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Price discrimination in the cash savings market: One rate, one solution?

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Summary

The Cash Savings Market Study found that the cash savings market is not working effectively for many consumers. Significant amounts of easy access cash savings sit in accounts opened a long time ago, earning lower interest rates than those opened more recently.

In this paper we explore the likely impact of a supply-side regulatory intervention that aims to enhance competition and improve consumer outcomes by delivering more uniform pricing across cash savings accounts. The intervention requires firms to have a single interest rate onto which a cash savings account reverts after a certain period of time (eg after a year). Firms are able to set this rate freely (in compliance with applicable legal requirements); the only restriction that they cannot discriminate by account age. We call this rate the Single Easy Access rate (SEAR).

We take a well-established model from economic literature and apply it to the data on the cash savings market to simulate the effect of the SEAR. We find that the SEAR is expected to result in a higher overall interest paid on easy access savings balances, as price-sensitive consumers are pooled with less sensitive ones – helping to 'protect' the latter. There is some waterbed effect because the overall higher interest rates for longstanding 'back-book' customers lowers their profitability, which reduces the ability and incentive for firms to pay high introductory interest rates for new 'front-book' customers.

The model predicts that under the SEAR, firms would pay a slightly higher overall average interest rate to their customers, adding up to a net increase of around £148m-£381m (median estimate is £261m) per year for the market total. The estimate takes into account the waterbed effect, so the benefit for back-book customers is larger than this but offset by the losses to the front- and mid-book customers.

The model quantifies the equilibrium price changes and market shares for small vs large firms. However, other aspects of competition are not quantified, such as increased price transparency that may enhance demand pressure, or those resulting from increased confidence in the cash savings market.

1 Overview

Introduction

In this paper we explore a supply-side regulatory intervention in the cash savings market that aims to enhance competition and improve consumer outcomes by delivering more uniform pricing across cash savings accounts.[1]

The cash savings market is not working effectively for many consumers because significant amounts of easy access savings sit in accounts that were opened long ago, paying lower interest rates than those opened more recently.[2] This is despite these older accounts being more stable in terms of annual change in balances, so they do not cost more to serve.

The market is characterised by a mix of active and inert consumers. The degree of customer engagement depends on many factors, and in some cases inactivity can be a rational choice. It is the interaction of active and inert consumers that can lead to very different pricing outcomes depending on how well firms can identify these consumer segments. When firms can offer different prices to different groups of consumers, and there is no search externality (ie inert consumers do not benefit from the presence of active consumers), the inert consumers receive lower interest rates than active ones. However, grouping these consumer segments into one may create a link between them, so that a positive search externality leads to the active and savvy consumers protecting the inactive ones. The reasoning is that a larger number of active consumers make demand more elastic, thereby making the combined group savvier than the (weighted) average of the two groups.

The intervention, called the Single Easy Access rate (SEAR), seeks to prevent firms from paying different interest rates to different consumers based on the age of account (after an initial period when a bonus interest rate can be offered). By doing so, we introduce a link between price-sensitive (front- and mid-book) and less price-sensitive consumers (back-book), so that the latter enjoy a positive search externality.

The SEAR requires firms to have a single interest rate onto which a cash savings account reverts after a certain period of time (eg after a year). It has a number of key features:

- Firms would not be able to price differentiate among accounts that are on the SEAR. At any point in time, all SEAR balances have to be on the same rate, regardless of the age, channel of sale, account size, or any other characteristics.

[1] This paper was originally published in July 2018. It was updated January 2019. The original publication of OP41 included an algebraic error that was also present in the modelling code. This has been revised, shifting the original policy impact from £150m-£479m to £148m-£381m. Other changes include a correction of a small number of typos.

[2] Cash Savings Market Study (FCA, 2015)

- There would be only one SEAR per firm, rather than several for different easy access cash savings products.[3] This is to ensure that the pooling effect is large enough to include the active as well as the inert consumer segments, rather than introducing SEARs for different consumer segments. This also has the potential to increase price transparency among back-book accounts.
- Each firm would be free to choose the level of SEAR and vary it over time.[4]
- There would be no restrictions on the interest rates offered on balances before they revert to the SEAR, so firms would be free to offer introductory rates to new accounts.

This paper takes a well-established model from the economic literature and applies it to data on the cash savings market to simulate the effect a SEAR might be expected to have on the market.[5]

Key findings

There are 3 key findings:

1. The introduction of the SEAR is expected to result in a higher overall interest paid on easy access savings balances, as price-sensitive consumers protect less sensitive ones.
2. Given that overall higher interest rates on the back-book lower the profitability of back-book customers, the SEAR may reduce the incentive of firms to pay high introductory interest rates for new front-book customers. This is known as a 'waterbed effect'. We find that it would partially offset the increase of interest rates on the back-book, but only marginally due to competitive pressures in the market.
3. Smaller, challenger, firms are impacted less by the SEAR as they have smaller back-books.

The model indicates that, under SEAR, market participant firms would pay a slightly higher average interest rate, adding up to around £148m to£381m (median estimate of £261m) per year for the whole market.[6] This estimate takes into account the waterbed effect, so the benefit for back-book customers is larger than this, while the losses to the front- and mid-book partially offset it.

The intuition behind the positive net impact is that the SEAR acts as a safety net for the more inert customers by pooling them with the more active ones. This estimate is obtained by looking at the difference between the modelled 'worlds'; one with the SEAR and one without it. This means that the impact is a comparison of where the markets would stabilise in the long run, rather than the immediate impact of introducing the SEAR.

[3] In this paper, we focus on easy access cash savings accounts. In practice, however, substitute products such as easy access cash ISAs should also be subject to a SEAR, so that product substitution does not undermine this policy.

[4] This assumes that a fair term in their contract allows them to do so, and they operate it fairly.

[5] The data collected as part of the Cash Savings Market Study (FCA, 2015) covering 13 firms, accounting for about 77% of balances in the market. The model is fitted to these data and we scale up the impacts to the entire market.

[6] The 90% confidence interval of the simulated SEAR impacts is £148m to£381m, meaning that under the given assumptions, this interval is expected to capture the actual impact 9 times out of 10.

However, caution should be taken if using these numbers alone to justify policy; other aspects of the policy should be considered alongside them. The model does not and is not intended to quantify:

- compliance costs to firms
- the potential impact on funding models and liquidity of banks and building societies
- the extent to which firms pass through any changes in their cost of funding to other markets, such as the changes in the lending market
- the potential impact on product design and innovation
- the potential improvement in competitive dynamics from a simplified price structure (one SEAR per firm compared with many on- and off-sale products as is currently the case)
- the impact on switching costs (task and search costs), although we expect these to decrease;
- the costs of not switching (delay costs), which are expected to reduce significantly and directly by the introduction of the SEAR
- the potential effect of increased confidence in the cash savings market

The first 4 would act as a cost to the market outcomes, while the others would improve them. For more on these other factors, see the FCA Discussion Paper DP18/06.

Structure of this paper

This paper is organised as follows:

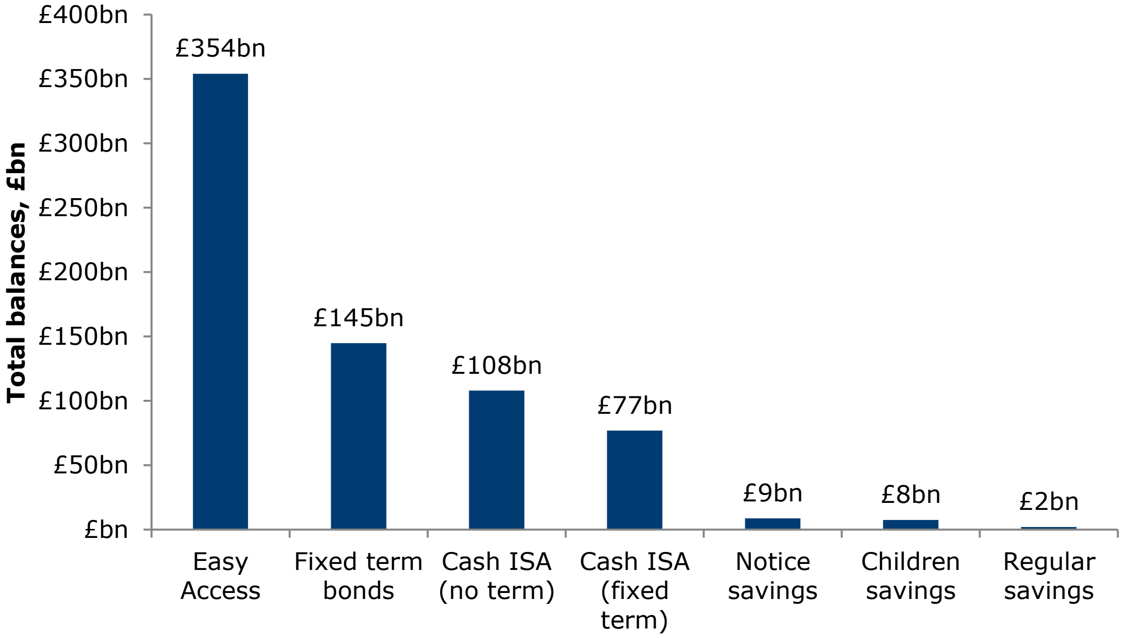
- Section 2 describes the context of this research.
- Section 3 describes the data used.
- Section 4 introduces the methodology and results.
- Section 5 concludes.
- The annexes give details on background literature, model derivation, and estimation methodology.

2 Research context

In January 2015, the FCA published the final report on its Cash Savings Market Study (the Market Study) highlighting that competition in this market is not working effectively for many consumers.

In 2017 87% of UK adults held a savings product.[7] The Market Study covered 7 main products comprising a total of £702bn in 2013. The most popular products were easy access cash savings accounts, which held £354bn worth of balances at the end of December 2013.[8] Easy access cash ISAs comprised £108bn in balances in 2013 (see Figure 1).

Figure 1: Total balances in the seven different types of cash savings accounts[9]



Easy access savings accounts have few or no restrictions on making additional deposits or withdrawals. These accounts include instant access accounts and no-notice accounts. Easy access accounts usually offer a variable rate of interest and an unlimited term. They may also offer a time-limited introductory bonus interest rate or a preferential interest rate to certain groups of customers that qualify for it.

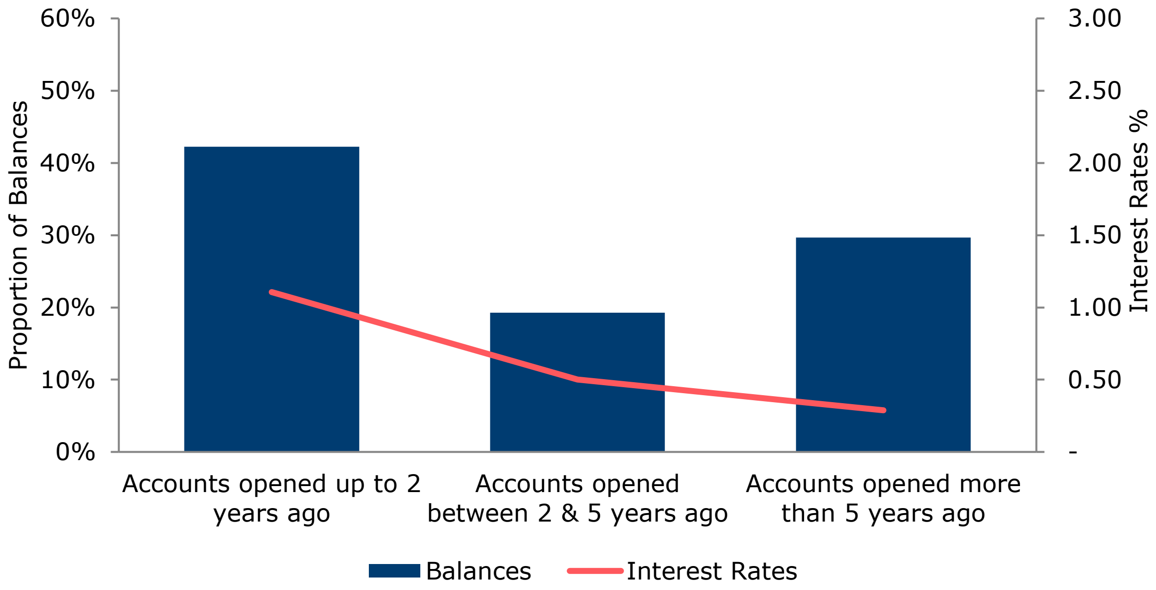
Cash ISAs pay interest tax-free. Easy access (no term) cash ISAs usually have a variable rate of interest and an unlimited term. Consumers can withdraw money from them with few or no restrictions (although doing so may impact the tax-free interest earned).

[7] Financial Lives Survey (FCA, 2017), p.119
[8] Based on a sample covering 77% of the market (FCA, 2015).
[9] Cash Savings Market Study (FCA, 2015), pages 56-57.

The FCA found that significant amounts of consumers' savings balances were in accounts opened long ago, with these accounts paying lower interest rates than those opened more recently. The study reported that as of end of December 2013, 33% of balances in easy access products[10] were in accounts more than 5 years old, while 46% of balances were in accounts more than 2 years old. At the same time, interest rates were on average 0.82 percentage points higher in accounts opened within the last 2 years than accounts opened more than 5 years ago (1.1% compared with 0.2%). This gap was 0.87 percentage points for cash ISAs. (1.6% compared with 0.7%).[11]

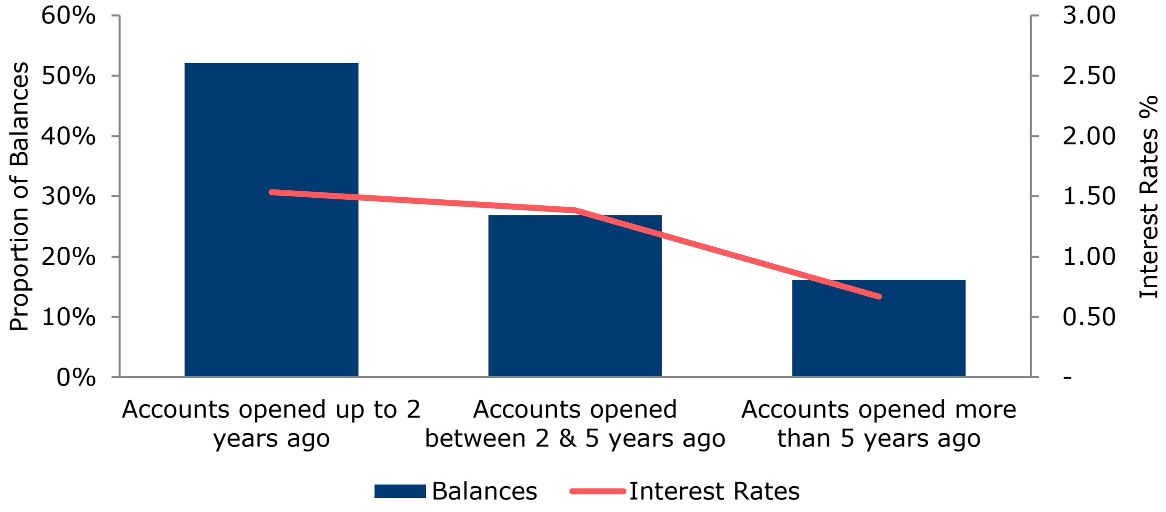
Figure 2 and Figure 3 illustrate the interest rate decline by account age for these products.

Figure 2: Proportion of balances and average interest rates for easy access accounts by age of account, December 2013[12]



[10] Those accounts with no notice period for withdrawals
[11] Cash Savings Market Study (FCA, 2015), pages 56-57
[12] Source: Cash Savings Market Study (FCA, 2015)

Figure 3: Proportion of balances and average interest rates for cash ISA products by age of account, December 2013[13]



The Market Study also showed that this type of price discrimination by age of account is evident from the market data in 2006, and 2010 to 2013. This is the case for individual firms as well as for the market aggregates illustrated above.

The FCA also found that smaller providers on average paid higher interest rates on easy access accounts than larger providers.

The figures above are consistent with the hypothesis that deposit takers can differentiate consumers according to their price sensitivity linked to the age of the account. Despite the lower rates for older accounts the observed levels of switching suggest consumer inertia. The Market Study shows that most variable rate savings accounts have not been switched in the last 3 years. Only 15% of easy access accounts and 23% of easy access cash ISAs were switched (both internally to the front-book and externally to other firms) at least once in the 3 years up to 2014.

Low levels of switching may be driven by the existence of actual or perceived search and switching costs for some consumers in the market. The Market Study mentions the lack of expected benefits (ie, low balance held in an account) and the convenience of having all banking products with the same provider among the factors that may cause the observed low levels of switching. Low awareness of customers' own interest rates, inattention, procrastination as well as the consequences of consumer mistakes may all play a role in apparent inertia in consumer behaviour. So the factors for low levels of engagement are both rational and behavioural.[14]

The Market Study concluded that the interest rate discrimination does not depend on the cost of provision. The costs of a cash savings account do not generally increase with the age of the account.[15]

[13] Source: Cash Savings Market Study (FCA, 2015)

[14] For an overview discussion of apparent inertia in consumer behaviour see Annex 1 of (Adams, Palmer, Hunt, & Zaliauskas, 2016).

[15] The FCA also added that "*The direct costs of a cash savings account are (i) account opening costs (which tend to be fixed and do not vary with the account balance or number of transactions); (ii) account maintenance costs (such as annual statements and*

These pricing patterns are not unique to the UK or to the studied time period. There is evidence of similar practices from studies on UK deposit data from 1999.[16] Similar practices exist internationally as well, with one example being the Spanish deposit market dating back to at least 1986.[17]

Such findings confirm the theoretical results in the academic literature.[18] The presence of perceived or actual switching costs lead firms to price discriminate between new and existing customers and competition does not eliminate the incentives to do so.[19]

Policy background

Following the Market Study, in 2015 the FCA published a Policy Statement[20] which introduced new rules to improve information provided pre- and post-sale, and the switching process. The package of remedies aimed to:

- make it easier for consumers to access information about savings products when shopping around
- make it easier for them to access information about the interest rate which applies to their savings account and
- make it clearer when this rate has changed

The FCA also published Occasional Paper 19 on the results of different randomised controlled trials on possible disclosure remedies, including a switching box providing additional information. The aim was to prompt more customers to consider their choice of savings account and provider.[21] It found that the trialled disclosure remedies had a low impact on consumer switching internally, and no impact on external switching due to low attention, and a cautious reaction, to disclosure.

Following from the Market Study and the disclosure testing, this paper considers a requirement that firms have a single interest rate onto which a cash savings account reverts after a specified period of time (eg after 1 year). We call this the Single Easy Access Rate (SEAR). See the FCA Discussion Paper DP18/06 on price discrimination in the cash savings market for a wider discussion on this topic and possible interventions to address price discrimination.

processing changes of address); and (iii) transaction costs (such as transfers in and out). Evidence we saw suggested that account opening and maintenance costs are broadly flat as the size of balances and the volume of transactions increase, while transaction costs increase with transaction volumes but are broadly flat as the size of balances increase."

[16] (Anderson, Ashton, & Hudson, 2014)

[17] (Carbo-Valverde, Hannan, & Rodriguez-Fernandez, 2011)

[18] See Annex 1: Literature review.

[19] For competition in the presence of switching costs, see (Klemperer, 1995). A good source for discussion of price discrimination in financial services is (Lukacs, Neubecker, & Rowan, 2016).

[20] Policy Statement PS15/27 (FCA, 2015)

[21] (Adams, Palmer, Hunt, & Zaliauskas, 2016)

3 Data

The data used in our analysis are based on the easy access cash savings market,[22] and were collected in July 2014 for the Market Study.

The dataset covers 13 large and small providers and tracks interest rates and balances held between January 2010 and June 2014.[23] The cash savings products offered by the 13 providers comprised total balances of around £150bn in 2010.[24] This includes on-sale products (ie products available to new customers) opened in the 4 quarters of 2010 and existing products that were off-sale (ie products not available to new customers) in the first quarter of 2010.

The on-sale product data consist of 4 cohorts of new customers who opened an account in different quarters of 2010. The first cohort includes all customers who opened an account in the first quarter of 2010; the second cohort includes all customers who opened an account in the second quarter of 2010 and so on.

The quarterly observations include balances (aggregated as well as broken down by balance intervals[25]), interest rates (aggregated and broken down by balance intervals), split by indicators of whether the product had a bonus rate, and whether the customers had a PCA with the deposit taker. This information is disaggregated at both product level and, for the on-sale products, at cohort level. Annex 3: gives more details on the database used.

Table 1: Brief overview of dataset on easy access cash savings accounts

	On-sale products	Off-sale products
Period	2010Q1 to 2014Q2	2010Q1 to 2014Q2
Number of observations	9,941	2,122
Balances at end of 2010	£89.58bn	£36.37bn

Trends on interest rates and balances

By tracing the interest rates across the observed time period, Figure 4 shows a sharp decrease after the first year from 1.50% to about 1.00%. This is followed by a gradual decline to about 0.80% in the subsequent years. The sharp decrease after the first year is consistent with the expiry of the bonus rate. The slower decline (on average) after the first year is consistent with the hypothesis that firms decrease interest rates as the

[22] Sometimes called 'instant access' cash savings.

[23] These 13 providers accounted for 16 brands.

[24] This excludes cash ISA products.

[25] The data are split by eight balance bands: Less than £10, between £10 and £1,000, between £1,000 and £5,000, between £5,000 and £10,000, between £10,000 and £25,000, between £25,000 and £50,000, between £50,000 and £85,000 and more than £85,000.

accounts age. In contrast, the (even older) off-sale products have a lower interest rate that is constant around 0.40% during this time period.[26]

There is also a visible increase in first year interest rates, especially in cohort 1. This is driven by a change in front-book rates of one of the large firms, which pushes the average up.

This figure is based on the interest rates (including bonus rates) weighted by the corresponding balances for the 13 cash savings providers in our sample.

Figure 4: Weighted average rates of cash saving account products 2010Q1 to Q4, aggregated by cohort

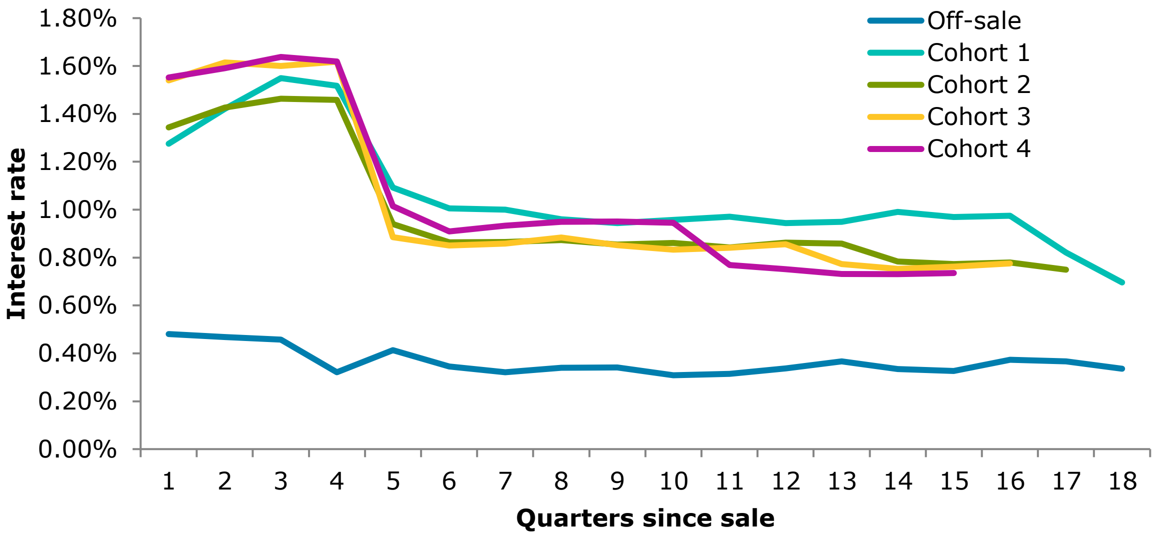


Figure 5 shows attrition of balances since their sale for the 4 cohorts (balances sold 2010Q1 to Q4) and existing 2010 off-sale balances cohort. Thus, Cohort 1 includes balances opened in 2010Q1, Cohort 2 opened in 2010Q2, etc. The balances are normalised to 100 at time of sale or normalised to 100 in 2010Q1 for off-sale (opened before but data are from 2010Q1).

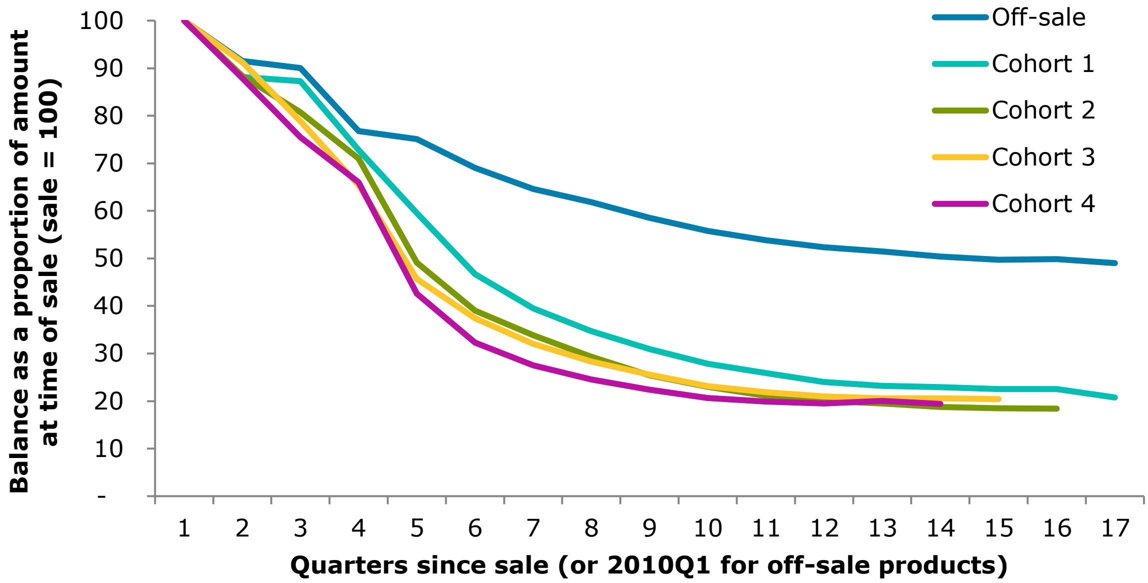
The attrition rate in a given period represents the balance in an account as a proportion of the balance held in the initial period. As an illustration, an attrition rate of 80% in the fourth quarter indicates that, at the end of the fourth quarter, 20% of the initial balance left the account. Note that there is no restriction on account holders paying in additional balances and for some providers there are instances where balances increase from one year to another.

The high rate of balance attrition is evident during the first 18 months, after which this attrition gradually decreases to about 10% to 15% per year. Off-sale balances are typically older accounts, for which the attrition is lower and between 25% and 4% per year. The figure suggests that older balances are much stickier than balances in recently opened accounts.

[26] The dispersion of interest rates in a specific time period, measured by the standard deviation of the sample, also decreases over time. This is not shown here.

Also, combined with Figure 4, the figures indicate that customers both switch when their interest rates decrease as well as gradual switching due to other factors.

Figure 5: Attrition of balances from cash saving account products on-sale 2010Q1 to Q4 and 2010 off-sale (weighted averages, first observation normalised to 100)



4 Modelling the SEAR

We draw from the extensive literature on switching costs to design the theoretical framework (see Annex 1 for further detail).

The theoretical model in this paper is based on Klemperer (1995) who shows how consumers' switching costs lead firms to offer introductory offers and, in his words, fiercely compete for market shares. Several papers apply Klemperer's theoretical framework to the bank deposit (including cash savings) market. In particular, Carbo-Valverde, Hannan & Rodriguez-Fernandez (2011) study price discrimination in the Spanish deposit market in different geographical areas. Building on Klemperer's framework, their model studies how prices depend on the proportion of new and existing customers, and how pricing decisions vary across regions with different levels of migration flows. The study concludes that firms offer higher interest rates in regions characterised by greater immigration (and therefore a larger number of new customers) and offer lower interest rates in regions where firms have large back-books of customers.

We extend the model presented in Carbo-Valverde, Hannan & Rodriguez-Fernandez (2011) by studying the way firms price discriminate between different groups of consumers.

Given our observation that providers of savings products typically pay different interest rates to different consumer groups by age of the account, our model allows for firms price discriminating between consumers based on the age of their account. For simplicity, we assume that a firm faces 3 different groups of consumers, namely a front-book, a mid-book and a back-book. It chooses the optimal interest rate for each group. To make the model tractable, the modelling assumes that firms know the price sensitivity of each consumer group.

There are some policy aspects of the SEAR that are not estimated by the model, primarily because they can and are considered separately, and because amending the model to include other aspects would make it much more complex and less tractable. These areas are:

- compliance costs to firms
- the potential impact on funding models and liquidity of banks and building societies
- the extent to which firms pass through any changes in their cost of funding to other markets, such as the changes in the lending market
- the potential impact on product design and innovation
- the potential improvement in competitive dynamics from a simplified price structure (one SEAR per firm compared with many on- and off-sale products as is currently the case)[27]

[27] At the end of 2013, the 21 providers in the sample covering 77% of the market, had 761 on-sale easy access products and over 1,300 off-sale products. See pages 56 and 63 of the Cash Savings Market Study (FCA, 2015)

- the impact on switching costs, although we expect these to decrease; the costs of finding a new product (task costs) would decrease for searching within the firm due to a more salient pricing difference between the SEAR and the front-book rate, and is expected to be unaffected outside the firm because the intervention does not restrict the new product offering
- the costs of not switching (delay costs), which are expected to reduce significantly and directly by the introduction of the SEAR
- the potential effect of increased confidence in the cash savings market

The first 4 would act as a cost to the market outcomes, while the others would improve them. For more on these other factors, see the FCA Discussion Paper DP18/06.

Theoretical foundations

We consider one firm that maximises profits over an infinite horizon choosing interest rates on deposits. Consumers demand one unit of deposits per period. They decide to save depending on the interest rate offered on deposits, the return on alternative products and their preference (eg risk attitude). The firm maximises the future stream of profits at time t, labelled by $\mathrm{V^t}$, defined as follows:

$$\mathrm{V^t} = \sum_{k=0}^{\infty} \delta^k \cdot \pi^{t+k} \qquad (1)$$

Here $\boldsymbol{\delta}$ denotes the firm's discount factor and profits at time t, π^t, are defined as:

$$\pi^t = \overbrace{(r_s^t - r^{o,t})x^{o,t}}^{current\ period's\ profits\ on\ backbook} + \overbrace{(r_s^t - r^{m,t})x^{m,t}}^{current\ period's\ profits\ on\ mid\ book} + \overbrace{(r_s^t - r^{n,t})x^{n,t}}^{current\ period's\ profits\ on\ front\ book}$$

The back-book profits in period t are defined as the gain earned on a unit of deposits $(r_s^t - r^{o,t})$ multiplied by the number of back-book depositors $x^{o,t}$. The mid-book profits in period t are defined as the gain earned on a unit of deposits $(r_s^t - r^{m,t})$ multiplied by the number of mid-book depositors $x^{m,t}$. Finally, the front-book profits in period t are defined as the gain on a unit of new deposit $(r_s^t - r^{n,t})$ multiplied by the proportion of new balances $x^{n,t} = \mathrm{new}^t Z^t$ from customers opening new accounts. Here new^t represents the number of new customers entering the market in period t. Z^t represents the firm's share of new customers.[28]

The next period's $(t+1)$ profits on the back-book are defined as the gain earned on a unit of next period's back-book deposit $(r_s^{t+1} - r^{o,t+1})$ multiplied by the size of next period's back-book balances $x^{o,t+1} = (\rho^{o,t+1}x^{o,t}) + (\rho^{o,t+1}x^{m,t})$. Next period's profits on the mid-book are defined as the gain earned on a unit of next period's mid-book deposit $(r_s^{t+1} - r^{m,t+1})$, multiplied by the size of mid-book $x^{m,t+1} = (\rho^{m,t+1}x^{n,t})$. The next period's profits on the front-book are defined as the gain earned on a unit of next period's front-book deposit $(r_s^{t+1} - r^{n,t+1})$, multiplied by the number of next period's front-book depositors $(\mathrm{new}^{t+1}Z^{t+1})$.

[28] We assume that a monopolist can commit to future pricing plans which has important consequences (for a wider discussion see the literature on Coase conjecture). We make this assumption to keep the model tractable.

This characterisation between profits in time t and $t+1$ can also be applied between $t+1$ and $t+2$, and so an infinite number of future periods. Equation (1) above uses this characterisation to aggregate the discounted future stream of profits.

We do not model firms' lending decisions. Instead, we assume that firms hold some securities in their portfolio and earn some interest. This is reasonable as it is unlikely that firms are large enough to affect the lending rates. Also, this allows us to keep the model tractable while retaining the main drivers of the market.

The balances thus evolve across periods, by taking in new balances that become mid-book in the next period and then back-book for all subsequent periods, subject to balance attrition. More formally, front-book balances in period t, $x^{n,t}$, become mid-book balance in $t+1$, as defined by the relationship $x^{m,t+1} = \rho^{m,t+1}x^{n,t}$. Here $\rho^{m,t+1}$ denotes the proportion of depositors in the front-book in period t that survive to period $t+1$. The front-book retention function depends on the mid-book interest rate at time $t+1$, $\rho^{m,t+1} = \rho^{m,t+1}(r^{m,t+1})$. Similarly, mid-book balances in time t become back-book balances in time $t+1$, subject to the mid-book retention rate. The mid-book retention is a function that depends on the back-book interest rate at time $t+1$. By the same mechanism, retention of back-book depends on the retention rate (itself a function of back-book interest rate at $t+1$) of back-book balances between t and $t+1$. So the back-book is described by the expression $x^{o,t+1} = \rho^{o,t+1}(r^{o,t+1})x^{m,t} + \rho^{o,t+1}(r^{o,t+1})x^{o,t}$. Table 2 shows how the 3 books evolve over time.

Table 2: Evolution of balances on the books at time *t*

Time	t	t+1	t+2	t+3	t+4	...
	$x^{o,t}$	$\rho^{o,t+1}x^{o,t}$	$\rho^{o,t+2}\rho^{o,t+1}x^{o,t}$	$\rho^{o,t+3}\rho^{o,t+2}\rho^{o,t+1}x^{o,t}$	...	...
	$x^{m,t}$	$\rho^{o,t+1}x^{m,t}$	$\rho^{o,t+2}\rho^{o,t+1}x^{m,t}$	$\rho^{o,t+3}\rho^{o,t+2}\rho^{o,t+1}x^{m,t}$	...	...
	$x^{n,t}$	$\rho^{m,t+1}x^{n,t}$	$\rho^{o,t+2}\rho^{m,t+1}x^{n,t}$	$\rho^{o,t+3}\rho^{o,t+2}\rho^{m,t+1}x^{n,t}$	...	...

The evolution of balances is thus very much dependent on retention rates. For stability of the model, it is required that for a given set of interest rates, $0 < \rho^{o,t} < 1$ and $0 < \rho^{m,t} < 1$ for all t. This is consistent with the data; on average we see partial retention of the balances, as shown in Figure 5. In practice, this is achieved by the choice of functional form of $\rho^{o,t}$ and $\rho^{m,t}$ (page 30).

The retention function is thought of as the probability of a given £1 in balances to switch away from the firm. We assume that the retention functions are increasing functions of the interest rates. This means that the higher the interest rate, the more likely it is that the firm will retain those customers' balances. This assumption about balance retention is confirmed by the data (see Figure 4 and Figure 5).

Moreover, we assume that consumers in the mid-book and in the back-book do not factor in the front-book rate, ie the rate they would get by switching. This is a simplification that reflects the fact that these consumers are relatively inelastic. In fact, the Market Study found that more than 50% of consumers who responded to the Market Study survey either did not know, or were unable to estimate, their interest rate. Moreover, more than half (56%) of the respondents did not know whether their provider was offering a similar account with a different interest rate to their savings account in which they had the highest balance. It also found that consumers are typically overly optimistic about how little their variable rate may change in the future, which may explain why they do not scrutinise what happens with their interest rates over time.

Demand is modelled with the demand function Z^t, determining the amount of new balances deposited with the firm. These new balances come from switching in the market as well as moving balances from other substitute markets. We assume that Z^t is a function of the front-book rate and depends positively on $r^{n,t}$ and negatively on $\bar{r}^{n,t}$, $Z^t = Z^t(r^{n,t}, \bar{r}^{n,t}, y)$, where $\bar{r}^{n,t}$ is a proxy for an exogenous outside option of a substitute product. It is also a function of exogenous non-price factors contained in y, which includes factors such as brand recognition, branch network, etc. We recognise this is a simplification of competition, as demand only depends on the rate provided by the firm and exogenous factors. Rates offered by other firms are not factored in.[29]

Impact evaluation

We solve the model described above by calculating the equilibrium profit maximising interest rates. In equilibrium, firms choose the interest rate for each consumer group (ie front-, mid- and back-book).[30]

We then adjust the model parameters to match the data characteristics, the interest rates and the balance distribution between front-, mid- and back-books. We call this the 'no-SEAR model'.

Next, we constrain the firm's pricing ability, so that it can only set 2 interest rates, one for the front-book and one for the mid- and back-book, ie the SEAR. We refer to this as the 'SEAR model'.

To assess the impact of the SEAR, we compare the no-SEAR and the SEAR model outputs. In both sets of outputs, firms are choosing the profit maximising sets of interest rates and consumers respond in line with different interest rates provided. The set of outputs used is shown in Table 3 – the total interest paid under each model is calculated and the difference yields the impact estimate.

Table 3: Outputs of the pre-SEAR model versus the outputs of the post-SEAR model

<table>
<tr><th></th><th colspan="2">No-SEAR model outputs</th><th colspan="2">SEAR model outputs</th></tr>
<tr><td>Front-book</td><td>Front-book rate ($r^{n,t}$)</td><td>Front-book balances ($x^{n,t}$)</td><td>New front-book rate ($r^{n,t}$)</td><td>Front-book balances ($x^{n,t}$)</td></tr>
<tr><td>Mid-book</td><td>Mid-book rate ($r^{m,t}$)</td><td>Mid-book balances ($x^{m,t}$)</td><td rowspan="2">SEAR ($r^{BSR,t}$)</td><td>Mid-book balances ($x^{m,t}$)</td></tr>
<tr><td>Back-book</td><td>Back-book rate ($r^{o,t}$)</td><td>Back-book balances ($x^{o,t}$)</td><td>Back-book balances ($x^{o,t}$)</td></tr>
</table>

[29] It is possible to take this model a step further to incorporate competitive dynamics in the demand function. However, for the purposes of this policy evaluation, we use a simplified form of demand that is more tractable and is possible to estimate with the existing datasets.

[30] Annex 2 shows the mathematical expression of the interest rates in equilibrium.

We model a 'market equilibrium' where both supply and demand determine the market prices. These two sides interact, that is, firms respond to consumer behaviour and consumers also respond to firm pricing.

First, this equilibrium is a long-run steady state which assumes that interest rates and consumer behaviour are in a long-run stable balance, where neither firms nor consumers will change their behaviour in the absence of external factors. The equilibria are not unique, rather they would change if the economic environment were to change. This is based on the idea that firms have found the optimal prices and consumer behaviour is stable over time, given the economic environment characterised by the data. In practice, this assumption means the data onto which the model is fitted (2010-2014) are assumed to represent a long-run stable dynamic. This is a simplifying assumption, because although base rates largely did not change during this time, other factors have changed, such as quantitative easing and evolving consumer confidence in the economy, among others. The interpretation of these results is thus one of a comparison of two worlds, one current and another counterfactual with SEAR, both of which are in a stable equilibrium. In other words, the modelled impact of the SEAR is not the expected immediate impact of SEAR implementation but a parallel market with the SEAR *ceteris paribus* – where everything else is held equal.

Secondly, the model assumes that this is a 'closed market', where cash savings balances remain constant. This is again a simplifying assumption, as in reality consumers can move their savings into other products, such as fixed term. However, this market appears stable in terms of account ownership[31] and outstanding balances over time.[32] Figure 1 also shows the much larger relative size of easy access outstanding balances to other cash savings products, suggesting that the instant access feature is not trivial in terms of product substitution.

Results

The model outputs fit as closely as possible to the data. The fit of interest rates can be seen by comparing the dotted line of actuals with the dark line of model in Figure 6. The balance distribution fit is shown in Figure 7 by comparing the left (bright) columns with the middle (dark) columns. The dotted line and the left columns indicate the market actuals, based on the data. This serves as a goodness of fit measure.

The policy impacts are obtained by comparing the modelled values with and without SEAR. So the SEAR counterfactuals are obtained by switching it on in the model. The policy impact on the interest rates is the difference between the burgundy and the bright solid lines in Figure 6. The policy impact on the distribution of balances is the difference between the burgundy and right (bright) columns in Figure 7. Multiplying the differences in interest rates and the changes in balances yields the policy impact per firm. We then scale these differences up to the market level.

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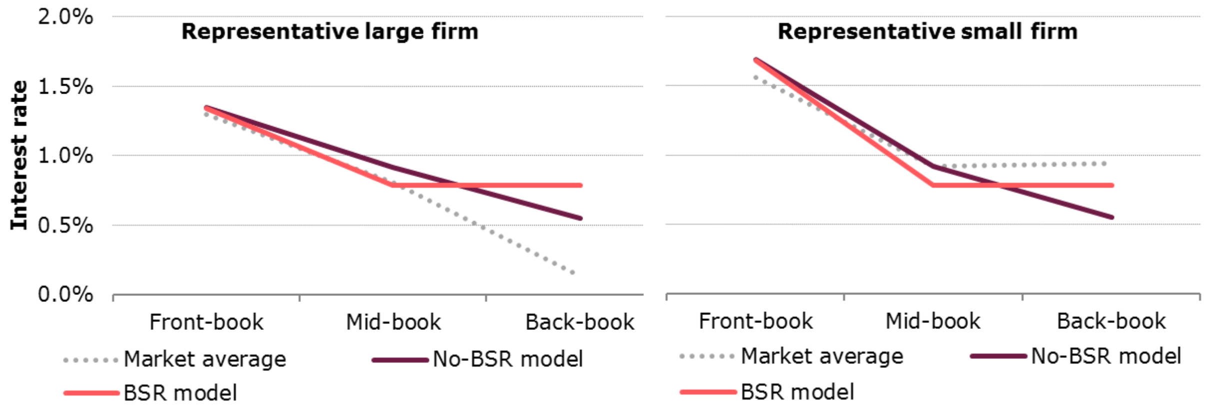
[31] GfK reports any cash savings ownership at 59% in 2013, 53% in 2015 and 54% in 2017.

[32] Bank of England data show that the total outstanding retail savings balances in September 2017 was £1,595bn, up from £1,133bn in January 2010. This is equivalent to cumulative annual growth rate in balances of 5%.

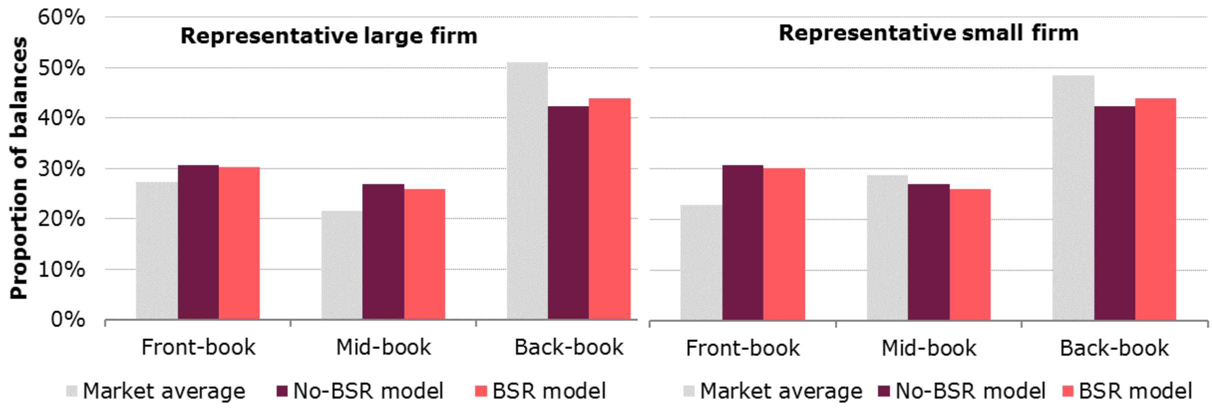
Figure 6: Interest rates – actuals and model simulation[33]



The calculated SEAR (bright solid line) is expected to be slightly below the unrestricted front- and mid-book and above the unrestricted back-book rates (dark).

The SEAR affects the balance distribution between front-, mid- and back-books, as consumers change their behaviour in response to the changes in the interest rates. This is the demand side response. Under the SEAR, the mid-book customers are expected to switch more and the back-book customers less. These differences are relatively small, as shown in Figure 7.

Figure 7: Balance distribution - actuals and model simulation[34]



The slight decrease in retention rate in the mid-book indicates that customers are expected to switch some of their balance onto a new product either within the firm or

[33] We note that the data on small firms are only partial and do not capture the majority of small firms or some of their typical characteristics. For instance, we know from a different dataset collected as part of the 2015 Market Study that the small firms in 2013 had relatively smaller back-books. However, the sample in the cohort data used here does not replicate this characteristic. So the results are more reliable for large firms than small firms. Nevertheless, using the data on these firms is still beneficial for the modelling purposes as it adds other dimensions, such as demand response to the firms in the sample. Having a broader representation of small firms in the dataset would improve the modelling accuracy but it would not change the conclusion of this paper. This is because the larger firms drive the results (due to their size) and our data do cover them.

[34] As in the footnote above, we note that the data on small firms are only partial and do not capture the majority of small firms or some of their typical characteristics. The results are more reliable for large firms as opposed to small firms.

externally to another. At the same time, the back-book customers are expected to decrease switching slightly. Those who switch move balances onto the front-book.[35]

Taking these results together, we calculate that the change in interest paid as a result of the SEAR is about £261m in the easy access cash savings market (excluding cash ISAs), with the 90% confidence interval of £148m-£381m per year. Given that the total balances in this market in 2013 were £354bn, this is an average increase in the interest rate paid on savings accounts of about 0.074 percentage points.

[35] As explained in the beginning of this section we assume that this is a closed market such that consumers are not switching savings balances to other savings products.

5 Conclusion

This paper builds on a well-established economic model and applies it to the UK cash savings market. This allows us to understand the competitive dynamics between firms, and the market interaction between firms and consumers. We calculate a counterfactual equilibrium in the form of a Single Easy Access rate (SEAR) which constrains firms' ability to price discriminate their existing customers' products. This allows us to quantify what impact the SEAR might have compared to a world where it did not exist. The model estimates how the SEAR would change the market interest rates (supply side) and the switching dynamics among consumers (demand side).

We find that the introduction of the SEAR means that those in the front-book and mid-book would receive lower interest payments, and those in the back-book would benefit from higher interest payments. At the same time, the demand side responds by adjusting the switching patterns. Total front-book balances increase slightly, mid-book balances decrease and back-book balances increase. The net outcome in terms of interest paid is a positive transfer from firms to consumers.

The intuition behind these results is that by restricting the ability to price discriminate we pool the more active consumers (mid-book) with the less active, inert, ones (back-book). In the SEAR world, firms do not have the ability to price discriminate between the less and the more inert consumers. They therefore have to take into account the price sensitivity of the more active customers when setting the price for all their existing customers.

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Annex 1: Literature review

The theoretical model we developed in this paper is based on Klemperer (1995). Klemperer shows how consumers' switching costs lead firms to offer introductory offers and fiercely compete for market shares. We refer to Farrel & Klemperer (2006) for an extensive review. Several papers apply Klemperer's theoretical framework to the bank deposit (including cash savings) market.

Carbo-Valverde, Hannan & Rodriguez-Fernandez (2011) study price discrimination in the Spanish deposit market in different geographical areas. The study concludes that firms offer higher interest rates in regions characterised by greater immigration (and therefore a large number of new customers) and offer lower interest rates in regions where firms have large back-books of customers. This confirms the theoretical findings whereby firms compete fiercely for new customers and exploit existing ones. Hannah (2008) also studies the pricing pattern in different geographical areas in the US and finds that firms offer higher rates on deposits in areas that experience higher level of immigration compared to lower interest rates in areas with lower immigration.

Deuflhard (2016) finds similar results using data on Dutch savings products. Deuflhard observes that older accounts pay lower rates than newer accounts.

Anderson, Ashton & Hudson (2014) compare interest rates across accounts with different ages. By using UK data on easy access savings they find that older accounts receive significantly lower interest rates than recently opened accounts. The paper describes the implication of a low level of consumer switching for both prudential financial regulation and competition policy. While beneficial as it results in more stable source of funding, low switching may be a symptom of weak competition and consumers may obtain lower returns than in a competitive market.

More recently, Siciliani & Beckert (2017) study competition in the presence of heterogeneous switching costs through the lens of a spatial linear model. This study contributes to the literature on competition and switching costs. They consider the impact of regulatory intervention on price discrimination by age of the product (they call it history-based price discrimination) by making it easier for internal switching (labelled as 'leakage') and finds that this increases firms' customer acquisition costs. At the same time, they find that the presence of smaller firms causes leakage, and regulatory intervention which mandates leakage only for the larger firm greatly benefits smaller rivals. The imposition of such measures by a regulator may be detrimental to consumers, unless market shares are sufficiently skewed and/or the relative inconvenience of external switching is not too high. Tariff proliferation means that too many tariffs with different formats might be created, which would make it very difficult to identify the best one. Siciliani & Beckert find that there could be a need for measures designed to facilitate internal switching by removing firms' incentives for allowing tariffs to proliferate.

Brown, Guin & Morkoetter (2014) study the withdrawals patterns from European commercial banks after the financial crisis. They find that withdrawal (which can be interpreted as switching) is lower when consumers have a strong relationship with the firm. For example, they identify the physical proximity to the firm and the existence of a credit relationship as factors that prevent consumers from withdrawing retail deposits.

Papers by Varian (1980), Salop & Stiglitz (1977) and Stahl (1989), study the interaction between active and inert consumers leading to different outcomes depending on market characteristics. As active consumers protect inert ones, average prices decrease as the proportion of savvy consumers increases. The intuition is that a larger number of active consumers make demand more elastic and firms will increase the average price.

Armstrong (2015) considers an extension of Varian (1980) and argues that, when firms are able to offer different prices to different groups of consumers, the link between the two groups is broken and there is no search externality (ie inert consumers do not benefit from the presence of active consumers). This is relevant for the introduction of the SEAR as it prevents firms from paying different interest rates to different consumers based on the age of account. By doing so, it reintroduces a link between price-sensitive and less price-sensitive consumers and the latter enjoy a positive search externality.

If the SEAR impacts the market so that the funding costs are higher due to higher interest paid on savings, the firms may seek to re-price their other products. Harimohan, McLeay, & Young (2016) shed some light on how firms may react as a result of a shock on the funding costs. The paper suggests that most firms are able to pass higher funding costs (deposit rates) through onto lending (proxied by a 75% loan-to-value mortgage rate). This mechanism depends on the firms' wholesale funding costs as well, measured by credit default swap (CDS) premiums.

Annex 2: Model description

The model

First order conditions

We solve the model in (1) by finding the interest rates that maximise the present discounted sum of profits. We assume a steady state where the model is stable over time, which simplifies the expressions and makes the model solvable.

Differentiating the discounted future profits with respect to back-book rate $\mathrm{r}^{\mathrm{o,t}}$, mid-book rate $\mathrm{r}^{\mathrm{m,t}}$and front-book rate $\mathrm{r}^{\mathrm{n,t}}$, in the steady state we obtain the following first order conditions:

$$\frac{\partial \mathrm{V}^{\mathrm{t}}}{\partial \mathrm{r}^{\mathrm{o,t}}} = -\rho^{o} + (r_s - r^{0})\frac{\partial \rho^{o}}{\partial r^{o}}\frac{1}{1-\delta\rho^{o}} = 0$$

$$\frac{\partial \mathrm{V}^{\mathrm{t}}}{\partial \mathrm{r}^{\mathrm{m,t}}} = -\rho^{m} + (r_s - r^{m})\frac{\partial \rho^{m}}{\partial r^{m}} + (r_s - r^{o})\frac{\partial \rho^{m}}{\partial r^{m}}\frac{\delta\rho^{o}}{1-\delta\rho^{o}} = 0$$

$$\frac{\partial \mathrm{V}^{\mathrm{t}}}{\partial \mathrm{r}^{\mathrm{n,t}}} = -\mathrm{Z} + (r_s - r^{n})\frac{\partial Z}{\partial r^{n}} + \delta(r_s - r^{m})\rho^{m}\frac{\partial Z}{\partial r^{n}} + \delta^{2}(r_s - r^{o})\rho^{m}\frac{\partial Z}{\partial r^{n}}\frac{\rho^{o}}{1-\delta\rho^{o}} = 0$$

First, consider the expression for $\frac{\partial \mathrm{V}^{\mathrm{t}}}{\partial \mathrm{r}^{\mathrm{o,t}}}$. This condition implies that the loss in current period profits resulting from a unitary increase of the interest rate on the back-book, $-\rho^{o}$, must be equal to the future gains on the back-book resulting from retaining additional customers, $(r_s - r^{0})\frac{\partial \rho^{o}}{\partial r^{o}}\frac{1}{1-\delta\rho^{o}}$.

The second condition is very similar. It implies that the loss in current period profits resulting from a unitary increase of the interest rate on the mid-book, $-\rho^{m}$, must be equal to the future gains resulting from retaining additional customers, $(r_s - r^{m})\frac{\partial \rho^{m}}{\partial r^{m}} + (r_s - r^{o})\frac{\partial \rho^{m}}{\partial r^{m}}\frac{\delta\rho^{o}}{1-\delta\rho^{o}}$.

The third first order condition implies that the loss in current-period profits resulting from a unitary increase of the interest rate on the front-book, Z, must be equal to the sum of current-period gain on the front-book resulting from attracting additional new customers, $(\mathrm{r_s} - \mathrm{r^n})\frac{\partial \mathrm{Z}}{\partial \mathrm{r^n}}$, and the additional future profits on the back-book resulting from having a larger mid- and back-book, $\delta(r_s - r^{m})\rho^{m}\frac{\partial Z}{\partial r^{n}} + \delta^{2}(r_s - r^{o})\rho^{m}\frac{\partial Z}{\partial r^{n}}\frac{\rho^{o}}{1-\delta\rho^{o}}$.

Note that when the rates on the back-book r^{o} increase, current-period front-book rates $\mathrm{r}^{\mathrm{n,t}}$ are reduced. This is because future profits on the back-book are squeezed as a result of an increase in the future back-book rate, and therefore the incentives to attract new customers today (who represent the future back-book) are reduced. This reduces the appeal to compete fiercely for new customers in the current period, because new customers are now less valuable. This in turn reduces the incentives to increase front-book rate in the current period.

First order condition for the SEAR

This section describes the model with the SEAR in place where firms maximise their profits by choosing one front-book rate and a single rate for the back-book, the SEAR .

Similarly to the case illustrated in equation (1), firms' net present value profits (or value function) are

$$V^t = \sum_{k=0}^{\infty} \delta^k \cdot \pi^{t+k} \tag{2}$$

where δ represents the discount factor and profits π in period t are equal to

$$\pi^t = (r_s^t - r^{SEAR,t})(x^{o,t} + x^{m,t}) + (r_s^t - r^{n,t})new^t Z^t$$

Differentiating the discounted future profits with respect to $r^{SEAR,t}$ and $r^{n,t}$ we obtain the following first order conditions:

$$\frac{\partial V^t}{\partial r^{SEAR,t}} = -(x^o + x^m) + \left(r_s - r^{SEAR}\right)\frac{1}{1-\delta\rho^o}\left(\frac{x^o}{\rho^o}\frac{\partial\rho^o}{\partial r^{SEAR}} + \frac{x^m}{\rho^m}\frac{\partial\rho^m}{\partial r^{SEAR}}\right) = 0 \tag{3}$$

The first order condition on the front-book is the same as for the baseline model.

Annex 3: Structure of the data

The data are set up in4 cohorts of new balances for products that are on sale, and one large cohort of older balances from products that are no longer on sale. Table 4 illustrates this structure.

Table 4: Data availability by age of account

	Front-book (0-1y old balances)		**Mid-book (1.5y-2.5y old balances)**		**Back-book (balances older than 2.5y)**	
	Interest rates	Balances	Interest rates	Balances	Interest rates	Balances
2010Q1-2010Q4	✓	✓	×	×	✓	✓
2011Q1-2011Q2					✓	✓
2011Q3-2012Q2	×	×	✓	✓	✓	✓
2012Q3-2013Q2	×	×	×	×	✓	✓
2013Q3-2014Q2	×	×	×	×	✓	✓

Annex 4: Model estimation approach

Estimation methodology – Minimum-distance estimator

We estimate the vector of parameters $\psi = \{\alpha, \beta_1, \beta_2\, \mu, \lambda, \lambda^m\}$ using a minimum-distance estimator. This estimator chooses parameters that best match moments in the data with the corresponding moments computed from the model's numerical solution.[36]

We fit the model against small and large firms; this is denoted with the subscript i below. These are thought of as representative of small and large firms, where the only difference is the front-book demand, as described in moments 1 and 2. We estimate the interest rate elasticity separately for each type of firm, as denoted by $(\beta_1 + \beta_2)$ for large and β_1 for small.

The model is assumed to be a steady state representation of this market. In order to smooth out the temporary shocks, we average the data across time. In the notation below, we thus drop the time superscript (t) and the bar notation indicates averaging across time. The intuition is that in a steady state the system is in equilibrium so it does not change over time. The outcome variables, such as interest rates, market shares and retention rates are stable over time.

We use the following set of moments, $m(\psi)$:

1. The fraction of new balances for *large firms* in the market, which in the model equals
$$Z_i = \alpha y_i + (\beta_1 + \beta_2)(r_i^n - \bar{r}^n)$$

2. The fraction of new balances for *small firms* in the market, which in the model equals
$$Z_i = \alpha y_i + \beta_1 (r_i^n - \bar{r}^n)$$

3. The front-book interest rate for *large firms*, which comes from the profit maximising first order condition
$$r_i^n = \frac{1}{2(\beta_1 + \beta_2)}\Big[-\alpha y_i + (\beta_1 + \beta_2)(r_s + \bar{r}^n) + \delta(\beta_1 + \beta_2)(r_s - r_i^m)\rho_i^m + \delta^2(\beta_1 + \beta_2)(r_s - r_i^o)\rho_i^m \frac{\rho_i^o}{1 - \delta\rho_i^o}\Big]$$

4. The front-book interest rate for *small firms*, which comes from the profit maximising first order condition

[36] For a textbook discussion of minimum-distance estimation method, see for example Chapter 13 of (Greene, 2012). An example of its application can be found in (Gavazza, 2016).

$$\mathrm{r_i^n} = \frac{1}{2\beta_1}\Big[-\alpha y_i + \beta_1(\mathrm{r_s} + \bar{\mathrm{r}}^{\mathrm{n}}) + \delta\beta_1(\mathrm{r_s} - \mathrm{r}_i^{m})\rho_i^{\mathrm{m}} + \delta^2\beta_1(\mathrm{r_s} - \mathrm{r}_i^{o})\rho_i^{\mathrm{m}}\frac{\rho_i^{\mathrm{o}}}{1-\delta\rho_i^{\mathrm{o}}}\Big]$$

5. The mid-book interest rate from the profit maximising first order condition

$$\mathrm{r_i^m} = \mathrm{r_s} - \frac{\left(1 - \frac{1}{\lambda^m}\exp\left(-\lambda^m\frac{\mathrm{r_i^m}}{\mathrm{r_s}}\right)\right)}{\frac{1}{\mathrm{r_s}}\exp\left(-\lambda^m\frac{\mathrm{r_i^m}}{\mathrm{r_s}}\right)} + (\mathrm{r_s} - \mathrm{r}_i^{o})\cdot\frac{\delta\left(1-\mu\exp\left(-\lambda\frac{\mathrm{r_i^o}}{\mathrm{r_s}}\right)\right)}{1-\delta\left(1-\mu\exp\left(-\lambda\frac{\mathrm{r_i^o}}{\mathrm{r_s}}\right)\right)}$$

6. The back-book interest rate from the profit maximising first order condition

$$\mathrm{r_i^o} = \mathrm{r_s} - \left(1-\mu\exp\left(-\lambda\frac{\mathrm{r_i^o}}{\mathrm{r_s}}\right)\right)\left[\frac{1-\delta\left(1-\mu\exp\left(-\lambda\frac{\mathrm{r_i^o}}{\mathrm{r_s}}\right)\right)}{\frac{\lambda\mu}{\mathrm{r_s}}\exp\left(-\lambda\frac{\mathrm{r_i^o}}{\mathrm{r_s}}\right)}\right]$$

7. The mid-book retention rate

$$\rho_i^{\mathrm{m}} = 1 - \frac{1}{\lambda^m}e^{-\lambda^m\frac{\mathrm{r_i^m}}{\mathrm{r_s}}}$$

8. The back-book retention rate

$$\rho_i^{\mathrm{o}} = 1 - \mu e^{-\lambda\frac{\mathrm{r_i^o}}{\mathrm{r_s}}}$$

The discount factor δ is thought of as the weighted average cost of capital. As a simplification, the discount rate is fixed to one minus the average lending rate,[37] $\delta = 1 - \frac{1}{\mathrm{T}}\sum_t \mathrm{r_s^t}$, where $\mathrm{r_s^t}$ is assumed exogenous. The data average yield $\frac{1}{\mathrm{T}}\sum_t \mathrm{r_s^t} = 3.95\%$ and so $\delta = 0.9605$.[38]

We then match the simulated moments with the data. This follows Hansen's (1982)[39] optimal two-step estimator, which is of the form

$$\hat{\psi} = \arg\min_{\psi\in\Psi}\{(m(\psi) - m_S)'\mathbf{\Omega}(\tilde{\psi})(m(\psi) - m_S)\}$$

where $m(\psi)$ is the vector of moments above, evaluated at the parameter vector ψ. Further, m_S is the corresponding vector of sample moments based on the data, and $\mathbf{\Omega}(\tilde{\psi})$ is a consistent (first-step) estimate of the inverse of the asymptotic variance-covariance matrix of the moments, obtained a preliminary consistent estimate $\tilde{\psi}$ of ψ.

In practice, we use the identity matrix for the initial weighting matrix to obtain a first-step consistent estimate of $\tilde{\psi}$. We specify all moment conditions in the form $E\left(\frac{m(\psi)-m_S}{m_S}\right) = 0$, thereby rescaling of the moments in percentage deviation from their target means, ie $\frac{m(\psi)-m_S}{m_S}$. This rescaling is because some of the moments have different scale (the

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[37] We assume that the lending rate is the standard variable mortgage rate prevailing in 2010-14. These data are obtained from the Bank of England, quoted household interest rates, combined from banks and building societies – IUMTLMV – Monthly.

[38] The effect of choosing different values of δ between 0.85 and 0.98 is shown in the sensitivity analysis below.

[39] (Hansen, 1982)

retention rates and the fraction of new balances) than others (interest rates). This approach also makes the numerical routines more stable.[40]

In the second step, we use $\mathbf{\Omega}(\tilde{\psi})$ as the weighting matrix.

It is reasonable to assume that the front-book interest rate $\mathrm{r_i^n}$ is endogenous. A shock to demand Z_i will affect how a firm chooses its $\mathrm{r_i^n}$. As a result, we instrument for $\mathrm{r_i^n}$ with data on the 2009 market wide PCA market share by firm. We use this variable as an instrument because the PCA market shares are assumed to be less susceptible to short-term demand shocks than the choice of interest rates. At the same time, this variable also captures the relationship between the size of the firm and its ability to attract customers. The correlation coefficient between PCA market shares and the front-book interest rate $\mathrm{r_i^n}$ is 0.10. We know that the demand for cash savings accounts is driven by factors such as PCAs and brand recognition etc[41] which is proxied by the PCA market shares variable.

We also use the branch network market share variable, y_i, to control for the availability of branches affecting demand for new products (see 1. and 2. above).

Instrumenting has an upward effect on the value of $\widehat{\beta_1}$ a negligible impact on $\widehat{\beta_2}$ and a negligible impact on the other parameters.

Estimates

As explained in the preceding sections, we estimate the 6 parameters with the above moment equations. Due to missing data on balances, one of the smaller firms is not used in the estimation. This reduces the number of firms to 12.

Table 5 shows the estimated parameter values along with the robust standard errors.

Table 5: Estimates and robust standard errors

Parameter	Estimate	Robust standard error
α	0.6043	(0.0302)
β_1	0.1447	(0.0224)
β_2	0.5811	(0.0224)
μ	0.4322	(0.0119)
λ	0.7537	(0.0057)
λ^m	3.5540	(0.3070)

Table 6 displays the fitted values against the data. Referring to the body of this paper, Figure 6 and Figure 7 are based on the outputs reported in this table.

[40] See for instance pp. 870-878 of (StataCorp LP, 2015)
[41] Cash Savings Market Study (FCA, 2015)

Table 6: Fitted values for representative small and large firms – midpoint estimates

	Data average	No-SEAR Model	SEAR Model
Interest rates (Figure 6)			
Front-book			
r^{n}_{large}	1.30%	1.35%	1.34%
r^{n}_{small}	1.56%	1.69%	1.68%
Mid-book			
r^{m}_{large}	0.81%	0.92%	0.78%
r^{m}_{small}	0.92%	0.92%	0.78%
Back-book			
r^{o}_{large}	0.13%	0.55%	0.78%
r^{o}_{small}	0.94%	0.55%	0.78%
Fraction of new balances in the market			
Z_{large}	0.11	0.12	0.11
Z_{small}	0.03	0.03	0.03
Balance distribution (Figure 7)			
Large firm			
Front-book	27%	31%	30%
Mid-book	22%	27%	26%
Back-book	51%	42%	44%
Small firm			
Front-book	23%	31%	30%
Mid-book	29%	27%	26%
Back-book	48%	42%	44%

Large firm is assumed to have an 11.2% market share in branches (data average[42] [43]) while small firm has a market share of 2.9%. These values are given from the data averages, excluding one small firm due to incomplete data.

The 90% confidence interval of the impacts is generated in 2 stages. First, we generate 10,000 draws of the parameter vector from the distribution defined by the coefficient means (Table 5) and the variance-covariance matrix of the coefficients (Table 7). Secondly, we evaluate the model against each of the 10,000 randomly generated coefficient vectors. This yields 10,000 different estimates; eliminating the bottom 500 and the top 500 yields a range of £148m to £381m. The median value in this range is £261m. Figure 8 shows the distribution of these simulated policy impacts.[44]

[42] Based on branch figures from 2009, source: Payments UK.

[43] Two out of 13 firms have no data on the number of branches and one of the firms is online only. For these 3 firms, we approximate the number of branches by taking their market share in cash savings accounts in 2010 and attribute to them the same proportion of 2009 UK branches in the market

[44] This is a histogram plotting the frequency of simulations falling into each £25m interval, as indicated with horizontal axis labels indicating the centre of each interval.

Figure 8: Distribution of policy impact estimates based on 10,000 simulations

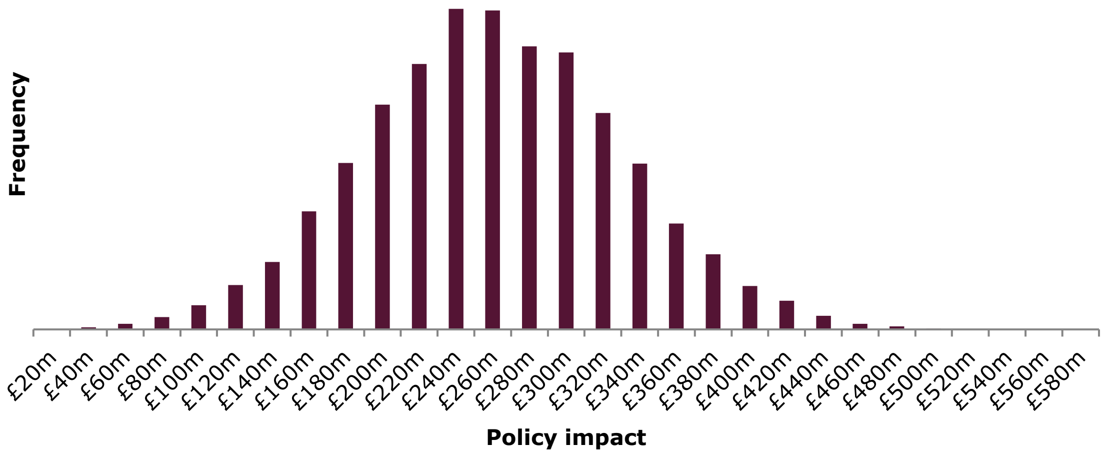

Table 7: Variance-covariance matrix of parameter estimates

Parameter	α	β_1	β_j	μ	λ	λ^m
α	0.000912					
β_1	0.000141	0.000502				
β_2	0.000154	- 0.000374	0.000501			
μ	0.000019	0.000082	0.000061	0.000142		
λ	0.000067	0.000054	- 0.000022	- 0.000010	0.000033	
λ^m	- 0.002745	- 0.001949	0.001785	0.001425	- 0.001565	0.094239

Sensitivity analysis

Table 8 shows changes to the SEAR impact as we vary 2 model inputs: lending interest rate (r_s) and the discount rate (δ). Both the midpoint estimates and the 90% confidence intervals are shown.

Decreasing the discount rate, while keeping other model inputs fixed, has the effect of increasing the SEAR impact. This can be explained by the first order conditions above. As the discount rate decreases, firms put a higher weight on the near future. They value a higher retention of mid-book customers over higher profits that these same customers might generate in the future when they become back-book.

Decreasing the lending rate has the effect of decreasing the impacts.[45] The intuition is that in a higher interest rate environment, the spread between mid- and back-book rates increases on average, thereby making SEAR more restricting in an environment when

[45] Because we assume that $\delta = 1 - \frac{1}{T}\sum_t r_s^t = 1 - r_s$, the discount rate varies with different inputs for the lending rate.

firms have more room to price discriminate. This is again driven by the outcome of the first order conditions.[46]

Table 8: Sensitivity scenarios

Scenario	Midpoint impact estimate	90% confidence interval
Base case: $\delta = 0.9605$, $r_s = 3.95\%$	£261m	(£148m, £381m)
$\delta = 0.90$ ($r_s = 3.95\%$)	£344m	(£202m, £504m)
$\delta = 0.85$ ($r_s = 3.95\%$)	£403m	(£268m, £570m)
$r_s = 2\%$ ($\delta = 1 - r_s = 0.98$)	£162m	(£71m, £265m)
$r_s = 6\%$ ($\delta = 1 - r_s = 0.94$)	£383m	(£219m, £580m)
$r_s = 8\%$ ($\delta = 1 - r_s = 0.92$)	£517m	(£297m, £769m)

46 This is also confirmed by the Market Study data, eg when comparing interest rates in 2006 vs 2013.

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