University of Warsaw
Faculty of Economic Sciences

Working Papers
No. 29/2020 (335)

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Warsaw 2020

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# Lottery "strategies": monetizing players' behavioral biases

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**Abstract:** The popularity of lotteries around the world is puzzling. In this paper, we study one factor, which might contribute to this phenomenon, namely lottery "strategies" that could allegedly improve players' odds. In an online survey of lottery players we find that such strategies are popular and their use is related to more frequent lottery play and a number of personality traits and beliefs about gambling. Systematically searching for websites and books, we amass the largest dataset of lottery strategies in existence. We subsequently analyze their descriptions, categorize them, and investigate how they exploit their target audience's behavioral biases, including the illusion of control, authority bias, magical thinking, the illusion of correlation, gambler's fallacy, hot hand fallacy, representativeness heuristic, availability heuristic, and regret aversion. We find that the strategies maintain gamblers' (false) beliefs about the possibility of controlling lottery results. This exploratory work contributes to a deeper understanding of (problem) gambling and lays the foundation for the design of experiments testing how the specific features of different strategies may interact with beliefs and trigger (excessive) lottery play.

**Keywords:** decision making under risk, lottery strategy, illusion of control

**JEL codes:** C91, D01, D81, D83, D91

**Acknowledgements:** We gratefully acknowledge the support of the National Science Centre, grant 2016/21/B/HS4/00688 and Konstanty Kalinowski Scholarship Program II.

## 1 Introduction

Given their low expected return (typically less than 50% of the money invested), the popularity of state lotteries around the world is puzzling. One factor that might contribute to explaining the puzzle is the use of *strategies*. By these, we mean instances, in which external sources (for example, authors of books) advise lottery consumer which *practices* to follow when playing: which numbers to choose, how many tickets to buy, when or where to buy them, or what actions should precede or accompany playing.

We focus our attention on the strategies promoted as a way to increase either the chances of winning or the winning amount. Most of them make explicit recommendations concerning the general betting strategy or concrete combinations of numbers to bet on. Strategies effectively encourage extensive lottery play because they convey the message that the players may be in control, turning the game of chance into a game of skill. Strategies often rely on the "analysis" of past drawings, magic formulas, or combinatorics (lottery wheeling[1]). Strategies may thus promote unsound beliefs, resulting in unrealistic expectations, painful disappointments, and suboptimal financial planning.

They may also encourage users to spend a lot of time on completely futile attempts to predict the unpredictable – the lottery outcomes – instead of more satisfactory or productive activities. They may promote the usage of mystery winning formulas or convince them of conspiracy theories or a secret way to win, undermining the belief that the lottery is random and fair, which could be a fertile ground for other conspiracy theories. These negative consequences are likely to fall disproportionately upon the most vulnerable populaces, for example, those with less education and those prone to pathological gambling.

Existing literature shows that lottery strategies cannot be profitable. Lottery drawing machines are regularly checked for possible biases and independent scholarly studies confirm that they do not show any (Chen et al., 2014; Farrell et al., 2000). The only feat that the players may achieve (and only in the parimutuel lotteries) is to slightly reduce their expected losses by picking relatively unpopular combinations, which translates into a lower probability of having to share the jackpot with others. In particular, Chen et al. (2014) and Oyeleke and Otekunrin

[1] Appendix A contains description of lottery strategies and other specific, lottery-related, terms.

(2014) found that betting on "cold" numbers (that have not been drawn for a while) brings a bit more than betting on truly random numbers.

If strategies cannot bring money, why would players want to use them? While insufficient research has been devoted to the issue, we may expect reasons largely analogous to those of playing the lottery in the first place. Thus, strategies may appeal to players' dreams of winning and getting rich in an instant. They may strengthen the belief that the game is not purely random, thus appealing to the illusion of control (J. Langer, 1975). Ejova et al. (2010) propose a useful distinction here between primary control (direct control over the outcome of a stochastic process) and secondary control (ability to detect lucky moments). Naturally, neither type of control is possible with lotteries.

Studies exploring the cognitive psychology of lottery play (M Griffiths & Wood, 2001; Rogers, 1998) propose that the decisions of many lottery players are influenced by their irrational beliefs (R Ladouceur et al., 1995; Robert Ladouceur & Walker, 1996; Toneatto et al., 1997; N. E. Turner et al., 2005)– for example, magical thinking or superstition. Such irrational beliefs could be a way of dealing with the uncontrollable surrounding environment (Rudski, 2004; Vyse, 2013). We may expect strategies to feed into such erroneous beliefs.

One specific, popular misconception is that sequences such as {1, 2, 3, 4, 5, 6} are generally (incorrectly) considered less likely to be drawn (Hardoon et al., 2001; Krawczyk & Rachubik, 2018; Robert Ladouceur & Walker, 1996). This could be explained by the representativeness heuristic (Kahneman & Tversky, 1972), under which even a small sample is expected to show the features of the random process, which has generated it. Thus, a "truly random" combination is expected to include, for example, some low numbers and some high numbers. Another popular bias is gambler's fallacy (C. T. Clotfelter & Cook, 1993), in which subsequent drawings are perceived as not independent, so that numbers may be "due" and so supposedly more likely to show up if they have not been drawn recently.

Strategies are also likely to affect players' feelings, including positive anticipatory emotions, such as hope, related to the lottery (Kocher et al., 2014). One way to model such a tendency is in terms of overweighting small probabilities of extreme events, as in prospect theory (Tversky & Kahneman, 1992) in which, unlike in the normative expected utility theory, decision weights given to different monetary outcomes may deviate from their factual probabilities. Interestingly, it is not only the probability of winning but the expectation of the

level of happiness after hitting the jackpot that is overly optimistic (Brickman et al., 1978; Loewenstein & Schkade, 1999).

To the extent that strategies appeal to hope and the illusion of control, they are likely to be particularly attractive to more vulnerable populaces – poorer and less educated individuals. Indeed, they are more in need of extra cash and the feeling of control over their financial situation. If that is happening, it would contribute to the tendency of these groups to disproportionately likely to gamble, also gamble pathologically (Brown et al., 1992; C. Clotfelter & Cook, 1999; C. T. Clotfelter & Cook, 1989).

Behavioral tendencies observed in decision making under risk and uncertainty may also explain why people may continue to use strategies. For example, many players bet on the same combination of numbers in each drawing (Suetens et al., 2016). One explanation refers to regret aversion – players tend to avoid the anticipatory regret that could ensue once their regular numbers are drawn but they have not purchased a ticket (Wolfson & Briggs, 2002). This notion is consistent with the observation that people are reluctant to exchange a lottery ticket for another ticket (Bar-Hillel & Neter, 1996; Krawczyk & Rachubik, 2018).

Risk seeking in losses (Tversky & Kahneman, 1992) could motivate a player to keep using a strategy due to the existing losses associated with strategy purchase or usage. Such a practice of "chasing losses" is an important sign of problem gambling. Due to illusory correlation (M Griffiths & Wood, 2001), the player could continue to use a strategy due to the false impression that it indeed increased their winning rate. "Near miss" or "near win" could create an illusion that the player almost guessed the winning numbers and should thus keep using the strategy (Rogers, 1998).

Similarly, persuasion employed by the sellers of lottery strategies is likely to contribute to their use. Among Cialdini's principles of influence (2007), three seem particularly important, namely authority, consistency, and scarcity. Indeed, as casual observation suggests, strategy vendors often strive to establish themselves as experts, provide a spotless portfolio of testimonials, and suggest that their "limited-time offer" is a very special occasion indeed.

It is also worth checking if the willingness to use strategies or, more generally, special practices when playing, depends on the influence of other people (Mark Griffiths & Barnes, 2008), who could also use strategies or practices. Interestingly, playing in a group could be an aspect of a strategy by itself. Indeed, playing in a lottery syndicate, in which players

proportionately share the costs of tickets and the winnings is a popular practice (Rogers & Webley, 2001).

To the best of our knowledge, the only closely related previous study (investigating lottery strategies) is that by Turner (2003). These authors located a large number of sources, mostly books (1157 items in total) offering advice on gambling. However, they investigated only a small sample of them (18 books and 4 webpages), of which four books and one webpage contained lottery strategies. The work is rather exploratory and descriptive. Their key observation is that a large number of gambling strategies are available on the market and most of them contain a mix of accurate and inaccurate, misleading information about gambling.

In our Study 1 we built upon this analysis, modifying it on several dimensions. We focused on sources solely devoted to lottery strategies, rather than considered all sources on gambling. We examined in detail a much larger number of sources, namely 89 books and 83 websites. We did not merely inspect the sources; we also rated them on several features. As a result, we were able to assess the prevalence of implicit references to various constructs proposed in the previous behavioral literature of decision making under risk and uncertainty such as the illusion of control and regret aversion, among others (see Appendix A). Finally, we were able to perform a quantitative analysis, including factor analysis, identifying key dimensions that span the variability observed in the data.

It should be emphasized that Study 1 represents an exploratory work in a vast and as of yet poorly scrutinized research area. This is associated with certain limitations. In particular, we initially planned to measure the popularity of various (online) sources of lottery strategies and relate their popularity to strategy-specific features. We faced extreme practical difficulties in this enterprise. Roughly, we only have the measure of the popularity of books and some webpages promoting lottery syndicates. This approach could tell us very little about the demand side of the market: we could tell what strategies are offered but not much about who and why consumes them.

To address these important issues, we supplemented our ethnographic work with an online survey of lottery players (Study 2). We inquired about their use of strategies from books and webpages and motivations to use them. We also asked about their practices when playing. We identified demographic, personality, and cognitive correlates of these choices.

## 2 Study 1: analysis of available strategy materials

### *2.1 Research goals and methodology*

Our hypothesis was that lottery strategies exploit cognitive biases, heuristics or the irrational beliefs of players about lottery play. Additionally, we wanted to check whether popular and unpopular lottery strategies appeal to different cognitive biases and heuristics. We gathered lottery strategies from books (available on Amazon.com) and webpages. We also attempted to measure the popularity of each source. Then we classified the obtained data, describing the main features of each source.

#### *2.1.1 Data collection*

Webpages with lottery strategies were identified using Google Search, Alexa.com, keywordtool.io, and Google Keyword Planner. We were not aware of an existing database detailing lottery strategy websites. Thus, we constructed it ourselves using the snowball method, starting from the sample of webpages and extending it to include similar pages.

First, we performed an initial Google search using lottery strategy related keywords, for example, “lottery strategy”, “lottery system”, and “how to choose lottery numbers”. We performed every search using a new virtual machine and the United States IP and English language settings to avoid search engine bias. In this way we have come up with an initial list of webpages. At this point, we had both webpages with and without lottery strategies. Then, using the Alexa.com service provided by Amazon, we collected a list of webpages visited by the same audience[2], as those of our initial lists that did contain strategies. We repeated this exercise until the last (fifth, as it turned out) iteration increased the number of unique webpages on our list by less than 1%.

Of the resulting 632 webpages, 228 were found to indeed contain lottery strategies, including 41 webpages promoting syndicate lottery play only. The latter represents a distinct case, as they generally do not advise when and where to play or how to choose numbers – they merely encourage playing in groups. Among the webpages excluded from the analysis were those containing a review of lottery strategies, lottery rules, or online lotteries. Some of these webpages were not classified as containing strategies but were still misleading - a webpage

[2]Specifically, we used Alexa’s Audience Overlap tool, see https://try.alexa.com/marketing-stack/audience-overlap-tool for details.

containing statistics about the frequent and infrequent numbers from recent drawings but without explicit advice about how to use this information is a case in point.

To verify the comprehensiveness of our list, we used the leading search engine, namely Google. To come up with relevant queries, we used Alexa.com to define the keywords ($n$ = 754) that people typically use to find the webpages with lottery strategies from our list. Using the keywordtool.io service, we found keywords ($n$=2323) related to the aforementioned list of keywords. Then, we took a sample of the keywords ($n$ = 50) to check if someone searching for them will indeed end up on a webpage from our list. We performed Google Search with each of these 50 keywords, storing the first 10 results (as 95% of users do not look beyond the top 10 hits (Lorigo et al., 2006)). We confirmed that as much as 99% of the webpages found in this way had already been on our list.

Because a detailed analysis of each source is very time consuming, we only conducted such an analysis for a random sample of one-third of them (Appendix A), resulting in 83 investigated webpages. Likewise, of the most popular e-books found in Amazon's Humor & Entertainment\Puzzles&Games\Gambling\Lotteries section we investigated all that we could access, totaling 89. Despite various attempts, we did not find a good measure of webpage popularity. In the case of books, we measured popularity based on their Amazon bookstore popularity ranking provided by Amazon.com. For example, a book titled "Lotto Wheel Five To Win" by Gail Howard ranked 2 in the Humor and Entertainment\Puzzles&Games\Gambling\ Lotteries section was the second best-selling book in this category.

*2.1.2 Data classification*

For each book, we collected the link to the book at Amazon, title, author's name, year of publication, price, and the Amazon bookstore popularity ranking. For each book, we collected the link to the homepage and price. Some webpages offer either a web software available directly in the browser, or downloadable software. In both cases, we collected the link to the software (if any).

Based on the previous literature, we defined twelve features that we call explicit recommendations (or simply recommendations) because they tell the players how, when, or where to choose lottery numbers – for example, that they should avoid recently drawn numbers. We also defined ten other features that did not represent any specific advice but were still an

important component of the strategy. Appeal to authority is one example in this category. All the explicit recommendations and other features are described in Appendix A.

Further data collection was performed by two independent raters.[3] Each of them carefully investigated each website and book in the sample. For every feature, she indicated which books and websites contained this feature, if possible supplementing this categorization with relevant quotes from the source. As a result for each source-feature combination we had a rating of 0 if both rathers agreed the source did not have the feature, a rating of 1 if both agreed it died and a rating of .5 if only one did.

For webpages, we also collected information about the design, which could have an impact on strategy popularity. We measured subjective webpage design score, ranging from 1 to 4, where 1 generally indicates an old-fashioned and/or overly flashy webpage that is hard to read and navigate, whereas 4 indicates a modern, elegant, and user-friendly one. For books, we collected information about book cover design. We also indicated the availability of graphs and tables, as well as videos and screenshots (in case lottery software was a part of the offer).

We calculated recommendations' and other features' indicators, as well as webpage and book design scores, as the average score given by two separate reviewers. Of course, these were to some extent subjective. Still, the inter-rater agreement was acceptable for all variables, and high on average (see Appendix B for all the details).

*2.2 Results*

We divide the results section into two parts. Firstly, to give a general picture of the available lottery systems, we ran a qualitative analysis of their features. We start with those that frequently appeared and were roughly uniform across all types of strategies: an appeal to an illusion of control, establishing an authority, or magical thinking. Then we describe the broad themes identified: the analysis of the past, the elimination of "unlikely" combinations, lottery wheeling, lottery syndicates, and others. They roughly correspond to different types of strategies, although these themes are not mutually exclusive.

Secondly, we present the results of the quantitative analysis. We report the prevalence of all features using dummy variables to indicate whether the given feature is present in

[3] Average interrater agreement was 0.78 for books and 0.76 for webpages. For details – see Table B1.

a specific strategy. We subsequently show the results of factor analysis to find the main strategy traits. Finally, we investigate the correlation of features with books' popularity.

*2.2.1 Qualitative analysis*

**Illusion of control**

Perhaps the most important feature of a lottery strategy is that it appeals to the illusion of control. What good is a strategy that leaves the user at the mercy of a lottery's poor odds? Not surprisingly, authors thus routinely try to create an impression that you can "fix the odds", that a lottery is a game of skill which may be profitable if played right. Many sources explicitly state: "turn a game of chance into a game of skill" (B1[4]). Interestingly, the word "control" itself is often used – "you can actually control and improve your luck" (B2); "I'll prove to you that the lottery absolutely is controlled" (B3).

As a result, "each dollar that you wager in the lottery or lotto becomes a logical investment designed to reap profits" (B4). Because the lottery is supposedly not about luck anymore, once the right strategy is used, a *guarantee* to win may be given: "GUARANTEED WIN! (…) your numbers are (…) combined into the correct combinations to give a specific win guarantee"; "learn a technique that can guarantee you success more than 99% of other scratch card players" (B5).

Exactly how the winning guarantee comes about depends on the strategy. They may emphasize skill and effort or speak of the "proven steps and strategies on how to join the elite lottery winners' circle by transforming a game of chance and luck into a game of skill; if you do not develop your skill in choosing numbers … the odds of winning any lottery are quite unfavorable" (B6).

**Establishing authority**

Why should the reader believe that the strategy will help her "fix the odds", turning a lottery into a game of skill? Establishing authority is a key element. One way to achieve this involves using (pseudo) scientific terminology, promising that the promoted software uses "neural

[4] Each book and webpage has its code, which starts with the letter B or W, respectively. Exact book title or webpage link could be found by its code in the "Reference list of cited book and webpages", at the end or the work

networks" and "advanced combination[al] logic" (W1). Occasionally, this delivers highly dubious statements such as "negative emotions vibrate on a negative frequency" (B7). Many authors also make their language sufficiently vague to prevent the verification of their recommendations. Additionally, the mechanics of the strategy are rarely disclosed: "once you have the winning numbers for at least seven previous drawings (...) plug them into the simple formula… [which is] based on [a] lot of complex mathematics. But I've done all the hard work for you" (W2).

Another narrative strategy involves providing pseudo-arguments that mix fact and fiction or draw unwarranted conclusions. For example, a book by Michael A. Muse, whose first seven chapters contain no words at all, consisting of just one number each, assures in the concluding chapter that "if you play these numbers, in any combination, every time that you buy a lottery ticket, the statistical probability that you will win increases with each ticket that you buy, no matter which lottery or size" (B8). While this claim cannot be refuted, the recommendation to play these rather than some other numbers is at best worthless. At worst, the advice is harmful – if others follow it, the jackpot is more likely to be split. Similarly, Gail Howards argues that strategies work, because the fraction of strategy users is higher among lottery winners than among all players (B9). Of course, even if true, this pseudo-argument overlooks the possibility that strategy users on average purchase more tickets than other players.

Another way to establish credibility, several books and websites are signed by "doctors" and "professors". Some of these people, for example, Dr Iliya Bluskov and Dr Scott Brown, appear to be or have been genuine university faculty with PhDs. By contrast, we could not locate Professor William R. Foster, for example. References to a "vast study" by a "Belgian science man" (W3) and the "conclusions of a major class project at a well-known University" (W4) are completely elusive. Likewise, if a strategy was created by "an MIT Professor" and it "took 27 years to develop" (W5), why were they not willing to sign their magnum opus?

Regardless of alleged academic credentials, many books and websites relate a long personal story of how the developer was looking for a way to win a lottery and although frustrated with their initial attempts, persevered and perfected their strategy. "I built my own strategies through countless hours of studying the odds and investigating how and why people are able to win" (B10). Another page reports that the findings of "[a] ten-year experiment [in which] dreams have been painstakingly analyzed" (B11).

These stories are often accompanied by warnings against other allegedly misleading, ineffective, or expensive strategies that the author encountered during their search for the ultimate lotto strategy. For example, "95% of other so-called lottery strategies being sold out there are Not Tested or Proven to give you wins, they are just cheap useless software or made-up strategies by some person then hyped up to sound great, with a high price tag" (W6). Raising suspicion towards others is noteworthy given that creating a general impression that the business is corrupted may undermine their trustworthiness. This is particularly true given that these claims are essentially never substantiated, so the reader may have a hard time guessing why she should only be suspicious towards these other authors.

Two main strategies are used at this stage to remedy any doubts about a strategy's credibility. First, the claims made by the strategy stating that they are "the most reliable" or "the only" are made and often "backed" by shiny images of all sorts of seemingly made-up certificates of a "trusted seller", "number one", or guaranteeing "100% satisfaction". Second, many websites provide numerous testimonials. Of course, it is difficult for a typical user to verify whether "Charles from [the] United States" (W7) won, let alone whether this happened because he had been using the strategy in question.

**Magical thinking**

Moving now to the first of the four broad themes showing up in some strategies only. Many strategies derive the feeling of control from various forms of magical thinking. The sources speak of the "laws of attraction", which vaguely suggests that a strong desire to win suffices to somehow exert at least partial control over the outcomes. The readers are told that "in your mind you have the power to make your thoughts a reality" (B12). This is because "thoughts are charged with energy, especially when triggered by emotion (…) a strong desire for a goal that is charged with positive energy, attracts a positive response, especially when every effort is made to attain that goal". These strategies often include warnings that a "barrier of negativity [must be eliminated] from the fabric of [their] belief strategy" (B2).

Numerous sources recommend exercises to "focus on opportunities", "attract good luck" "visualize winning", "manifest your millions" and "use your vibrational reach to enhance your lottery winnings" (B13). Occasionally, these sources deliver factually wrong claims, for example, that "the actual chance of you winning the lottery is 50-50" (W8). Often, they resemble religious or spiritual texts. They recommend prayers and meditation and assert

a Belief in Just World. Lottery prizes are portrayed as a reward for good deeds or a promise to put them to good use after winning – "in order to attract great wealth you need to give"; "[returning a lost ring] will engage forces in the universe to create equilibrium by returning to me incredible fortunes at some point in the future" (B2).

Often, references to the ancient art of interpreting dreams are made. Many sources teach which lottery numbers are associated with special dates, items, people, events, and feelings experienced in dreams. Some take the magical link beyond dreams: "every experience, encounter, dream, tragedy, event, action or reaction produces its own unique single digit number" (B11). Some sources try to link magic with science or technology, asserting that "it has been *proven* that our process works out a magic for our members" (W9). Others are promising the "psychic ability to correctly predict the winning lotto numbers through our new lottery software breakthrough" (W10), and that "your numbers are magically (mathematically) combined", recommending "scientific prayer to the universal intelligence of your subconscious mind" (B14).

**Analysis of previous draws**

The second major theme we analyze, the strategies focusing on the analysis of the past, usually try to distinguish themselves from the magic: "we achieved this not by hocus pocus ideas, mysterious patterns, (…) but by thorough and professional mathematical analysis" (W11). These sources speak of "hot" and "cold" numbers, "trends", "patterns", and "cycles", and encourage users to analyze the "past five" draws or "games out".

This type of strategy usually comes with lottery software to assist the player in storing and analyzing past results. Often, the program is what the user is paying for. The typical functionalities include downloading past results, checking players' numbers against them to find out whether they won, implementing strategy recommendations, and even printing selected numbers directly onto a lottery ticket. All these could significantly simplify and speed up gambling, making intense lottery play (and consequently, greater losses) possible with less effort.

Computer-assisted scientific analyses of previous drawings seem to be a logical approach to selecting numbers. After all, that is what intelligent people do before making an important financial decision: they analyze the data. Several sources reinforce this way of thinking, advertising a "Lottery Statistical Analysis tool that uses past lottery results to give you

the best possible information for selecting and playing your lottery numbers" (W12) and talking about "intelligently choosing lottery numbers based on the data" (B15). It may be intuitively difficult to accept that the analysis of data is useless in this context.

More specifically, there are two main ways in which past drawings can be taken into account. First, several sources recommend betting on numbers that have not been drawn much recently. It is argued "that the same lottery number combination that won the jackpot or the grand prize will win again in the future… had never been a possibility" (B6). Likewise, "when picking lottery numbers you should NEVER pick the numbers that were drawn last week, because there is no chance they will be drawn this week" (B16). By a natural extension, the users are recommended to bet on numbers that have not been drawn for a while ("due" or "cold" numbers). The belief that they are more likely to show up this time is related to several concepts discussed in the literature: the negative recency effect, the gambler's fallacy, and the representativeness heuristic.

The opposite strategy involves betting on numbers that are "hot" because they have been drawn recently. The authors recommend "get[ting] relevant data about a particular lottery and then choos[ing] your numbers as per the highest frequently drawn numbers" (B17). It is claimed that "each lottery will have its own unique set of unlucky numbers" (B10). Such claims are often validated by showing small and likely purposefully picked samples with no statistical analysis. While it may seem suggestive that one number has been drawn five times in a given sample while another has not been drawn once, in fact, such an occurrence arising randomly under a uniform distribution is not that unlikely. Again, the concept of representativeness explains why such "evidence" is persuasive – there is a natural tendency to expect a very uniform distribution even in a small sample so that observing actual, unequal frequencies of numbers leads to the suspicion that the underlying probabilities are not identical.

Some of the sources point to specific reasons for this. These "explanations" range from quite general, simple, and sometimes vague, like "balls have different weight" (B3), "balls in many lotto picking machines at times do not thoroughly mix" (W13); through to more elaborate ones using technical language – "the drag coefficient of each ball is different, therefore patterns will develop that can be tracked" (B18). All these explanations (conspiracy theories) could appeal to the need to be unique – being chosen to obtain secret knowledge that others have no access to (Lantian et al., 2017) – and a need for control (Byford, 2011; Newheiser et al., 2011).

Although betting on numbers that have been frequently drawn recently and betting on numbers that have not been drawn recently seem contradictory, they are often combined in the same source. They may be reconciled by using different time horizons: it is intuitively appealing to bet on the numbers that seem to be drawn often in the long run but have not been drawn for a while. Alternatively, one strategy may be applied to individual balls, another to combinations. In any case, the naturally contradictory nature of being "hot" and being "cold" might help to avoid the negative verification of the strategy. If only it is sufficiently vague as to when one should go for the "hot" and when for the "due", whatever shows up may be ex post interpreted as "confirming" the strategy.

**Elimination of "unlikely" combinations**

The third major theme that can be found in several strategies involves the promise of improving the odds by excluding some combinations, regardless of whether they had been recently drawn. Interestingly, just like the authors of the strategies based on the analysis of the past sometimes want to emphasize that they have nothing to do with magical thinking, strategies in this category may be positioned as distinct from those based on the past: "winslips is a fail-safe number reduction strategy based on PURE mathematics, certainly NOT a pointless prediction website based on past history results" (W14).

A typical example in this group is Gail Howard's concept of "most typical ranges" (W8). It is based on a pseudo-argument: because it is very rare that the sum of the drawn numbers is very low or very high, these combinations should be avoided. Of course, these combinations have the same probability of being drawn as any other combination. Analogously, many authors recommend avoiding betting on odd numbers only or even numbers only, instead advocating for "balanced" combinations.

**Lottery wheeling**

Finally, the last major group of strategies involves wheeling. Based on combinatorics, these strategies involve a conditional guarantee of success. For example, if a player is lucky enough to select 10 numbers in a 6/49 lotto such that five of them turn out to be winning numbers, a wheeling system may guarantee that she ends up with at least four winning numbers in one of her lines (which are the appropriately chosen six-element subsets of the set of 10). In most cases, the strategy requires the purchase of many tickets, which might make them particularly interesting to syndicates. In the case of individual players, this might induce overspending.

Most sources focusing on wheeling alone provide relatively reliable information. Then again, it should be clear that wheeling seems particularly attractive when the player is able to determine a possibly narrow set (for example, a set of 10 in the example above) of "likely" numbers, which is not possible. It is thus not surprising to see lottery wheeling combined with more misleading concepts. For example, Gail Howard proposes "balanced wheels", based on the fallacious idea that combinations of all very low or all very high numbers are particularly unlikely.

**Other strategies**

Syndicate play represents a distinct case. Webpages promoting syndicates often give no explicit advice on how to choose numbers, but promise to take care of all the difficulties associated with number picking and prize sharing. Besides, syndicates tend to win many prizes due to the large number of tickets they buy (which of course means their clients lose even more money). Reporting only winners, syndicate organizers appeal to availability heuristics and create the illusion of control, attracting more new players.

To complete the qualitative analysis, it should be noted that quite a few of the sources do give some reasonable (even if not sophisticated) advice: that one should not bet more than one can afford to lose; that losing a ticket means losing money; that one should double-check for possible winnings; and that in pari-mutuel games it is better to bet on unpopular combinations (although it is not necessarily easy to identify them). It seems, however, that in some cases these sensible recommendations are mostly used to lend credibility to the whole strategy (including its useless or misleading components).

2.2.2 Quantitative analysis

In total, we have reviewed 89 books and 83 webpages – see Table 1 and Table 2, respectively, for descriptive statistics and Appendix A for the full list. We report the values for books and webpages separately because they are different in many ways. For example, because books tend to be longer, whereas websites may offer more visuals and interactive elements; they may also appeal to different audiences. Perhaps more importantly, as strategy books seem to be gradually getting replaced by websites and online videos. It is interesting to see what changes in the form and content are likely to come with this transition. Appendix A also contains a detailed explanation of variables.

**Table 1** Descriptive statistics: books

| Variable | Obs | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|---|
| *price* | 88 | 7.12 | 21.23 | 0.99 | 199.99 |
| *year* | 89 | 2014 | 5.18 | 1987 | 2020 |
| *number_of_pages* | 77 | 86.35 | 110.00 | 4 | 673 |
| *review_score* | 80 | 3.40 | 0.89 | 1 | 5 |
| *number_of_reviews* | 80 | 44.63 | 102.55 | 1 | 645 |
| *ranking* | 72 | 94.15 | 108.49 | 1 | 429 |
| *design_score* | 89 | 2 | 0.67 | 1 | 4 |

As can be seen in Table 1, the books in our sample are not so recent. We generally judged them to be poorly designed (2 design points out of 4). It is interesting to note that these books had on average as many as 44 Amazon reviews, giving them a surprisingly high mean of 3.4 stars out of 5. Of course, some of the reviews may have been paid for or simply made up. Amazon has an indicator for reviews made by buyers ("Amazon Verified Purchase" review). We did not differentiate between "Amazon Verified Purchase" reviews and other reviews due to the significant manual effort needed to collect this information.

**Table 2** Descriptive statistics: webpages

| Variable | Obs | Mean | Std.Dev. | Min | Max |
|---|---|---|---|---|---|
| price | 34 | 21.83 | 19.88 | 0 | 97 |
| software | 83 | 0.81 | 0.40 | 0 | 1 |
| nmbr_of_products | 83 | 3.65 | 6.64 | 1 | 37 |
| design_score | 83 | 2.51 | 0.83 | 1 | 4 |

The descriptive stats for webpages are reported in Table 2. The systems offered via webpages sometimes come in many versions, in which case we considered the cheapest one. One outlier with lottery software price of $729.99 (W15) was disregarded in the calculation of the mean. Webpages show a smaller range of prices, with strategies typically being considerably more expensive than books ($p < .001$)[5]. 11 webpages offer a subscription service, for example, delivering lucky numbers weekly for a fee. Webpages tend to be worse designed than books ($p = .002$).

**Table 3** The prevalence of explicit recommendations in books and webpages

| Explicit recommendation | Books ($n$=89) | Webpages ($n$=83) | One-sided Fisher's exact test (p-value) |
|---|---|---|---|
| *magic* | 38%* | 32% | 0.149 |
| *special_meaning_nmbrs* | 9% | 9% | 1.000 |
| *secret_knowledge* | 29% | 22% | 0.458 |
| *based_on_past* | 52% | 61% | 0.370 |
| *high_freq* | 22% | 29% | 0.039 |
| *low_freq* | 24% | 23% | 1.000 |
| *wheeling* | 24% | 41% | 0.039 |
| *syndicate_promotion* | 11% | 13% | 0.543 |
| *has_syndicate* | - | 7% | - |
| *bet_on_the_same_nmbrs* | 6% | 1% | 0.060 |
| *bet_on_unpopular_numbers* | 8% | 29% | 0.498 |
| *bet_on_rnd_nmbrs* | 2% | 0% | 0.001 |
| *other_useful_advice* | 8% | 30% | 0.000 |

*numbers add up to more than 100% because categories are not mutually exclusive

[5] Here and thereafter we use one-sided Fisher's exact test

The books and webpages are similar in terms of their prevalence of explicit recommendations (Table 3), except that more websites (30%) than books (8%) offer some ($p$<.001). Also, webpages tend to speak more about lottery wheeling ($p$=.039). It is difficult to tell if this is partly because, for example, they cater to different populaces.

The most frequent advice both for books and webpages is to make a decision based on the analysis of lottery history (52% and 61%, respectively, no significant difference). Books and webpages are also similar in terms of the high popularity of a reference to numerology and suggestions to use a secret lottery formula ($p$=.149 and $p$=.458, respectively).

**Table 4** The prevalence of other features in books and webpages

| Other feature | Books (n=89) | Webpages (n=83) | One-sided Fisher's exact test (p-value) |
|---|---|---|---|
| *promise_of_contrl* | 70%* | 57% | 0.053 |
| *testimonials* | 37% | 47% | 0.123 |
| *free_or_moneyback* | 9% | 22% | 0.017 |
| *limited_offer* | 4% | 13% | 0.038 |
| *authority* | 19% | 13% | 0.203 |
| *scientific_style* | 40% | 53% | 0.067 |
| *calc_formulas* | 11% | 19% | 0.104 |
| *graphs_or_tables* | 30% | 36% | 0.259 |
| *biased_wheel* | 1% | 0% | 0.517 |
| *software* | - | 81% | - |
| *forum* | - | 10% | - |

* numbers add up to more than 100% because categories are not mutually exclusive

The books and webpages are also similar in terms of their prevalence of other features (Table 4), except that a promise of money back or a trial offer is more common in webpages than in books – in 22% of cases versus 9%, respectively ($p$=.017). This is not surprising, because 81% of webpages offer either downloadable or online web software, which could be tested by the user and blocked by the strategy author after a test period. We did not verify if the promise to pay back was credible.

The most frequent feature is an explicit promise of gaining control over the lottery, often supported by testimonials, personal authority, usage of a (pseudo-) scientific terminology, tables and graphs, with no significant difference between books and webpages.

To comprehensively uncover the main dimensions underlying data variability, we conduct a factor analysis. Table B2 shows the results for the explicit recommendations and Table B3 for other features. Overall, the factor analysis is largely consistent with the qualitative analysis, indicating universally important features, such as the appeal to authority and specific themes, analysis of the past, superstition, lottery syndicate promotion, and lottery wheeling. The promise of control was not associated with any specific factor – it was common across different types of strategies.

Concerning book popularity, we run a series of regression models to discover their correlates. They showed only moderate goodness of fit and very little robust findings, beyond that better-designed books tend to sell better. This analysis is available upon request.

## 3 Study 2: online survey

To gain insight into the popularity of strategies and their users' motivations and characteristics, we conducted an online survey. The participants were recruited using advertisements on several Internet forums for lottery players, within the subject pool of our laboratory of experimental economics, as well as using Amazon mTurk virtual labor market. Only individuals who reported playing state lotteries – at least occasionally – were invited to respond to the survey. In total, we had 342 participants, of which 42.4% were female. About 73.4% resided in the US, the rest coming from a number of different countries. The mean age was 37.3, with a standard deviation of 14.0 years. Nearly 13.5% declared playing the lottery daily, 30.1% a few times per week, 36.3% a few times per month, and 20.2% a few times per year.

*3.1 Survey questions*

The survey was displayed on four screens, with a median filling time of 10 minutes. The entire questionnaire can be found in Appendix A. The most important questions referred to the knowledge and use of strategies available as books or websites. Participants were asked how often they played and whether they used "quickpicks" (and why/why not). They were also asked about several *practices* they followed when playing the lottery that were identified as important in our Study 1, such as using numerology or analysis of past lottery outcomes, regardless of how they were inspired to do so and beliefs about the lottery. Finally, we collected demographic data, including religiosity attitudes (Koenig & Büssing, 2010), administered the Big Five personality scale TIPI (Gosling et al., 2003), elicited beliefs about games of chance (Wood & Clapham, 2005) and risk attitudes in general and in financial matters (Dohmen et al., 2011).

*3.2 Results*

As explored before, a pre-condition of using a typical published strategy is that one chooses lottery numbers on their own, instead of relying on the randomization device provided by the lottery operator (quickpicks). As shown in Table 5, a large fraction of our responders does that, at least some of the time.

**Table 5** Responders using quickpicks and playing with own numbers

| | N | Share of all responders (n = 342) | Share of responders saying quickpics are available (n = 322) in the lottery usually played |
|---|---|---|---|
| Quickpicks unavailable in the lottery usually played | 36 | 10.1% | - |
| Quickpics available and… | 322 | 89.9% | 100.0% |
| … never used | 39 | 10.9% | 12.1% |
| … occasionally used | 53 | 14.8% | 16.5% |
| … usually used | 94 | 26.3% | 29.2% |
| … always used | 136 | 38.0% | 42.2% |

Those who always use quickpicks, when asked about their pros and cons, most commonly mentioned that they save time (31% - percentages calculated from expert-coded open-ended responses, see Appendix A). Of those who at least occasionally play with their numbers, the most common explanation, provided by 30% of responders, emphasized that it allows them to play with their favorite/lucky/meaningful numbers, not necessarily implying that they believed it to increase their probability of winning. As one of them put it, "(…) number has a significance sometimes. They may come from a dream, or a life situation, or a simple preference." Interestingly and in keeping with the results of Study 1, as many as 21% spontaneously said that playing with their numbers gave them more *control*: "I feel like I have more control and it's more personal."

Choosing numbers on one's own does not imply following any specific published strategy. Judging from their free-form responses, about 21% would just use personally important dates (like the birthday of a loved one) and 22% other personally meaningful or lucky numbers. About 18% would choose randomly and 9% go with a hunch, with just 8% performing some kind of analysis of the history of past drawings, as often encouraged by published strategies. As shown in Table 6, it is indeed only a sizeable minority of responders that recall a book or a website containing a strategy; of these who do, most follow it to some extent at least.

**Table 6** Responders recalling and using published strategies

| | N | % of all responders (n = 342) | % of responders who recall at least one strategy (n = 128) |
|---|---|---|---|
| Never come across a strategy | 199 | 60.9% | X |
| Came across at least one strategy and… | 128 | 39.1% | 100.0% |
| … does not follow it at all | 11 | 3.4% | 8.6% |
| … follows it to a minor extent | 77 | 23.6% | 60.2% |
| … follows it to a large extent | 30 | 9.2% | 23.4% |
| … follows if fully | 10 | 3.1% | 7.8% |

These data confirm our supposition that a non-trivial share of lottery players use published strategies at least some of the time. Unfortunately, in this case, the direct open-ended questions about the contents of these strategies and reasons for using (or not using) them did not yield much. Indeed, only a small minority of those recalling a strategy came up with its unique identifier (for example, website address or full book title), summarized in a meaningful way, or responded to our question as to why they followed it (or did not follow it). These isolated responses will thus not be analyzed here.

We identified the correlates of following a strategy. Our key dependent variable was *followstrategy_all*, taking the value of 1 for those who never follow one, 2 for those who follow it only to a minor extent, 3 - to a large extent, and 4 - for those who fully follow the strategy[6]. Of course, in any case, the distances between the levels are not interpretable, so we revert to the ordered logit. Several model specifications are reported in Table 7. In model 1 we only include basic demographics. In model 2, we add the frequency of lottery play. In model 3 we further add questions about religious practice. In model 4 we add psychological traits. Model 5 adds reported beliefs about lottery, model 6 adds questions about social aspects of playing and model 7 – risk attitudes.

**Table 7** Determinants of the tendency to follow a strategy: an ordered logistic regression

| Variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| *source_mturk* | 0.07 | 0.50 | -0.09 | -0.59 | -1.00 | -1.00 | -0.93 |
| *age* | -0.04 | -0.03 | -0.03 | -0.01 | -0.05 | -0.07 | -0.06 |
| *age2* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *woman* | -0.18 | -0.02 | -0.12 | -0.10 | -0.14 | -0.19 | -0.20 |

[6] The construction of this variable may require some discussion. We merge together those who do not recall any published strategy with those who have seen one (or more) but disregard it, the bottom line being they are not following any strategy. Some justification for this categorization comes from the fact that some players may have never seen a strategy or have seen one but forgotten it precisely because they were not interested in strategies (and so they would not follow one even if they recalled it). Alternative modeling choices would have led to qualitatively similar results.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *university* | 0.12 | 0.02 | -0.11 | -0.14 | -0.03 | 0.00 | 0.02 |
| *income* | 0.14 | 0.17 | 0.12 | 0.14 | 0.13 | 0.09 | 0.08 |
| *USA* | 1.46*** | 1.24** | 1.43** | 1.20** | 0.97 | 0.93 | 0.90 |
| *India* | 0.60 | 0.50 | 0.49 | 0.24 | 0.40 | 0.40 | 0.32 |
| *Poland* | -14.57 | -13.60 | -13.66 | -14.24 | -15.54 | -15.01 | -14.91 |
| *frequency* | 0.48*** | 0.34** | 0.31** | 0.26* | 0.22 | 0.21 | |
| *religiosityprivate* | | 0.12 | 0.11 | 0.10 | 0.10 | 0.11 | |
| *religiositydivine* | | 0.03 | 0.06 | -0.02 | -0.04 | -0.06 | |
| *religiositycarry* | | 0.28** | 0.25** | 0.12 | 0.13 | 0.13 | |
| *extraversion* | | 0.12 | 0.10 | 0.11 | 0.11 | | |
| *agreeableness* | | 0.09 | -0.01 | 0.01 | 0.01 | | |
| *conscientiousness* | | -0.02 | 0.01 | 0.01 | 0.01 | | |
| *emotional_stability* | | 0.04 | 0.06 | 0.03 | 0.04 | | |
| *openness_to_experience* | | -0.06 | -0.10 | -0.13 | -0.14 | | |
| *bhigher* | | | 0.01 | 0.03 | 0.02 | | |
| *blower* | | | 0.10 | 0.11 | 0.09 | | |
| *bthesame* | | | -0.02 | -0.04 | -0.05 | | |
| *blotteryfair* | | | -0.07 | -0.04 | -0.04 | | |
| *blotteryskill* | | | 0.39*** | 0.45*** | 0.44*** | | |
| *bluckycoin* | | | 0.13 | 0.14 | 0.14 | | |
| *brituals* | | | -0.02 | -0.01 | 0.00 | | |
| *bgamblfallacy* | | | -0.10 | -0.11 | -0.11 | | |
| *blotteryunfair* | | | 0.03 | 0.04 | 0.05 | | |
| *bjackpot* | | | 0.10 | 0.10 | 0.09 | | |
| *peerplaybuy* | | | 0.231* | 0.23 | | | |
| *peerplaychoice* | | | -0.12 | -0.14 | | | |
| *peerplayresults* | | | -0.19 | -0.21 | | | |
| *peerplaypeople* | | | 0.28 | 0.29 | | | |
| *riskgeneral* | | | | 0.07 | | | |
| *riskfinancial* | | | | 0.02 | | | |
| cut1 _cons | 0.98 | 3.23** | 3.78** | 4.47** | 3.99* | 3.89 | 4.14* |
| cut2 _cons | 2.48* | 4.78*** | 5.41*** | 6.12*** | 5.73** | 5.66** | 5.91** |
| cut3 _cons | 3.97*** | 6.29*** | 6.99*** | 7.70*** | 7.35*** | 7.32*** | 7.57*** |
| N | 324 | 324 | 324 | 324 | 324 | 324 | 324 |

*** p<0.01, ** p<0.05, * p<0.1

We find a robust (and intuitive) link between the willingness to follow a strategy and the belief that the lottery is a game of skill. The effect of frequency of lottery play appears to be mediated by beliefs about the lottery, as it loses its significance as we add them.

We now move on to the specific practices our responders employ when playing, no matter if they come from a published strategy or not. All of them are fairly common, with the median response being "sometimes" or "often" for each of them, see Table B4 in Appendix B. We also find these practices to be highly correlated. For concise reporting, we thus run a factor analysis, see Table B5 in Appendix B. As evidenced by parallel analysis (see Figure 3 in Appendix B), a single variable represents a disproportionate part of these variables' variance. We thus use this aggregate factor, interpretable as a general tendency to use various practices when playing the lottery, as a dependent variable in our analysis. We run ordinary least squares regression using several specifications analogous to those reported previously in Table 7, see Table 8. Regressions modeling individual lottery practices are available upon request - they tend to yield qualitatively similar results.

**Table 8** Determinants of the general tendency to follow various practices when playing

| Variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| *source_mturk* | 0.94*** | 1.13*** | 0.89*** | 0.58*** | 0.39*** | 0.24* | 0.24* |
| *age* | -0.02 | -0.02 | -0.01 | 0.00 | -0.01 | 0.00 | 0.00 |
| *age2* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *woman* | -0.036 | 0.020 | -0.035 | -0.048 | -0.072 | -0.12* | -0.11* |
| *university* | 0.21** | 0.14 | 0.06 | 0.01 | -0.03 | 0.00 | 0.01 |
| *income* | 0.03 | 0.05 | 0.01 | 0.03 | 0.03 | 0.03 | 0.03 |
| *USA* | 0.44** | 0.09 | 0.11 | 0.318* | 0.20 | -0.04 | 0.24 |
| *India* | 0.39 | 0.13 | 0.09 | 0.24 | 0.23 | (omitted) | 0.293 |
| *other_country* | -0.08 | -0.27 | -0.28 | 0.04 | -0.02 | -0.24* | 0.04 |
| *frequency* | 0.19*** | 0.15*** | 0.12*** | 0.09** | 0.06* | 0.05* | |
| *knowstrategies* | 0.36*** | 0.25*** | 0.16** | 0.05 | 0.06 | 0.06 | |
| *religiosityprivate* | | 0.08*** | 0.07** | 0.05** | 0.03 | 0.03 | |
| *religiositydivine* | | 0.02 | 0.04 | 0.01 | -0.02 | -0.02 | |
| *religiositycarry* | | 0.13*** | 0.10*** | 0.03 | 0.03 | 0.03 | |
| *extraversion* | | 0.040** | 0.012 | 0.01 | 0.02 | | |
| *agreeableness* | | 0.07*** | 0.04** | 0.03** | 0.03** | | |
| *conscientiousness* | | -0.07*** | -0.04** | -0.04** | -0.04** | | |
| *emotional_stability* | | -0.01 | -0.01 | 0.00 | -0.01 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| *openness_to_experience* | | -0.01 | -0.01 | -0.02 | -0.02 | | |
| *bhigher* | | | 0.01 | 0.00 | 0.00 | | |
| *blower* | | | 0.03 | 0.03 | 0.03 | | |
| *bthesame* | | | 0.01 | 0.00 | 0.00 | | |
| *blotteryfair* | | | 0.02 | 0.02 | 0.02 | | |
| *blotteryskill* | | | 0.09*** | 0.07*** | 0.07*** | | |
| *bluckycoin* | | | 0.02 | 0.01 | 0.01 | | |
| *brituals* | | | 0.05** | 0.04* | 0.04* | | |
| *bgamblfallacy* | | | 0.03 | 0.02 | 0.02 | | |
| *blotteryunfair* | | | 0.06*** | 0.04** | 0.04** | | |
| *bjackpot* | | | 0.01 | 0.01 | 0.02 | | |
| *peerplaybuy* | | | 0.10*** | 0.10*** | | | |
| *peerplaychoice* | | | 0.09*** | 0.09*** | | | |
| *peerplayresults* | | | 0.01 | 0.01 | | | |
| *peerplaypeople* | | | 0.02 | 0.02 | | | |
| *riskgeneral* | | | | -0.02 | | | |
| *riskfinancial* | | | | 0.02 | | | |
| *_cons* | -0.90* | -1.70*** | -2.04*** | -2.12*** | -2.47*** | -2.27*** | -2.54*** |
| N | 324 | 324 | 324 | 324 | 324 | 324 | 324 |
| r2_a | 0.28 | 0.37 | 0.48 | 0.56 | 0.66 | 0.70 | 0.70 |

*** p<0.01, ** p<0.05, * p<0.1

Among demographic variables, we find the part of the sample recruited via Amazon mTurk to be more willing to employ various playing practices. Perhaps more interestingly, responders who play a lot, who know strategies from books or websites, those who are agreeable and not conscientious, those who think that lottery takes skill to win and is unfair, those who play with others, those who are superstitious and perhaps religious (though this is not robust across all specifications) to be more likely to employ various practices when playing the lottery. Of course, all of these are just correlations, we cannot be sure about causality.

## 4 Conclusion

There are a myriad of different types of lottery strategies available on the market, the overwhelming majority of which are highly misleading and manipulative. One interested in lottery play will easily find a number of webpages or books detailing how to win millions using lottery history analysis, wheeling, magic, or just by joining a lottery syndicate. However, none of these options will increase one's expected payoff.

We did not succeed in obtaining high-quality data on the popularity of specific strategies, especially those available via webpages. Thus, we could not reliably pin down the number of lottery strategy buyers, although the sheer volume of strategies suggests that they find a lot of customers. This is also clearly confirmed by our survey results; using them we can cautiously estimate that about one-third of those who play the lottery at least occasionally (thus about one-sixth of the adult US population) have encountered a published strategy and follows some of its elements at least some of the time. Our results also suggest that those who play more, are more likely to use strategies, although it is impossible to establish causality (which could plausibly go either way).

We found that lottery strategies try to create an illusion of control over lotteries by making extensive use of various cognitive biases and heuristics, including the illusion of correlation, authority bias, gambler's fallacy, hot hand fallacy, and magical thinking. It is interesting to note how many strategies try to establish authority using scientific terminology, formulas, and calculations. Of course, the bad news is that probability theory is largely misrepresented or not taken seriously. The chances are, though, that most readers will not notice sloppiness and internal inconsistencies. While reasonable recommendations can occasionally be found, perhaps to boost reliability, they do not change the wider picture.

In most cases, errors, manipulations, contradictions, and non-sequiturs can be easily found even without expert knowledge of probability and statistics. Lottery players are likely to stick to their motivated beliefs, though. What could be more enjoyable than to believe that you are destined to win a fortune one day? Thus, the authors of lottery strategies, by creating an illusion of control, just make it easier to believe in what people want to believe. These observations are corroborated by our survey results, showing that the need for control is a key motivation to choose numbers on one's own (rather than rely on operator's "quick picks") and that the fundamentally wrong belief that lottery is a game of skill is correlated to following a strategy and to following various dubious lottery playing practices, whatever their source may be.

Unfortunately, there are populaces that are particularly vulnerable to false promises to gain control over lottery results. For many poorer and less educated people, lotteries become a source of dream and hope. They spend their time and money on this activity not only because of entertainment but also to escape (or at least have a chance to escape) from poverty. Unfortunately, in almost all cases lottery play makes poor people even poorer.

Obviously, lottery strategies could be extremely dangerous for problem gamblers, which is not a small group, although specific estimates vary considerably (Williams et al., 2012). Such a gambler, already convinced that she has some "expertise" in betting, could find confirmation of her false beliefs in a lottery strategy. Fortunately, we have not found much evidence of lottery strategy authors trying to explicitly address specific vulnerable populaces, although many of their techniques are likely to appeal to less educated people who are frustrated with already having lost a lot of money on gambling.

Despite the obstacles and limitations of our analysis, the results of our work could be of interest to anyone studying cognitive biases and heuristics beyond the context of lotteries. The most important result is perhaps the apparent need for control, "a biological imperative for survival" (Leotti et al., 2010). Because inherently random and unprofitable lotteries offer no such control, one needs to develop a battery of false beliefs. Thus, the results of our work are deeply rooted in psychology and neuroscience.

In the exploratory work, Turner (2003) postulated that information about good and bad sources of gambling information should be available to the public. They also suggest monitoring the quality of gambling materials. As we could not agree more that this is an important practical benefit of such research, we have developed a webpage aimed at the general public, http://www.lotto-facts.wne.uw.edu.pl/en/ with a "light" version of our analysis of strategies, accompanied by reliable advice, debunking some popular myths about lottery play.

A more far-reaching policy implication of our findings would be it may be advisable to strengthen the legal safeguarding of lottery players against costly and misleading advice. These apparently highly popular and often highly manipulative contents are worth a closer look from the consumer protection agencies.

Finally, our findings could inform the ethical advertising of lotteries. Responsible operators should not encourage consumers to make use of costly, worthless, misleading strategies. Knowing how they operate and why people may find them appealing should make it easier to avoid such an occurrence. In particular, operators arguably have an obligation to emphasize the message that the lottery is a game of chance only and no "control" is possible really. Currently, it is a fairly common practice for them to publish frequently and infrequently drawn numbers without further comment (or worse, labeling them as "hot", "cold"). Should

they publish such statistics at all, it should be accompanied by reminders that these are merely random occurrences of no predictive value.

Subsequent research could investigate how persuasive different types of strategies are and what manipulations could reduce this impact. For one example, recall that our analysis using different qualitative and quantitative approaches converged on the key distinction between the strategies that relied on magical thinking and superstition ("magical" strategies) and those based on flawed logic ("analytical" strategies, for example, the "analysis" of past drawings). It may be true that in the end they all appeal to the illusion of control and, in Arthur Clarke's words, "any sufficiently advanced technology is indistinguishable from magic" anyway.

Then again, it seems possible, even if difficult, to reduce the appeal of "analytical" strategies by exposing the logical flaws they contain. It is probably useless to use a similar approach to individuals who, advised by "magical" strategies, believe that a "scientific prayer to the universal intelligence of (their) subconscious mind" (B19) will make them rich. These important questions could be addressed in experimental studies exogenously manipulating various elements of a customized strategy and measuring subjects' willingness to follow it.

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***Reference list of cited book and webpages***

Each book and webpage has its code, which starts with the letter B or W, respectively. We sort books and webpages in the same order as we cite them in the main text.

B1 - Howard, G. 2003. Lottery Master Guide

B2 - Drew A., 2015. Make A Killing With The Laws Of Attraction, Awareness And Reciprocation: A Million Dollar Lottery Winner's Guide On How To Attract Money

B3 - Dragu C., 2017. Number Patterns: Cracking The Lottery Pick 4

B4 - Professor Jones 2015. The Basics Of Winning Lotto

B5 - Lee, A. 2010. How To Win Scratch Offs

B6 - Dunkin, J. 2014. Win The Lottery: Learn The Secrets That Turn This Game Of Luck Into A Game Of Skill

B7 - Powers, N. 2014. Lottery: Law Of Attraction: Secret Lottery Strategies And Systems To Effortlessly Manifest: Abundance!

B8 - Muse, M. 2016. Lottery Book: 7 Numbers That Win The Lottery Most Often

B9 - Howard, G. 2014. Lottery Winning Strategies: & 70 Percent Win Formula

B10 - Henriksen, R. 2016. How To Win The Lottery: Secret Techniques, Tips And Tactics To Give You An Unfair Advantage And Significantly Improve Your Chances Of Winning The Lottery

B11 - Villett, A. 2014. Lotto Dreams & Numbers 2015

B12 - Howard, G. 2008. Strategies For Attracting Good Luck

B13 - Powers, N. 2014. Lottery: Law Of Attraction: Secret Lottery Strategies And Systems To Effortlessly Manifest: Abundance!

B14 - Williams, A. 2014. Winning The Lottery: Revealed! Proven Tips, Techniques, And Strategies On How To Win The Lottery

B15 - Daneth, R. 2013. Powerball, How To Play To Win: 2016 Edition

B16 - Powerball Money Secrets 2017. How To Win Mega Millions Lottery Jackpot

B17 - McKnight, J. 2016. The Winning Lottery Ticket: The 10 Ways To Increase Your Chances Of Winning The Big Lottery Jackpot Drawing

B18 - Prof. Jones 2013. Winning Lotto & Lottery For The Everyday Player

B19 - Williams, J.L. 2015. Win The Lottery, My Story: I Did, You Can Too!

W1 - www.lottery-analyst.com

W2 - www.lotterydominator.com

W3 - www.iwinthelottery.net

W4 - www.tiptopwebsite.com/lotto

W5 - www.formula1lottosystem.com

W6 - www.lottoguy.net/wp/lotto-guy-system-website

W7 - www.beatlottery.net

W8 - www.smartluck.com

W9 - www.lazyjetcat.com

W10 - www.psychicjackpot.com

W11 - www.lotteryhelp.com

W12 - www.millennium2k.com

W13 - www.use4.com/lotto.html

W14 - www.winslips.com

W15 - https://powerfall.com/BuyNow/

## Appendix A. Data description

### Study 1 - description of variables

Study 1 data, code and full codebook (variables description) can be found here: https://drive.google.com/drive/folders/10tysxvTYhQoNyAblJ8KgBaRU9xoC3wRh?usp=sharing

Explanation of variables mentioned in the main text, sorted in the same order as appeared in the main text:

*price* - the minimum price at which a book or webpage strategy could be fully accessible. For example, in the case of a book, it could a price of the used book.

*year* – book's publication year.

*number_of_pages* – the number of pages in the book.

*review_score* - the number of stars on Amazon, book's score.

*number_of_reviews* - the number of reviews on Amazon.

*ranking* - rank of the e-book in the "Lotteries (Kindle Store)" category on Amazon.

*design_score* - a subjective score of how well a webpage or a book's cover is designed.

*software* - equal to one if web software or downloadable software is offered on the webpage.

*nmbr_of_products* - a number of strategies (products, software, books) offered. For example, there could be 5 programs for sale, in this case, this variable will be equal to 5.

**Study 1 - description of the variables: explicit recommendations**

These variables capture information about explicit recommendations on how to play the lottery. Applied to both books and webpages. Initially, all variables are binary, equal to 1 if a book or webpage includes a corresponding suggestion on how to play the lottery and 0 otherwise. Because classification was done by two independent reviewers, variables used in the analysis sometimes also take the value of .5

*magic* - A suggestion to use lucky numbers, numerology, or magic when playing the lottery. Example: "just close your eyes and imagine good cosmic vibrations, imagine that you win the lottery - then play and you will win the lottery!".

*special_meaning_nmbrs* - A suggestion to bet on numbers associated with some special meaning (for example, one's date of birth).

*secret_knowledge* - a promise to reveal a secret winning formula or lottery conspiracy theory.

*based_on_past* - a general suggestion to analyze the history of previous drawings to obtain the numbers that should be bet on.

*high_freq* - high frequency or hot numbers strategy, a suggestion to bet on the numbers that appear relatively frequently in previous lottery drawings.

*low_freq* - low frequency or cold numbers strategy, a suggestion to bet on the numbers that appear relatively infrequently in previous lottery drawings.

*wheeling* - lottery wheeling - a technique of distributing players' numbers across multiple tickets to be sure (have a guarantee) that at least one ticket will contain a specific number of winning numbers under the condition that the player guesses a sufficiently high number of winning numbers (also called a combinatorial play, wheels, wheel).

*syndicate_promotion* - a suggestion to play in a lottery syndicate, which is a group of people sharing lottery costs and winnings proportionally to their contributions (could be also called lottery pool, group play).

*has_syndicate* - there is a lottery syndicate on a webpage with a lottery strategy. A lottery syndicate is a group of people sharing lottery costs and winnings proportionally to their initial payment (could be also called lottery pool, group play).

*bet_on_the_same_nmbrs* - advice to bet on the same numbers in every lottery draw.

*bet_on_unpopular_numbers* - a suggestion to bet on unpopular or less popular numbers, for example, to avoid betting on dates.

*bet_on_rnd_nmbrs* - a suggestion to bet on random numbers using a random number generator or buying a ticket with numbers randomized by the lottery organizer ("quick pick").

*other_useful_advice* - other useful, reliable information. For example, that one should not spend more than one can afford; that one should sign their ticket; that one should check their tickets carefully; information about the true odds of winning the lottery.

**Study 1 - description of variables: other features**

These variables capture the characteristics of books and webpages that are not explicit recommendations on how to play the lottery. Applied to both books and webpages. Initially, all variables are binary, equal to 1 if a book or webpage includes a corresponding suggestion on how to play the lottery and 0 otherwise. Because classification was done by two independent reviewers, variables used in the analysis sometimes also take the value of .5

*promise_of_contrl* - a false promise of gaining control over lottery results to increase the player's expected winnings. Please note that in the case of lottery wheeling "guarantee" is guaranteed sometimes.

*testimonials* - testimonials or statements that people have won huge prizes using this strategy. It could be the author of the strategy or other people.

*free_or_moneyback* - trial or a promise to return the money paid for the lottery strategy if a player is not satisfied. It is also applied if a webpage offers a trial version of its lottery software. Not related to a fact that strategy is free in general.

*limited_offer* - a limited–time offer (including discount) that "cannot be missed", appealing to regret aversion.

*authority* - usage of personal authority, including an authority unrelated to lottery play.

*scientific_style* - usage of scientific (statistics, math) or pseudoscientific (numerology) terminology.

*calc_formulas* - usage (or mention of usage) of formulas, calculations, or equations that help to win the lottery. For example calculations of possible future winnings are not important here.

*graphs_or_tables* - indicator, if graphs or tables available on the webpage or in a book

*biased_wheel* - a claim that the probabilities of different numbers or combinations are not uniform, for example, due to different weights of different lottery balls.

*software* - indicator, if web software or downloadable software is offered on the webpage

*forum* - the webpage has a forum (or a blog with comments, please put a note if it is a forum or a blog with comments).

**Study 2 – description of variables**

Data, codebook, STATA code and printed survey

https://drive.google.com/drive/folders/16eHmOvurdJxHEfaK8edPrGMU9YTnoa68?usp=sharing

Survey without the contact details is also available under the link https://lee.wne.uw.edu.pl/ankieta/index.php/861813?lang=en

Explanation of variables mentioned in the main text, sorted in the same order as appeared in the main text (more details available in the codebook online):

*source_mturk* - boolean indicator that the participant was recruited at mTurk

*age* - age of the participant

*age2* - age squared

*woman* – boolean indicator that the participant was female

*university* - equal to one if the participant has completed university education

*income* - stated income level

*USA* - boolean for country

*India* - boolean for country

*Poland* - boolean for country

*frequency* - stated frequency of lottery play

*religiosityprivate* - answer to the question "How often do you spend time in private religious activities, such as prayer, meditation, reading Bible, or other religious books?"

*religiositydivine* - answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. In my life, I experience the presence of the Divine (in other words, God)"

*religiositycarry* - answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. I try hard to carry my religion over into all other dealings in life"

*extraversion* - extraversion according to Big Five personality scale TIPI

*agreeableness* - agreeableness according to Big Five personality scale TIPI

*conscientiousness* - conscientiousness according to Big Five personality scale TIPI

*emotional_stability* - emotional stability according to Big Five personality scale TIPI

*openness_to_experience* - openness to experience according to Big Five personality scale TIPI

*bhigher* - answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. Comparing to other people, I have higher chances to win the lottery"

*blower* - answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. Comparing to other people, I have lower chances to win the lottery"

*bthesame* - "answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. Comparing to other people, I have the same chances to win the lottery"

*blotteryfair* - answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. The lottery is only a game of chance"

*blotteryskill* - answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. There are secrets to successful lottery play that can be learned"

*bluckycoin* - answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. I like to carry a lucky coin, charm or token when I'm doing something important"

*brituals* - answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. I can improve my chances of winning by performing special rituals"

*bgamblfallacy* - answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. The longer I've been losing, the more likely I am to win"

*blotteryunfair* - answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. In general, the lottery is an unfair game"

*bjackpot* - answer to the question "Please choose a number, to indicate the extent to which you agree or disagree with the following statement. I have a decent chance to win a jackpot during my lifetime"

*peerplaybuy* - answer to the question "If you play the lottery, do you perform the following activities together with your friends or family? Buy the tickets"

*peerplaychoice* - answer to the question "If you play the lottery, do you perform the following activities together with your friends or family? Choose the numbers"

*peerplayresults* - answer to the question "If you play the lottery, do you perform the following activities together with your friends or family? Check the results"

*peerplaypeople* - answer to the question "Are there people who often play the lottery or similar games among your close friends or family?

*riskgeneral* - answer to the question "How willing are you to take risks, in general? "

*riskfinancial* - answer to the question "People might behave differently in various situations. How willing are you to take the risk in financial matters? "

*other_country* - boolean for country (other)

*knowstrategies* - answer to the question "Some books and websites offer lottery “strategies” or “systems”, guiding players as to how they should pick lottery numbers. Have you read some of these materials?"

**Appendix B. Supplementary analysis**

**Table B1** Interrater agreement for each variable in Study 1

| Variable | Books | | Webpages | |
|---|---|---|---|---|
| | N | Interrater agreement (books) | N | Interrater agreement (books) |
| authority | 89 | 0.83 | 83 | 0.59 |
| based_on_past | 89 | 0.75 | 83 | 0.78 |
| bet_rnd_nmbrs | 89 | 0.78 | 83 | 0.77 |
| bet_thesame_nmbrs | 89 | 0.90 | - | - |
| bet_unpopular_nmbrs | 89 | 0.49 | - | - |
| biased_wheel | 89 | 0.66 | - | - |
| calc_formulas | 89 | 0.70 | 83 | 0.67 |
| design_score_max4 | 89 | 0.80 | 83 | 0.70 |
| forum | - | - | 83 | 0.64 |
| free_or_moneyback | 89 | 0.82 | 83 | 0.93 |
| graphs | 89 | 1.00 | 83 | 0.85 |
| has_syndicate | - | - | 83 | 0.88 |
| high_freq | 89 | 0.80 | 83 | 0.77 |
| limited_offer | 89 | 0.65 | 83 | 0.69 |
| low_freq | 89 | 0.79 | 83 | 0.79 |
| magic | 89 | 0.86 | 83 | 0.89 |

| | | | | |
|---|---|---|---|---|
| other_useful_advice | 89 | 0.53 | 83 | 0.55 |
| promise_of_contrl | 89 | 0.82 | 83 | 0.83 |
| scientific_style | 89 | 0.84 | 83 | 0.78 |
| secret_knowledge | 89 | 0.80 | 83 | 0.80 |
| special_meaning_nmbrs | 89 | 0.86 | 83 | 0.84 |
| syndicate_promotion | 89 | 0.82 | 83 | 0.55 |
| tables | 89 | 0.74 | 83 | 0.65 |
| testimonials | 89 | 0.86 | 83 | 0.90 |
| wheeling | 89 | 0.90 | 83 | 0.95 |
| average | | 0.78 | | 0.76 |

Kappa could be interpreted according to the following classification (Landis & Koch, 1977):

- below 0.0 – poor;
- 0.0 – 0.20 – slight;
- 0.21 – 0.40 – fair;
- 0.41 – 0.60 – moderate;
- 0.61 – 0.80 – substantial;
- 0.81 – 1.00 – almost perfect.

**Study 1 - parallel analysis and factor analysis**

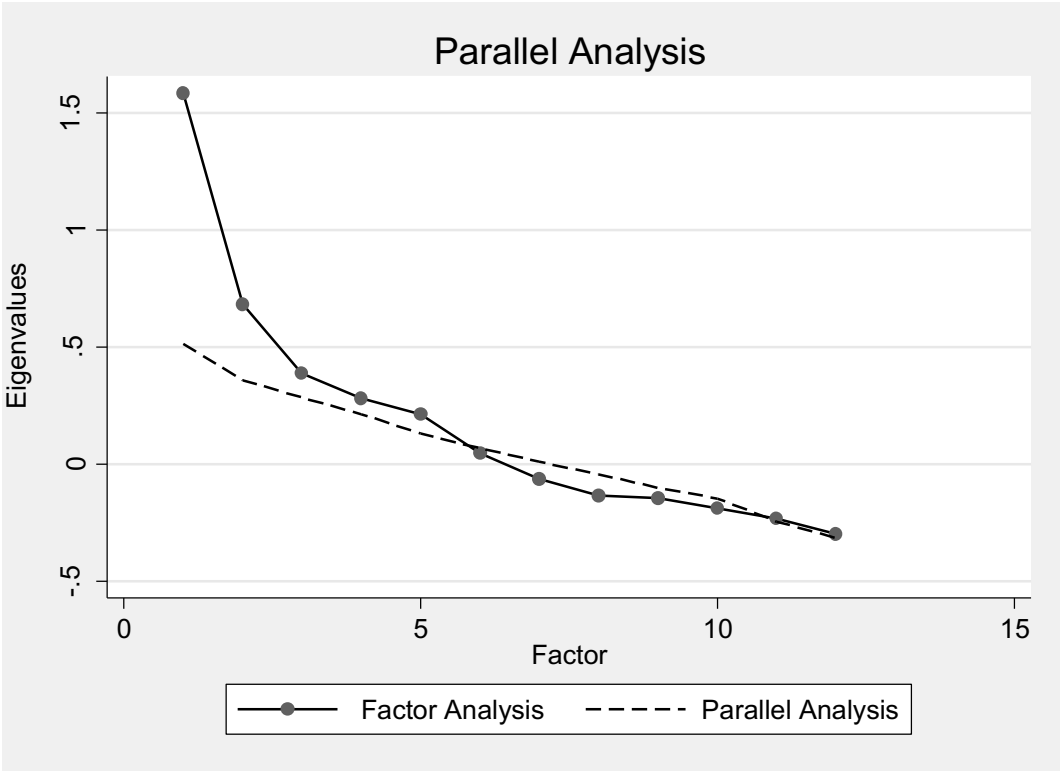


**Fig. 1** Parallel analysis for the factor analysis of explicit recommendations, N = 172

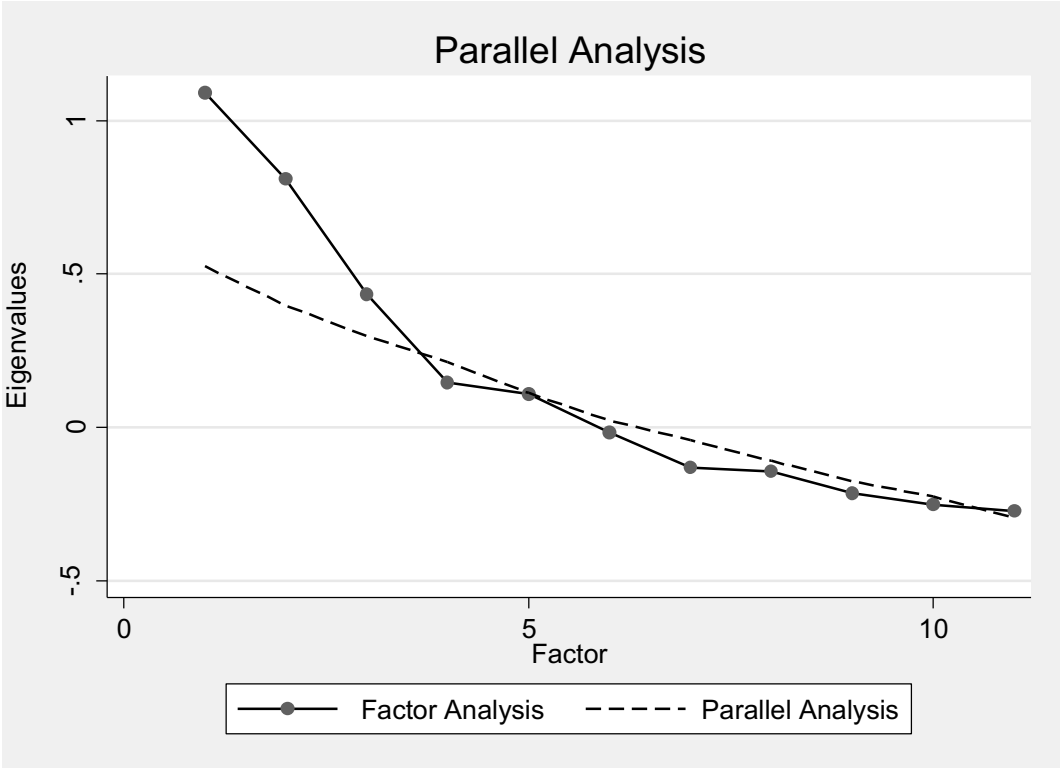


**Fig. 2** Parallel analysis for the factor analysis of other features, N = 153

**Table B2** Rotated factor loadings (pattern matrix) and unique variances: explicit recommendations

| Variable | Factor1 | Factor2 | Factor3 | Uniqueness |
|---|---|---|---|---|
| *magic* | -0.183 | **0.394** | 0.115 | 0.798 |
| *special_meaning_nmbrs* | 0.001 | **0.412** | -0.008 | 0.831 |
| *secret_knowledge* | -0.072 | 0.153 | -0.106 | 0.960 |
| *based_on_past* | **0.402** | -0.194 | 0.091 | 0.793 |
| *high_freq* | **0.763** | -0.081 | -0.059 | 0.408 |
| *low_freq* | **0.726** | 0.061 | 0.119 | 0.455 |
| *wheeling* | **0.302** | -0.253 | -0.097 | 0.836 |
| *syndicate_promotion* | 0.052 | **0.315** | 0.295 | 0.811 |
| *bet_on_the_same_nmbrs* | 0.105 | 0.201 | -0.082 | 0.942 |
| *bet_on_unpopular_numbers* | 0.293 | 0.093 | -0.002 | 0.906 |
| *bet_on_rnd_nmbrs* | 0.050 | 0.071 | **0.501** | 0.742 |
| *other_useful_advice* | 0.172 | -0.130 | **0.303** | 0.862 |

Entries above .3 are printed in **bold** to facilitate their quick identification.

We use the analysis of eigenvalues to determine how many factors should be kept. The parallel analysis (Fig. 1, Appendix B) indicates that as many as 2 factors have significantly higher eigenvalues than would be obtained had the data been generated randomly. We still decided to report the 3rd factor, which could be not taken into account. Factors are:

Factor 1. Corresponds to the lottery wheeling, analysis of past drawings, including high and low-frequency strategies.

Factor 2. Associated with different forms of superstition, exploiting magical thinking, and lottery syndicate promotion.

Factor 3. Captures reliable advice, such as recommending betting using quick picks, and advice to bet on random numbers.

While Factor 1 is more analytical in nature, Factor 2, on the contrary, is appealing to superstition. Surprisingly, Factor 2 includes the promotion of lottery syndicates - it requires further investigation. Also surprisingly, Factor 3 includes only reliable advice – to use the random number generator and other non-misleading suggestions.

Table 6 shows the results of the factor analysis of other features (together with the logarithm of price and design scores).

**Table B3** Rotated factor loadings (pattern matrix) and unique variances: other features

| Variable | Factor1 | Factor2 | Factor3 | Uniqueness |
|---|---|---|---|---|
| *ln_price* | **0.5624** | -0.0003 | 0.1325 | 0.6661 |
| *promise_of_contrl* | 0.2524 | 0.2431 | 0.2434 | 0.818 |
| *testimonials* | **0.3939** | 0.144 | -0.2291 | 0.7716 |
| *free_or_moneyback* | **0.4264** | -0.088 | 0.0081 | 0.8104 |
| *limited_offer* | **0.4084** | 0.0214 | -0.1451 | 0.8117 |
| *authority* | 0.1325 | 0.2009 | **0.3321** | 0.8318 |
| *scientific_style* | 0.1575 | **0.4824** | -0.0288 | 0.7417 |
| *calc_formulas* | -0.0987 | **0.5651** | 0.0171 | 0.6707 |
| *graphs_or_tables* | 0.095 | 0.3937 | -0.0314 | 0.835 |
| *biased_wheel* | -0.1081 | 0.2831 | 0.1832 | 0.8746 |
| *design_score* | -0.0165 | 0.1289 | **-0.3847** | 0.8351 |

Entries above .3 are printed in **bold** to facilitate their quick identification.

The parallel analysis (Fig. 2, Appendix B) indicates that 3 factors have higher eigenvalues than would be obtained had the data been generated randomly:

Factor 1. Includes price; the use of testimonials; a promise that the system is free, or money will be paid back to unsatisfied customers; a claim that offer is limited in time. All these should establish authority and, despite higher price convince to buy a strategy, appealing to regret aversion.

Factor 2. Associated with the usage of (pseudo-) scientific style, formulas and calculations used to establish authority.

Factor 3. Negatively associated with design score and positively with an appeal to authority.

While Factors 2 is directly associated with authority Factors 1 and 2 are also naturally related to it, as both testimonials and money-back mechanisms are meant to assure the player that there is no risk involved.

**Study 2**

**Table B4** statistics of practices usage, n = 342

| stats | median | corresponding answer label | mean |
|---|---|---|---|
| *syndicate* | 1 | never | 0.71 |
| *analysis* | 4 | often | 3.52 |
| *numerology* | 3 | sometimes | 3.29 |
| *wheeling* | 3 | sometimes | 3.34 |
| *prey* | 4 | often | 3.61 |
| *loa* | 4 | often | 3.65 |
| *samenumbers* | 4 | often | 3.66 |
| *randself* | 4 | often | 3.84 |

| | | | |
|---|---|---|---|
| *randsoftware* | 3 | sometimes | 3.23 |
| *softwarehelp* | 4 | often | 3.32 |
| *softwareprob* | 4 | often | 3.38 |

**Study 2 - parallel analysis and factor analysis**

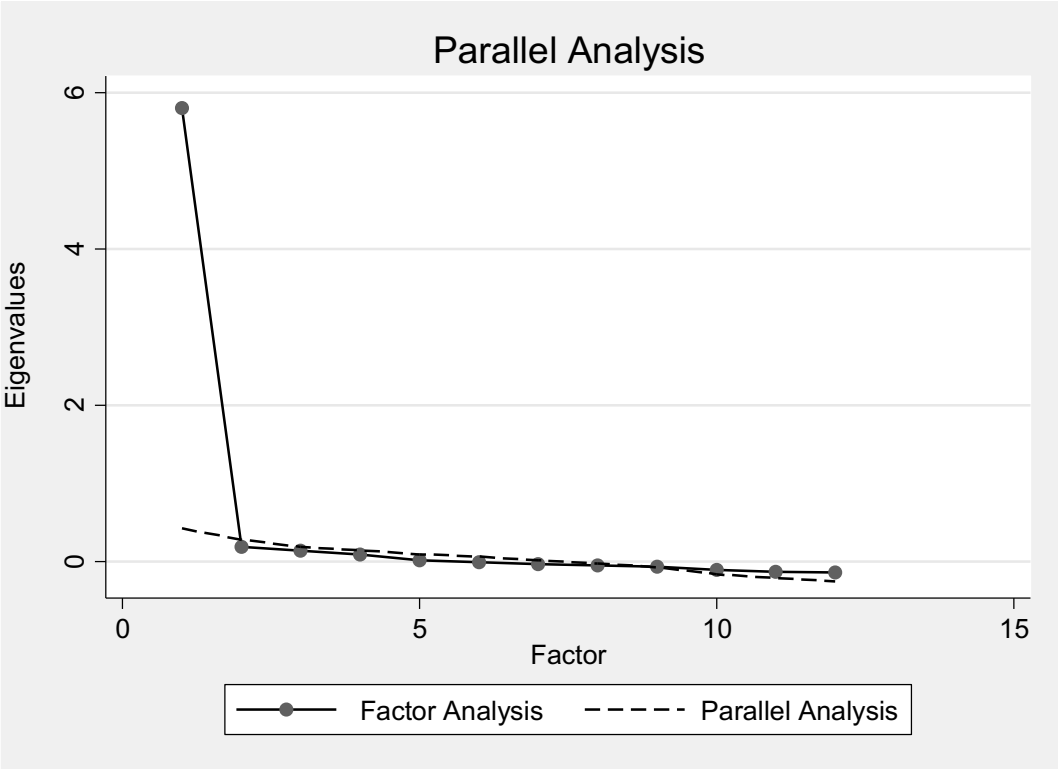


**Fig. 3** Parallel analysis for the factor analysis of other features, N = 327

**Table B5** Rotated factor loadings (pattern matrix) and unique variances: practices

| Variable | Factor1 | Factor2 | Factor3 | Factor4 | Factor5 | Uniqueness |
|---|---|---|---|---|---|---|
| syndicate | 0.42 | 0.20 | 0.28 | 0.03 | -0.03 | 0.70 |
| software | 0.28 | 0.13 | 0.30 | 0.08 | 0.03 | 0.81 |
| analysis | 0.69 | 0.33 | 0.06 | 0.10 | 0.05 | 0.40 |
| numerology | 0.68 | 0.43 | 0.14 | 0.02 | 0.00 | 0.33 |

| | | | | | | |
|---|---|---|---|---|---|---|
| wheeling | 0.72 | 0.38 | 0.11 | 0.12 | -0.01 | 0.31 |
| prey | 0.58 | 0.39 | 0.03 | 0.10 | -0.05 | 0.50 |
| loa | 0.56 | 0.37 | 0.04 | 0.08 | 0.06 | 0.54 |
| samenumbers | 0.49 | 0.22 | 0.13 | 0.28 | 0.00 | 0.62 |
| randself | 0.41 | 0.23 | -0.02 | 0.22 | 0.02 | 0.73 |
| randsoftware | 0.79 | 0.13 | 0.16 | 0.17 | 0.01 | 0.31 |
| softwareprob | 0.86 | 0.15 | 0.07 | 0.05 | -0.01 | 0.24 |
| softwarehelp | 0.83 | 0.11 | 0.04 | 0.04 | 0.00 | 0.30 |

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