Essays on the British Premium Bonds Programme

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Contents

1 Introduction

(…) The Ants then said to Grasshopper in derision: "If you had sung all the summer, you must dance supperless to bed in the winter."

Aesop fable n. 373, Townsend version

Many recent household surveys[1] are pointing out to the alarming number of financially fragile households in developed countries, such as UK and the US. Following the thought of Aesop's well-known fable, there are, unfortunately, too few 'ants' and too many 'grasshoppers' in the economies. During our lifetime we are all exposed to consumption shocks - severe, moderate or routine - and the role of savings in smoothing these shocks is undeniable, as is their impact on overall economic growth and welfare.

The behaviour of economic agents towards savings and investments is vital not only for the future of any given individual but also for the overall economy. Therefore, it has important implications for government policy on pensions and savings. Many policies have been introduced to tackle these issues (Tufano and Schneider 2008). They are often based on financial innovations designed to boost the attractiveness of savings for households. The success of these policies has been mixed and a number of studies have been undertaken to evaluate their impact as well as examine the potential for further improvements (e.g. Gale et al. 2006, Hurst and Ziliak 2004, Jappelli and Pistaferri 2003).

Recent studies of at-risk households have revealed a quite remarkable association between insufficient savings and the highest lottery expenditures as a proportion of households' income (Kearney et al. 2010). This association motivates us to re-evaluate an attractive, yet understudied solution - the prize-linked savings (PLS) accounts, which are not only interesting because of their unusual structure, but have also proven successful in raising overall saving

[1] For example, 44% of respondents participating in Wealth and Assets Survey in the period covering July 2016 to December 2017 reported that they would not be able to make ends meet for longer than three months in case of losing the main source of income. 12% of all respondents reported running out of money at the end of the week or month, or were in need of using a credit card or overdraft to get by in the previous year (Office for National Statistics 2018). 33% of British adults report they do not save money regularly (Lloyds Bank 2019).

rates, particularly among the low-income families (Tufano 2008, Cole et al. 2007, Guillen and Tschoegl 2002).

As indicated by the studies based on both real and experimental data, prize-linked savings programmes appear to be, a potentially effective but underestimated tool for nudging people towards saving. Moreover, the PLS mechanism, based on combining the security of principal with lottery-type jackpots, is believed to be the most cost-effective among the policies introduced thus far in the form of financial incentives (Kearney et al. 2010). Nevertheless, a vast majority of research on PLS products has been conducted relatively recently, still leaving some critical questions unanswered.

This dissertation aims to investigate different aspects of the demand for prize-linked savings products, based on the flagship example of the British premium bonds. The programme, which has been in operation in the United Kingdom since 1956, is offered by a government agency, the National Savings and Investments (NS&I). Today, as many as 23 million individuals across the UK hold premium bonds, and their total value is the highest among all NS&I financial products. Lobe and Hölzl (2007), for example, investigate the success of premium bonds to appeal to such a wide range of investors. Estimating the risk tolerance measures across different groups of taxpayers, the authors show that these financial products tend to be broadly perceived as not particularly risky.

Each chapter in this dissertation, can be regarded as an independent research paper, focusing on different aspects of the PLS product structure. The second chapter focuses on the socio-economic profile of premium bondholders. We establish a set of individual characteristics that are associated with either a higher likelihood of allocating money to premium bonds or greater value of premium bonds held by a person, both in absolute terms as well as in relation to their overall savings. The literature on prize-linked savings commonly suggests that the attractiveness of this kind of banking product results from a widespread preference for gambling (Kearney et al. 2010). For example, Tufano (2008) finds strong correlations of the time series of the premium bond net sales with both gambling activity as well as the size of the largest prize offered in the premium bond draws, suggesting a gambling motive for investing in these financial product and a possible complementarity with traditional gambling activities. A strong appeal of PLS products to gamblers is found by Cookson (2018), who uses transaction-level data on cash withdrawals at casinos, to show that an introduction of PLS in Nebraska, US, was followed by a significant reduction in gambling expenditure. Such conclusions have not, however, been tested with any real individual-level data. This chapter aims to fill this gap by using the expected expenditures on the variety of gambling activities derived from the British Gambling Prevalence Survey and explores their relationship with the observed demand for premium bonds. Finally, by allowing for heterogeneity in these effects across different groups of potential customers, the analysis sheds light on the differentiated motivations of people to allocate money to the prize-linked savings products.

The third chapter of this dissertation explores the role of social comparisons in individual savings and investment decisions, based on the association between aspiration income and the decisions to hold premium bonds. The closest environment people live and work in, serves as a benchmark in the self-assessments and the resulting satisfaction (Frank

2005, Luttmer 2005, Stutzer 2002, Clark and Oswald 1995). An individual is believed to set specific goals and aspirations based on comparisons they regularly perform - comparing their incomes, living standards, jobs or skills to those of their family members, neighbours, colleagues, friends, etc. Such aspirations, in turn, can substantially alter both the way people feel about their economic position as well as the decisions they make. For example, it has been shown that feeling disadvantaged relative to others, makes the person prone to take up more risk (Payne et al. 2017, Haisley et al. 2008). In this chapter, we test the effect of the relative financial position of a person within 'their community', on his or her decision to invest in premium bonds.

In the fourth chapter, we analyse whether the shocks to the gambling motives for allocating money to the PLS products are related to the observed changes in the PLS demand and savings behaviour. The analysis originates from two fundamental issues to do with premium bonds. First, the programme was launched with the primary purpose of encouraging British households to save. Both the participation rate and the total value of deposits have been rapidly growing since its launch; however, it has not been demonstrated how these changes affect a bondholder's savings portfolio. Second, the hybrid structure of the PLS-like products primarily aimed at exploiting the commonly observed appetite for gambling. Together, these two objectives imply that people are attracted substantially by the lottery mechanism incorporated into the model of premium bonds, and the money they allocate to these products builds up their additional savings. Therefore, exogenous shocks to the gambling side of PLS products are expected to result in observed changes both to the programme take-up and overall savings levels. The PLS structure also implies that the participants are prone to some of the fallacies that the 'regular' gamblers are usually exposed to. A common example is a 'hot-hand' heuristic, which is based on players' erroneous belief that particular gambling devices, places, people or numbers that experienced some winning streaks in the past are more likely to continue in the future. In case of prize-linked savings programmes, their participants might fall subject to a similar fallacy by assigning a higher probability of a top prize to be won in the same geographical area it was won in the recent drawing. By analysing information on the monthly draws of prizes, supplied by the British premium bond issuer, the chapter investigates the effect of such demand shocks on people's decisions to hold premium bonds. Moreover, we look at how these decisions affect the overall savings - a crucial issue from the policy perspective.

Relevant literature is presented in each chapter individually. The primary dataset used in all three chapters was built based on the Family Resources Survey (FRS). It is an annual survey conducted jointly by the Office for National Statistics (ONS) and the National Centre for Social Research (NatCen), containing questions on individual characteristics, incomes, different forms of savings, including premium bonds, and investments. With appropriate sampling and stratification, the conclusions from analysing the responses can be generalised to the UK population. The main description of the data is provided in chapter two; the data sections in chapters three and four highlight the chapter-specific differences in particular datasets.

2 Analysis of Individual Motivations to Invest in Prize-Linked Savings Products

2.1 Introduction

The British premium bonds, offered continually since 1956, are one of the most prominent prize-linked savings (PLS) products in the world, currently attracting around 30% of the country's population[2]. A central feature of any PLS-like mechanism is a combination of a traditional savings account (guaranteed deposit protection) and gambling (entering random draws of financial prizes with a highly skewed distribution). Wherever introduced, PLS products have attracted a broad range of clientele. However, the rationale for such a phenomenon has been understudied to date.

This paper aims at filling that gap by exploring the main determinants of the demand for premium bonds. The analysis consists of three main parts. First, it derives a socio-economic profile of a typical premium bond holder. For this purpose, the following measures of the demand for premium bonds are used: (i) probability of an individual holding premium bonds, (ii) amount invested in premium bonds, and (iii) ratio of the value of premium bonds to the value of one's overall savings. Second, the relationship between decisions to invest in premium bonds and gambling behaviour is investigated. Considering the structure of prize-linked savings products, their observed attractiveness is believed to originate from people's preference for gambling. Third part of the analysis tests for diversified effects of gambling on premium bond demand across different groups of potential customers.

The data used in this paper come from the Family Resources Survey (FRS). We attempt to contribute to the PLS literature by using a uniquely constructed country-representative individual-level dataset with observed behaviour on premium bonds. It covers eighteen consecutive FRS waves[3] and includes a rich set of economic and demographic characteristics as well as the data on individual savings and investment portfolio and premium bond holdings. Analysis of how different attributes are associated with different measures of demand for

[2] The premium bonds issuer, National Savings and Investments, reports the recent number of premium bond holders at 23.22 million (state as at March 2019). The UK population is estimated at 66.44 million (Office for National Statistics).

[3] At the time of preparing this paper, eighteen waves of FRS provide the longest possible time horizon that could be used for the analysis. It covers all financial years between 1999/2000, which is the earliest FRS wave that includes questions on premium bonds, and 2016/2017, which is the most recent FRS wave released up to date.

premium bonds is conducted by applying logistic regressions when estimating the likelihood of holding the bonds, and Tobit regressions when considering the value of money allocated to premium bonds. The data on gambling activities come from the British Gambling Prevalence Survey (BGPS). We propose a two-stage procedure with complementary datasets. First, it uses a Tobit model to explore the patterns in how various personal characteristics are typically associated with spending money on gambling. The obtained estimates are then used to derive the expected values of gambling expenditure for each individual of the primary dataset, the Family Resources Survey, given the demographic and economic attributes. Finally, the predicted values of gambling expenditure are incorporated into the models describing the demand for premium bonds.

In this paper, we find that the demand for premium bonds is significantly related to a set of demographic and economic characteristics of a potential buyer. For instance, among two persons of close characteristics, the one with income higher by, say, 10% is expected to be by 0.11 percentage points more likely to hold premium bonds, but also to invest, on average, 0.35% more money or a 0.03% higher portion of their overall savings to premium bonds. Furthermore, both the likelihood of holding as well as an absolute and relative values of premium bonds held by an individual tend to increase along with age, degree-level qualifications, white ethnicity, being single, with no children looked after, or female. A 10% increase in the level of savings is also observed to be associated both with a 0.36 percentage points higher probability of holding premium bonds and a 1% higher amount held in these securities. Relative to the overall savings, though, the value set aside in the form of premium bonds tends to be lower with higher savings level - with a 10% increase in overall savings being related to a 0.1% drop in the weight of premium bonds in the savings portfolio, holding all the other attributes unchanged. Having other types of investment is also observed to be strongly correlated with demand for premium bonds. For instance, a probability that a stock market investor would hold premium bonds is 12.4 percentage points higher than otherwise. Additionally, a stock market investor is expected to allocate 39% more money in absolute terms, or a 2.7% higher portion of their total savings to premium bonds, as compared to an individual of the same characteristics but no shares held.

The relationship between gambling behaviour and premium bond participation is found to be strongly negative for all the individuals in the dataset but those with a diversified investment portfolio. A 10% increase in a predicted value of gambling expenditure is associated with an average drop of 7.4% in the value of premium bonds held. Meanwhile, in case of those individuals who invest in other types of financial instruments, e.g. stocks, gilts or unit trusts, the same change in gambling behaviour refers to an increase in the premium bonds demand, with the increment in the amount invested in premium bonds becoming almost twice as much as the change in money spent on gambling. We attempt to interpret this result suggesting difference in motivations to hold premium bonds as a possible reason. The analysis points out to the observed clustering of the demand for premium bonds around both ends of the savings distribution. A group of individuals with the lowest levels of savings is observed to substitute between premium bonds and other types of savings, as well as between premium bonds and various forms of gambling.

Due to the limited data sources, existing studies examining the demand either for the PLS-type products or premium bonds in particular, are scarce. For example, Tufano et al. (2011) analyse the results of the survey conducted among a group of 500 single-state residents in the US, in which the respondents were asked about their potential interest in the PLS-like banking products, if such were to be offered. A few other examples are based on experimental data (Abraham et al. 2016, Filiz-Ozbay et al. 2015, Atalay et al. 2014). Studies of real-world data include a macro-level analysis of premium bond sales (Tufano 2008), as well as a study of the demand for Million-a-Month Account - a PLS product offered by a commercial bank in South Africa during years 2005-2008 (Cole et al. 2014). This paper complements the demand for PLS products literature both by the research questions addressed, but also the data used - it explores an actual demand for an existing, commonly chosen PLS product. The dataset includes micro-level information on the total savings as well as other personal characteristics. Furthermore, analysis of the premium bonds demand is conducted with a reference to the overall British population.

The paper is structured as follows. Section 2.2 provides details on the UK premium bonds programme. Section 2.3 describes the data used in the analysis: the primary dataset of Family Resources Survey and British Gambling Prevalence Survey. Section 2.4 gives background for the methodology used for the two-stage model with complementary datasets, while Section 2.5 describes the empirical results. Section 2.6 concludes.

2.2 Premium Bond Programme

The British premium bonds constitute a special type of the Treasury-backed bonds. They do not pay any coupons to the holders, but instead every £1 invested is assigned with a unique code, which works as a ticket of participation in the drawing of financial prizes. The interests foregone are distributed among the holders at the end of the month via a random draw mechanism. Thus, from the perspective of the issuer, the cost of raising the capital should be the same for premium bonds as for the regular T-bonds (Brown 2006). The difference refers to the recipient of the interests paid out, i.e., while the regular bond holders get the certain coupon payments in regular time intervals, in case of the premium bond holders it is only a randomly generated subgroup who receive the significantly higher payouts.

Premium bonds are issued by the National Savings and Investments (NS&I). It is a state-owned savings bank, "both a government department and an Executive Agency of the Chancellor of the Exchequer. (…) When customers invest in NS&I products, they are lending to the Government, which goes towards the public purse[4]."

The programme offering premium bonds was first launched in 1956. Its main goal was to encourage savings among the British citizens after World War II. According to the National

[4] NS&I corporate website, URL: https://nsandi-corporate.com/, accessed on 02 March 2019.

Savings and Investments statistics, there are currently over 23 million people across the UK (around 30% of the country's population) holding the premium bonds, totalling to £81.7 billion value invested. For example, as for the February 2019 draw, the total value of the prize pool amounted to £92 million, resulting in over 3 million individual financial prizes distributed among the bondholders in this single draw[5]. The capital raised by the NS&I via premium bond sales is higher than in case of any other financial product it offers[6].

The drawing procedure starts with generating a random number by the Electronic Random Number Indicator Equipment (ERNIE), which is then matched with the appropriate bond code. The total capital invested per person is currently limited to £25 at minimum, and £50,000 at maximum[7]. An exemplary distribution of prizes drawn in February 2019 is presented in Table 2.1.

Table 2.1: Prizes Distribution in a Premium Bond Draw, February 2019

Prize Band	Prize Value	Number of Prizes
Higher value	£1 million	2
(5% of prize fund)	£100,000	5
	£50,000	11
	£25,000	21
	£10,000	51
	£5,000	104
Medium value	£1,000	1,843
(5% of prize fund)	£500	5,529
Lower value	£100	25,283
(90% of prize fund)	£50	25,283
	£25	3,165,599
Total	**£92,144,925**	**3,223,731**

Source: National Savings and Investments.

The shares of the total pool of funds assigned to each of the prize bands (i.e., 'higher', 'medium', and 'lower') are fixed across the draws. In each draw, there are two £1 million jackpots paid out. The rest of the funds within the higher-value band is shared equally across the remaining prizes. In the medium-value band, the proportion of the amount of £1,000 to £500 prizes is set at 1:3. Finally, in the lower-value band there are equal numbers of £100 and

[5] The results of the prize drawing provided are based on the information published regularly on the NS&I official website, URL: www.nsandi.com, accessed on 02 March 2019.

[6] For example, during the financial year 2018/19, the capital raised in premium bonds exceeded £15.2 billion, which is 40.8% out of a total £37.3 billion in all the NS&I products. For comparison, the second and third highest amounts received from investors during the year, were £9.7 billion in Direct Saver accounts and £6.4 billion in Income Bonds, respectively (NS&I Annual Report 2018-19).

[7] The information provided is valid as at March 2019. The floor deposit value was reduced to £25 from £100 in February 2019. The cap deposit value was increased to £50,000 from £40,000 in June 2015. The ceiling for the premium bond holdings serves as a means of reducing any possible crowding-out of the traditional bonds with taxable coupons.

£50 prizes. Moreover, the total number of the prizes should be always equal to the number of bond codes ('tickets') divided by the odds.

The odds for winning in the monthly draw are currently 24,500 to 1 for each £1 invested, and the annual interest rate for the prize fund amounts to 1.4%[8]. All the prizes are exempt from both income tax and capital gain tax.

The prize fund rate serves as an expected rate of return on premium bonds. From the issuer's perspective, it is a reference rate at which the total value of the prize pool is derived, and later distributed among the premium bond holders. The prize fund rate is set by the National Savings and Investments. It is adjusted based on the current economic conditions as well as the current needs of the government to finance its activities. On top of the rate, the distribution of prizes is also subject to minor changes over time. The NS&I adjusts the probability of winning a prize in a single draw, but sometimes also introduces amendments to the structure of prizes.

When using 'premium bond sales' and 'premium bond purchases' throughout this thesis, we refer to the new acquisition of premium bonds by either an individual or a group of individuals over a specific time period. On the other hand, 'demand for premium bonds' as well as 'premium bond holdings' are used interchangeably in the thesis when referring to the total value of savings held by an individual in the form of premium bonds at a given point in time.

2.3 Data

The following paper exploits the datasets constructed from multiple waves of the two independent UK-representative surveys: (i) Family Resources Survey, and (ii) British Gambling Prevalence Survey. The former is applied in all the analyses throughout the paper, while the latter is used as complementary in our two-stage model with the gambling expenditure imputation. This section highlights the main characteristics of both surveys.

2.3.1 Family Resources Survey (FRS)

The primary data source, Family Resources Survey, is conducted annually by the Office for National Statistics (ONS) along with the National Centre for Social Research (NatCen), while sponsored by the Department for Work and Pensions (DWP). The survey collects information on the income and living circumstances among the British households. It was carried out for the first time in 1992, with the leading aim of existing policy evaluation.

The major reason for limitations of the previous research on premium bonds and PLS products lies in the data used. To our knowledge, this paper is the first to use such a coherent

[8] For comparison, the Direct ISA offers 0.9% tax-free interest, and Income Bonds (both provided by the NS&I) currently offer 1.16%. Both interest rates, and the statistics provided with regard to the premium bonds are prevailing as at March 2019.

and rich dataset: a country-representative individual-level set of eighteen subsequent pooled cross-sections, including all the economic and socio-demographic characteristics of interest.

2.3.1.1 FRS Standardization

The FRS data are structured in the three hierarchical levels: (i) household, (ii) benefit unit, and (iii) individual. The central variables we are interested in refer to the premium bonds – in case of household and benefit unit levels, the number of people with premium bond accounts open is indicated, whereas at individual level the survey provides information whether the person holds premium bonds or not (in the form of a binary response). The most recent wave, for which this variable is available, covers the 2008-2009 financial year. Meanwhile, each FRS wave contains an "accounts" table, which gives details of some chosen savings and investment products for each individual surveyed[9]. The premium bond account is included even after the 2008-9 financial year, which means that it is possible to track down the individual premium bond holdings up to the most recent FRS survey to date, i.e., the 2016-17 financial year.

The dataset constructed for this project covers eighteen consecutive waves of the FRS, with the binary response to the premium bond holding question derived manually for all the waves after 2008-9. Those individuals who claimed to hold premium bonds during an interview, had been asked further to indicate a banded value of their premium bond holdings. We incorporate this piece of information into our dataset from the "accounts" table, by matching account-level to individual-level data. The banded value of premium bonds is provided in the form of a categorical variable with 12 levels, as shown in Table 2.2.

Table 2.2: Banded Values of Individual Premium Bond Holdings

Band	Monetary Range
1	£50 or below
2	£51 - £100
3	£101 - £250
4	£251 - £500
5	£501 - £1,000
6	£1,001 - £2,000
7	£2,001 - £3,000
8	£3,001 - £5,000
9	£5,001 - £10,000
10	£10,001 - £20,000
11	£20,001 - £30,000
12	over £30,000

Source: Family Resources Survey documentation.

[9] The Family Resources Survey does not provide the information on the total value of capital/wealth. For example, beside the standard savings reported as the sum of values of all the financial products held by a benefit unit, its members might also own a property and/or other fixed assets in a form of own company's equipment. The property ownership is controlled for in the regressions presented in the paper, but only as a dummy since the FRS respondents are not asked about the value of the property owned.

Based on Table 2.2, we use the mid-values within each band as a proxy for the value of individual premium bond holdings. In the highest band, though, the top value is adjusted by the time changes in the maximum premium bond deposit allowed by the issuer. Our eighteen-year dataset starts with the premium bond cap of £20,000, which was raised to £30,000 in 2003. Further adjustments took place in 2014 and 2015, with a premium bond cap increased to £40,000 and £50,000, respectively.

Among the set of tables included in each FRS wave, there is one carrying a separate evaluation of the financial holdings for those benefit units that report their total savings at or below the threshold of £20,000. Table "assets" contains therefore the actual values of each financial product held by every individual whose benefit-unit savings fall below the threshold. The value of the premium bonds in our final dataset is adjusted for those individuals by extracting the appropriate information from the "assets" table, again using the matching of account- and individual-level observations. Finally, the premium bond values are adjusted for inflation[10].

The three indicators of the demand for premium bonds are used in the analysis: (i) whether an individual holds premium bonds, (ii) the absolute value of the individual premium bond investment, and (iii) the relative value of the individual premium bond investment as a percentage of the total savings.

2.3.1.2 FRS Data Representativeness

The objective of the Family Resources Survey is to provide information on the income structure, consumption, and savings behaviours of the British households. As such, it uses a stratified clustered probability sample, drawn from the Royal Mail's small users Postcode Address File (PAF). The small users PAF is a list of all the addresses where fewer than 50 items of mail are received per day. The survey samples 1,848 postcode sectors with a probability of selection that is proportional to the sector's size. Each sector is known as a Primary Sampling Unit (PSU). The PSUs are stratified by 27 regions, along with three other variables: (i) the proportion of households where the reference person belongs to one of the groups 1-3[11], according to the National Statistics socio-economic classification (NS-SEC), (ii) the proportion of economically active adults aged 16-74, and (iii) the proportion of economically active men aged 16-74 who are unemployed, as derived from the Census of Population. Stratifying ensures that the proportions of the sample falling into each group reflect those of the overall country's population.

Beside the sample choice methodology, the FRS implements a grossing regime, allowing for the data to be scaled-up in order to provide estimates for the number of households in the UK with a particular set of characteristics. In the descriptive analysis, it is a general

[10] In the final dataset, we calculate the real values of all the monetary variables based on the annual rates of change in the Consumer Price Index (CPI). The data come from the Office for National Statistics.

[11] In the standard eight-class version of the NS-SEC, the first three refer to: (1) higher managerial and professional occupations, (2) lower managerial and professional occupations, (3) intermediate occupations (Office for National Statistics).

recommendation for the weights to be incorporated into the statistical model, in order to reflect the different probabilities of a survey respondent being selected into the sample (Deaton 1997). The empirical results presented in this paper are therefore based on the weighted regressions[12].

2.3.2 British Gambling Prevalence Survey (BGPS)

The data applied in our two-stage complementary-dataset model for describing the association of the individual socio-demographic characteristics and the propensity to gamble, come from the British Gambling Prevalence Survey. It is a "large-scale nationally representative survey of participation in gambling and the prevalence of problem gambling in Great Britain" (NatCen 2007). BGPS is sponsored by the Gambling Commission and conducted by the National Centre for Social Research.

The BGPS data are, similarly to the Family Resources Survey, repeated cross-sectional, with information provided at individual level. Correspondingly to the time frame in our FRS dataset, there are three waves available for BGPS: 1999, 2007, and 2010. However, due to the substantial differences in the variables coding between the 1999 wave and the other two waves of the survey, we are going to use the 2007 and 2010 waves in the model. This way, we aim at maximizing the amount of information that can be mapped from one dataset to another, thus keep the analysis more precise. Furthermore, in order for the data to refer to the same time period, in the complementary dataset model we use only two corresponding waves of the FRS: 2006/7, and 2009/10[13].

In the British Gambling Prevalence Survey, the respondents are asked about the amount of money that they recently spent on various gambling activities. In the analysis, we focus explicitly on the expenditure on: (i) the National Lottery, (ii) other gambling activities, and (iii) any gambling activity in general. In the 2007 wave of BGPS, the interviewees report their expenditure in the last 7 days, while in the 2010 wave they are asked to report their monthly spending by choosing an appropriate range of values. In order to unify the coding of the expenditure variables, we calculate the weekly spending on gambling by taking the midpoints of each range in the 2010 wave, and then rescaling the values from monthly to weekly figures. Finally, the values of the gambling expenditure are adjusted for the corresponding annual inflation rates.

As in case of the FRS, the BGPS data was adjusted *ex post* for non-response and selection biases. During the three-stage process of such adjustment, the corresponding weight for each individual observation is derived as to reflect the position of this person's characteristics in the overall UK population. The resulting weights are provided along with the

[12] Both the signs and significance of the effects in the regressions used in the paper are consistent for the weighted and non-weighted specifications.

[13] The 2007 wave of BGPS refers to the fieldwork time period of October 2006 - March 2007, mapped in our analysis to the 2006/7 financial year in FRS. The 2010 wave of BGPS refers to the fieldwork time period of November 2009 - June 2010, which we map to the 2009/10 wave of FRS.

responses of the survey. Again, all the regressions applied to the British Gambling Prevalence Survey data in this paper are weighted accordingly.

2.4 Methodology

2.4.1 Complementary Datasets Approach

The objective of this paper is to explore the main characteristics of a typical premium bond holder. To do this, we look at the associations between a set of individual socio-economic attributes and the demand for premium bonds. We apply the regression models to the dataset created based on the Family Resources Survey, in order to find the most important factors that could explain both the decision of whether to invest and how much to invest in those financial products. For the former, a logistic specification is used; the latter is modelled using Tobit regressions.

Among the potential determinants of the demand for premium bonds, one of the most commonly suggested in the literature is an individual propensity to gamble. We aim to test this hypothesis. To our best knowledge, however, there are no country-wide data that would contain both the information on premium bonds and the risk attitudes. The Family Resources Survey respondents are not asked any questions with respect to either their gambling activity or their risk aversion. Therefore, we propose a two-stage complementary-datasets model, in which the gambling behaviour is first modelled with the adequate survey data (BGPS). Next, based on the estimated parameters, the gambling behaviour response is predicted for the characteristics of individuals from a different dataset (FRS).

The procedures of 'extracting' some information from one dataset and applying it to another, known as complementary datasets or complementary population characteristics, has been exploited in the literature. For example, Arellano and Meghir (1992) use the UK Labour Force Survey and the UK Family Expenditure Survey to estimate a model of labour supply. Angrist and Krueger (1992) combine the information from the 1960 Census on the school entry age with the 1980 Census data on the educational attainment. Meanwhile, Bover and Arellano (2002) derive the conditional migration probabilities in Spain, by comparing the distribution of individual characteristics of the migrants from the Census of Residential Variations with the distribution of characteristics across the entire population from the Labour Force Survey.

2.4.2 Two-Stage Model with Imputed Gambling Preference

The process of estimating and imputing the gambling preferences into the primary dataset of the Family Resources Survey, is based on a 2-stage regression model. The first stage models the gambling behaviour. We consider two possible outcome variables: (i) expenditure on gambling (modelled with a Tobit regression), and (ii) whether an individual gambles

(modelled with a logistic regression). In the second stage of the procedure, we describe the observed investments in premium bonds by applying a Tobit regression.

We assume that the expenditure on gambling is a function of individual socio-demographic characteristics (Kallick 1979, among others). Following the existing literature, we use the Tobit regressions in the expenditure estimations, as their specification allows to treat the zeros in the dataset as possible corner solutions in the consumption optimization problems (Jones 2000). The values of expenditure observed in the data result from two simultaneous decisions of a consumer, i.e., of whether to buy and of how much to spend. As we cannot observe negative values of spending (a left-censored variable), the reported zeros might not necessarily reflect that individual's optimal choice. Consequently, a Tobit specification accounts for the impact of each explanatory variable on both the probability of limit responses and the value of the non-limit responses (Tobin 1958).

The first stage of our model describes the individual expenditure on gambling, and is estimated according to the following set of equations:

$$Gamb_i^{\cdot} = X_i'\beta + \varepsilon_{1,i}$$
$$Gamb_i = \begin{cases} Gamb_i^{\cdot} & for \quad Gamb_i^{\cdot} > 0 \\ 0 & for \quad Gamb_i^{\cdot} \leq 0 \end{cases} \tag{1}$$

In (1), we have that $\varepsilon_{1,i} \sim N(0, \sigma_1^2)$, with $i = 1, \dots, N_{BGPS}$, where N_{BGPS} is the number of observations in the British Gambling Prevalence Survey dataset that is used for gambling expenditure estimations. $Gamb_i^*$ is then the latent variable of the total spending for gambling activities of individual i, and can take both the non-negative and negative (non-observable) values. Next, $Gamb_i$ is an observed response variable of the gambling expenditure, and accounts for the possibly present corner solutions, i.e., the negative values of the latent variable.

Once the vector of the estimated coefficients of the first-stage regression, β, is derived, it is further used to fit the observations of the Family Resources Survey dataset. Hence, based on the chosen set of individual characteristics, we predict the total spending for gambling activities among the FRS respondents. The structure of the Tobit regression implies that the unadjusted fitting gives the expected value of the latent (unobserved) variable in the FRS dataset:

$$E\left[Gamb_j^{\cdot}\right] = \beta X_j \tag{2}$$

In (2), X_j is the vector of observations of the same set of socio-demographic characteristics as in (1), but for the individuals interviewed in the FRS dataset, that is, $j = 1, \dots, N_{FRS}$, with N_{FRS} representing the number of FRS observations.

To be able to impute the predicted values of gambling expenditure for the individuals in the FRS dataset, some adjustments need to be performed. First, based on the estimated expectation of the latent variable from (2), we obtain the conditional expectation of the censored (observed) variable:

$$E\left[Gamb_j \middle| Gamb_j > 0\right] = \beta X_j + \sigma \cdot \lambda\left(\frac{\beta X_j}{\sigma}\right) \tag{3}$$

In (3), $\lambda(\cdot)$ is an inverse Mills ratio, defined as:

$$\lambda(x) = \frac{\phi(x)}{\Phi(x)}, \tag{4}$$

The symbols: $\phi(\cdot)$ and $\Phi(\cdot)$, refer to a probability density function and a cumulative distribution function, respectively.

Finally, the unconditional expectation of the gambling expenditure is estimated by adjusting for the probability of the value being positive:

$$Gamb_j = \widehat{Gamb_j} = E\left[Gamb_j \middle| Gamb_j > 0\right] \cdot \Pr\left[Gamb_j > 0\right],$$
$$\text{where } Pr\left[Gamb_j > 0\right] = \Phi\left(\frac{\beta X_j}{\sigma}\right) \tag{5}$$

In case of modelling the individual decisions to gamble, a logistic regression of the likelihood of gambling, p_i, is estimated in the first stage. The dependent variable estimated with the BGPS dataset is:

$$logit(p_i) = log\left(\frac{p_i}{1-p_i}\right) = \beta X_i + \varepsilon_{3,i} \tag{6}$$

The unadjusted fitting of the FRS dataset will therefore result in the predicted values of $logit(p_j)$. The final transformation into the gambling probabilities is needed:

$$p_j = \widehat{p_j} = \frac{1}{1+e^{-\beta X_j}} \tag{7}$$

Having obtained the expected values for both the gambling expenditure, given by (5), and the likelihood of gambling, given by (7), the second-stage Tobit regression is estimated, explaining the value of premium bonds held by an individual in the FRS dataset:

$$PB_j^* = Z_j'\gamma + \varepsilon_{2,j}$$

$$\varepsilon_{2,j} \sim N(0, \sigma_2^2)$$

$$PB_j = \begin{cases} PB_j^* & for \quad PB_j^* > 0 \\ 0 & for \quad PB_j^* \leq 0 \end{cases} \tag{8}$$

In (8), PB_j^* is a latent variable for the optimal value of the premium bonds held by an individual, and PB_j represents the observed value of the premium bonds held after adjusting for the possible negative solutions. Z_j is the vector of the socio-economic characteristics of individuals interviewed in FRS, and, among other predictors, includes the imputed gambling variable, either with the expected spending on gambling activities or the expected probability of participation in such. The vector of γ consists of the estimated coefficients of the second-stage Tobit regression of the model.

Because of the particular structure of the Tobit model, we are interested in the average marginal effects (AMEs) of the variables representing the chosen individual characteristics on the changes in the money invested in premium bonds. The AMEs for the kth characteristic Z^k is then computed as the kth coefficient of the Tobit regression, γ_k, adjusted for the probability of the response variable being positive, i.e., probability that an individual j actually holds premium bonds:

$$\frac{\partial E\left[PB_j\right]}{\partial Z_j^k} = \Pr\left[PB_j > 0\right] \cdot \gamma_k$$

$$Pr\left[PB_j > 0\right] = \Phi\left[\frac{Z_j'\gamma}{\sigma_2}\right] \tag{9}$$

Finally, we need to recognize that the standard errors of the coefficients estimated in the second stage of our model are likely to provide biased results. This is because the estimation of (8) takes the fitted values of $Gamb_j$ and $\mathrm{p_j}$, respectively, as one of the independent variables. Therefore, the standard errors need to be recalculated and adjusted for the standard errors of the coefficients from the first stage of the model. We use the bootstrapping method[14] of deriving

[14] The bootstrapping procedure is used in the literature also as a tool for avoiding the complex analytical calculations when those are not the central point of interest (e.g. Angrist 2001). Efron and Tibshirani (1986) provide an extensive technical discussion about the application of bootstrapping in estimations, also in case of standard errors.

the adjusted standard errors of the average marginal effects. The bootstrap procedure repeats both the first-stage estimation of $Gamb_j$, and the second-stage estimation of the parameters describing the premium bond value function. We conduct the procedure based on 100 replicate samples.

2.5 Empirical Results

2.5.1 Diversity among Premium Bond Holders

The first piece of contribution of this paper to the existing research on the prize-linked savings products is the comprehensive analysis of the socio-economic characteristics of those individuals who choose to invest in premium bonds. We look at the way each of those attributes is associated with the premium bonds demand, and how such associations compare to the previous findings. Given the rich dataset comprising almost two decades, we are able to analyse the demand by using three different measures: (i) the likelihood of investing in premium bonds, (ii) the amount invested in premium bonds, and (iii) the relative value of the premium bonds held as a portion of the overall savings portfolio. Importantly, we are looking at the actual demand for one of the most prominent PLS products, attracting the savings of over 30% of people across the UK. Empirically, we run a logistic regression when investigating the participation likelihood, and Tobit regressions when examining the absolute and relative values of the premium bond investments.

The set of independent variables in our analysis captures the socio-demographic characteristics of the Family Resources Survey respondents: gender, age, marital status, ethnicity, education level, employment status, household structure. We analyse the values of the corresponding regressions coefficients, to find the strongest determinants of the demand for premium bonds among the British society. We also control for the region in which an individual is based as well as the time fixed effects. Following Kumar (2009), who carried out a similar type of analysis for the investors allocating money to the lottery-like stocks, we also include the portfolio characteristics, such as the total value of savings, property ownership, and the presence of shares and/or gilts in the individual portfolio structure. Additionally, we follow a common practice of controlling for non-linear effects of age, income and savings[15]. We thus use an extra variable for age squared, as well as logarithmize the values of income and savings[16]. Table 2.3 provides the results of the relevant regressions, with each applying a different demand measure.

[15] All monetary figures are adjusted for an inflation rate as measured by the year-to-year percentage change in the Consumer Price Index in the UK during years 1999-2017, according to the time frame of our merged FRS dataset.
[16] The dependent variables across all the regression specifications, are of a stock type in that they refer to the individual premium bond holdings: either indicating if an individual holds any premium bonds at a given point in time, or showing an absolute or relative value of premium bonds held by a person. One of the assumed predictors, income (also gambling expenditure, as analysed in 2.5.2), is a flow-type variable. As such, we acknowledge that one needs to be careful when interpreting the corresponding results. For example, for individuals who have acquired premium bonds relatively recently, their current income can be a more accurate driver of this acquisition than for those who have been holding premium bonds for many years, unless an average income level of a premium bond holder has not changed substantially over time. The FRS, however, does not include the information on the time of premium bond purchase, changes to the individual premium bond holdings over time (additional purchases and redemptions), or changes to income over a longer period.

Table 2.3: Premium Bond Holders Characteristics: Cross-Sectional Regression Estimates

Variable	Dependent Variable		
	(1) Likelihood of holding premium bonds	**(2) Premium bonds value (log)**	**(3) Premium bonds as proportion of savings (log)**
Log income	0.011***	0.035***	0.003***
	(0.001)	(0.003)	(0.0002)
Log savings	0.036***	0.101***	-0.010***
	(0.0003)	(0.001)	(0.0001)
Whether property owner	0.120***	0.340***	0.019***
	(0.003)	(0.007)	(0.0004)
Marital status (ref.: single)			
married/civil partnership	-0.070***	-0.215***	-0.011***
	(0.003)	(0.010)	(0.0005)
Ethnicity: White	0.225***	0.599***	0.030***
	(0.005)	(0.014)	(0.001)
Gender: male	-0.020***	-0.052***	-0.003***
	(0.002)	(0.006)	(0.0003)
Age	0.016***	0.037***	0.003***
	(0.0004)	(0.001)	(0.0001)
Age^2	-0.0001***	-0.0002***	-0.00001***
	(0.000)	(0.000)	(0.000)
Highest qualifications (ref.: none)			
at degree level or above	0.125***	0.384***	0.023***
	(0.002)	(0.010)	(0.0004)
Employment status (ref.: employed)			
self-employed	0.016***	0.060***	0.006***
	(0.004)	(0.012)	(0.001)
unemployed	0.032***	0.117***	0.018***
	(0.008)	(0.022)	(0.001)
Whether any children looked after	-0.021*	-0.069**	-0.009***
	(0.012)	(0.033)	(0.002)
Three or more adults in household	-0.003	-0.015*	-0.0004
	(0.003)	(0.008)	(0.0004)
Whether holding any stocks	0.124***	0.391***	0.027***
	(0.002)	(0.007)	(0.0004)
Whether holding any gilts	0.029***	0.107***	0.015***
	(0.009)	(0.030)	(0.001)
Controls: more categories	Yes	Yes	Yes
Controls: UK region	Yes	Yes	Yes
Controls: financial year of interview	Yes	Yes	Yes
No. observations	701,289	701,289	701,289
McFadden's pseudo-R^2	0.1611	0.0941	0.1578

Note: The results are based on the grossed-up FRS data. Identification of variables follows the official FRS documentation. Categorical variables were recoded when necessary to standardize the classification over all waves

of analysis. 'Controls: more categories': as some variables include more detailed categories than those presented in the table, the regression specifications include all of those categories. Types of regressions used: logistic in column (1), Tobit in columns (2) - (3). All figures represent the average marginal effects. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

On average, during the 1999/00 - 2016/17 financial years, the FRS respondents allocated 18.5% of their overall savings to premium bonds, corresponding to around £3.7k per individual holder. As shown by the results in Table 2.3, we find some significant associations between the observed demand for premium bonds and certain individual characteristics. Both the direction of such relationships as well as their significance levels are mostly consistent across all three measures of the demand for premium bonds tested. An important difference is found for the savings variable. Namely, the individuals with higher savings are more likely to be premium bond holders, but also tend to allocate on average more money to premium bonds. The savings allocated to premium bonds, however, represent a smaller weight in these individuals' overall savings portfolios[17]. For example, a 10% increase in the total savings is associated with an average 0.36 percentage point increase in the probability of holding premium bonds, a 1% increase in the value of the premium bonds held, and a 0.1% decrease in an average portion of the overall savings allocated to premium bonds.

Further analysis of the regressions results suggests that the demand for premium bonds increases along with higher income and age, as well as among individuals who are single, White, female, well-educated, and holding other investments. A twofold increase in one's income can be related to an increase in the likelihood of premium bond programme participation, of 1.1 percentage points, an increase in the expected value saved in premium bonds, of 3.5%, and an increase in the expected weight of premium bonds in their savings portfolio, of 0.3%. Married individuals are, on average, by 7 percentage points less likely to hold premium bonds than the single ones, and their expected value of premium bonds held is 21.5% lower in absolute terms, and 1.1% lower in relative terms. Whites are by 22.5 percentage points more likely to invest in premium bonds than people of other ethnicities, the unemployed are by 3.2 percentage points more likely to hold the bond than those in employment, and investors holding stocks or gilts are by 12 percentage points and 3 percentage points, respectively, more likely to also have money allocated to premium bonds. Owning a property is associated with a probability of holding premium bonds higher on average by 12 percentage points, approximately a 34% higher value of the premium bonds held, and 1.9% higher portion of the total savings held in the form of the premium bonds. The likelihood of holding premium bonds among men is by 2 percentage points lower, on average, than among women. The expected value of savings allocated to premium bonds among the male bondholders, is by 5.2% lower than among the female bondholders. The value of premium bonds expressed as a fraction of the total savings, tends to be by 0.3% higher among women, on average. Having obtained degree-level qualifications is related to a 12.5 percentage points increase in the probability of

[17] The negative association between overall savings level and its fraction allocated to premium bonds has been found stronger among those holders whose value of premium bonds held is equal or close to the maximum value allowed by the issuer at a given time point. However, the average marginal effect among the rest of the premium bond holders is still negative and statistically significant, even when controlling for the holders close to the cap.

investing in premium bonds, as well as a 38% increase in the absolute value and 2.3% increase in relative value of premium bonds held. The household structure does not seem to have a strong relation to the interest in premium bonds.

The prize-linked savings products are designed in a way to target especially those individuals with strong preferences for gambling. If that is indeed a major determinant of the PLS take-up, then we should observe similar effects in personal socio-economic characteristics in gambling and participation in PLS programmes. However, the results presented in Table 2.3 are not fully consistent with such view. The more insight regarding the gambler's profile and a gambling preference potential impact on the demand for premium bonds, is provided in 2.5.2.

We also find some differences in the characteristics typically related to the higher demand for premium bonds, as compared to the analysis done by Tufano et al. (2011). Based on the survey conducted to assess the potential demand for the PLS-like hypothetical product if offered in the US market, the authors derived a set of individual characteristics with the strongest association to the reported interest in PLS. These include zero or low levels of savings, optimism, age (with younger people expressing more interest in the product), marital status (with the separated individuals more likely to purchase the product, as compared to the married), and heavy lottery expenditure. An inverse relationship between the level of savings and the PLS demand was also documented by Filiz-Ozbay et al. (2015), Atalay et al. (2014), and Cole et al. (2014). Meanwhile, the study of Tufano et al. (2011) finds no evidence of the effect of the characteristics referring to the financial risk profile, access to financial services, financial literacy, gender, employment status, household size, or education, on the PLS demand. Our results suggest, however, that the financial portfolio, gender, employment status and education are all strongly associated with the premium bond demand. Also, the general interest in premium bonds seems to increase with age, as opposed to the US survey respondents. The regression results from Table 2.3 indicate that the demand for premium bonds increases with the levels of income and savings.

When analysing the profile of a typical premium bond holder based on the Family Resources Survey data, it should be acknowledged that the issuer, National Savings and Investments, allows for premium bonds to be bought as a gift for children under 16 years old. According to the NS&I's statistics, there are over 800,000 children aged under 16, currently holding premium bonds, which accounts for the total value of £1.3 billion deposited[18]. This means that overall, 1.6% of total capital raised by NS&I in the form of premium bonds is currently owned by children. Only parents and grandparents used to be able to do that, but in 2019, the NS&I relaxed the restrictions so that currently any adult can purchase premium bonds for any child[19]. Consequently, if a person decides to gift premium bonds driven by their own preferences, their contribution to an overall PB holder profile might be underrepresented. On the other hand, if such decision is made due to the child's preferences, then their socio-

[18] National Savings and Investments, *Annual Report and Accounts and Product Accounts 2019-20*, URL: https://nsandi-corporate.com/sites/default/files/2020-06/NS%26I_Annual_Report_2019_20_digital.pdf, accessed on 14 December 2020.

[19] National Savings and Investments, URL: https://www.nsandi.com/products/premium-bonds, accessed on 14 December 2020.

demographic profile can be captured in the FRS dataset only as long as they have turned 18 by the time of a survey interview. Unfortunately, the FRS respondents are not asked about the time of premium bonds purchase, which would allow us to identify those individuals who have received premium bonds as a gift.

From the policy perspective, the relationship between one's demand for premium bonds and their overall savings, is of particular importance. Therefore, we want to look closer at this issue, beginning with an investigation of the demand for premium bonds along the overall distribution of savings (Table 2.4). Following Kearney et al. (2010), for example, we expect to observe the highest relative demand among the poorest households.

Table 2.4: Premium Bond Holdings and Participation, by Savings Classes

(1) Savings Distribution Percentile	(2) Corresponding Savings Threshold	(3) % Premium Bond Holders within Savings Group	(4) Mean Premium Bond Value	(5) Mean Premium Bond Value as % of Savings
≤ 30	£0	0%	£0	0%
30 - 40	£195	21%	£43	79%
40 - 50	£1,495	13%	£179	30%
50 - 60	£4,000	14%	£394	16%
60 - 70	£8,497	17%	£659	11%
70 - 80	£17,879	21%	£1,323	10%
80 - 90	£52,931	31%	£4,263	13%
> 90	£6,039,521	41%	£8,929	7%

Note: The results are based on the grossed-up Family Resources Survey data.

The first striking observation is that almost one in three British families admitted having no savings at all[20]. Within the group of the lowest savers, i.e., between the thirtieth and fortieth percentiles of the overall savings distribution, every fifth family surveyed reported to hold premium bonds. Among this group of premium bond holders, the portion of the family's savings in the form of premium bonds averaged to almost 80%.

Further, the statistics for participation in the premium bond programme drop to 13% in the fifth decile of the savings distribution, but increase gradually afterwards, up to as much as 41% among the families of the highest-savings group (above the ninetieth percentile). Meanwhile, the average value of the premium bonds held in relation to the overall savings tends to drop across all the savings groups, reaching around 7% among the top savers. The average value of investment in premium bonds, in absolute terms, rises across all groups, from £43 in the lowest non-zero savings group, to almost £9,000 in the top decile.

Based on the statistics derived from the FRS dataset, we can conclude that the demand for premium bonds exhibits some clustering around the lowest and the highest portions of the

[20] Similar statistics at a UK-level were published by the House of Commons (2018), as having originated from a report by the Open University Centre for Public Understanding of Finance (2018).

savings distribution. We thus extend the analysis of the previously applied regressions describing the premium bond investment behaviour, by splitting the sample into three groups, depending on the level of total savings. The results are presented in Table 2.5.

Table 2.5: Premium Bond Holders Characteristics: Comparison across Savings Groups

Variable	(1) Subsample: Top Savers		(2) Subsample: Mid-Savers		(3) Subsample: Low-Savers	
	(1A)	(1B)	(2A)	(2B)	(3A)	(3B)
Log income	0.022***	0.011***	0.016***	0.013***	0.007***	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log savings	-0.015***	0.027***	-0.105***	0.050***	-0.108***	-0.041***
	(0.001)	(0.001)	(0.003)	(0.003)	(0.001)	(0.001)
Whether property owner	0.089***	0.087***	0.109***	0.097***	0.122***	0.087***
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.004)
Marital status (ref.: single) married/civil partnership	-0.073***	-0.080***	-0.066***	-0.077***	-0.050***	-0.089***
	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)
Ethnicity: White	0.135***	0.133***	0.220***	0.212***	0.254***	0.270***
	(0.008)	(0.008)	(0.011)	(0.011)	(0.010)	(0.010)
Gender: male	-0.013***	-0.007**	-0.026***	-0.024***	-0.024***	-0.022***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Age	0.022***	0.019***	0.014***	0.013***	0.013***	0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Qualifications (ref.: none) at degree level or above	0.074***	0.064***	0.130***	0.119***	0.187***	0.162***
	(0.005)	(0.004)	(0.007)	(0.006)	(0.007)	(0.007)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
N	159,100	159,100	159,121	159,121	150,109	150,109
McFadden's pseudo-R^2	0.0448	0.0460	0.0576	0.0472	0.1686	0.0584

Note: The results are based on the grossed-up Family Resources Survey data. All figures are the average marginal effects of logistic regressions. 'Top Savers', 'Mid-Savers' and 'Low-Savers' categories include individuals in a top 33.3%, mid 33.3% and bottom 33.3% of an overall savings distribution, respectively. Specifications (A) in each savings group use the savings figures net of individual premium bonds value, while specifications (B) use the total savings figures. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

As shown by Table 2.5, in case of the demographic attributes, similar associations to the likelihood of investing in premium bonds are observed across all three groups. The income elasticities are positive across all the groups, too, but with the lowest effects among the low-savers. The main differences are observed in the savings variable. Specifically, the relation between the likelihood of participation in the premium bonds and the value of all the other savings is negative across all the savings groups, with the highest absolute effect among the low-savers. This might be the result of the strong substitutability between the savings in the form of premium bonds and savings allocated to other financial products, in case of those with

a low level of resources. At the same time, though, it is also observed that only among the low-savers any increase in the overall level of savings is associated with a lower probability of premium bonds holding[21]. Combined, those two results suggest the strongest appeal for the premium bonds participation to the individuals with the lowest overall savings. Further along the savings distribution, the extra money saved aside tends to be usually allocated into other forms of savings than the premium bonds[22], with this tendency weakening towards the top-savers[23]. It might be, therefore, that the low-savers do not perceive premium bonds as the primarily savings tool, but instead exhibit some different motivations when deciding to hold this type of financial products.

2.5.2 Effect of Propensity to Gamble on Demand for Premium Bonds

It has been commonly suggested in the literature on the prize-linked savings, that the particular nature of such banking products attracts potential customers by appealing to their preference for gambling (Cookson 2018, Filiz-Ozbay et al. 2015, Atalay et al. 2014). According to the statistics, the highest lottery participation is observed among the poorest households[24] (Beckert and Lutter 2012, Kearney 2002, Clotfelter and Cook 1987 and 1989). Meanwhile, those who gamble are more likely to lack precautionary savings (Lusardi et al. 2011). Consequently, the PLS products might serve as a cost-effective policy intervention encouraging savings, particularly among those who need such the most.

Assuming that the PLS products target a group of potential customers of a similar profile to that of gamblers/lottery players, a further question arises, as to whether both products are perceived as substitutes or complements. In that context, the results of an online experiment by Atalay et al. (2014) suggest a substitution effect between the lottery expenditure and the money allocated to the PLS accounts. A similar conclusion is drawn by Cole et al. (2014), as the observed demand for PLS products in the South African programme was exceptionally strong during the periods of smaller jackpots offered by the National Lottery. The data on another PLS product, a Save-to-Win programme in the U.S., provide yet further evidence of substitution between PLS and gambling, as shown by Cookson (2018). Using the difference-in-differences approach, the author found out that people living in the counties where the programme was offered, reduced on average their expenditure on gambling activities, following an introduction of the PLS products[25]. Furthermore, the substitution effect was stronger, the more similar the particular gambling activity was relative to the PLS product. However, as argued by Abraham et al. (2016), the cut in gambling spending observed by

[21] All the results are robust to the Tobit specifications for the value of premium bonds held, across all the savings groups.
[22] As a result, both AMEs for net savings and overall savings variables are negative among the low-savers.
[23] As a result, in both the top- and mid-savers groups, the AMEs for net savings are negative, but positive for the overall savings variable.
[24] Individuals with low income tend to spend a significantly higher proportion of their budget on gambling, relative to other players.
[25] The analysis primarily utilized the transaction-level casino cash withdrawals data, but the result on the substitution effect was robust to other gambling activities, e.g. scratch tickets.

Cookson might have been a consequence of the anti-gambling campaign running at that time. In their experiment with a mobile savings product in Kenya, Abraham et al. (2016) found no effect of availability of PLS products on gambling expenditure.

In this paper, we add to the studies mentioned above by addressing the question of substitutability between PLS products and gambling. We believe that our analysis can highly contribute to the debate as the first individual-level case study. Not only we use the country-representative data on one of the most widely known PLS programmes, but the rich dataset allows us to control for many socio-demographic characteristics that were already proved important in predicting certain gambling behaviours (Orford et al. 2003, Clotfelter and Cook 1989, Kallick 1979), or saving behaviours (Kuhnen and Miu 2015, Lusardi 1998). Moreover, as the first such study in the field of PLS to our knowledge, we control for the total level of the survey respondents' savings allocated to all the banking products, not limited to a specific bank with a PLS account on its offer.

As described in Section 2.4, we run a two-stage model that incorporates, via a complementary dataset approach, imputed data on individual gambling expenditure. The first-stage regressions describe either the probability of gambling, or the spending on the gambling activities[26], depending on the specification used, as a function of income and other demographic characteristics. Table 2.6 contains the results of the first-stage regressions for several different specifications used.

Table 2.6: First-Stage Results: Regressions of Gambling on Socio-Economic Characteristics

Variable	**(1A)**	**(1B)**	**(1C)**	**(2A)**	**(2B)**	**(2C)**
Log income	0.014***	0.010***	0.013***	0.019***	0.013***	0.026***
	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)	(0.005)
Marital status (ref.: single)						
married/civil partnership	0.043**	-0.022	0.022*	0.065***	-0.030	0.032
	(0.017)	(0.015)	(0.012)	(0.015)	(0.021)	(0.027)
Ethnicity: White	0.119***	0.113***	0.153***	0.154***	0.145***	0.302***
	(0.019)	(0.023)	(0.020)	(0.026)	(0.029)	(0.042)
Gender: male	0.060***	0.110***	0.080***	0.108***	0.171***	0.236***
	(0.009)	(0.012)	(0.008)	(0.012)	(0.013)	(0.019)
Age	0.028***	-0.0001	0.021***	0.040***	0.001	0.037***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Age^2	-0.0003***	-0.00001	-0.0002***	-0.0004***	-0.00002	-0.0004***
	(0.00002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Qualifications (ref.: none)						
at degree level or above	-0.160***	-0.190***	-0.175***	-0.218***	-0.239***	-0.364***
	(0.011)	(0.019)	(0.013)	(0.018)	(0.022)	(0.025)
Whether any children	-0.0004	-0.007	-0.009	0.0004	-0.020	-0.026
looked after	(0.012)	(0.011)	(0.011)	(0.016)	(0.020)	(0.023)

[26] In the regressions, we use the variables of expenditure for (i) National Lottery, (ii) any other gambling activity, and (iii) any gambling activity in general.

Three or more adults in household	-0.015 (0.011)	-0.0001 (0.012)	-0.005 (0.011)	-0.026* (0.013)	0.005 (0.017)	-0.008 (0.021)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
N	15,281	15,281	15,281	15,281	15,281	15,281
McFadden's pseudo-R^2	0.0694	0.0610	0.0702	0.0470	0.0428	0.0404

Note: The results are based on the weighted data of British Gambling Prevalence Survey. Types of regressions used: logistic in columns (1A) - (1C), Tobit in columns (2A) - (2C). Response variable used: (A) participation in National Lottery, (B) participation in any other gambling activity (excluding National Lottery), (C) participation in any kind of gambling activity. All figures are the average marginal effects. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

The results of the first stage in our complementary dataset model indicate that the participation in gambling activities is correlated with the set of individual attributes. Specifically, both the likelihood of such participation as well as the amount of spending tend to be positively related to being married[27], White, and without a degree-level qualification (Brenner and Brenner 1990). On average, men tend to exhibit a higher propensity to gamble than women (Price and Novak 1999), which is also supported by our first-stage results. The income elasticities of demand for gambling activities[28] are positive in all the specifications used, but relatively low, implying a strong appeal of gambling to the low-income individuals, and a regressive implicit lottery tax (Clotfelter and Cook 1989). Furthermore, the effect of age on the gambling propensity is mostly positive across the specifications, but at a decreasing rate of change. As such, our first-stage outcomes are in line with the literature on gambling and lottery participation.

The implementation of a two-stage model with the complementary dataset approach allows us now to make use of the first-stage results in fitting the matched characteristics of the individuals from the FRS dataset. By doing this, we aim at estimating the propensities to gamble of those respondents. As a result of the procedure, six additional variables are imputed in the FRS dataset: three of them estimating the expenditures on three groups of gambling activities[29], and the other three binary variables estimated by the logistic specifications, indicating the participation of an individual in each of the three groups of gambling activities.

In the second stage of the model, we investigate the effect of the propensity to gamble on the demand for the premium bonds. Having imputed the information about the anticipated gambling behaviour to the FRS dataset, we next describe the participation in the premium bond programme using the imputed gambling variables as one of the predictors. The results are presented in Table 2.7.

[27] This result, however, is only valid for the case of National Lottery and gambling in general (not significant for the latter). The relationship between the gambling behaviour excluding National Lottery and being married turns out negative, but not statistically significant.

[28] Both the response variables as well as income are logged in all the regression specifications, so the income figures indicate the effect of a one-percent change in income on the percentage change in the expenditure on gambling (income elasticity of demand).

[29] The three groups of gambling activities we consider are: (i) National Lottery, (ii) any other gambling activity, and (iii) any gambling activity in general.

Table 2.7: Second-Stage Results: Regressions of the Demand for Premium Bonds on Socio-Economic Characteristics with Imputed Propensity to Gamble

	(1A)	(1B)	(1C)	(2A)	(2B)	(2C)
Gambling	-0.744***	-0.930***	-0.676***	-1.321***	-2.006***	-1.499***
	(0.181)	(0.130)	(0.101)	(0.280)	(0.359)	(0.312)
Log savings	0.049***	0.045***	0.049***	0.050***	0.045***	0.051***
	(0.003)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)
Log income	0.114***	0.114***	0.113***	0.114***	0.114***	0.113***
	(0.001)	(0.0003)	(0.0004)	(0.001)	(0.0004)	(0.001)
Other social covariates	Yes	Yes	Yes	Yes	Yes	Yes
N	81,310	81,310	81,310	81,310	81,310	81,310
McFadden's pseudo-R^2	0.0904	0.0907	0.0908	0.0905	0.0907	0.0908

Note: The results are based on the weighted data of Family Resources Survey. All figures are the average marginal effects of Tobit regressions. Gambling variable used: (1A) logged weekly expenditure on National Lottery, (1B) logged weekly expenditure on any other kind of gambling, excluding National Lottery, (1C) logged weekly expenditure on any kind of gambling, (2A) whether an individual participates in National Lottery, (2B) whether an individual participates in any kind of gambling except for National Lottery, (2C) whether an individual participates in any kind of gambling in general. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

Not surprisingly, given a profile of a typical premium bond holder derived in part 2.5.1, both the level of savings and income are positively correlated to the amount invested in the premium bonds. In this case, however, our major interest lies in the effect of the propensity to gamble on the demand for premium bonds. In all the specifications used in the second stage of our model, this effect is significantly negative. This suggests a strong substitution between spending money on gambling activities and allocating it to the PLS account. The absolute values of those effects are lower than one, which indicates that the unit-percentage reduction in the gambling expenditure is expected to generate a relatively lower increase in the value of premium bond holdings. However, that is a reasonable outcome due to the nature of both variables in the dataset. The demand for premium bonds is measured as a stock-type variable (how much value a respondent has accumulated in premium bonds up to date), while the gambling expenditure is measured as a flow-type variable (in weekly terms). Therefore, the individual observations of the gambling variable naturally represent a higher value to the respondent of the survey, as compared to their savings allocated across different financial products. Meanwhile, the average marginal effects of the probabilities of gambling on the amount invested in premium bonds, are above the unity for all the gambling measures used in the first stage. For example, participation in any type of gambling activity is expected to generate an average 1.5% drop in the total value of premium bond holdings.

The significantly negative coefficients for the gambling variables in Table 2.7 are particularly interesting considering the contrary results of the time series macro-level analysis published by Tufano (2008). Specifically, the author finds a positive relationship between the

time series of the net sales of premium bonds in the UK[30] and the annual flows of gambling activity, at the aggregate country level. The outcome is interpreted as the premium bonds and gambling products being either complementary goods, or both being associated with some common factor, such as wealth. Our individual-level results, however, do not fully support that view. Having controlled for a set of demographic characteristics as well as income and savings, we observe, on average, a negative effect of gambling on the premium bonds demand.

Following Tufano's (2008) discussion on premium bonds being perceived as a hybrid of savings and gambling, we would expect to observe differences in the impact of gambling on the demand for premium bonds across two groups of potential customers - those who perceive premium bonds in terms of savings or investment, and those who do not. Considering the FRS dataset, we use the individual holdings of shares as a proxy for such perception. Specifically, those who hold any shares in their investment portfolio and decide to allocate money to the premium bonds are expected to use premium bonds as one of the products to diversify the risk away, as the expected return on premium bonds does not directly depend on the fluctuations in the stock market. For simplicity, let us refer to the first group of individuals as 'investors', and the other group as 'non-investors'. As the gambling effect among previously defined group of investors loses its statistical significance, we verify the outcomes also for the stricter rules of classification. Considering the information available in the FRS dataset, we further test two additional scenarios, classifying an individual as 'investor' when holding any investments in stocks and (i) unit trusts, (ii) gilts. The corresponding results are presented in Table 2.8.

Table 2.8: Results of Regressions of Premium Bond Holdings on Gambling Behaviour among Investors and Non-Investors

Variable	(1) All Sample	(2) Subsample: Non-Investors	(3a) Subsample: Investors	(3b) Subsample: Investors
Gambling	-0.744***	-0.725***	-0.392*	1.803***
	(0.096)	(0.085)	(0.193)	(0.345)
Investors: gambling	0.096***			
	(0.017)			
Investors: dummy	0.293***			
	(0.011)			
Log income	0.053***	0.051***	0.073***	0.117***
	(0.003)	(0.003)	(0.002)	(0.006)
Log savings	0.117***	0.097***	0.207***	0.198***
	(0.0004)	(0.0003)	(0.001)	(0.001)
Other social covariates	Yes	Yes	Yes	Yes
N	81,310	70,021	11,289	1,524
McFadden's pseudo-R^2	0.0901	0.0829	0.0241	0.0124

Note: The results are based on the weighted Family Resources Survey data. All figures are the average marginal effects of Tobit regressions. Gambling variable used measures the expected expenditure on any gambling activity,

[30] The sales of premium bonds figures adjusted for redemptions.

but the above results are robust to applying either of the two remaining measures of gambling expenditure. Columns (2) and (3a) provide results for samples of individuals without any stocks held and those with stock holdings, respectively. Column (3b) defines 'investors' as individuals investing both in stocks and unit trusts. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

When decomposing the effect among the investors and non-investors, the gambling preference seems to work in the opposite directions. For example, other things unchanged, a 10% higher spending on gambling refers to a 7.25% drop in the amount of money allocated to premium bonds among the non-investors. Among the investors, however, a 10% increase in the gambling expenditure can be associated with a smaller drop in the demand for premium bonds, by 3.9%, at a lower statistical significance. This effect gets even as high as 18% when higher restrictions are applied for investors classification. The results hold for different measures considered as a proxy for individual investment portfolio diversification and the resulting assignment to the 'investors' group.

The heterogeneity in the effect of gambling expenditure on the demand for premium bonds, suggests differences in perception of those products across groups of customers. The non-investors, i.e., those without other investments, tend to hold premium bonds as substitutes to the more traditional gambling activities. This observation is policy-relevant as it suggests that premium bonds might in fact generate new savings by, for example, redirecting the money spent otherwise on gambling. Meanwhile, individuals with more diversified portfolios seem to treat premium bonds and gambling activities either as independent (in case of more general 'investors' classification), or complementary goods. In this group, therefore, a risk-seeking attitude can lead to the choice of more traditional gambling behaviour, and the premium bonds, if held, result in the further diversification of the savings portfolios.

The results discussed above constitute an important contribution of this paper to the existing research as, interestingly, no study so far has looked for such heterogeneous effects in the demand for premium bonds. An investigation as to how individuals perceive such financial products might help to better understand the motivations underlying the decisions to invest in premium bonds as well as identify which elements of their hybrid structure are effective in targeting certain groups of consumers.

2.5.3 Different Perceptions, Different Benchmarks

As suggested by the results of 2.5.2, the issue of substitutability between the PLS and gambling products, needs to be addressed with respect to different types of customers. Due to the differences in the perception of the prize-linked savings products, any change to a specific feature of their structure might results in a different effect on the demand, depending on an

individual. For example, changes in the highest jackpot should therefore affect mostly those PLS customers, who think of PLS as a gambling device[31].

Building up on the results obtained in 2.5.1 and 2.5.2, we extend the analysis and test the effect of some chosen exogenous factors on the demand for the premium bonds. Since we received some evidence about the possible heterogeneity in the perception of those financial products across different groups of customers, we also expect to observe differences in the response to the chosen structural changes to the premium bond product. Following Tufano (2008), we focus on two potential motives for holding premium bonds: gambling and saving. In our analysis, the gambling incentive is proxied by the odds for winning a prize in a given premium bond draw. In the regressions, we incorporate the odds in the form of integers, e.g. 20,000 means that the winning odds during a given financial year were 1:20,000, on average. As the saving motive for saving in the form of premium bonds, the spread between the prize fund rate, applied by the NS&I in determining the pool of funds in each premium bond draw, and the Bank of England rate is used. The corresponding results are provided in Tables 2.9 and 2.10.

Table 2.9: Responses to Gambling Incentives in Premium Bonds Structure, by Portfolio Diversification

Variable	(1) Premium Bond value (log)		(2) Premium Bond value (log) in subsamples		(3) Likelihood of participating	
	(1a)	(1b)	(2a) Investors	(2b) Non-investors	(3a)	(3b)
Log winning odds	-0.256*** (0.021)	-0.335*** (0.026)	-0.058 (0.097)	-0.273*** (0.022)	-0.110*** (0.008)	-0.129*** (0.010)
Investor dummy	0.413*** (0.007)	-0.267*** (0.493)			0.134*** (0.002)	-0.519** (0.194)
Investor dummy * Log winning odds		0.305*** (0.049)				0.651*** (0.019)
Other social covariates	Yes	Yes	Yes	Yes	Yes	Yes
N	701,289	701,289	103,236	598,053	701,289	701,289
McFadden's pseudo-R^2	0.0912	0.1403	0.0257	0.0800	0.1562	0.1741

Note: The results are based on the weighted Family Resources Survey data. Regressions used: Tobits explaining the value of premium bonds held in Columns: (1) and (2), logistic explaining the likelihood of participation in the premium bond programme in Column (3). Columns: (1) and (3), use the full set of data; Column (2) splits the data with respect to an investment portfolio structure. All figures are the average marginal effects. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

[31] It has been shown that changes to the highest jackpot (e.g. in the form of rollovers), affect the demand for the product severely - not only in the draw with a changed jackpot, but also the successive ones (Addison and Chowdhury 2003, Farrell et al. 2000). Also, as found by Cole et al. (2014), the observed demand for PLS in South Africa was the highest in the periods of relatively lower top prizes offered by the National Lottery.

As suggested by the results in Table 2.9, it is the group of non-investors, i.e., individuals with low portfolio diversification, who respond to the changes in the odds for winning by substantially adjusting their demand for premium bonds. An increase in the odds for winning from, for example, 1:30,000 to 1:27,000 (corresponding to a 10% drop in the log odds variable used in the regressions), can be related to an increase in the expected value of premium bonds held by a non-investor of around 2.6% (2.7% when using only a subsample of non-investors, as in specification (2b) of Table 2.9, or even 3.4%, as shown in specification (1b) of Table 2.9), and an increase in the probability of a non-investor holding premium bonds, of 1.1 percentage points (1.3 percentage points in specification (3b) of Table 2.9). The negative figures among the non-investors thus indicate a positive relationship between the probability of winning and both the value of premium bonds as well as the likelihood of holding premium bonds. This result is consistent with the findings in part 2.5.2, indicating that the non-investors perceive premium bonds as substitutes to the gambling products. Among the investors, the effect of winning odds on the demand is clearly weaker, even insignificant when using only a subsample of investors from the dataset (as in specification (2a) of Table 2.9).

Table 2.10: Responses to Saving Incentives in Premium Bonds Structure, by Portfolio Diversification

Variable	(1) Premium Bond value		(2) Premium Bond value in subsamples		(3) Likelihood of participating	
	(1a)	(1b)	(2a) Investors	(2b) Non-investors	(3a)	(3b)
Interest rate spread	-0.018*** (0.002)	-0.026*** (0.002)	0.191*** (0.008)	-0.021* (0.002)	-0.011*** (0.001)	-0.013*** (0.001)
Investor dummy	0.413*** (0.007)	0.442*** (0.009)			0.132*** (0.002)	0.140*** (0.003)
Investor dummy * Rate spread		0.033*** (0.005)				0.007*** (0.002)
Other social covariates	Yes	Yes	Yes	Yes	Yes	Yes
N	701,289	701,289	103,236	598,053	701,289	701,289
McFadden's pseudo-R^2	0.0911	0.0912	0.0257	0.0799	0.1563	0.1571

Note: The results are based on the weighted Family Resources Survey data. Regressions used: Tobits explaining the value of premium bonds held in Columns: (1) and (2), logistic explaining the likelihood of participation in the premium bond programme in Column (3). Columns: (1) and (3), use the full set of data; Column (2) splits the data with respect to an investment portfolio structure. The interest rate spread variable measures the difference between the premium bond prize fund rate and the official Bank of England interest rate, expressed in percentage points. All figures are the average marginal effects. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

On the other hand, the results presented in Table 2.10 suggest that, on average, the response to the interest rate spread in terms of the premium bonds demand is positive among the investors, and negative otherwise. The closer look on the spread changes over the analysed time horizon shows that before the financial crisis, the prize fund rate on premium bonds tends to be below the Bank of England rate of interest, but after the crisis this tendency reversed. Meanwhile, as suggested by the results of British Gambling Prevalence Survey as well as other studies (House of Commons Report 2012), the expenditure on gambling activities increased after the financial crisis. Thus, the negative effect of the interest rate spread on the demand for premium bonds that we observe among the non-investors might be a result of those individuals having switched to other forms of gambling coincidently at the time of the higher interest rate spread. Importantly, though, this negative tendency does not hold for the group of investors. An increase in the rate spread of 1 percentage point can be related to an increase in the value of premium bond holding of an investor, amounting to 39.5% (41.3 - 1.8, from specification (1a) of Table 2.10, or 19.1% if analysing a subsample of investors, as in specification (2a) of Table 2.10), and an increase in the probability of holding premium bonds of 12.1 percentage points (13.2 - 1.1, from specification (3a) of Table 2.10).

As suggested by the previous results, investors tend to perceive premium bonds more as a savings tool, complementary to the traditional gambling, and therefore are observed to adjust their demand for premium bonds according to how attractive they are relative to other banking products. Once again, the incentives applied to a certain characteristic of the premium bond structure (either gambling or saving) affect their demand differently, depending on how certain customers perceive the product. Those who substitute premium bonds with the traditional gambling activities, are responsive to the gambling-side incentives, like higher odds for winning prizes in a premium bond draw, whilst those who save in the form of premium bonds are more likely to respond to the saving-side incentives, like higher relative expected return.

2.6 Conclusion

This paper investigates the main demographic and economic characteristics that are observed to be associated with the higher demand for premium bonds. It is more likely for a person who is older, better educated, White, female, single, with higher income, with other investments held, to hold premium bonds. People who save more, on average, allocate more money to premium bonds in absolute terms, but the value of their bonds relative to the total savings is lower. Further, we observe heterogeneity in the effect of the risk appetite on the demand for premium bonds. Those who do not hold other forms of savings or investments exhibit a strong negative relationship between the expected gambling expenditure and premium bond demand. Such trend suggests a substitution effect between the two types of products. This effect weakens, however, among the more financially sophisticated individuals, who are likely

to hold premium bonds not because of their risk-seeking preferences, but more as a diversification tool.

As one of the most popular financial products in the UK, premium bonds attract different types of customers. As pointed out by Tufano (2008) in his macro-level analysis, premium bonds are perceived as a hybrid of savings and gambling mechanisms, and, as such, aim at nudging people to save by referring to their propensity to gamble. This paper contributes to the existing literature in three ways. Its first distinctive feature is a unique individual-level dataset, which provides a country-representative sample, contains information on demand for a real-life PLS programme, and covers a span of eighteen years. Second, it is the first such analysis addressing the association between an actual demand for a publicly available PLS-type product and gambling behaviour at an individual level. Third, the results suggest diversified motivations of premium bonds take-up across consumers, which has not been noted before.

All results presented in the paper can be relevant for policy makers. Considering the substantial social purpose of premium bonds to encourage overall savings in the population, it becomes crucial to get a better insight into the motivations driving people to allocate their money to such banking products. For example, those that save relatively little, and so might be needing such nudge the most, are observed to be driven primarily by the lottery-like features of premium bonds. However, the results suggest that this group also substitutes between saving money in premium bonds and more traditional savings accounts. Therefore, further studies should address this issue by exploring other mechanisms aimed at attracting people towards more regular savings input, which could complement the structure of premium bonds.

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3 Relativity Concerns in the UK Premium Bond Investment Decisions

3.1 Introduction

A relative financial standing, instead of absolute level of income, is gaining more and more attention as a determinant of self-reported satisfaction (Easterlin 1995). When offered a range of options, people are reported to choose in such a way as to maximize their position relative to others, even at a sacrifice of their own absolute income (Frank 2005). When living in a community of people with higher earnings, a given individual tends to be less happy overall than in case of choosing a neighbourhood with lower living standards. This is due to an urge of 'keeping up with the Joneses', that is, evaluating any changes to one's economic situation in relation to people he or she is surrounded by (Hagerty 2000). Meanwhile, a relative position has been also documented to shape the behaviour. For instance, relative deprivation originates from the perception that a person (or a social group that person belongs to) has less than they deserve, less than they can expect, or less than other people similar to themselves. The accompanying feeling of frustration can often result in aggression (Aronson 1999, Kulik and Brown 1979).

There is a growing branch of literature in psychology, sociology and biology focusing on social comparisons. In economics, relativity concerns have been pointed out as being of potentially substantial impact on the utility of consumption as well as individual well-being, although the relative position of an individual in a given community is still rarely incorporated in the formal models.

The primary purpose of this paper is to test the hypothesis that the relative income affects the financial decision-making process of holding premium bonds. It stems from an idea that people form aspirations based on observing the financial outcomes of others. Next, depending on how far these reference points are from their actual standing, it might lead to an individual reassessing their utility from a financial prospect, affecting their risk preference and, eventually, the final decision made. Considering the existing evidence from both psychology (Payne et al. 2017) and lab experiments in behavioural economics (Haisley et al. 2008) as well as given the highly skewed structure of the prizes distribution in the premium bond draws, we further hypothesize that this impact of aspirations on the demand for premium bonds is stronger for people that might be relatively deprived, aspiring to catch up with their group of reference. The dataset used in the analysis comes from the most recently released wave of the Family

Resources Survey (FRS), referring to the financial year of 2017/18[32], with a country-representative sample of 33,146 individuals in the UK.

The paper provides several findings. First, there exists a strong positive association between the level of aspiration income and the likelihood of holding premium bonds. What is more, the magnitude of this association increases when the aspirations are estimated based on smaller groups of comparison, considering people of similar demographic and socio-economic characteristics, as well as in case an individual performs upward social comparisons. Introducing the relative income concerns into the premium bond demand analysis, the effect of absolute level of income plummets, indicating it is primarily a relative position that people care about when making financial decisions. Finally, our results show that people with incomes exceeding their reference level are less likely to save money in the form of premium bonds when their absolute income gets closer to the reference level. This analysis contributes to the limited studies on the British premium bonds and prize-linked savings products in general, which have not formally accounted for the relativity concerns in their evaluations of demand. Additionally, it adds up to the aspiration and relative deprivation literature in applying the existing methodology in the new context - explaining the demand for banking products, but also introducing new elements to that approach, with clustering analysis used for deriving aspirations among groups of people with close personal profiles, or allowing for the non-symmetric effects of aspirations, depending on one's relative position within the group of comparison. All those innovations help to obtain more accurate results as well as some possibly substantial policy implications.

The paper is organized as follows. Section 3.2 reviews the literature on aspiration theory, social comparisons and inequity preferences. Section 3.3 describes the data used for the analysis. Section 3.4 provides details of the methodology applied to derive aspirations and explore their impact on the demand for premium bonds. Section 3.5 presents the empirical results. Section 3.6 concludes.

3.2 Literature Overview

Aspiration level theory has been considered in the literature for many decades now. In classical economics, however, the relative level of income is still rarely incorporated in the formal models. The subject of social comparisons has gained more attention in psychology, sociology and biology.

Despite little empirical research, the issue of relativity and its impact on individual utility and consumption behaviour has been noted by many economists in the past. Without putting a formal label on the phenomenon yet, Marx (1849), for example, pointed out the relative nature of human wants and pleasures. Similarly, Veblen (1899) introduced the

[32] The results of the 2017/18 wave of the Family Resources Survey were published in May 2019.

expression of conspicuous consumption, referring to such consumption decisions that aim at displaying consumer's wealth and impressing others. Therefore, a luxury good which ownership provides a particular status among other consumers, is known as a Veblen good (Wood 1993). The concept of positional goods was further discussed extensively by Frank (1985, 1997).

Some of the first cases of including the concept of the relative position into the economic models date back to Duesenberry (1949). The author argued that the savings behaviour of a household depends not only on the income earned, but also on the percentile position of that household in the income distribution. The relative income hypothesis was later extended, for example, by van de Stadt et al. (1985), Kosicki (1987), or Stark and Taylor (1991).

The behavioural economic models existing within aspiration theory, such as Kahneman and Tversky (1979), or Koszegi and Rabin (2006), use particular forms of the individual utility functions that are defined around reference points, setting the corresponding aspiration levels. Similar interpretation has been provided by Friedman and Savage (1948), with a further extension by Markowitz (1952). In both models, the reference points were also injection points of the utility function for wealth accumulation, implying the risk-seeking behaviour on some intervals of the domain. It was concluded that the inclination towards more risky decisions results from additional satisfaction for an individual obtained from reaching such reference point and thus moving up the distribution to the higher social class.

Complementary to the process of forming aspirations from social comparisons, are the processes of adaptation (Brickman and Campbell 1971, Frederick and Loewenstein 1999). The increments in individual utility, resulting from accumulation of wealth or increases in consumption of goods and services, diminish not only in those domains, but also over time. For example, winning a lottery jackpot provides a surge in the winner's overall utility, but this new higher utility level does not prevail for too long. In fact, people tend to get used to the new conditions of more possibilities, higher consumption, or standards of living, and the initial boost effect wears off with time. On average, life satisfaction, in case of individuals having won the top jackpots in lotteries, was shown to come back to the levels from before the win (Cartwright 2011). Also, studies based on sample surveys, such as in Easterlin (1974) or Argyle (1989), found only little upward change in the average reported level of happiness in the long-time horizon. Consistently, Scitovsky (1976), Layard (1980) and Oswald (1994) concluded that, on average, the contemporary levels of satisfaction are not significantly higher than in the past.

The branch of literature that incorporates habit formation into the analysis of individual preferences include, for example, Modigliani (1949), Pollack (1970), Carroll et al. (2000). Meanwhile, the interdependent preferences associated with individuals making comparisons of their living standards to those of others, have been discussed, for example, by Frank (1985), Pollack (1976), Clark and Oswald (1998), or van de Stadt et al. (1985), with the latter highlighting the changes in aspiration levels along with the changes in income earned.

Stutzer (2004) considers the two processes mentioned above, working simultaneously to set individual aspirations: adaptation to changes in consumption and social comparisons. The study uses income evaluation measures as a proxy for aspiration levels. First, it is shown that the individual income aspirations increase both with the absolute level of individual's income as well as the average income in that person's neighbourhood. Second, higher income aspirations are found to be associated with reduced life satisfaction. In fact, regressing the subjective well-being on income measures and individual characteristics, the coefficient for the gap between income aspirations and actual income, as opposite to the actual income itself, is statistically significant. The paper, therefore, provides evidence that it is the relative position in the income distribution rather than the absolute level of income that people particularly care about.

The results of multiple experiments also support the notion of relativity. Tversky and Griffin (1991), for example, highlighted the importance of assessing one's conditions as compared to that of others, for the reported level of happiness. Haisley et al. (2008) conducted two experiments by surveying people recruited from the Greyhound Bus Station in Pittsburgh, PA. First experiment evaluated the effect of the relative income on the propensity to participate in lotteries. The questions about income earned were designed in a way to create particular feeling of relativity for a respondent, by manipulating the income ranges in the survey answers. Those participants who were framed to perceive their income as relatively low, purchased 1.28 lottery tickets on average, as compared to 0.67 tickets purchased by those perceiving their income as relatively high. In the second experiment, participants in the experimental group were asked about their judgements on fairness, while the control group of participants was asked to fill out a different survey with questions irrelevant to the fairness concerns. Afterwards, when asked about their willingness to enter a lottery, the respondents in the experimental group decided to purchase significantly more lottery tickets, on average, than the control group. The overall study, therefore, provides evidence that people in the low-income class may be particularly prone to playing lotteries, and the profound reason might be the attractive feature of an equal opportunity of winning. That is, every lottery player is originally in the same position, with the same winning probabilities faced. Association between inequality concerns and risk-taking behaviour was also a subject of the experimental study by Payne et al. (2017). First, the 221 participants' perception of payoffs inequality was manipulated by providing each person with one of the two versions of the distribution of returns on the gamble achieved by the previous players, with one version showing low-inequality condition and another one under high-inequality condition. Next, participants were asked to estimate a minimum amount of money that they would need to win in a gamble in order to be satisfied. Finally, each participant faced an opportunity to gamble, with several options of equal expected returns but different levels of risk. It was shown that those individuals who were framed into perceiving the outcomes of the game as highly unequal, also established significantly higher monetary needs. Having formed such high aspirations, these participants exhibited higher risk tolerance, by deciding to gamble on more risky options. Therefore, the experiment concluded that the upward social comparisons tend to increase the perceived needs, resulting in higher financial goals. Consequently, people are willing to take greater risks in order to meet those needs.

A central question arising in the context of aspiration theory is how the relevant reference groups are formed. That is, who an individual is comparing their relevant position to and whether this choice of reference is fully conscious and dependent on an individual only, or exogeneous. The answer varies across the existing studies. For example, Veblen (1899) assumed it is the rich families that provide the benchmark for others in setting their aspiration levels. Duesenberry (1949) claimed it is the closest neighbours, generally referred to as the Joneses, while Schor (1998) pointed out that such benchmark might be even set by the TV characters that people identify themselves with. The latter finds, moreover, that when a person perceives their financial situation as relatively bad, i.e., worse than the position corresponding to their reference group, then such a person is likely to save less than otherwise. According to Neumark and Postlewaite (1998), on the other hand, women facing the decision of whether to join the labour market tend to look at what other women in their families have chosen to do. This is an example of using a different measure of aspirations in the analysis, as opposed to defining aspirations in terms of income or accumulated wealth, as is the case in most of the studies. Another exception can be found in Munshi and Myaux (2006). The paper looks at the characteristics of religious groups in Bangladesh. It provides evidence that the fertility behaviour of a couple is profoundly affected by the existing fertility norms valid for the specific religious group the couple belongs to.

Other studies mostly also looked at a more general context of comparison, relaxing the necessity for an individual to have any personal relationship with their reference group. The results thus lead to an assumption that individuals make social comparisons with the groups of people that are most similar to themselves in particular domains. For example, Clark and Oswald (1996), in their analysis of the job satisfaction, take other employees of the same labour market characteristics as the reference group for each individual. Hence, it first estimates the expected income earned by a typical worker with particular attributes, which is then used as comparison income in the satisfaction estimation. The study concludes that individual utility, approximated by the self-reported job satisfaction level, drops as the comparison wage rates increase. It also provides evidence that it is relative, not absolute earnings, that matter most in the overall happiness of the employees.

Another example of forming the reference groups is provided by Ferrer-i-Carbonell (2002), who uses similarities in age and education level when determining the aspiration benchmarks. Consistently to Clark and Oswald (1996), the study finds a negative effect of the mean income level of the comparison group on the reported level of life satisfaction. Genicot and Ray (2017) also argue that the reference groups are influenced by social environment of an individual, contrary to their past experience. Furthermore, as the social outcomes form people's comparison groups and, as a result, their aspiration levels, these aspirations aggregated over all individuals in a group, affect then the overall development of a society.

In the aspiration theory, an underlying assumption regarding social comparisons is mostly concerned with upward comparisons. That is, when setting financial goals, people are believed to more likely look at the financial position of those who are better situated than themselves, rather than looking at those down the social ladder. As shown by the experimental data, people decide to punish the free riders even at a cost to their own payoffs. One's relative

position in an income distribution of the society (or a less aggregated social group), therefore, can affect their further decisions, and such effect can be twofold. First, looking at the higher positions in the distribution, an individual takes actions aimed at improving their own position via forming higher aspirations. Second, a possible change in one's behaviour might result from their equity aversion, i.e., when a person dislikes an outcome because it provides an unfair distribution of payouts across the players. The latter became a subject of Fehr and Schmidt's (1999) model of inequity aversion. This model assumes that the decisions made by at least some individuals are affected by their fairness concerns. A more technical explanation is provided in Section 3.4 as it forms a base for the empirical model used in this paper.

An important role of fairness in the process of decision-making was also noted by Becker (1974) and Fehr and Gaechter (2000) in the structure of their theoretical models as well as, for example, by Hagerty (2000) and Schwarze and Haerpfer (2002) in their empirical works on distributive concerns. Survey results provide evidence that people care about fair outcomes in economic exchanges (Kahneman et al. 1986). Consistently, laboratory experiments conducted by Smith (1994) show that the players tend to prefer a fair distribution of payoffs, even when it results in a smaller absolute payoff for themselves. Furthermore, studies by Boskin and Sheshinski (1978) and Frank (1997) provide rationale for changes in economic policy due to people's concerns for income equality, inflation and unemployment, in relation to the economic growth.

3.3 Data

The data used in this paper come from the 2017/18 wave of the Family Resources Survey (FRS), which refers to the 2017/18 financial year. The dataset uses a stratified sample of 33,289 individuals, aggregated also to 22,504 benefit units or 19,105 households. The stratification strategy is applied to ensure that the sample of interviewees can adequately represent the British society. In the dataset, there are around 13% of premium bond holders, as shown in Table 3.1 below.

Table 3.1: Summary Statistics

Measure	Premium Bond Holders
N	4,397
Percentage in FRS Sample	13.21%
Grossed-up Weight	12.78%

Note: Grossing factors are provided by the data owner to maintain the country-level representativeness of the data after adjusting for the missing values and errors in responses.

The details of both the structure and the content of the Family Resources Survey, are discussed extensively in Chapter 2. The reason why we use only the most recent wave of the survey in this analysis, is that it includes an additional set of questions that are relevant for modelling the aspirations, as indicated by the existing literature. Characteristics referring to the respondents' health condition, job sector, employment specifics, have been introduced to the survey gradually over the years. Also, some of the questions regarding those characteristics changed across the waves. Therefore, the 2017/18 wave is used in this chapter in order to account for all the attributes of interest as well as to ensure consistency.

3.4 Conceptual Framework

The hypothesis tested in this paper is based on the social comparisons. We attempt to first determine an aspiration level of income for each individual in the dataset. Next, the effects of aspirations on the demand for premium bonds will be explored. Therefore, the first part of the empirical model refers to the formation of aspirations. We assume that, during the decision-making process, people compare their financial position to those who are similar to themselves in socio-economic dimensions. Following the most widely cited studies in the field (e.g. Genicot and Ray 2017, Ferrer-i-Carbonell 2002, Clark and Oswald 1996), we measure the similarities in a multi-dimensional manner.

In the process of forming aspirations based on the interpersonal comparisons, we start by following the existing studies, and, therefore, apply the Mincer equation as the first stage of the model. This semi-logarithmic specification describes earnings as a function of an individual's education and work experience. After Clark and Oswald (1996), we also account for other individual characteristics that are likely to affect the outcome earnings, as in the following formula:

$$ln\, w_i = \beta_0 + \beta_1 edu_i + \beta_2 xp_i + \beta_3 xp_i^2 + \gamma X_i' + \varepsilon_{1,i} \quad (10)$$

In (10), w_i stands for individual i's earnings, which are regressed on: edu_i - their education level, xp_i - their work experience, and X_i - a vector of other variables likely to explain one's current level of earnings. Following the strategy applied in Clark and Oswald (1996), we choose a wide range of characteristics to be included in X: age, gender, health condition, job sector, type of an employment contract, a dummy for incentives included in a usual work pay, employment status, property tenure, geographical location, occupation, industry, size of the workplace, marital status and the structure of savings and investment portfolio of an individual. Having estimated equation (10), its predicted value of income for individual i is further assumed to represent i's reference (aspiration) level of income. Based on the structure of incomes in the society, a person forms certain expectations as to own financial outcomes.

Knowing that, on average, people with similar personal characteristics to i benefit from higher income, might lead this individual to a feeling of relative deprivation and, as a result, alter their behaviour in order to catch up with the group.

In this paper, we suggest also an alternative method for derivation of the aspiration income. As it has been shown that people are more likely to perform social comparisons within the smaller groups of reference than a society (Genicot and Ray 2017), we use clustering analysis to identify such comparison groups. Consequently, an individual is assigned to the group they have the most in common with - the group which members share the most similar socio-economic profile characteristics.

The clustering algorithm is based on assigning each observation to the nearest cluster prototype. After each assignment, it recomputes the statistics for each cluster prototype. This iterative process is carried on for as long as no further improvements are possible. As such, the k-prototypes algorithm works in a similar way to the common k-means technique. The major difference is that, while k-means uses only numerical variables, k-prototypes method was introduced to be applied to data with a mix of categorical and numeric features (Huang 1998). Each cluster is thus identified by the mean values of the numerical variables and modes of the factor variables. The distance, $d(\cdot)$, between two individuals in the dataset in terms of the sets of their personal attributes, a and b, is calculated according to the following formula:

$$d(a,b) = d_{euc}(a,b) + \lambda d_{match}(a,b) \tag{11}$$

In (11), $d_{euc}(\cdot)$ denotes the Euclidean distance between a pair of observations, and is applied in case of numerical explanatory variables, while $d_{match}(\cdot)$ stands for the simple matching distance, applied for categorical explanatory variables. The λ coefficient defines the weight that the distances within categorical variables would carry in calculating the final inter-cluster distances, relative to that of numerical variables. For example, higher values of λ shift the emphasis of the clustering estimation towards factor variables. Once the clustering analysis is complete, the average level of income in each cluster is calculated. It is then assumed that individuals assigned to a given cluster are most likely to compare their financial position to that of others within the same cluster. Therefore, the average income of a cluster is used as a reference level of income for all the cluster's members.

Once the aspiration level of income is estimated for each individual in the dataset, we examine the demand for premium bonds. For this purpose, the logistic regression model is applied, incorporating the information on relative income according to the following specification:

$$PB_i = \begin{cases} 1 & if \quad \alpha_0 + \alpha_1 \, ln(inc_i) + \alpha_2 \, ln\left(\frac{\widetilde{inc}_i}{inc_i}\right) + \delta Z_i' + \varepsilon_{2,i} > 0 \\ 0 & otherwise \end{cases} \tag{12}$$

An outcome variable of PB_i is observed in a binary form, taking the value of 1 if an individual is a premium bond holder and 0 otherwise. Among independent variables, the regression includes logged values of individual i's absolute income, inc_i, logged values of aspiration income assumed for that individual, $\widetilde{inc}_i$, and a set of other personal characteristics, Z. The latter is again based on the set of controls from Clark and Oswald (1996), carrying the additional information on gender, age, health condition, working time, ethnicity, geographical location, occupation and industry.

In (12), due to the structure of the aspiration gap measure, the pure income effect is evaluated by the expression $(\alpha_1 - \alpha_2)$. Meanwhile, the effect of aspiration income on the likelihood of holding premium bonds is provided by α_2.

$$PB_i = \begin{cases} 1 & if \quad \alpha_0 + \alpha_1 \, ln(inc_i) + \alpha_2 I^+ \, ln\left(\frac{\widetilde{inc}_i}{inc_i}\right) + \alpha_3 I^- \, ln\left(\frac{\widetilde{inc}_i}{inc_i}\right) + \delta Z_i' + \varepsilon_{3,i} > 0 \\ 0 & otherwise \end{cases} \quad (13)$$

The changes introduced in (13) include: I^+ to denote a dummy of whether an individual's current financial standing is above their reference level, I^- for a dummy of whether an individual currently earns less than their aspiration, as well as coefficients of the aspiration gap corresponding to each of those dummies: α_2, α_3 of downward and upward social comparisons, respectively. Consequently, the pure income effect for an individual with income higher than their level of reference is given by $(\alpha_1 - \alpha_2)$, and for an individual with income below their reference level, this effect is given by $(\alpha_1 - \alpha_3)$. An importance of the relative income is described by α_2 when an individual performs downward comparison, and α_3 in case of upward comparison.

3.5 Empirical Results

The results of the first stage of the analysis can be found in Appendix. Table 3.A.1 provides the coefficients of an OLS regression of income on the set of demographic and socio-economic characteristics. It shows that, on average, it is a group of the well-educated men between 35 and 44 years old in full employment, that benefits from the highest income. The conclusions are consistent with those of Clark and Oswald (1996). Having identified the clusters, assumed as the groups of social comparison, and providing the background to the formation of individual aspirations, we can conclude, for example, that a London-based 50-year-old male professional with a permanent job in a private sector and degree-level education, would be assigned to a comparison group with an average weekly income of £905.71 and the current ratio of premium bond holders of 8.74%.

Having identified the background for social comparisons for each interviewee in the dataset, it can now be assessed how each individual stands financially within the group of comparison. The relative position is derived in reference to the income distribution. The first method, Mincer equation, uses the full set of observations to estimate the individual predicted level of income, which is further assumed as an aspiration threshold. Therefore, the gap between one's current relative income position and aspirations is determined by how far their actual income is from its expectation given the individual characteristics as well as the job specification. Meanwhile, the clustering analysis allows for an identification of a group of individuals that are most similar to the subject based on the set of both individual- and job-level attributes. As a result, the aspiration income level is set within each comparison group and is based on the within-group distribution of income.

A primary aim of the paper is to test the hypothesis that the financial decisions regarding participation in the premium bond programme are significantly affected by the relative position of an individual. The relative standing provides the base for a person to set their financial goals that they would aspire to achieve. It is assumed that the aspirations are higher, the better are the living conditions of those around us who we are looking up to (Genicot and Ray 2017, Ray 2006, for example). Every such person provides a reference point for setting others' aspirations. Further, it is assumed that the gap between a current financial standing of an individual and the position they aspire to impacts the decisions made by that individual (for example, Clark et al. 2008 on the decisions regarding investment, savings and migration, Neumark and Postlewaite 1998 on employment decisions, Haisley et al. 2008 on the decisions to purchase lottery tickets, Payne et al. 2017 on the gambling decisions with different levels of risk).

To provide some preliminary picture of the premium bond holdings with respect to the individual aspirations, Table 3.2 describes both the absolute and relative numbers of premium bond holders among those individuals, whose current income was identified as being below their aspirations. Overall, 12.76% individuals among the representative sample of the British population held premium bonds. A comparable proportion of premium bond holders can be observed among those with actual income lower than anticipated, as described by the Mincer income equation. The FRS data also demonstrate that the premium bond participation decreases with the downward movement along the overall income distribution. For example, there are 11.46% premium bond holders among those with earnings below the mean (£437 per week), and only 9.27% premium bond holders within the lowest 10% of income distribution (below £84 per week). On the other hand, considering individuals below the aspiration threshold at a comparison group level, that is, within each cluster, the trend in premium bond holding is quite reversed: on average, 13.33% of individuals with income below their group average hold premium bonds. Finally, within the bottom decile of income distribution in each comparison group, the premium bond participation rate surges to 14.50%. Such inconsistency in the premium bond holdings statistics may suggest a need for more insight into the process of forming aspiration windows by an individual, with the relevant reference points lying far closer to that individual than in case of the country-level population.

Table 3.2: Summary Statistics on Premium Bond Holdings in the Context of Social Comparisons

Measure	No. Observations in a Category	No. Premium Bond Holders	Ratio of Premium Bond Holders [%]
Full sample	33,146	4,372	12.76%
Mincer equation: below threshold	14,399	1,900	12.74%
Subsample: below threshold (mean)	21,286	2,528	11.46%
Clustering: below threshold (mean)	19,905	2,370	13.33%
Subsample: below threshold (lowest decile)	3,309	333	9.27%
Clustering: below threshold (lowest decile)	3,026	362	14.50%

Note: The last column of the table calculates the ratio of premium bond holders adjusted for the grossing factor of the FRS dataset. In Mincer equation, an observation is considered as being below the threshold if the actual income of an individual is lower than the level predicted by the model. Subsample categories provide the statistics on the number of observations and the number of individuals holding premium bonds, as observed in the FRS data below the threshold level of income. The threshold is assumed as either the mean value of income or the lowest decile of the income distribution, respectively. In clustering results, the absolute figures are calculated as the number of observations across all the clusters. The ratio of premium bond holders is derived as the average ratio of premium bond holders across all the clusters built on the FRS data.

Based on the results of the income aspiration analysis, a systematic approach towards incorporating the derived information on relative income in the decision-making of holding premium bonds is performed. The method used for estimation is a logistic regression, with a binary dependent variable of whether an individual reported to be holding premium bonds at the time of an interview, or not. We assume that this observed outcome is associated with a variety of personal characteristics via an implicit utility function, which can be also affected by both the absolute and relative levels of income. To explore such effects, we follow Stutzer (2004) and Clark and Oswald (1996) by using a logged ratio of income aspiration and the actual level of individual's income as an aspiration gap measure. Next, we take their idea one step further by attempting to disentangle the effects of upward and downward social comparisons, arguing that accounting for an aspiration gap in general is not sufficient to understand the role of individual aspirations in financial decisions.

A set of results obtained by following the specifications adopted by Clark and Oswald (1996) are presented in the first two columns of Table 3.3. As the authors use gross income figures, the results presented in this section are also based on gross individual income. All the specifications, however, have been additionally tested for the net income effect (Tables: 3.A.2 and 3.A.3 in the appendix). The first column of Table 3.3 estimates a basic form of a premium bond demand function, assuming that it depends on an absolute level of income as well as a set of demographic and socio-economic characteristics of an individual: gender, age, health, number of hours worked, ethnicity, location, occupation and industry. Such form has been applied by Clark and Oswald (1996) to estimate a utility function explaining the self-reported job satisfaction. Similar specifications, however, were also used in the literature when describing the observed investment behaviour of individuals (e.g. Kumar 2009).

Table 3.3: Premium Bond Holding Equation, with Aspiration Income

	(1)	(2)	(3)
Log income	0.008***	0.004*	0.005**
	(0.002)	(0.002)	(0.002)
Log aspiration income		0.030***	0.076***
		(0.005)	(0.006)
Male	-0.008*	-0.014***	-0.025***
	(0.004)	(0.004)	(0.004)
Age	0.011***	0.012***	0.011***
	(0.001)	(0.001)	(0.001)
Age^2	-0.0001***	-0.0001***	-0.0001***
	(0)	(0)	(0)
Progressive health condition	0.028***	0.027***	0.025***
	(0.005)	(0.005)	(0.005)
Log number of hours worked	-0.002	-0.012***	-0.015***
	(0.002)	(0.002)	(0.002)
Ethnicity dummies (6)	Yes	Yes	Yes
Regional dummies (12)	Yes	Yes	Yes
Standard Occupational Classification dummies (10)	Yes	Yes	Yes
Standard Industrial Classification dummies (12)	Yes	Yes	Yes
Number of observations	33,146	33,146	33,146
McFadden's pseudo-R^2	0.1542	0.1559	0.1603

Note: Aspiration income is derived based on: (i) Mincer equation (column (2)), (ii) clustering analysis (column (3)). All specifications use gross income figures. Each column provides the average marginal effects of a logistic regression with a response variable indicating whether an individual is a premium bond holder. Standard errors are shown in parentheses. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

The basic results presented in the first column of Table 3.3 show premium bonds as a normal good, for which an increase in gross (net) income by 10% is associated with an average increase in the probability of holding premium bonds by 0.08 (0.07) percentage points. A drop in the probability of being a bondholder, by 0.8 percentage points, can be observed among men, as compared to women, although this result is significant only at the level of 10%. Participation in the premium bond programme increases with age at a diminishing rate. Reported health issues are associated with an average increase in the likelihood of premium bond participation by 2.8 percentage points, holding all the other measures constant. The number of hours an individual works does not have a significant impact on the propensity to hold premium bonds.

The remaining two columns of Table 3.3 provide the results of the premium bond holding equation with incorporated information on the aspiration income level. In column (2), the aspirations have been derived with an application of Mincer equation. Hence, an individual is assumed to compare their actual income to that predicted by the income model. On the other hand, the figures provided in column (3) have been based on the results of the clustering

analysis, with the aspiration income equal to the average income within the cluster an individual was assigned to.

Having included the relative income concerns in each specification, both the magnitude and significance of the effect of the absolute level of income deteriorated. Now, a 10% increase in income is associated with an average increase in the probability of holding premium bonds by 0.04 or 0.05 percentage points, although the likelihood of such association is lower (confidence levels of 90% and 95%, respectively). The level of aspiration income, however, is shown as highly relevant for the decision to hold premium bonds. Among two individuals of equal absolute income and the same types of other characteristics, the one with a 10% higher level of predicted income is more likely to have premium bonds, and this likelihood is 0.3 percentage points higher. In case of a 10% increase in an average income of an individual's comparison group (cluster), the probability of holding premium bonds is 0.76 percentage points higher. As a result, not only does the clustering analysis indicate that the relative income effect can be almost ten times higher than the effect of an absolute level of income, but it also strengthens the effect of the Mincer-equation predicted income. Such a difference between the results in columns (2) and (3), can point out that people are more likely to compare themselves to those they perceive as close in different domains, instead of the whole society (Frank 1985). Applying clustering algorithm allowed us to identify the reference groups of individuals with the most similar characteristics. Moreover, having included the aspiration income level in the analysis, both aspiration-deriving methods suggest a significantly negative relationship between the number of hours worked and the likelihood of holding premium bonds. Along a 10% increase in the total number of hours spent at work, the outcome probability is expected to drop by 0.12 or 0.15 percentage points, on average. Men are expected to hold premium bonds with a probability lower by 1.4 or 2.5 percentage points than women - two- and three-times the change, respectively, as compared to the basic results of no relative income concerns.

An analysis of the results presented in Table 3.3 explores the separate effects of the absolute and aspiration income levels of an individual, and the likelihood of that individual to be holding premium bonds. In order to disentangle the effect of the discrepancy between income and aspiration level (aspiration gap) from the pure income effect on the propensity to hold premium bonds, we now implement an approach of Stutzer (2004). In the logistic regression describing the likelihood of holding premium bonds, along the logged values of actual income, a set of explanatory variables includes information on the aspiration gap - derived as the logged ratio of aspiration to absolute income. The corresponding results are shown in columns (1) and (3) of Table 3.4.

Table 3.4: Premium Bond Holding Equation, with Aspiration Gap

	(1)	**(2)**	**(3)**	**(4)**
Log income	0.034***	0.042***	0.081***	0.085***
	(0.004)	(0.005)	(0.006)	(0.006)
Log aspiration gap	0.030***		0.076***	
	(0.005)		(0.006)	

Log aspiration gap: downward comparison		0.019*** (0.005)		0.052*** (0.008)
Log aspiration gap: upward comparison		0.047*** (0.006)		0.087*** (0.006)
Male	-0.014*** (0.004)	-0.017*** (0.004)	-0.025*** (0.004)	-0.027*** (0.004)
Age	0.012*** (0.001)	0.012*** (0.001)	0.011*** (0.001)	0.010*** (0.001)
Age^2	-0.0001*** (0)	-0.0001*** (0)	-0.0001*** (0)	-0.0001*** (0)
Progressive health condition	0.027*** (0.005)	0.027*** (0.005)	0.025*** (0.005)	0.025*** (0.005)
Log number of hours worked	-0.012*** (0.002)	-0.013*** (0.002)	-0.015*** (0.002)	-0.015*** (0.002)
Ethnicity dummies (6)	Yes	Yes	Yes	Yes
Regional dummies (12)	Yes	Yes	Yes	Yes
Standard Occupational Classification dummies (10)	Yes	Yes	Yes	Yes
Standard Industrial Classification dummies (12)	Yes	Yes	Yes	Yes
Number of observations	33,146	33,146	33,146	33,146
McFadden's pseudo-R^2	0.1567	0.1559	0.1603	0.1613

Note: Aspiration income is derived based on: (i) Mincer equation (columns: (1) and (2)), (ii) clustering analysis (columns: (3) and (4)). Aspiration gap is calculated as the logged ratio of aspiration income to the actual income of each individual. All specifications use gross income figures. Specifications (2) and (4) split the aspiration gap term into downward and upward comparisons. An individual is considered to perform downward (upward) comparison if their actual income is above (below) that predicted by the income equation (column (2)), or above (below) the average income level within the cluster they have been assigned to (column (4)). Each column provides the average marginal effects of a logistic regression with a response variable indicating whether an individual is a premium bond holder. Standard errors are shown in parentheses. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

Naturally, the conclusions from columns (1) and (3) of Table 3.4, are consistent with those of Table 3.3. Given the derivation of the aspiration gap measure, a 10% increase in an absolute income is associated with a 0.34 - 0.30 = 0.04 percentage point increase in a probability of holding premium bonds in case aspirations were evaluated based on the income equation, or a 0.81 - 0.76 = 0.05 percentage point increase in this probability in case aspirations were evaluated by applying the clustering analysis. The main advantage of the Stutzer's specification, though, is a direct interpretation of the effect of aspiration gap on the premium bond demand. Intuitively, it is the discrepancy between how much an individual currently earns and how much they desire to earn looking at others that can affect their financial decisions. Therefore, among two persons of similar demographic attributes, one with income twice as distant from the level predicted based on the income structure in a society, is expected to be more likely to hold premium bonds, with the difference amounting to 3 percentage points, on average. Meanwhile, for a person with income twice as distant from the average level within

their social group of comparison, the probability of holding premium bonds is higher, on average, by 7.6 percentage points.

All the specifications referred to so far (Stutzer 2004, Clark and Oswald 1996) implicitly assume that the effect of an aspiration gap on the observed outcome is symmetric. There exists some evidence, however, suggesting this might not be the case. The effect known in psychology as relative deprivation, for example, is based on upward social comparisons (Solberg et al. 2002). The lower the level of individual's income relative to their point of reference, the less happy the person tends to be. On the other hand, an excess beyond the average income earned by others has been shown to have a positive impact on individual satisfaction, even when the actual income of the individual in question was lower in absolute terms (Frank 2005).

We attempt to address the above concerns by introducing yet another modification to the premium bond demand equation. In order to explore a non-symmetric effect of social comparisons, the aspiration gap term is now split into two separate terms entering the logistic regression: (i) aspiration gap conditional on an individual earning more than their aspiration level of income ('log aspiration gap: downward comparison') and (ii) aspiration gap conditional on an individual earning less than their aspiration level of income ('log aspiration gap: upward comparison'). Column (2) of Table 3.4 provides the corresponding results with aspiration income derived from the Mincer equation. In column (4), the results are based on the average income of each cluster serving as a reference point for each individual.

As the symmetry assumption is relaxed, it can be noticed that the aspiration gap effect observed in the data does, in fact, differ depending on one's relative position in the income distribution among the relevant group of comparison. The conclusions are again consistent across the methods applied in deriving the aspiration income level, along with the relative income effects being magnified (doubled, approximately) in case of clustering. With both the absolute income level of an individual as well as their demographic profile unchanged, a two-fold increase in their aspiration income is observed to be associated with a rise in the likelihood of that individual holding premium bonds of 1.9 percentage points in case the person currently earns more than it could be expected based on the income structure of the British society (that is, estimated with Mincer equation), or 4.7 percentage points otherwise. Meanwhile, having identified the group of people closest to that person in terms of the demographic and socio-economic characteristics (that is, estimated via clustering), the same change in aspiration income can be associated with a 5.2 percentage point increase in the probability of participation in the premium bonds programme if the person's financial standing is better than of those around them, or a 8.7 percentage point increase given that the aspiration level is based on the upward social comparisons. Rather surprisingly, the pure income effect differs across the two types of social comparisons, too. People earning less than their aspiration levels of income are observed to exhibit a negative relationship between their actual income and their demand for premium bonds, although its magnitude can be, on average, 10 or 40 times smaller (using Mincer equation or clustering analysis, respectively) than the positive effect of the relative income. On the other hand, those individuals whose income exceeds the level predicted by the society's income structure (or the average income within their group of reference), exhibit a

higher positive relationship between their absolute income and the propensity to hold premium bonds. In this group, a 10% increase in actual income is observed along with an average increase in the premium bond likelihood of 0.42 - 0.19 = 0.23 percentage points when using the full dataset for income predictions, or 0.85 - 0.52 = 0.33 percentage points in case of using a cluster of the observations most relevant to the individual.

Put differently, the larger the aspiration gap, the more likely an individual is to hold premium bonds. This effect is higher in case of upward social comparisons, i.e., when one's actual income lies below their aspiration level. The top prize of £1 million, offered in the premium bond draws, might be therefore particularly attractive to those who feel relatively worse than others. Winning such a jackpot can seem as a possible way of finally 'catching up with the Joneses'.

3.6 Conclusion

This paper attempts to test the hypothesis that the demand for UK premium bonds depends on individual income perceived in relation to a reference level. Its contribution to the existing research is threefold. First, it enriches the state of knowledge on premium bonds. Considering the hybrid structure of these financial products, a broad range of consumers, as well as limitations of the existing studies, there is still a call for an insightful analysis of the motivations driving people to use such a form of savings. Previous studies, either those concerning the British premium bonds or, more generally, prize-linked savings, have not yet considered the issue of relative income and its effect on the demand for these products. Second, the paper provides probably the first instance of applying the methodology used primarily in economics and psychology of happiness and well-being to the context of financial decision-making, although the potentially substantial impact of the relativity concerns on gambling decisions (Payne et al. 2017) or decisions to purchase lottery tickets (Haisley et al. 2008) has been already found in lab experiments. Third, this methodology is further extended - both at the stage of deriving individual aspirations as well as at the final stage of exploring their effects on the outcome variable. The studies most closely related to this paper estimate aspiration income as relative either to the level predicted by the Mincer income equation, that is, for a sample-representative individual of a specific set of characteristics - based on the sample of 5,000 British workers (Clark and Oswald 1996), or the average income level in the community of residence (Stutzer 2004). The solution suggested here builds up on those considerations by attempting to identify the groups of reference. Using clustering analysis across a set of demographic and socio-economic characteristics, each individual in the dataset is assigned to a group of people that share a similar profile, making it more likely for an individual to perform social comparisons within that group. Consequently, the average income in each cluster is then considered a reference (aspiration) level of income for everyone within such community. Furthermore, examination of an impact of aspiration gap on the demand for premium bonds is

also extended by allowing for differentiation between downward and upward social comparisons.

The central finding of the paper is that of a crucial role of the relative position in the income distribution within the relevant group, in explaining the propensity of participation in the premium bond programme. The choice to save in the form of premium bonds is shown to be associated not so much with the absolute level of one's income, as it is with the relative income. This result suggests that people form some expectations (aspirations) in financial domain based on their relative standing in a relevant community. These aspirations, in turn, can affect the undertaken financial decisions. Consequently, as presented in the paper, the effect of the actual income of an individual relatively deprived on the probability of that individual holding premium bonds, becomes almost negligible. Also, the analysis indicates that it is the upward social comparisons that mostly affect the decision to hold premium bonds. People at the far bottom end of the income distribution can allocate money to premium bonds due to a lack of alternative opportunities for improving their relative position. The highly appealing prizes offered by this form of savings can therefore be perceived as particularly attractive means of climbing up the social ladder.

In general, the results presented in this paper point out how important it is to account for the relativity issues in order to better understand people's financial decisions, including those of holding premium bonds. In this context, it might be particularly policy-relevant, as a primary objective of launching the premium bond programme was to encourage savings among the general population. An analysis of aspiration-forming processes can thus contribute towards an efficient savings-enhancing policy by addressing the relatively poor, who might need those savings the most. Currently, the main limitation to the research on the subject raised in this paper, is a lack of relevant data. As a result, identification of the reference groups, within which social comparisons are conducted, can be not fully accurate. Further studies should, therefore, consider ways of attaining such information with a targeted experimental or survey design.

3.7 References

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3.A Appendix

Table 3.A.1: Income Equation Estimates

Age band (ref.: age 16 to 24):	
Age 25 to 34	0.346***
	(0.030)
Age 35 to 44	0.475***
	(0.030)
Age 45 to 54	0.450***
	(0.030)
Age 55 to 64	0.386***
	(0.031)
Age 65 and over	0.274***
	(0.033)
Male	0.330***
	(0.014)
Progressive health condition / activities reduced due to illness/disability	0.009
	(0.019)
Highest qualification at degree level	0.048***
	(0.029)
Main job in private sector	0.677***
	(0.046)
Employment contract description:	
Permanent job	0.209***
	(0.029)
Fixed term or temporary job	0.042
	(0.045)
Work without contract/ other arrangements	-0.053
	(0.038)
Usual pay includes incentives	-0.228*
	(0.138)
Employment status (ref.: in employment):	
Unpaid family worker	-1.920***
	(0.116)
Unemployed	-2.934***
	(0.050)
Economically inactive	-1.835***
	(0.037)
Member of pension scheme run by employer	0.318***
	(0.021)
Property tenure (ref.: owner, incl. mortgage and partial ownership):	
Renting	-0.159***
	(0.015)

Rent-free / squatting	-0.173*** (0.061)
Regional dummies (12)	Yes
Standard Occupational Classification dummies (10)	Yes
Standard Industrial Classification dummies (12)	Yes
Number of employees in organization dummies (5)	Yes
Marital status dummies (4)	Yes
Savings / investment products held dummies (5)	Yes
Constant	4.946*** (0.061)
Number of observations	33,146
Adjusted R^2	0.385

Note: The results refer to an OLS regression explaining individual income level (logged). Standard errors are shown in parentheses. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

Table 3.A.2: Premium Bond Holding Equation, with Aspiration Income (applying net income figures)

	(1)	**(2)**	**(3)**
Log income	0.007***	0.003*	0.005**
	(0.002)	(0.002)	(0.002)
Log aspiration income		0.031***	0.076***
		(0.005)	(0.006)
Male	-0.007*	-0.014***	-0.025***
	(0.004)	(0.004)	(0.004)
Age	0.011***	0.012***	0.011***
	(0.001)	(0.001)	(0.001)
Age^2	-0.0001***	-0.0001***	-0.0001***
	(0)	(0)	(0)
Progressive health condition	0.028***	0.027***	0.025***
	(0.005)	(0.005)	(0.005)
Log number of hours worked	-0.002	-0.012***	-0.015***
	(0.002)	(0.002)	(0.002)
Ethnicity dummies (6)	Yes	Yes	Yes
Regional dummies (12)	Yes	Yes	Yes
Standard Occupational Classification dummies (10)	Yes	Yes	Yes
Standard Industrial Classification dummies (12)	Yes	Yes	Yes
Number of observations	33,146	33,146	33,146
McFadden's pseudo-R^2	0.1542	0.1558	0.1603

Note: Aspiration income is derived based on: (i) Mincer equation (column (2)), (ii) clustering analysis (column (3)). All specifications use net income figures. Each column provides the average marginal effects of a logistic regression with a response variable indicating whether an individual is a premium bond holder. Standard errors are shown in parentheses. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

Table 3.A.3: Premium Bond Holding Equation, with Aspiration Gap (applying net income figures)

	(1)	(2)	(3)	(4)
Log income	0.026***	0.033***	0.059***	0.067***
	(0.004)	(0.005)	(0.006)	(0.006)
Log aspiration gap	0.021***		0.053***	
	(0.004)		(0.006)	
Log aspiration gap: downward comparison		0.010**		0.028***
		(0.005)		(0.007)
Log aspiration gap: upward comparison		0.037***		0.067***
		(0.006)		(0.006)
Male	-0.011***	-0.014***	-0.018***	-0.021***
	(0.004)	(0.004)	(0.004)	(0.004)
Age	0.012***	0.012***	0.011***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)
Age^2	-0.0001***	-0.0001***	-0.0001***	-0.0001***
	(0)	(0)	(0)	(0)
Progressive health condition	0.028***	0.028***	0.026***	0.026***
	(0.005)	(0.005)	(0.005)	(0.005)
Log number of hours worked	-0.008***	-0.008***	-0.009***	-0.010***
	(0.002)	(0.002)	(0.002)	(0.002)
Ethnicity dummies (6)	Yes	Yes	Yes	Yes
Regional dummies (12)	Yes	Yes	Yes	Yes
Standard Occupational Classification dummies (10)	Yes	Yes	Yes	Yes
Standard Industrial Classification dummies (12)	Yes	Yes	Yes	Yes
Number of observations	33,146	33,146	33,146	33,146
McFadden's pseudo-R^2	0.1559	0.1552	0.1579	0.1592

Note: Aspiration income is derived based on: (i) Mincer equation (columns: (1) and (2)), (ii) clustering analysis (columns: (3) and (4)). Aspiration gap is calculated as the logged ratio of aspiration income to the actual income of each individual. All specifications use net income figures. Specifications (2) and (4) split the aspiration gap term into downward and upward comparisons. An individual is considered to perform downward (upward) comparison if their actual income is above (below) that predicted by the income equation (column (2)), or above (below) the average income level within the cluster they have been assigned to (column (4)). Each column provides the average marginal effects of a logistic regression with a response variable indicating whether an individual is a premium bond holder. Standard errors are shown in parentheses. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

4 Does Winning a Jackpot in Premium Bond Draw Affect Individual Savings Behaviour?

4.1 Introduction

The primary objective of launching the premium bond programme in 1956 was to raise the overall savings rate of British households. This remains the case, given that many of the previously proposed public policy solutions have been found either ineffective or cost-inefficient, particularly among middle and low-income households (Hurst and Ziliak 2006, Jappelli and Pistaferri 2003, Hurst and Ziliak 2001). Insufficient long-term savings are expected to be of concern for future pensioners, given the diminishing replacement rates from the public pension system, associated with an ageing population.

Premium bonds are designed to exploit the commonly observed instinct for gambling. Since the main reason for the popularity of lotteries is a chance of winning a substantial, life-changing amount of money, the two top £1 million prizes in the monthly premium bond draws, should be the primary driver of demand for premium bonds. Thus, any factors affecting the jackpots' value, number, or the channel of information flow, are expected to cause a shock to the demand for premium bonds. The value of the biggest prizes has remained unchanged for over 25 years. What is subject to change, however, is a winner's location, published each month by the premium bond issuer, National Savings and Investments (NS&I).

The savings-gambling hybrid structure of premium bonds implies that demand shocks - originating from the bonds' lottery-like feature - should affect both the demand for these banking products as well as the overall savings level in the population. As the disturbances are related to the geographical area that the winning bondholder comes from, any potential effects should be observed locally. A motivation for such conjecture is such that, a winner's location acts as a demand shock via a 'hot-hand' bias - a common fallacy among gamblers that some numbers, devices or places are more probable than others to produce a winner, based on their past streaks of luck (Gilovich et al. 1985). Hence, a biased investor who learns that a premium bond holder from their area had recently won a £1 million prize, might respond by allocating additional savings to premium bonds, hoping for their region to be selected again. In such a case, the extra resources should contribute towards the investor's new savings, as opposed to resulting from a mere reshuffling of assets in their savings portfolio.

The purpose of this paper is to explore the effects of the monthly announcements about the location of the top winners in the premium bond draws, on the local demand for premium bonds as well as people's savings behaviours. To do this, we examine such measures as participation rates and the average values of investments in the premium bond programme, as well as the overall savings levels and the relative number of savers. We test whether these measures in the areas of the recent premium bond winners, differ substantially from those elsewhere, during the period directly following the draw.

This paper uses multiple data sources. First, all the information about the locations of the top winners in the premium bond draws during the nineteen-year period, April 1999 - March 2018, was provided by the National Savings and Investments[33]. Second, the data on the savings indicators and premium bonds take-up during the above time frame, are derived from the Family Resources Survey (FRS). Third, socio-demographic structures of the regions in the UK are built based on the Local Area Labour Force Survey and the Annual Population Survey.

For each premium bond draw during the relevant time frame, the regional effect of a winner's location announcement is analysed with respect to the average values of several measures: premium bond programme participation rate, monetary value invested in the bonds, fraction of the total savings allocated to premium bonds, total savings, money saved in other forms than premium bonds, and the proportion of savers in the population. Each measure is then compared with the area reported as a £1 million winner's location, and its synthetic counterpart - a region constructed as an optimal-weighted combination of the remaining UK regions, closest to the winning one, both in terms of the socio-demographic characteristics as well as the past behaviour of the response variable. We propose an extension to the synthetic control methodology of Acemoglu et al. (2016) in two main ways. First, as our analysis covers almost two decades of monthly draws, both the cumulative average effects of the lucky region announcements, as well as their statistical inference, are estimated based on a series of treatments, as opposed to a standard single-treatment setting. Second, the analysed time frame consists of periods of varying number of the £1 million prizes offered. The procedure adopted in the paper accounts for all those changes.

Our results suggest that an announcement of a location that each top prize winner comes from, affects the behaviour of other people both with respect to the decisions regarding premium bonds as well as overall savings. On average, the rate of participation in the premium bond programme in a lucky region tends to increase by 0.81 percentage points in the first, and 1.33 percentage points in the second month, as compared to the take-up rate that is expected, had the region experienced no win. At the same time, in the first and second month directly following a win, the 'lucky' areas exhibit an increase in the average value of premium bonds held per person, of £1,334 and £1,023, respectively. The unusually higher investments into premium bonds are found to be accompanied by the higher weights of the average savings portfolios being allocated to premium bonds.

[33] We are grateful to the National Savings and Investments for providing the list of all the past winning locations announced as well as the statistics on the regional distribution of premium bond holders in the UK.

The results however revealed that following the publication of the winner's geographical area, the amount of non-premium bond savings among the bondholders decreased by £1,792 within a month following the draw, suggesting that any additional money allocated to premium bonds, either by existing or new holders, can be a result of people reorganizing their savings portfolios and shifting the resources to premium bonds from other forms of savings. Furthermore, we find that the premium bond programme can also attract people with no prior savings in the banking system. The proportion of savers in the lucky regions in the same month as the draw, tends to be 0.49 percentage points above the level predicted, had the winner come from any other British region.

There are two papers most closely related to the research question posed in this chapter. First, the impact of a winner's location announcement on the behaviour of people in that area has been investigated by Guryan and Kearney (2008) in the context of lottery participation in Texas. It was found that the stores which sold the winning lottery tickets experienced significantly higher ticket sales following the win than others. Based on this observation, the authors define 'a lucky-store effect' as an erroneous belief that those stores where the recent winning tickets were sold, are more likely to do that again in the upcoming draw.

In the context of prize-linked savings (PLS), Cole et al. (2014) investigated the local spillover effects in the demand for one of such products, the Million-a-Month Accounts (MaMA), offered in South Africa. Assuming a prize win as an exogeneous shock to the financial situation of an individual who won the top prize in a MaMA draw, the authors explore the changes to the MaMA deposits across all the bank branches. The winners were observed to hold substantially higher deposits in their accounts as compared to others. Among the non-winners, the total value of the MaMA deposits was observed to grow by an excess of 11.6% at the winning branch in the month following the prize draw.

The main contribution of this paper to the existing literature is that it provides an insightful analysis of the effects of publishing the lucky locations in the premium bond draws on our set of savings measures set out above. The data used here, provide the country-representative information on both the demand for the existing PLS product as well as the total savings in all existing banking products. The studies by Guryan and Kearney (2008) and Cole et al. (2014) applied a similar methodology of evaluating the local effects of a win, regressing the response in local demand on whether an area experienced a win at a given time point, conditional on the previously observed local demand. Meanwhile, the analysis conducted in this paper also includes socio-economic differences across areas, thus ensuring improved precision and reliability of the results; this aspect of our analysis had not been considered in the previous research. Hence, when measuring the effects, we first model the expected future trajectory of the response variable in a winning region by considering its characteristics. The observed response is then compared with the expected outcome for a given region, instead of an average across all the other UK regions. Further, the product evaluated in this paper differs from the previously analysed ones in substantial ways. Designed with the purpose of encouraging savings, premium bond programme has distinctive policy implications compared to the lottery demand, as examined by Guryan and Kearney (2008). On the other hand, despite premium bonds and MaMA accounts belonging to the PLS products class, there are reasons to

look at both products separately - because of possible differences in investment behaviour between South Africa and the UK, higher scale of the premium bond programme, or different channels of spreading the 'lucky-store' effects, for example. Finally, the analysis by Cole et al. (2014) included an evaluation of the local spillover effects of a winner on the deposits on a regular savings account offered by the same bank that introduced the PLS products. While the question of the role of PLS in encouraging people to save remains valid, the data used in this paper allow us to examine the local effects of a winner's announcement on the total value of savings.

The rest of the paper is structured as follows: Section 4.2 gives a brief overview of the UK premium bond programme with respect to the differences in participation across the country, Section 4.3 describes the data used in the analysis, while Section 4.4 explains the underlying methodology. Section 4.5 presents and discusses the results of the analysis, and the conclusions are presented in Section 4.6.

4.2 UK Premium Bond Programme

The British premium bond programme was introduced on 1 November 1956. Issued by the National Savings and Investments (NS&I), an Executive Agency of the Chancellor of the Exchequer, premium bonds currently bring the highest sales revenue among the savings products offered by NS&I[34]. Every £1 allocated to premium bonds provides the holder with a chance of winning one of over 3 million financial prizes[35] each month. The distribution of the prizes is highly skewed, with a low probability of winning the top rewards. In each draw, there are two £1 million jackpots. The second- and third-highest prizes are £100,000 and £50,000, respectively. After that, the prizes increase in the number of winners, but go gradually down in the value, with the minimum of £25.

The drawing procedure starts with generating a random number by the Electronic Random Number Indicator Equipment (ERNIE), which is then matched with the appropriate bond code. The total capital invested per person is limited to £25 at minimum[36], and £50,000 at maximum[37]. The value of the individual deposit affects the chances of winning for that premium bond holder. Table 4.1 below shows the regional distribution of the premium bond holders across the UK as of March 2019, both in absolute terms and as a proportion of the local population.

[34] For example, during the financial year 2017/18, the capital raised in premium bonds exceeded £14.5bln, which is 34% out of a total £42.7bln. This proportion in the prior financial year was 43% (NS&I Annual Report 2017-18).
[35] The specific number of prizes available in each draw may be subject to adjustments, depending on the current prize fund rate and odds for winning. For example, in one of the recent draws, May 2019, the total of 3,292,546 prizes have been won (NS&I corporate website, URL: https://nsandi-corporate.com/, accessed on 01 July 2019).
[36] The floor deposit value was reduced to £25 from £100 in February 2019.
[37] The cap deposit value was increased to £50,000 from £40,000 in June 2015. The ceiling for the premium bond holdings serves as a means of reducing any possible crowding-out of the traditional bonds with taxable coupons.

Table 4.1: Distribution of Premium Bond Holders across UK Regions

Region	Population	No. Premium Bond Holders	Proportion of Premium Bond Holders
North East	2,143,800	763,484	35.6%
North West	5,806,200	2,264,702	39.0%
Yorkshire and The Humber	4,366,000	1,633,169	37.4%
East Midlands	3,839,000	1,467,997	38.2%
West Midlands	4,663,600	1,721,216	36.9%
East	4,952,800	2,293,068	46.3%
London	7,066,500	2,461,690	34.8%
South East	7,270,800	3,548,603	48.8%
South West	4,519,200	2,235,750	49.5%
Wales	2,543,800	1,091,181	42.9%
Scotland	4,455,900	1,526,902	34.3%

Source: Own analysis based on data provided by the National Savings and Investments, as of March 2019.

Table 4.1 indicates a higher density of the premium bond holders (of over 40%) among the local population in such regions as East, South East, South West and Wales. Therefore, it might be expected that those regions would be also characterized by a similarly higher frequency of winnings[38].

The areas the top winners come from are released by the National Savings and Investments in a way that ensures anonymity. Therefore, what is published is the most precise location where at least 100,000 premium bond holders live. The hierarchy of aggregation used by the NS&I is as follows: Level 1 - Royal Mail Postcode Address File (PAF) town, Level 2 - county or local authority, Level 3 - Government Standard Region, Level 4 - country. When a jackpot is won in a particular location, the issuer starts with the lowest level of aggregation (Level 1), then verifies if it meets the 100,000 holders criterion. If positive, the location is published at that level. Otherwise, the issuer moves to the higher geographical level and repeats the procedure until, finally, the location for publication purpose is found. The criterion on the number of premium bond holders is also valid when a winner lives outside the UK. If, in such case, there are fewer than 100,000 premium bond holders in the country of the winner's residence, the location is published as 'overseas'.

Table 4.A.1 in the appendix provides the list of locations of the £1 million prize winners in each draw from the 1999/2000 financial year to 2017/2018 financial year[39]. The areas are presented in the same way as they were originally published by the NS&I. The dataset includes different levels of aggregation - boroughs, towns, local authorities, counties, ceremonial

[38] The actual frequency of winnings depends on the total value of premium bond holdings in each region. Such statistics, however, are not published on the NS&I website.

[39] The time horizon was chosen for consistency with the complementary data used in the analysis, as discussed in the Data section.

counties and electoral regions, regions and a general indication of outside-UK winners ('overseas'). Our analysis was originally planned to be conducted at the levels of the lowest aggregation possible, so that to take advantage of all the geographical details provided by the NS&I. The source of our data on the local demand for premium bonds, Family Resources Survey (FRS), provides only the information on the regions of the respondents in its publicly available version. The more detailed locations of the respondents, at county- and local authority-level, are included in the secure version of FRS, available only to be used from the Safe Room of the UK Data Service. The author has started to run the analysis in the Safe Room; however, due to the Covid-19 outbreak, the possibility of accessing the Safe Room has been suspended. Consequently, the results presented in this paper are based on the analysis at the regional level.

During the analysed period, there occurred a few changes to the number of the top winners in the premium bond draws. Specifically, until August 2005 there was only one £1 million winner in each draw. The second top prize was introduced at first for a limited time only; as from April 2009 to July 2014 again only one holder could win £1 million. Since then, two premium bond holders are drawn each month to win £1 million prizes. Additionally, both December 2006 and June 2007 were exceptional, in that in each of those months there were five £1 million winners. The additional prizes were provided by the NS&I to celebrate the 50th anniversary of the UK premium bonds[40].

4.3 Data

The data used in this study come from several sources. First, we derive the information on regional demand for premium bonds from the Family Resources Survey. Second, the set of regional socio-demographic characteristics is built, based on the Local Area Labour Force Survey, the Annual Population Survey, and the Annual Survey of Hours and Earnings. Finally, the list of premium bond draws along with the locations of the top winners, has been provided by the National Savings and Investments.

4.3.1 Family Resources Survey

The Family Resources Survey (FRS) is a large-scale UK survey conducted annually by the Office for National Statistics (ONS) and the National Centre for Social Research (NatCen), sponsored by the Department for Work and Pensions (DWP). The survey collects information on the income and living circumstances among the British households. It was carried out for the first time in 1992, with the leading aim of existing policy evaluation.

[40] The Guardian, URL: http://www.theguardian.com/money/2006/nov/01/bonds.saving, accessed on 04 July 2019.

Because the NS&I does not release information on the local demand for premium bonds over time, we use the Family Resources Survey for that purpose. The FRS data are structured in the three hierarchical levels: (i) household, (ii) benefit unit, and (iii) individual. The respondents are asked a set of questions regarding their savings allocation across a range of banking products, including premium bonds. All individuals are asked whether they currently hold any premium bonds. Additionally, from the account-level table within the FRS we can obtain information on the value of the premium bonds held by each respondent[41].

In this study, we use nineteen consecutive waves of the Family Resources Survey, covering the period from the 1999/2000 financial year until the 2017/2018 financial year[42]. To ensure the country-representativeness of the data, the FRS implements the specific stratifying methodology, sampling the households with respect to the region, type of occupation, economic activity, and unemployment. Additionally, in order to control *ex post* for the missing responses, the FRS evaluates the grossing factors for each individual respondent to the survey. In this paper, we use the data on the local demand for premium bonds, from the nineteen merged FRS waves. The demand is measured both as a relative number of premium bond holders in the local population, and an average premium bond value[43], all grossed-up to represent the structure of the UK population. We construct such dataset at the regional level[44].

4.3.2 Regional Characteristics Data[45]

To evaluate a counterfactual to the area that experienced a premium bond holder winning a £1 million prize, we search for such a location (or set of locations), that resembles the lucky area as closely as possible in the outcome variable. In such comparison, we also control for a set of chosen demographic and economic characteristics of the regions.

We use the annual data on the proportion of individuals in the local population, with no educational qualifications and of ethnic minority, from both the Local Area Labour Force Survey and the Annual Population Survey. The two surveys are complementary in that the former preceded the latter, having been terminated in February 2004. Besides, we use the quarterly data on the local population, gender ratio, economic activity, and the rate of unemployment, provided by the Labour Force Survey. Moreover, we control for the average gross weekly wages, as well as the lowest quartile of the local wage distribution, as given by

[41] The data on the value of premium bonds held are matched from account level to individual level. For those respondents, whose benefit units report the total savings of over £20,000, the premium bond value is given in the form of a range of monetary values. Those respondents reporting the total savings lower than £20,000, are asked for the precise value of their premium bond holdings.
[42] The oldest FRS wave, in which the questions regarding premium bonds are included, is the wave corresponding to the 1999/2000 financial year. The most recent wave available is the 2017/18 wave.
[43] The values of premium bonds are adjusted for inflation, using the annual rates of change in the Consumer Price Index (CPI). The data come from the Office for National Statistics.
[44] The publicly available version of the Family Resources Survey only includes information on the region the respondent lives in.
[45] All the surveys mentioned in the section come from the Office for National Statistics (URL: https://www.nomisweb.co.uk, accessed on 05 July 2019).

the Annual Survey of Hours and Earnings - resident analysis. Both economic indicators are adjusted for inflation.

The summary statistics for all the measures used in the analysis across all the British regions are presented in Table 4.A.5 in the appendix. Over the time frame used in the analysis, i.e., the financial years of 1999/2000 - 2017/2018, the highest unemployment rate was recorded in the North East (7.9%), the highest economic activity rate was recorded in London (66.1%), and the lowest share of working-age individuals without any educational qualifications was recorded in the South East and the South West (8.9%). The proportion of men in the local population was relatively evenly distributed across the regions, with an average of 48.5%. London experienced the highest share of ethnic minorities (33.5%), as well as the highest average income (£693) and the 25th income percentile (£348).

4.4 Methodology

Our analysis in this paper is based on evaluating the treatment effects. We consider the eleven British regions as the primary units in the model. In line with the main objective of the paper, a treatment refers to an announcement made by the National Savings and Investments, about each £1 million winner in the most recent premium bond draw. We use a range of response variables, including the measures of the demand for premium bonds as well as the general savings behaviour. The treatment effects are then assessed as a gap between an observed value of a chosen outcome variable, and its predicted value under a hypothetical scenario that the top winner came from any other UK region. For that purpose, we apply a synthetic control approach, pioneered by Abadie and Gardeazabal (2003), Abadie et al. (2010), and further developed by Acemoglu et al. (2016).

In the proposed method, the counterfactual for a treatment implies building up an artificial unit, that serves as a base for comparison to the treated one. This synthetic region is derived as a particular combination of all the unaffected regions, so as to resemble the state of the treated region in the pre-treatment period, in the possibly closest way. The resemblance is built with respect to the socio-demographic regional profile, as well as the pre-treatment trajectory of the response variable.

Let us consider the outcome variable, Y_{it}, to be a measure of the demand for premium bonds in region i in month t. Given the available data, the demand measures used in the analysis are: (i) the number of premium bond holders relative to the total population of the region, (ii) the average value of individual premium bond holdings, and (iii) the average fraction of total savings allocated to premium bonds. We assume that any potential impact of a jackpot won in the area on the premium bond demand, and the local savings behaviour, would be observed over a relatively short time period - specifically, we assume a two-month post-treatment period, and, therefore, use the monthly premium bond demand data in the analysis.

The synthetic control method estimates the following panel data regression model of the demand for premium bonds:

$$Y_{it} = \delta_t + Z_i\theta_t + \mu_i\lambda_t + \varepsilon_{it} \quad (14)$$

In (14), δ_t captures the unknown time controls that are common across all units, Z_i is the matrix of observed covariates not affected by the intervention with θ_t parameters, λ_t contains the unobserved common factors, and μ_i includes the unobserved region-level factors. In this study, Z_i carries the information on: (i) the share of men in the local population, (ii) the rate of economic activity in the region, (iii) the rate of unemployment, (iv) individuals in the working age that do not hold any educational qualifications, (v) people of ethnic minorities, (vi) average income in the region, and (vii) the lowest quartile income level. The demographic characteristics are expressed as the proportions relative to the overall population in a given region. The income variables are adjusted for inflation[46].

The choice of the variables in Z is based on the existing evidence that certain demographic characteristics can be associated with significantly higher demand for the prize-linked savings products (Tufano 2008, Tufano et al. 2008). Also, the local income distribution characteristics were recognized as important determinants of the regional PLS demand - the take-up rates tend to be particularly high in low- and medium-income areas (Cole et al. 2014).

By the intervention we understand the announcement of the highest jackpot in the premium bond draw having been won in a given area, with T_0 being the month of intervention. Next, we investigate whether there exists any discrepancy in the outcome variable, i.e., the demand for premium bonds, in region i at time point t, between the observed outcome with intervention, Y_{it}^I, and the outcome of a synthetic counterpart without intervention, Y_{it}^N. The treatment effect is therefore measured as:

$$\alpha_{it} = Y_{it}^I - Y_{it}^N \quad (15)$$

Letting $i = 1$ for the region under intervention, the treatment effect is:

$$\alpha_{1t} = Y_{1t}^I - Y_{1t}^N = Y_{1t} - Y_{1t}^N \quad (16)$$

We are interested in evaluating the difference between the actual demand for premium bonds in the affected region and the demand that would be observed had that region not been

[46] Using the Consumer Price Index, as provided by Office for National Statistics (https://www.ons.gov.uk/economy/inflationandpriceindices).

treated at time t. Considering region i, where $i = 1$, the demand for premium bonds with intervention, Y_{1t}^{I}, is equal to the observed demand, Y_{1t}, as this region 'produced' a £1 million winner at time t, that is, was treated. On the other hand, the predicted demand for premium bonds in region i in case the winner came from elsewhere, is estimated using a synthetic region. The premium bond demand values in the synthetic region i in month t, $\hat{Y}_{it}$, are derived as the weighted average of the demand observations across the regions in the donor pool:

$$\hat{Y}_{it} = \sum_{j \, \epsilon \, control \, group} w_j^i Y_{jt} \tag{17}$$

Abadie et al. (2010) show that, under an assumption of region 1 having been treated, and given J regions in the donor pool, as long as $\sum_{j=2}^{J+1} w_j^* Z_j = Z_1$ and $\sum_{j=2}^{J+1} w_j^* \mu_j = \mu_1$, the unbiased estimator of the difference between the observed post-intervention demand for premium bonds and the demand that would have been observed in the absence of the intervention is given as:

$$\hat{\alpha}_{1t} = Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt} \tag{18}$$

Let X_1 be a vector of the pre-intervention characteristics of the treated region, and X_0 the matrix of the observations of the same types of characteristics for those regions in the control group. The characteristics include both the elements of Z as well as the average value of the outcome variable Y over the two-month pre-treatment period. In order to find the vector of optimal weights for the construction of the synthetic control, W^*, we aim at minimizing the distance between X_1 and $X_0 W$, subject to the conditions: (i) $w_2 \geq 0, \ldots, w_{J+1} \geq 0$, and (ii) $\sum_{j=2}^{J+1} w_j = 1$. The discrepancy between X_1 and $X_0 W$ is calculated as $\left((X_1 - X_0 W)' V (X_1 - X_0 W)\right)^{\frac{1}{2}}$, with V being a positive definite and diagonal matrix that assigns weights to the linear combinations of the variables in X_0 and X_1 in a way that the mean squared prediction error of the outcome variable is minimized for the pre-intervention period, following Abadie and Gardeazabal (2003).

In this analysis, we extend the existing synthetic control methodology because: (i) in some months, there are two or more major winners in the premium bond draws, (ii) we consider a set of independent treatments (every following month for several years). As a result, the parameters described earlier are adjusted in our model on a rolling basis from month to month. The set of control units changes, too, as we need to exclude from the donor pool those regions that were treated either during the pre-treatment or post-treatment periods.

Having derived the synthetic regions for each treated unit at every time point in our dataset, we then calculate the individual treatment effects, as in (18). Next, to see if the results are statistically significant, we use the permutation tests, as proposed by Abadie et al. (2010).

That is, for every premium bond draw, we pick the placebo-treated region by resampling the set of regions from the initial donor pool, while keeping the remaining units as control group. Repeating this procedure for all the possible combinations of treated-controls, we construct the set of placebo treatments. Having calculated the individual treatment effects for each of the placebo runs in a chosen premium bond draw, we obtain the distribution of the effects against which we then compare the value of the effect of the actual treated region.

Next, we follow Acemoglu et al. (2016) to evaluate the average treatment effects, ATE, in case of the multiple treated units. We further extend the model by allowing not only for multiple treated in one time point, but also observing the treatments taking place in multiple time points. Therefore, in our analysis, T_0, vector of $\hat{\sigma}$'s, $treatment\ group$, and $estimation\ window$ change from one draw to the next, with T_0 describing the date of the intervention, $[T_0, T_0 + k]$ showing the post-intervention time horizon, and T being the length of the estimation window. The overall effect of intervention is then calculated as:

$$\widehat{ATE}(T_0, T_0 + k) = \frac{\sum_{i\ \epsilon\ treatment\ group} \frac{\sum_{t=0}^{k} Y_{it} - \hat{Y}_{it}}{\hat{\sigma}_i}}{\sum_{i\ \epsilon\ treatment\ group} \frac{1}{\hat{\sigma}_i}} \tag{19}$$

where:

$$\hat{\sigma}_i = \sqrt{\frac{\sum_{t\ \epsilon\ estimation\ window} \left(Y_{it} - \hat{Y}_{it}\right)^2}{T}}$$

In other words, the overall treatment effect is derived as a weighted average of all the individual treatment effects of the single premium bond draws. The weights represent the quality of the matches of the synthetic controls, to the actual treated regions that those controls were set to resemble. Cases when the synthetic region is able to better predict the path of the outcome variable during the estimation window are treated as more important in assessing the final effect of the interventions.

Finally, we derive the confidence intervals based on 50 random draws of placebo treatment groups. The limited number of draws is due to computational power required for estimations of over 300 treatments with the time-varying synthetic control parameters. In case of the overall effects, we first construct the placebo set of the treated regions, i.e., given the list of the draws, we randomly choose the region(s) treated in every draw from the donor pool, such that this same region was not treated in reality (in the original dataset), either during the pre-treatment, or the post-treatment period. Having constructed the dataset of placebo treatments in such a way, we then calculate the average treatment effect as in (19), and obtain the distribution of the placebo effects, against which we then measure the actual effects

calculated for the original dataset. We test the null hypothesis that the ATE for the entire time horizon of monthly premium bond draws is zero, using the placebos as the null distribution. The p-values are then derived based on the position of the actual treatment effect in the placebo treatments distribution.

4.5 Empirical Results

4.5.1 Effect of Winner Announcements on the Demand for Premium Bonds

Our empirical analysis starts with a focus on the regional demand for premium bonds. We explore the effects that an announcement of a top winner in an average premium bond draw has, on the behaviour of others in the winner's area, regarding their investment in premium bonds. This response is assessed in the following three aspects: (i) a decision to invest in premium bonds, measured as a percentage of the bondholders in a region, (ii) any adjustments to the amount invested in these banking products, measured as an average premium bond value across the bondholders in a given region, and (iii) a relative value of one's premium bond investment to their overall savings, measured as a percentage of total savings allocated to premium bonds. For example, suppose that the most recent £1 million winner came from London. This section evaluates, therefore, whether such an announcement results in a change to the demand for premium bonds in London, as compared to a hypothetical local demand, had the winner come from Yorkshire or Scotland. Would it nudge some Londoners to purchase premium bonds for the first time? Or would it encourage the existing bondholders in London to increase their investments in anticipation of higher chances to win in the upcoming draws?

The post-treatment period during which the regional spill-over effects are evaluated, covers two months directly following the draw. As the drawing of financial prizes among the premium bondholders take place at the beginning of every month, we look at the premium bond decisions in the same month the draw took place, and the month after that. The pre-treatment period based on which the synthetic control for the region of the winner is generated, covers three months prior to the draw. It is also used to evaluate how well the synthetic region created mirrors the actual treated one, that is, how effective the synthetic control estimation had been. The dataset listing the lucky regions, excludes those entries when the same region is treated multiple times during the three-month estimation window. In the cases when there were multiple jackpot winners in a single draw living in the same region, that region enters the analysis only once, this way preventing double-counting of the effects.

The information on the regional demand for premium bonds comes from the Family Resources Survey (FRS), with the survey waves consistent with the time frame of the draws under analysis, i.e., nineteen consecutive financial years since 1999/2000 until 2017/2018. Tables: 4.A.2 to 4.A.4 in the appendix contain the corresponding summary statistics, while Table 4.A.5 provides the regional socio-economic statistics on the variables used in building

up the sequence of synthetic regions, i.e., share of the unemployed, the economically active, men, individuals with no formal qualifications, those belonging to ethnic minorities, average income and the lowest quartile of an income distribution in each UK region. Table 4.A.2 presents the distribution of premium bond holders across eleven UK regions[47] (excluding Northern Ireland), according to the FRS data as well as compared to the actual statistics[48] provided by the bond issuer, NS&I. Next, Table 4.A.3 shows the regional differences both in an average value invested in premium bonds as well as average total savings. The highest concentration both in terms of the premium bond programme participation rates as well as the value invested in these financial products can be observed in South East. The conclusion is consistent across the FRS data and the actual statistics provided by the NS&I. Table 4.A.4 compares the distribution of bondholders as well as an average value of premium bonds to the regional distribution of the top winners in the premium bond draws. Not surprisingly, we can observe a positive correlation between the percentage of winners and premium bond holders, as well as between the percentage of winners and an average value invested in premium bonds. Each £1 of the overall value of one's investment enters a monthly draw. As a result, the regions that experience the highest value of funds allocated to premium bonds in total, are also those with the highest probability of producing a £1 million winner.

The results of the analysis show that, on average, an announcement of the £1 million winner is followed by a statistically significant increase in demand for premium bonds in the winner's region. This conclusion holds both in case of the premium bond programme take-up rates and the average value of investment in premium bonds. Meanwhile, the bondholders in the winning regions are observed to increase the fraction of their overall savings allocated to premium bonds. The numerical results are given in Table 4.2 below.

Table 4.2: Average Treatment Effects of £1 Million Winners on the Regional Demand for Premium Bonds

Outcome variable	**Post-treatment period**	
	t_1	t_2
Proportion of PB holders [pp]	0.81***	1.33**
Average value of PB holdings	£1,334***	£1,023***
Average fraction of savings held in PB [pp]	0.71***	1.20**

Note: Periods: t_1 and t_2, refer to the month of the draw and the following month, respectively. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

Overall, a 'lucky' region is found to experience a surge in the premium bond programme participation rate, of 0.81 percentage points above the expected level in the month of the draw, and 1.33 percentage points as measured one month later. As a result of the structure

[47] The early waves of the Family Resources Survey do not include respondents from Northern Ireland. Therefore, the region is not included in this paper's analysis.

[48] The National Savings and Investments does not store the collective historical data on the regional distribution of premium bond accounts. In the midst of preparing this paper, we have successfully requested the most recent snapshot of such. The information was incorporated in Tables: 4.A.2 - 4.A.4 in the appendix.

of the synthetic control model, such divergence from the predicted outcomes can be associated with the treatment itself. Therefore, our result suggests that people who live in the same region as the winner, are more likely to enter the premium bond programme than those living elsewhere.

The further results presented in Table 4.2 indicate that, it is not only the decision to purchase premium bonds that can be altered by a £1 million winner in the region, but also the decision of how much to allocate to premium bonds - both in absolute terms and in relation to one's total savings. Namely, an average value saved in premium bonds is found to increase in the lucky regions by £1,334 above expectation in the first, and £1,023 in the second month directly following the draw. Moreover, the additional inflows into premium bonds are accompanied by an increase in the fraction of total savings that an average investor allocated to premium bonds. The weight of premium bonds in an overall savings portfolio, among the bondholders in the region of the recent winner, exceeds its expected rate, on average, by 0.71 percentage points in the month of the draw, and 1.20 percentage points in the following month.

The regional effects of a winner announcement on the value of premium bonds held, are most likely a consequence of other investors' decisions, as opposed to the winner's only. Even if each of the £1 million winners during the analysed period had only £1 in their premium bond account and reinvested as much of their prize as they could, it would still not explain the magnitudes of changes in the regional average premium bond deposits. The maximum amount that one can allocate to premium bonds is £50,000[49]. Therefore, our results suggest that a prize of £1 million having been won in a premium bond draw, is associated with a change in behaviour of other individuals living in the same region as the winner, in that more money in total becomes allocated to premium bonds. Meanwhile, our results show that the announcement of a winner's location also attracts those in the lucky region, without any premium bond investments *ex ante*. Such spill-over effects on other savers were also identified by Cole et al. (2014), as generated by the South African PLS programme.

Without a further analysis, it is not clear whether the changes to the regional demand for premium bonds occur due to the new participants allocating substantial amounts of their savings to premium bonds, therefore pulling the regional average holdings up, or it is also the existing bondholders who respond to the winner's announcements by increasing their current holdings of premium bonds. Also, we do not know whether the disproportional inflow of funds into premium bonds, resulting from a regional hot-hand effect, is due to the new generated savings, or reshuffling among the existing assets in the savings portfolios and so shifting some part of the total savings to premium bonds from other accounts.

[49] As at June 2020. Since the launch of premium bond programme in 1956, the maximum total value of premium bonds that one person is eligible to hold, has never exceeded £50,000.

4.5.2 Differences in Responses to the Winner Announcements

We have established that people living in the same region as a £1 million winner of a premium bond draw, respond to the news about the winner's location, by increasing both their participation rate as well as the average amount invested in premium bonds. Is the winner's location, however, the only determinant of the changes in the savings behaviour observed in the lucky region? This section aims at exploring any potential differences in the effects of the £1 million winner announcements on the regional demand for premium bonds, considering a full set of information available about the winner.

Following each monthly draw of prizes, the premium bond issuer, National Savings and Investments, publishes the basic information on the recent winners: area they come from, their gender, total amount invested in premium bonds, as well as the value, number and date of purchase of the winning bond. These are, therefore, the only pieces of information the other bondholders might consider when altering their decision of whether to invest, or how much to invest in the premium bonds. We now test if the differences in the major characteristics of the £1 million winners can be associated with different responses of the demand for premium bonds.

The set of initial results, i.e., the list of single treatment effects of each £1 million winner's location announcement, on the demand for premium bonds in the winner's region in the two-month period following the win, is analysed with respect to the characteristics of the winner. We consider the value of premium bond holdings, gender, region, and a post-2005 time dummy. During the period under consideration, 2005 can be thought of as a milestone in the way of offering premium bonds - as of then, premium bonds have become available to be purchased and managed online, via the NS&I's website. Not only did this event make the products more attractive due to the ease of access, but it also added a new, powerful channel of spreading the information about the winners.

The corresponding summary statistics are presented in Table 4.A.6 in the appendix. In the table, we look at the diversity across the effects of the top premium bond winner announcements on the demand for premium bonds, by grouping the individual results based on the characteristics of the winners: premium bond holdings and gender, as well as the time of a draw. The statistics indicate that the average magnitudes of the effects can differ significantly along with the winners' characteristics. For example, given a £1 million winner with a relatively high[50] initial value of premium bond investment, the local premium bond programme participation rate tends to increase by 3.6 percentage points, on average, while the value of premium bonds held increases locally by £1,034, on average. If, however, the announcement shows that the winner held a lower initial investment in premium bonds, the participation rate increases by 4.4 percentage points, and the average bond holdings increase by £768 in the lucky region. Moreover, the effects on both measures of the demand for premium bonds tend to be higher, on average, after 2005, as well as in case of the female winners. To

[50] 'High' and 'low' premium bond investments refer to the treatment effects when the winner was reported to hold premium bonds of the value above and below the average level, respectively.

test the joint effect of the winners' characteristics on the responsiveness of the premium bond demand to the winner announcements, we run the adequate regressions. The results are presented in Table 4.3 below.

Table 4.3: Regression Results of the Determinants of Responsiveness to the Announcements of £1 Million Winners' Locations

Variable	Effects on PB participation [pp]	Effects on value of PB holdings [£]
PB investment value	-0.012**	3.987**
	(0.005)	(1.821)
Post-2005 dummy	1.594***	758*
	(0.516)	(376)
Male	-1.242	-327**
	(0.958)	(354)
Regional dummies	Yes	Yes
Adjusted R^2	0.215	0.127

Note: The table contains the results of OLS regressions, weighted by the effectiveness of synthetic control procedure in estimating each treatment. The first column uses the effects on the proportion of premium bond holders as a dependent variable. The second column uses the effects on the average value invested in premium bonds as a dependent variable. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

The regressions results confirm the picture provided by the summary statistics analysis. The initial investment in premium bonds by the £1 million winners is associated with a lower response in terms of entering the premium bond programme, but also greater increments in the value invested by the existing bondholders. That is, assuming that a top winner reportedly has £100 allocated to premium bonds, such a win tends to be associated with a higher premium bond take-up rate as well as higher average premium bond holdings in the winner's region. However, this regional effect on the participation rate tends to be 1.2 percentage points higher under an assumption of the winner's £100 investment, as compared to £10,000. The effect on the average premium bond holdings in the lucky region, however, is expected to be lower by almost £400 in case of the winner's £100 initial investment, as compared to £10,000. Seeing that a bondholder with less money invested can enjoy a £1 million prize, can encourage more people to purchase premium bonds and hope to win, too. Knowing that the winner had to invest a substantial amount of money prior to the win, however, can nudge the other bondholders towards increasing their own investments, too.

Moreover, for both measures of the demand for premium bonds, the regional effects of the winner announcements are stronger after 2005. On average, the treatment effects on the premium bond programme participation rate are higher by 1.6 percentage points during the post-2005 period, while the treatment effects on the average value of premium bonds held are

higher by £758. People are also more likely to alter their behaviour with respect to premium bonds as a result of the winner announcement, if the recent winner was female. A man winning £1 million in a premium bond draw is associated with lower regional changes in an average amount invested in premium bonds, of £327, on average.

4.5.3 Regional Spill-over Effects on General Savings Behaviour

Having found significant effects of the winner's location announcements on the demand for premium bonds, an interesting issue arises, as to whether similar changes can be observed in case of the overall savings behaviour. A central question posed by the existing studies on the prize-linked savings is, whether offering such type of financial products induces people to save more in total, or whether the money allocated to PLS is merely a change in the structure within the individual savings portfolios. While the evidence from around the world provide some inconclusive results[51], the only such study to date on the UK premium bonds (Tufano 2008) suggests that there exists a positive correlation between the country-level net sales of premium bonds[52] and overall household savings over time.

In this paper, the issue of creating new savings is addressed by investigating whether the positive effects of the £1 million wins on the regional demand for premium bonds, found in 4.5.1, can be also observed with respect to the general savings levels. As shown earlier, more money in total tends to be deposited to premium bonds in the lucky regions. If these funds are the bondholders' new savings, the effects of the winner's location announcements on the overall savings should be also positive. However, if the local changes in the demand for premium bonds result from shifting the money across the financial products held, the value of savings outside of premium bonds should be observed to shrink simultaneously to surges in the premium bond demand.

To explore how the abnormal jumps in the demand for premium bonds - associated with the £1 million winner announcements - refer to the general savings behaviour, we apply the model of regional effects to a set of additional outcome variables. We look at the response of average savings, both in the general population and among the premium bond holders only, while measuring both the total savings and the savings net of the premium bond holdings, respectively. Additionally, we test a regional hot-hand effect on the ability to generate new savers. The results are presented in Table 4.4.

[51] For example, studies on MaMA programme in South Africa (Cole et al. 2014) or lab experiments on the hypothetical PLS-like products (Atalay et al. 2014, Filiz-Ozbay et al. 2013) provide evidence that individuals tend to set aside more money for the future when offered a PLS option. On the other hand, a field experiment in Kenya (Abraham et al. 2016) find no positive effects of PLS on overall savings rates.

[52] The sales of premium bonds figures adjusted for redemptions.

Table 4.4: Average Treatment Effects of £1 Million Winners on Savings Behaviour

Outcome variable	Post-treatment period	
	t_1	t_2
Average total savings	-£1,360	-£5,697**
Average total savings among PB holders	-£4,024*	-£10,595*
Average net savings (excl. PB)	-£828*	-£5,961***
Average net savings (excl. PB) among PB holders	-£1,792***	-£7,688***
Proportion of savers [pp]	0.49***	0.26*

Note: A respondent to the Family Resources Survey is classified as a saver if they report a non-zero value of total savings held in the banking products. Periods: t_1 and t_2, refer to the month of the draw and the following month, respectively. Significance reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.

The £1 million prizes in the monthly premium bond draws, are found to have some negative effects both on the average levels of savings in the winner's region, and the funds saved in the banking products other than premium bonds. During the second month after the draw, both the average total savings in the regional population as well as the average total savings among the premium bond holders, tend to be below their predicted levels for the lucky regions. The publicly available information that the winner came from a specific location, can be therefore associated with an average drop in savings, of £5,697 in general, and £10,595 among the group of bondholders, although these results hold at 0.95 and 0.90 confidence levels, respectively. At the same time, in the lucky region, the average value of savings held by the bondholders outside premium bonds, is found to be £7,688 lower than predicted in case the winner came from any other British region.

The previous research points towards a possible substitution effect between the prize-linked savings products and gambling activities[53] (Cookson 2018, Atalay et al. 2014, Filiz-Ozbay et al. 2013). Therefore, a nudge towards investing in premium bonds, such as learning that a person from the same area won a £1 million prize in the recent premium bond draw, may also encourage some gambling behaviour. In such case, one would expect a positive effect of the winner's location announcements on both the premium bond holdings and the gambling expenditure[54]. If the funds allocated to both premium bonds and gambling products come from one's banking assets, this could justify the observed reduction in the level of other forms of savings, of a higher magnitude than the positive effect on the average premium bond holdings. Unfortunately, due to the lack of the adequate data on the regional gambling expenditure, we are not able to test such hypothesis.

The substantial magnitude of the regional effects on savings might also result from the high level of aggregation of the data. The information on the local demand for premium bonds

[53] Cole et al. (2014), for example, found that the demand for the PLS-type South African programme, MaMA accounts, was lower during the times of larger top prizes offered in the National Lottery draws.

[54] One explanation might be a person diversifying - both increasing their premium bond investment and engaging in gambling. On the other hand, due to different preferences, some individuals might respond to the news about a local top winner by investing in premium bonds, while others might turn towards gambling.

was derived from the Family Resources Survey. With respect to location, the FRS publicly available version only reveals a region of each respondent. Therefore, the areas of the £1 million premium bond winners, as published by the NS&I, needed to be also aggregated up to the regional level for the purpose of our analysis. As a consequence, some valuable information might have been lost, having led to a possible overestimation of the true effects.

Importantly, the positive effects of the winner announcements on the regional premium bond programme take-up rates, appear to include some individuals who did not hold any banking products before. In the month of the draw, the winner's region tends to experience an increase in the proportion of people with non-zero levels of savings, of 0.49 percentage points, associated with that winner's location announcement. During the second month after the draw, still there are by 0.26 percentage points more savers in the lucky region than expected had the region not experienced a win, albeit this effect is significant at the 0.9 confidence level. The conclusion about the £1 million winner announcement attracting new savers, is again consistent with the results obtained by Cole et al. (2014), who showed that the prize-linked savings programme in South Africa had induced participation of individuals from outside the banking system.

4.6 Conclusion

The National Savings and Investments' announcements of the areas each recently drawn millionaire comes from, have been found to alter the savings behaviours in those locations. During the two months following a draw, both a premium bond take-up rate as well as an average value invested in premium bonds was found to increase in the winner's region, as compared to the anticipated statistics in that area if the winner came from somewhere else. Hence, publishing the winners' locations induces new premium bond holders and larger deposits from the existing holders, resulting in the premium bond funds taking up a higher portion of the bondholders' overall savings. Meanwhile, an average value saved in other banking products tends to drop substantially in the lucky areas following the wins. This result suggests that the effect of NS&I's announcements about the winners encourages people to turn to premium bonds, but it does so at a cost to other forms of savings.

Overall, the 'hot-hand' effects analysed in this paper have been observed and documented with respect to lottery ticket purchases (Guryan and Kearney 2008) as well as the demand for the prize-linked savings products offered in South Africa (Cole et al. 2014). This paper contributes to the existing research in three major ways. First, by using a rich dataset of a UK-representative sample, it investigates the changes in behaviour of the savers responding to an exogeneous shock as compared to the entire population. Second, applying an extended synthetic control methodology allows for assessing the cumulative effects of the announcements of the winners' locations over a long time period, also exploring the differences in the regional responses depending on the characteristics of the winner. Our model accounts

for multiple draws as well as multiple winners in a single draw, as the number of the top premium bond winners fluctuated over the analysed time frame. Third, people's response to the NS&I publishing the lucky areas is considered in this paper by evaluating a broad range of outcome variables, including both the demand for premium bond measures, as well as the general savings behaviour.

This paper sheds light on the possible sources of funds allocated to premium bonds and, therefore, effectiveness of premium bonds in generating new savings. Those highly policy-relevant issues have been addressed in this paper in the specific context of announcing the top winners' locations after every draw. Further research is needed in order to evaluate the impact of one's decision to allocate money into such products as premium bonds on their overall savings portfolio in a broader context. To do this, some relevant individual-level panel data are necessary.

4.7 References

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4.A Appendix

Table 4.A.1: Locations[55] of the £1 Million Winners in Premium Bond Draws during Financial Years 1999/2000 - 2017/2018

Month of draw	Location of Winner
Apr 1999	Cheshire
May 1999	Lincolnshire
Jun 1999	Devon
Jul 1999	West Yorkshire
Aug 1999	Suffolk
Sep 1999	LB of Merton
Oct 1999	Derbyshire
Nov 1999	LB of Havering
Dec 1999	Leicestershire
Jan 2000	Suffolk
Feb 2000	LB of Ealing
Mar 2000	West Yorkshire
Apr 2000	Surrey
May 2000	Buckinghamshire
Jun 2000	Nottinghamshire
Jul 2000	Essex
Aug 2000	Lancashire
Sep 2000	Cardiff
Oct 2000	Nottinghamshire
Nov 2000	Suffolk
Dec 2000	Wiltshire
Jan 2001	Carmarthenshire
Feb 2001	LB of Lewisham
Mar 2001	Surrey
Apr 2001	Merseyside
May 2001	Lincolnshire
Jun 2001	GT Manchester
Jul 2001	Tyne and Wear
Aug 2001	Kent
Sep 2001	Warwickshire
Oct 2001	Hertfordshire
Nov 2001	Cornwall
Dec 2001	Merseyside
Jan 2002	West Yorkshire
Feb 2002	Overseas
Mar 2002	Hampshire
Apr 2002	LB of Hillingdon
May 2002	Somerset
Jun 2002	Cheshire
Jul 2002	East Sussex
Aug 2002	LB of Redbridge
Sep 2002	Hertfordshire
Oct 2002	Lancashire
Nov 2002	LB of Camden
Dec 2002	North Yorkshire
Jan 2003	East Sussex
Feb 2003	LB of Richmond
Mar 2003	Aberdeenshire
Apr 2003	Aberdeenshire
May 2003	Dorset
Jun 2003	LB of Kingston upon Thames
Jul 2003	Lancashire
Aug 2003	Surrey
Sep 2003	East Riding of Yorkshire
Oct 2003	Tyne and Wear
Nov 2003	Worcestershire
Dec 2003	Devon
Jan 2004	Berkshire
Feb 2004	Gloucestershire
Mar 2004	Cumbria
Apr 2004	Surrey
May 2004	Hampshire
Jun 2004	Lincolnshire
Jul 2004	LB of Newham
Aug 2004	Bristol
Sep 2004	Devon
Oct 2004	Oxfordshire
Nov 2004	LB of Richmond
Dec 2004	Hampshire
Jan 2005	LB of Haringey
Feb 2005	Lancashire
Mar 2005	Warwickshire
Apr 2005	LB of Bromley
May 2005	Berkshire
Jun 2005	Lancashire
Jul 2005	Hertfordshire
Aug 2005	Bristol
Aug 2005	Hampshire
Sep 2005	Surrey
Sep 2005	Co Armagh
Oct 2005	Lancashire
Oct 2005	Surrey
Nov 2005	Glasgow
Nov 2005	LB of Barnet
Dec 2005	Berkshire
Dec 2005	West Midlands
Jan 2006	Derbyshire
Jan 2006	LB of Tower Hamlets
Feb 2006	Staffordshire
Feb 2006	County Down
Mar 2006	Kent
Mar 2006	Fife
Apr 2006	Nottingham
Apr 2006	Glasgow
May 2006	Preston
May 2006	Buckinghamshire
Jun 2006	Warwickshire
Jun 2006	Cumbria
Jul 2006	Nottingham
Jul 2006	Hampshire
Aug 2006	County Antrim
Aug 2006	County Down
Sep 2006	Essex
Sep 2006	West Midlands
Oct 2006	Cheshire
Oct 2006	Edinburgh
Nov 2006	LB of Richmond Upon Thames
Nov 2006	Powys
Dec 2006	Leicestershire
Dec 2006	Surrey
Dec 2006	North Humberside
Dec 2006	Essex
Dec 2006	Glasgow
Jan 2007	Kent
Jan 2007	Cheshire
Feb 2007	Glasgow
Feb 2007	Hampshire
Mar 2007	Birmingham
Mar 2007	Wolverhampton
Apr 2007	Aberdeen
Apr 2007	LB of Hounslow
May 2007	Bristol
May 2007	LB of Richmond Upon Thames
Jun 2007	East Sussex
Jun 2007	Nottingham
Jun 2007	LB of Hammersmith & Fulham
Jun 2007	Tyne and Wear
Jun 2007	Kent
Jul 2007	Glasgow
Jul 2007	West Yorkshire
Aug 2007	Overseas
Aug 2007	Nottingham
Sep 2007	Kent
Sep 2007	Shropshire
Oct 2007	Manchester
Oct 2007	LB of Bexley
Nov 2007	LB of Islington
Nov 2007	Devon
Dec 2007	Southampton
Dec 2007	Swansea
Jan 2008	Lothian
Jan 2008	West Sussex
Feb 2008	LB of Hillingdon
Feb 2008	Gloucestershire
Mar 2008	Dumfries and Galloway
Mar 2008	Wiltshire
Apr 2008	LB of Camden
Apr 2008	Leicestershire

[55] "LB of (…)" stands for London Borough.

May 2008	Gwent
May 2008	Kent
Jun 2008	Devon
Jun 2008	Worcestershire
Jul 2008	East Sussex
Jul 2008	Birmingham
Aug 2008	Dorset
Aug 2008	Sheffield
Sep 2008	Somerset
Sep 2008	Manchester
Oct 2008	Surrey
Oct 2008	Lanarkshire
Nov 2008	Northants
Nov 2008	Cardiff
Dec 2008	LB of Barnet
Dec 2008	Derbyshire
Jan 2009	Warwickshire
Jan 2009	Buckinghamshire
Feb 2009	Hertfordshire
Feb 2009	Devon
Mar 2009	Wiltshire
Mar 2009	Kent
Apr 2009	Brighton & Hove
May 2009	Devon
Jun 2009	Surrey
Jul 2009	Lancashire
Aug 2009	Wales
Sep 2009	Suffolk
Oct 2009	Inner London
Nov 2009	Clwyd
Dec 2009	Kent
Jan 2010	Outer London
Feb 2010	Outer London
Mar 2010	Scotland
Apr 2010	Tayside
May 2010	Kendal
Jun 2010	Surrey
Jul 2010	West Yorkshire
Aug 2010	Barnet
Sep 2010	Grampian
Oct 2010	Bristol
Nov 2010	Yorkshire
Dec 2010	Tyne and Wear
Jan 2011	Dorset
Feb 2011	Cleveland
Mar 2011	Wirral
Apr 2011	Manchester
May 2011	Warwickshire
Jun 2011	Cardiff
Jul 2011	Somerset
Aug 2011	Yorkshire
Sep 2011	Humberside
Oct 2011	Yorkshire
Nov 2011	Liverpool
Dec 2011	Birmingham
Jan 2012	Bedfordshire
Feb 2012	Cambridgeshire
Mar 2012	Shropshire
Apr 2012	Staffordshire
May 2012	Devon
Jun 2012	Hereford and Worcester
Jul 2012	Kent
Aug 2012	Cheshire
Sep 2012	Hertfordshire
Oct 2012	Overseas
Nov 2012	Hertfordshire
Dec 2012	Bedfordshire
Jan 2013	London
Feb 2013	Essex
Mar 2013	Kent
Apr 2013	London
May 2013	Cumbria
Jun 2013	London
Jul 2013	Leeds
Aug 2013	West Sussex
Sep 2013	London
Oct 2013	Essex
Nov 2013	Tyne and Wear
Dec 2013	Leicestershire
Jan 2014	Suffolk
Feb 2014	Hertfordshire
Mar 2014	Avon
Apr 2014	Durham
May 2014	Gloucestershire
Jun 2014	Kent
Jul 2014	Essex
Aug 2014	West Sussex
Aug 2014	Reading
Sep 2014	Tyne and Wear
Sep 2014	Dorset
Oct 2014	Coventry
Oct 2014	Surrey
Nov 2014	Kirklees
Nov 2014	Leeds
Dec 2014	South West Wales
Dec 2014	Berkshire
Jan 2015	Bristol
Jan 2015	Leeds
Feb 2015	West Midlands
Feb 2015	Cornwall
Mar 2015	Inner London
Mar 2015	Stoke on Trent
Apr 2015	Wiltshire
Apr 2015	Suffolk
May 2015	Nottinghamshire
May 2015	Essex
Jun 2015	Wirral
Jun 2015	Overseas
Jul 2015	Wales
Jul 2015	Surrey
Aug 2015	Dorset
Aug 2015	Outer London
Sep 2015	Overseas
Sep 2015	South West Wales
Oct 2015	Cambridge
Oct 2015	Derbyshire
Nov 2015	East Sussex
Nov 2015	Warwickshire
Dec 2015	Bedfordshire
Dec 2015	Cumbria
Jan 2016	Leicester
Jan 2016	Leicester
Feb 2016	Nottingham
Feb 2016	Wales
Mar 2016	Leicestershire
Mar 2016	Tyne and Wear
Apr 2016	Mid Scotland and Fife
Apr 2016	Devon
May 2016	Surrey
May 2016	West Scotland
Jun 2016	Lincolnshire
Jun 2016	Kent
Jul 2016	West Sussex
Jul 2016	West Sussex
Aug 2016	Somerset
Aug 2016	Cornwall
Sep 2016	Lancashire
Sep 2016	Suffolk
Oct 2016	Staffordshire
Oct 2016	Essex
Nov 2016	City of Bristol
Nov 2016	Norwich
Dec 2016	Essex
Dec 2016	Gloucestershire
Jan 2017	West Sussex
Jan 2017	Hampshire & Isle of Wight
Feb 2017	Liverpool
Feb 2017	Outer London
Mar 2017	Outer London
Mar 2017	Devon
Apr 2017	Harrow
Apr 2017	East Sussex
May 2017	Cheshire East
May 2017	Tyne and Wear
Jun 2017	Surrey
Jun 2017	Devon
Jul 2017	Cumbria
Jul 2017	Dorset
Aug 2017	Leicestershire
Aug 2017	Bristol
Sep 2017	Nottingham
Sep 2017	Northumberland
Oct 2017	Essex
Oct 2017	Edinburgh
Nov 2017	Edinburgh
Nov 2017	Cambridgeshire
Dec 2017	Cornwall
Dec 2017	Kent
Jan 2018	Wiltshire
Jan 2018	Kent
Feb 2018	City of Bristol
Feb 2018	Durham
Mar 2018	Wiltshire
Mar 2018	Bedfordshire

Source: National Savings and Investments.

Table 4.A.2: Summary Statistics of Premium Bond Holders Distribution Across UK Regions

Region	Beginning of period: wave 1999/2000		End of period: wave 2017/2018		Full time frame: nineteen FRS waves		NS&I statistics: March 2019
	N	PB holders	*N*	PB holders	*N*	PB holders	
North East	2,591	3.6%	1,392	2.6%	34,241	3.3%	3.6%
North West	3,908	7.5%	2,637	9.0%	61,534	7.9%	10.8%
Yorkshire East	5,041	10.0%	3,274	8.1%	81,901	9.0%	7.8%
Midlands West	3,234	7.3%	2,138	8.0%	53,582	7.2%	7.0%
Midlands	3,986	7.9%	2,599	7.6%	63,347	7.7%	8.2%
East	1,862	4.7%	2,827	14.4%	56,906	10.9%	10.9%
London	4,640	12.0%	2,969	9.6%	72,280	10.8%	11.7%
South East	8,802	25.9%	3,721	18.2%	107,014	21.3%	16.9%
South West	3,846	11.6%	2,478	13.3%	58,629	11.9%	10.6%
Wales	2,450	3.9%	1,503	3.3%	36,391	3.9%	5.2%
Scotland	3,747	5.7%	4,597	6.0%	113,567	6.1%	7.3%
Overall	**44,107**	**100%**	**30,135**	**100%**	**739,392**	**100%**	**100%**

Note: The first three columns correspond to the Family Resources Survey data. Among those, the first sub-columns present the number of respondents of the survey living in each region. The second sub-columns show the distribution of the premium bond holders across the regions for the FRS grossed-up data. The last column provides information on the distribution on the number of premium bond accounts across the regions, obtained from National Savings and Investments, as of March 2019.

Table 4.A.3: Summary Statistics for the Sample of Premium Bond Holders

Region	Beginning of period: wave 1999/2000		End of period: wave 2017/2018		Full time frame: nineteen FRS waves	
	Mean PB value	Mean savings	Mean PB value	Mean savings	Mean PB value	Mean savings
North East	£1,353	£47,703	£8,036	£63,992	£2,927	£56,018
North West	£1,097	£50,167	£6,088	£124,195	£3,109	£68,256
Yorkshire	£1,185	£62,089	£6,940	£84,744	£3,178	£70,991
East Midlands	£1,076	£50,291	£7,189	£151,040	£3,275	£71,494
West Midlands	£1,419	£56,906	£6,854	£140,922	£3,327	£75,754
East	£1,417	£53,533	£7,966	£127,404	£4,236	£86,239
London	£1,692	£98,127	£9,761	£127,180	£4,390	£85,163
South East	£1,522	£71,785	£8,258	£150,255	£4,112	£95,394
South West	£1,690	£56,132	£7,817	£118,942	£3,969	£79,717
Wales	£1,333	£51,130	£5,202	£80,327	£3,512	£63,950
Scotland	£848	£56,989	£7,234	£167,386	£3,278	£82,801
Overall	**£1,399**	**£64,450**	**£7,639**	**£128,803**	**£3,741**	**£80,563**

Note: All the figures are adjusted for inflation. Both mean values of premium bonds and mean value of overall savings are provided among the premium bond holders only. Figures for savings refer to the total value of all the banking products held.

Table 4.A.4: Distribution of Premium Bond Holders and Premium Bond Holdings Across UK Regions, Compared to Frequency of Winning £1mln Prizes

Region	PB holders	PB holdings	No. £1mln winners
North East	3.3%	2.5%	3.8%
North West	7.9%	6.6%	9.9%
Yorkshire	9.0%	7.7%	5.4%
East Midlands	7.2%	6.3%	8.3%
West Midlands	7.7%	6.9%	7.3%
East	10.9%	12.3%	10.2%
London	10.8%	12.7%	11.8%
South East	21.3%	23.4%	18.5%
South West	11.9%	12.7%	14.1%
Wales	3.9%	3.6%	4.2%
Scotland	6.1%	5.3%	6.4%
Total	**100%**	**100%**	**100%**

Note: The two first columns refer to the FRS data, the results presented are grossed-up. The frequency of £1mln prizes in the premium bonds monthly draws is calculated based on the data received from National Savings and Investments.

Table 4.A.5: Summary Statistics for the Regional Characteristics

Region	Unemp-loyed	Economi-cally active	Men	No formal qualifica-tions	Ethnic minorities	Mean income	25th income percen-tile
North East	7.9%	59.4%	48.3%	14.4%	3.3%	£462	£252
North West	6.5%	62.2%	48.6%	13.7%	7.7%	£476	£253
Yorkshire	6.2%	61.5%	48.5%	14.3%	7.0%	£493	£262
East Midlands	5.6%	63.6%	48.8%	13.3%	7.9%	£494	£261
West Midlands	6.8%	62.1%	48.8%	16.0%	12.7%	£490	£263
East	4.8%	64.9%	48.6%	11.7%	6.4%	£558	£273
London	7.4%	66.1%	48.9%	11.3%	33.5%	£693	£348
South East	4.5%	65.9%	48.5%	8.9%	6.5%	£598	£293
South West	4.5%	63.2%	48.4%	8.9%	3.1%	£486	£250
Wales	6.2%	59.2%	48.4%	14.7%	2.9%	£468	£258
Scotland	6.2%	63.0%	47.6%	13.2%	2.7%	£500	£266
Overall	**6.0%**	**62.8%**	**48.5%**	**12.8%**	**8.5%**	**£520**	**£271**

Note: The regional characteristics are used as outcome predictors in the synthetic control estimations. All the figures are averages of the respective measures over the time frame consistent with the FRS data, i.e. financial years: 1999/2000 - 2017/2018. The monetary values are adjusted for inflation. Proportions of unemployed, economically active, and men come from Labour Force Survey. Proportions of population in the working age with no educational qualifications are derived from both Local Area Labour Force Survey (for observations prior to February 2004) and Annual Population Survey. Proportions of ethnic minorities come from Annual Population Survey. Mean incomes and the lowest quartiles of regional income distributions come from Annual Survey of Hours and Earnings - resident analysis.

Table 4.A.6: Summary Statistics on the Effects of £1 Million Winners on the Demand for Premium Bonds

Sample	Average effect on PB participation [pp]	Difference	Average effect on PB holdings [£]	Difference
High PB investment	3.581		1,034	
Low PB investment	4.361		768	
		0.780* **		**-266*** **
Pre-2005	3.359		530	
Post-2005	4.195		1,042	
		0.836* **		**512**
Men	3.104		645	
Women	4.739		1,178	
		1.635		**533*** **
Overall	3.955		895	

Note: The first set of columns refers to the average effects on the proportion of premium bond holders, measured in percentage points. The second set of columns refers to the average effects on the average value invested in premium bonds, measured in pounds. Categories: 'high PB investment' and 'low PB investment' refer to the groups of effects when the winner was reported to hold premium bonds of the value above and below the average level, respectively. Significance derived by applying an unpaired two-sample t-test for differences in means, reported for *, ** and *** at the levels of 10%, 5% and 1%, respectively.