Since gambling harms are typically linked to 'excessive' money and time spent gambling, one might have hoped for different outcomes than these.

[66] https://www.theguardian.com/uk-news/2016/dec/08/cut-fixed-odds-betting-stakes-to-2-mps-urge

[67] See reference cited in footnote 55 above.

However, it would be going too far to predict, from the results of the 'trial', that a future reduction of maximum stake would fail to mitigate gambling harm. Setting a limit at £50 affected a very limited number of players (and indeed only a minority of problem players[68]) because the others never played at that level anyway. Any fresh limit would affect a bigger group of players and they may have different characteristics and risk preferences compared with the smaller group targeted by the Regulations introduced in 2015. *Their* responses to a constraint on staking behaviour may therefore be different.[69] Consequently, extrapolation from the results reported here would be problematic.

Nevertheless, our findings do sound a warning that focusing exclusively, or mainly, on the issue of maximum stake has the potential to lead to policies with disappointing outcomes. They provide empirical support for a comment by Parke, Parke & Blaszczynski[70]: "A stake-only approach ignores the role of game speed, game volatility and return-to-player…..A coherent policy approach targeting cost of play to protect players must account for all characteristics contributing to how much a consumer can lose".[71]

In the event that a new stake limit were to be introduced, it would clearly be desirable to monitor its effects. This would not only provide guidance for future regulatory decisions in Great Britain. It would also be valuable research from an international perspective. Stake restrictions on gaming machines have been debated keenly in many jurisdictions, especially latterly in Australia, but there is a lack of empirical evidence to discipline the debate. In their much cited review, more than 100 pages long, of the efficacy of measures to prevent problem gambling, Williams, West & Simpson[72] allocated barely more than one page to the subject of stake and prize limits. This simply reflected lack of material to review.

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[68] See reference cited in footnote 55 above.

[69] Further, even those players affected so far may not repeat their pattern of responses when faced with a still lower limit. For example, a £50 stake on a roulette spin may generate enough excitement even though the risk is still spread over several sub-bets. If the maximum stake is very much lower, spreading the risk in this way may yield a probability distribution of returns that is definitely unexciting. At that point players may switch to very risky bets or they may choose to gamble via other channels or they may even quit gambling altogether.

[70] J. Parke, A. Parke & A. Blaszczynski, *Key Issues in Product-Based Harm Minimisation*, Sophro Ltd. for GambleAware, 2016, p. 108.

[71] These authors also draw attention to the potentially greater impact that may be derived from policies targeting access to funds during play. Currently, for example, while the direct use of a debit card at a FOB-T is not permitted, cards may be used to load money from the counter.

[72] R.J. Williams, B.L. West & R. Simpson, *Prevention of Problem Gambling: A Comprehensive Review of the Evidence, and Identified Best Practices. Report prepared for the Ontario Problem Gambling*

An evaluation of any restriction to be introduced should be carefully planned for, particularly the collection of relevant data from the period before a new intervention. The industry generates rich data but not all of it is retrieved and retained. We have had to work with highly aggregated data series. More granular data might be more informative. In particular, the behavioural responses of players could be understood more clearly from observing records of the content of each player session with a view to measuring the degree of risk associated with each play. Currently information on sub-bets is not retrieved from the machines. To do so would be costly but it would not be necessary to collect data from every session on every machine. Sampling on a relatively small scale would still yield a large data set for analysis.

There would be some advantages to conducting a test of any new restrictions in trial areas prior to their general application.[73] This would add to the confidence with which researchers could evaluate the impact of new regulations since data for the trial ("treated") areas could be compared with data from other areas, which would effectively serve as the control (or "untreated") group. We regard this as particularly important at the present time. In our modelling, we did not feel it necessary to include macroeconomic variables in the models to account for the evolution of data series over time because the study period was one of broad stability in the national economy.[74] Given the current uncertainty over relations between the United Kingdom and the rest of the European Union, and other risks facing the international economy, there is a possibility, if not a likelihood, that the study period around a future regulatory change would be marked by economic and social turbulence. It might then be very hard to disentangle the impact of regulatory changes from effects on the gambling industry coming from the national macroeconomic situation.

Research Centre and the Ontario Ministry of Health and Long Term Care, 2012, http://hdl.handle.net/10133/3121

[73] These advantages would hold whether the intention was to consider extension of new rules to other areas only after evidence from the trial areas was considered *or* to decide on the intervention now but introduce it in stages to allow things to be learned about how players respond.

[74] Allowing for fluctuations in the national economy would in any case be highly problematic given the shortness of the data period and uncertainty over which macroeconomic variables to include (unemployment rate?, personal disposable income?, etc) and whether lagged, current or expected values would be most relevant.

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Appendix A: Analysis of Monthly Data

In our Report we have based conclusions on analyses of weekly data series extending back to February, 2014, 61 weeks prior to the Intervention. In addition to these 'weekly' data, the machine manufacturers also supplied us with a file of 'monthly' data. The monthly data set had the advantage of covering a longer period pre-Intervention: the first observations were for January, 2012. Its disadvantage was that it included a very limited set of variables: just value of stakes and number of plays, broken down by game type (e.g. B2 roulette, B2 slots).

We chose to conduct our study using the weekly data set because it included a rich range of variables, such as on length of sessions and player losses in different size ranges, which were credible correlates of harm.

Typically our conclusions were drawn from comparing the standardised value of a statistic in early October, 2016 first with its standardised value at the point of Intervention and second with the projection (to October, 2016) of a trend estimated over the pre-Intervention period. Essentially these comparisons were against alternative counter-factuals. The first counter-factual was that the standardised value of the statistic would have remained the same as its value at the point of Intervention. The second was that the standardised value would have continued to change in accordance with the pre-Intervention trend.

Thus conclusions in Chapter 4 have a degree of dependence on the pre-Intervention trend having been captured accurately by the statistical model. One risk is that the trend will have been estimated spuriously because it was estimated over a relatively short period. For example, perhaps B2 roulette stakes had been increasing fast in the 61 weeks prior to the Intervention but long-run growth, estimated over a longer period, was somewhat slower. Would it be more realistic to take the counter-factual as that the evolution of B2 roulette stakes would have grown at the trend rate identified in the relatively short period pre-Intervention or that the path would have been in line with longer-run growth?

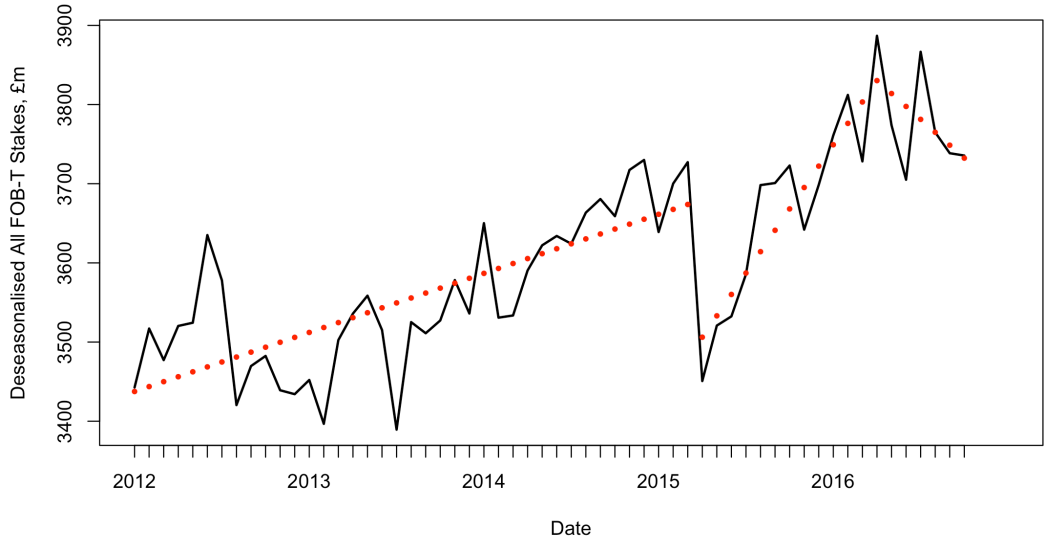
The question cannot be answered. We never know for sure what the true counter-factual is. But it is always reassuring if broad conclusions from analysis prove robust to alternative counter-factual scenarios. In this Appendix, we are able to check whether some of our conclusions remain the same if the model is estimated (on monthly data) from a longer period.

In Chapter 3.3 we reported that, despite the introduction of the £50 Regulations having been a significant negative shock at the point of Intervention, the value of total weekly standardised stakes on FOB-Ts had recovered, by early October, 2016, to be only 2.1% below that at the point

of Intervention. However, stakes were 7.1% lower than they would have been if there had been no Intervention *and* if the pre-Intervention trend had continued. The size of the discrepancy between these two estimates is related to the steepness of the upward trend in stakes in the first 61 weeks of the weekly data set.

Figure A.1 shows the evolution of total monthly stakes over the monthly data period (black line) and the standardised values from fitting the statistical model. Details of the statistical model are the same as for the 'weekly' model described in chapter 3.3 except that there was no *roll-out* term in the monthly model.[75] The model was estimated on deseasonalised data as it was for all other series in the monthly data set.[76]

Figure A.1. Total monthly stakes on FOB-Ts



Certainly the general pattern is similar to that shown in the bottom panel of Figure 3.1, which was the corresponding exhibit for total stakes in our account of analysis of the weekly data. There is an upward trend up to the point of Intervention; then a sharp jump downwards at the

[75] The £50 Regulations took effect on April 6, 2015 but some machines will have been adjusted in the preceding days. We therefore treat April as the first month of the new regime (and March as the last month without the new rules).

[76] Each data series was tested for seasonality. The test involved fitting all possible exponential smoothing models and looking at whether the best fitting (which has seasonality included) was statistically significantly better than the best fitting without seasonality. Seasonality was always supported.

point of Intervention; then a recovery; finally, around Spring, 2016, a reversal of trend in the direction of moderation of play.

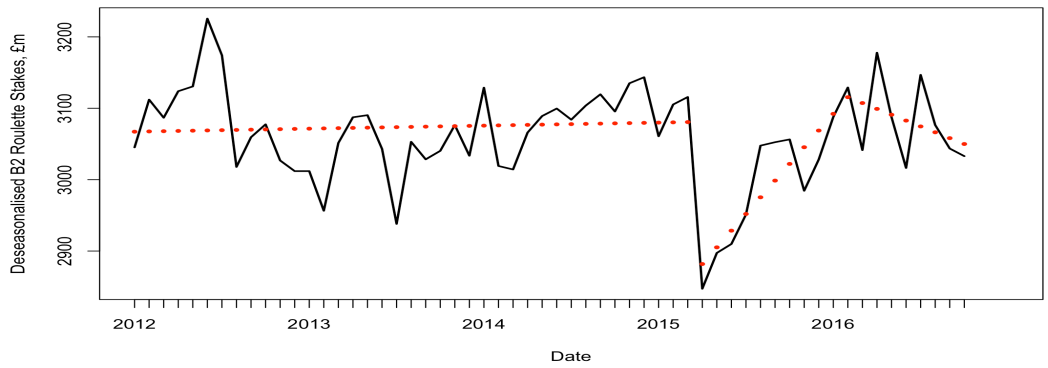
If the general story is similar, what about the numbers? At the point of Intervention, the standardised value of monthly stakes is £3,680.0m. At October, 2016, the figure is £3,732m. Thus, by the end of the study period, total stakes are actually marginally higher than immediately before the Intervention. After a passage of time, the loss of stakes produced by the Intervention has been entirely dissipated.

What of the alternative counter-factual? Had the trend from 2012-2014 simply continued to October, 2016, the model suggests standardised sales by then of £3,792.0m. This produces an estimate that a consequence of the Intervention was that stakes in October, 2016 were just 1.6% lower than where they would otherwise have been.

Considering the two estimates from the two alternative counter-factual scenarios, **a plausible conclusion is that the impact of the Intervention on total stakes eighteen months later was close to zero**. In early analysis of the weekly data, we reached a slightly weaker conclusion, namely that the impact was modest (despite an initial sharp drop).

It was at roulette that the Intervention was really targeted because that is where high stakes are placed. Figure A.2 shows monthly roulette stakes.

Figure A.2. Monthly stakes on roulette



Visual inspection of Figure A.2 suggests that the amount staked on roulette was similar at the end of the period as it had been at the point of Intervention *and* as it would have been given no Intervention and a continuation of the old trend. The arithmetic suggests a 1.0% deficit in the standardised value of roulette stakes in October, 2016 when compared with the figure at the point

of Intervention and a 1.2% deficit compared with the value projected from the pre-Intervention trend.

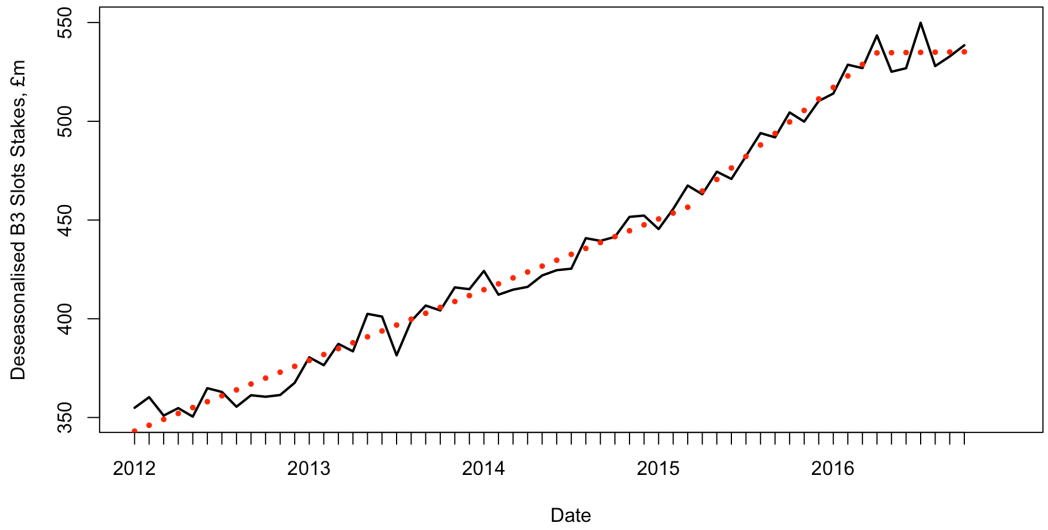
The details of results from the weekly and monthly models are different. They arise principally from the steeper trend line estimated for the pre-Intervention period when the pre-Intervention period was of shorter duration. Nevertheless, these results from the monthly data are not too dissimilar to those from the weekly data. In the weekly analysis (summarised earlier in the top panel of Figure 4.9), roulette stakes at the end of the study period were depressed by 3.3% or 4.1% depending on choice of counter-factual. Thus analysis of a longer period has shifted our assessment of impact even closer to zero. Thus the finding that total roulette stakes were roughly unchanged once players had adapted is supported and strengthened by this fresh analysis. **The results are consistent with the soft cap on the stake on an individual play having done no more in the end than shift roulette stakes around between stake size bands**. The money was still spent.

Finally, consider B3 slots play. We reported in chapter 4 that the amount of money staked on B3 slots games seemed to have been unaffected by the £50 Regulations: there was no apparent substitution of B3 play for roulette consequent on the Intervention. We were conscious that this conclusion depended on assuming a continuation of the steep upward trend in B3 in the 61 weeks of data before Intervention.

Analysis with monthly data allowed the pre-Intervention sub-period to be extended back by more than an extra two years. This would mean that the pre-Intervention trend that we observed in the weekly series would have had to have been really entrenched for the same results as before to be obtained.

Figure A.3 represents results from modelling monthly stakes on B3 games between January, 2012 and October, 2016. Again, it is difficult to discern a substantive difference between the evolution of actual and projected standardised stakes after the Intervention. The model did detect a faster increase in stakes after the Intervention. On the other hand, crucially, the shock to stakes at the point of Intervention was statistically insignificantly different from zero. At the end of the study period, stakes were 2.2% higher than they would have been from a simple projection. Projecting past trends into a hypothetical space (where there is no Intervention) is a risky affair since they are unlikely to have continued forever. With this in mind, we judge that the 2.2% figure is sufficiently close to zero to say that **there is no convincing evidence that the new Regulations that were applied to roulette induced players to substitute into B3 games**.

Figure A.3. Monthly stakes on B3 slots games



We estimated models for all the other data series in the monthly data set but do not report the results because the variables did not relate to any of our principal findings as presented in Chapter 4 (where our concern was with likely correlates of gambling harm, which were not in the monthly data set). Although we cannot carry out further relevant robustness tests, we are encouraged by the similarity of conclusions in the analysis of the monthly data we can offer (in this Appendix) and conclusions drawn (in chapter 4) from shorter-run weekly data.

Appendix B: Regression Analysis Tables

In all tables, statistical significance is shown as follows:

*** significant at p<0.001; ** significant at p<0.01; * significant at p<0.05; † significant at p<0.1

Figure 4.2: Weekly number of roulette plays with stake in the range £50-£100

	estimate (s.e.)
constant	3.710*** (0.06)
week number	-0.003 (0.00)
roll-out	-1.066*** (0.23)
post-Intervention	-1.944*** (0.09)
weeks since Intervention	-0.019*** (0.00)
weeks since end of adaptation period	0.037*** (0.00)
Adjusted R^2	0.964

Figure 4.3. Number of FOB-T player sessions each week

	estimate (s.e.)
constant	4107651.7*** (16,949.60)
week number	-1129.1* (483.30)
roll-out	-11461.5 (67,005.60)
post-Intervention	-54234.1† (31,004.40)
weeks since Intervention	7560.3*** (1,787.00)
weeks since end of adaptation period	-10632.6*** (1,994.80)
Adjusted R^2	0.506

Figure 4.4. Average session duration

	sessions with at least one play >£50	sessions including B2 play	B2-only sessions	all sessions
	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)
constant	21.943*** (0.07)	9.49*** (0.02)	8.15*** (0.02)	9.561*** (0.03)
week number	-0.007*** (0.00)	0.005*** (0.00)	0.000 (0.00)	0.003*** (0.00)
roll-out	0.965** (0.29)	0.354*** (0.10)	0.336*** (0.09)	0.349** (0.11)
post-Intervention	1.198*** (0.11)	0.16*** (0.04)	0.224*** (0.03)	0.1 (0.10)
weeks since Intervention	0.073*** (0.00)	0.026*** (0.00)	0.018*** (0.00)	0.096* (0.05)
weeks since end of adaptation period	-0.062*** (0.01)	-0.025*** (0.00)	-0.014*** (0.00)	-0.09† (0.05)
Adjusted R^2	0.971	0.983	0.960	0.940

Figure 4.5. Average number of plays per session

	estimate (s.e.)
constant	40.843*** (0.15)
week number	0.083*** (0.00)
roll-out	1.754** (0.59)
post-Intervention	0.762*** (0.21)
weeks since Intervention	0.032*** (0.01)
weeks since end of adaptation period	-0.032* (0.01)
Adjusted R^2	0.983

Figure 4.6. Average speed of play

	estimate (s.e.)
constant	4.274*** (0.01)
week number	0.007*** (0.00)
roll-out	0.013 (0.04)
post-Intervention	-0.045** (0.02)
weeks since Intervention	0 (0.00)
weeks since end of adaptation period	-0.004*** (0.00)
Adjusted R^2	0.970

Figure 4.7. Average player loss per session

	estimate (s.e.)
constant	7.461*** (0.03)
week number	0.014*** (0.00)
roll-out	-0.023 (0.12)
post-Intervention	-0.406*** (0.04)
weeks since Intervention	0.004** (0.00)
weeks since end of adaptation period	-0.012* (0.01)
Adjusted R^2	0.939

Figure 4.8. Average intensity of play

	estimate (s.e.)
constant	0.781*** (0.00)
week number	0.001*** (0.00)
roll-out	-0.031** (0.01)
post-Intervention	-0.063*** (0.00)
weeks since Intervention	0.000* (0.00)
weeks since end of adaptation period	-0.001* (0.00)
Adjusted R^2	0.753

Figure 4.9. Stakes in four product categories

	Total stakes on…			
	...Roulette (£m)	…B2 slots (£m)	…B2 card games (£m)	…B3, B4 and Cat C (£m)
	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)
constant	704.818*** (3.33)	22.638*** (0.25)	45.456*** (0.33)	94.602*** (0.50)
week number	0.281** (0.09)	0.173*** (0.01)	0.151*** (0.01)	0.23*** (0.01)
roll-out	-20.757 (13.17)	-0.824 (0.99)	-0.216 (1.32)	2.709 (1.99)
post-Intervention	-48.253*** (4.58)	-1.544* (0.63)	-1.348** (0.50)	-0.653 (0.71)
weeks since Intervention	0.44*** (0.12)	0.318*** (0.09)	-0.286*** (0.02)	0.046 (0.02)
weeks since end of adaptation period	-2.875*** (0.59)	-0.452*** (0.09)	0.149*** (0.03)	-0.29*** (0.05)
Adjusted R^2	0.493	0.960	0.754	0.959

Figure 4.11. Total amounts staked in high stake roulette plays

	Total amount of stakes…	
	…between £50 and £100	…of exactly £100
	estimate (s.e.)	estimate (s.e.)
constant	300.905*** (4.77)	126.178*** (1.94)
week number	-0.132 (0.14)	0.056 (0.06)
roll-out	-85.049*** (18.87)	-34.117*** (7.68)
post-Intervention	-156.039*** (7.38)	-62.012*** (3.00)
weeks since Intervention	-1.548*** (0.26)	-0.585*** (0.11)
weeks since end of adaptation period	2.957*** (0.36)	1.066*** (0.15)
Adjusted R^2	0.965	0.955

Figure 4.12. Total amounts staked in roulette plays with stakes in ranges up to £50

	Total amounts staked in roulette plays with stakes between…				
	…£40 and £50	…£30 and £40	...£20 and £30	…£10 and £20	…£0 and £10
	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)
constant	36.434*** (3.08)	67.604*** (0.39)	81.559*** (0.37)	112.233*** (0.46)	106.083*** (0.38)
week number	0.515*** (0.09)	0.065*** (0.01)	0.015 (0.01)	-0.044** (0.01)	-0.139*** (0.01)
roll-out	54.69*** (12.16)	3.771* (1.53)	2.431 (1.47)	2.593 (1.81)	0.807 (1.52)
post-Intervention	102.358*** (4.67)	5.328*** (0.59)	1.292* (0.63)	-0.728 (0.80)	-1.598* (0.69)
weeks since Intervention	1.389*** (0.16)	0.156*** (0.02)	0.21*** (0.03)	0.234*** (0.04)	0.218*** (0.04)
weeks since end of adaptation period	-2.654*** (0.23)	-0.281*** (0.03)	-0.27*** (0.03)	-0.289*** (0.05)	-0.223*** (0.04)
Adjusted R^2	0.981	0.955	0.813	0.336	0.907

Figure 4.13. Weekly number of sessions with a player loss more than £100

	Weekly number of sessions with a play loss…			
	…between £100 and £200	…between £200 and £500	…between £500 and £1000	…between £1000 and £5000
	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)
constant	111529.55*** (499.07)	54791.023*** (300.31)	10288.704*** (75.29)	2793.059*** (30.86)
week number	196.37*** (14.23)	128.815*** (8.56)	20.749*** (2.15)	4.054*** (0.88)
roll-out	47.03 (1,972.95)	-962.645 (1,187.19)	-902.547** (297.63)	-403.297** (121.98)
post-Intervention	-5976.19*** (1,618.29)	-1785.812*** (424.93)	-936.228*** (106.53)	-570.037*** (43.52)
weeks since Intervention	1237.18* (542.44)	-0.438 (12.05)	10.963*** (3.02)	6.122*** (1.23)
weeks since end of adaptation period	-1287.46* (545.22)	-188.04*** (29.65)	-29.484*** (7.43)	-10.445** (3.17)
Adjusted R^2	0.906	0.922	0.840	0.634

Figure 4.15. Weekly number of sessions in duration bands above 45 minutes

	Weekly number of sessions of duration…				
	…more than 240 mins	…between 120 and 240 mins	…between 90 and 120 mins	…between 60 and 90 mins	…between 45 and 60 mins
	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)
constant	350.099*** (4.27)	2962.07*** (18.03)	4323.479*** (23.67)	14506.602*** (70.25)	21406.881*** (93.87)
week number	-0.84*** (0.12)	-3.173*** (0.51)	-3.472*** (0.67)	-10.186*** (2.00)	-19.81*** (2.68)
roll-out	18.25 (16.86)	97.314 (71.26)	252.807** (93.56)	592.58* (277.73)	860.433* (371.08)
post-Intervention	12.141 (6.15)	173.469*** (26.19)	190.509*** (34.53)	659.495*** (102.50)	925.342*** (136.95)
weeks since Intervention	1.623*** (0.18)	10.426*** (0.79)	12.594*** (1.05)	29.843*** (3.11)	37.215*** (4.16)
weeks since end of adaptation period	-1.187** (0.36)	-11.91*** (1.47)	-16.163*** (1.90)	-46.103*** (5.65)	-55.864*** (7.54)
Adjusted R^2	0.408	0.850	0.817	0.747	0.603

Figure 4.16. Weekly number of sessions in duration bands below 45 minutes

	Weekly number of sessions of duration between…					
	…30 and 45 mins	20 and 30 mins	15 and 20 mins	10 and 15 mins	5 and 10 mins	0 and 10 mins
	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)	estimate (s.e.)
constant	57151.15*** (219.55)	105.941*** (0.43)	117.154*** (0.45)	231.863*** (0.93)	559.733*** (2.37)	1821.353*** (7.41)
week number	-20.03** (6.26)	-0.014 (0.01)	-0.065*** (0.01)	-0.139*** (0.03)	-0.477*** (0.07)	-3.568*** (0.21)
roll-out	1499.07† (867.94)	3.35† (1.70)	2.319 (1.77)	2.95 (3.69)	-0.269 (9.38)	-55.183† (29.31)
post-Intervention	1009.32*** (371.88)	1.411† (0.75)	0.701 (0.79)	-1.141 (1.64)	-9.69* (4.22)	-42.158*** (10.16)
weeks since Intervention	95*** (17.04)	0.1** (0.04)	0.089* (0.04)	0.215* (0.08)	0.607** (0.22)	1.852*** (0.27)
weeks since end of adaptation period	-144.72*** (20.27)	-0.239*** (0.04)	-0.179*** (0.05)	-0.49*** (0.10)	-1.201*** (0.25)	-2.562† (1.44)
Adjusted R^2	0.515	0.577	0.752	0.851	0.901	0.949

Figure A.1. Total monthly stakes on FOB-Ts

	estimate (s.e.)
constant	3431.301*** (19.96)
month number	6.218*** (0.87)
post-Intervention	-173.921*** (37.11)
months since Intervention	20.794*** (4.21)
months since end of adaptation period	-43.333*** (11.95)
Adjusted R^2	0.747

Figure A.2. Monthly stakes on roulette

	estimate (s.e.)
constant	3066.829*** (17.72)
month number	0.354 (0.77)
post-Intervention	-199.148*** (34.53)
months since Intervention	23.016*** (4.56)
months since end of adaptation period	-31.567** (9.21)
Adjusted R^2	0.381

Figure A.3. Monthly stakes on B3 slots games

	estimate (s.e.)
constant	340.098*** (2.31)
month number	2.985*** (0.10)
post-Intervention	5.222 (4.30)
months since Intervention	2.842*** (0.49)
months since end of adaptation period	-5.734*** (1.38)
Adjusted R^2	0.987