Reference Points in Refinancing Decisions

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November 20, 2020

Abstract

This paper shows that households' mortgage refinancing decisions suboptimally depend on uninformative reference points, imposing a friction to the refinancing channel of monetary policy. I study refinancing behavior in the UK, where on pre-determined dates initial fixed rates reset and mortgagors automatically move onto a reversion rate above market rates. A borrower's expired fixed rate determines whether failing to refinance is perceived as a loss or as a gain, thus serving as a salient reference point. I find that borrowers for whom inaction implies a relative gain refinance on average 13.4% less than borrowers who face a loss. This evidence is at odds with optimal models of refinancing since future borrowing costs are unrelated to past rates.

Keywords: reference points, mortgage refinancing, household finance, behavioral finance, interest rate pass-through

JEL classification: G41, G51, E52, E71

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1 Introduction

In countries where the majority of mortgages are fixed rate, the ability of the central bank to stimulate consumption through the refinancing channel of monetary policy crucially relies on households optimally responding to financial incentives. However, several studies document that borrowers wait too long to refinance their mortgages when interest rates fall, thus missing out on substantial savings and imposing a friction to the pass-through of low rates onto households balance sheets (Agarwal et al., 2016, Andersen et al., 2015, Bajo and Barbi, 2018, Campbell, 2006, Keys et al., 2016). Despite its key role in monetary policy transmission and its implications for household welfare, our understanding of households' refinancing decision-making is still limited. While showing that borrowers make refinancing mistakes is already a complicated task, since we generally do not observe neither the rates they were offered (if any) nor the upfront fees, showing *why* they make them is even more challenging.

One potential explanation for the observed sluggishness in mortgage refinancing is that people treat opportunity costs differently than "out-of-pocket" costs (Johnson et al., 2019, Kahneman et al., 1991). Foregone savings implied by expensive mortgage payments may not be perceived as an actual loss, if only deviations from regular payments are considered as a loss or a gain. Empirically, testing the hypothesis of reference dependence in refinancing choices is hard, either because individual reference points are not observable, or because actual payments never deviate from reference payments unless borrowers do refinance. To address this challenge, I exploit the design of mortgages in the United Kingdom where the interest rate on a typical mortgage is scheduled to reset after an initial period, at which point borrowers are faced with the choice of refinancing to current market rates or letting the rate automatically change to a punitive reversion rate.[1] Reversion rates are punitive because they are usually substantially higher than current rates, and increasingly so in recent years. At the same time, *expensive* reversion rates can be *cheaper* than the expiring initial rate, depending on when the loan was originated and the evolution of interest rates since then. This setting allows me to disentangle borrowers' responses to potential savings from responses to

[1] Cloyne et al. (2019) exploit the same setting to investigate the relationship between house prices and borrowing. Interest rate resets of adjustable-rate mortgages in the US have been used as quasi experimental variation by various authors to explore different questions. Fuster and Willen (2017) and Tracy and Wright (2016) use data on hybrid ARMs in the US to study the impact of refinancing on default and find that reductions in mortgage payments lead to a substantial decrease in default probabilities. Di Maggio et al. (2017) similarly rely on the variation in the reset timing as an exogenous shock to income to study the real effects of decreasing debt servicing costs, but extend the analysis to consumption responses and debt overpayment.

changes in mortgage payments relative to the past. I find that the probability to refinance decreases the larger the nominal gain (or the smaller the nominal loss) experienced in case of inaction. In particular, borrowers who perceive inaction as *relatively* cheap compared to the past are significantly more likely to stick with the *absolutely* expensive rate that applies by default after the interest rate resets. This negative relationship is apparent in Figure 1, which plots the average refinancing probability conditional on the relative gain in case of inaction. Refinancing is significantly less frequent when gains are positive. This evidence is at odds with models of optimal refinancing (Agarwal et al., 2013). Since past rates are uninformative about borrowing costs going forward, they should not matter for refinancing choices.

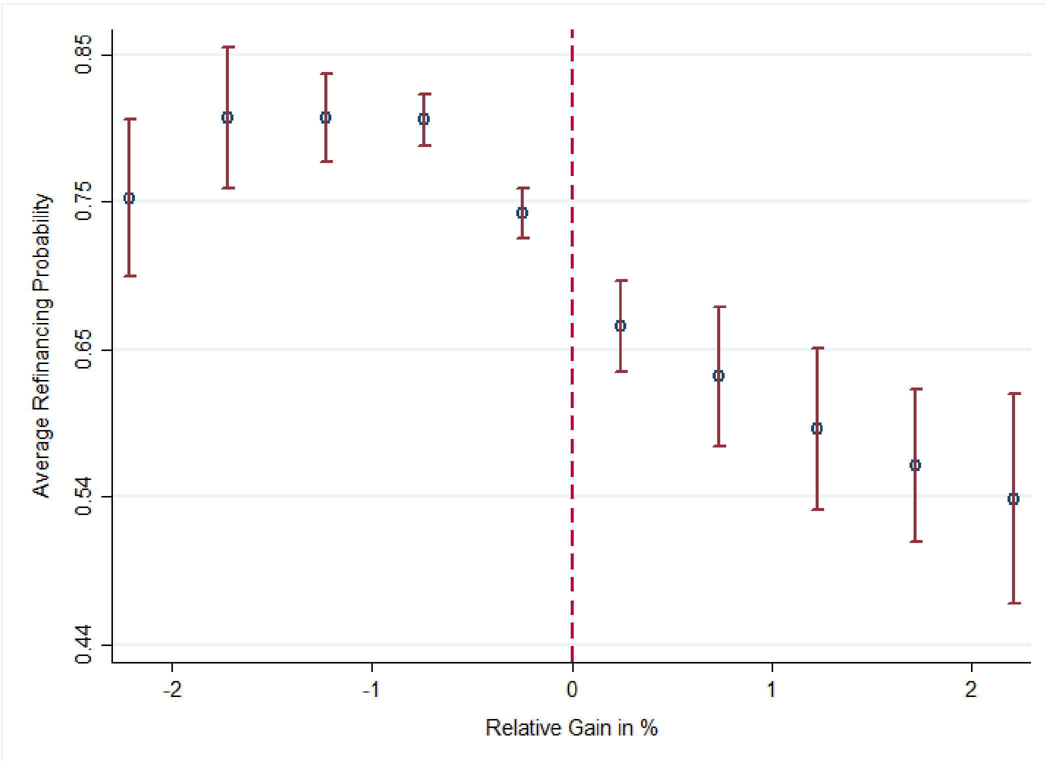
The idea that the utility of an outcome is a function of the outcome's distance from a reference point is a fundamental tenet in prospect theory (Tversky and Kahneman, 1981). Extensive evidence from laboratory experiments and field studies documents the importance of framing effects on decision making.[2] While this paper is the first to look at the effect of reference points on mortgage refinancing decisions, in finance reference-dependence has been studied in a number of other settings (Baker et al., 2012, Loughran and Ritter, 2002), including borrowing markets and housing decisions. Closest to this paper are the results in Dougal et al. (2015), which shows from the syndicated loan market that firms borrowing rates seem unduly influenced by previous rates, providing evidence that uninformative historical information may enter negotiations through the effect of reference points. Andersen et al. (2019) and Genesove and Mayer (2001) study anchoring and reference dependence in listing premia in the housing market and find that listed prices increase sharply when households face nominal losses. While previous work establishes the role of reference points or anchors to simplify the complex tasks of valuation and negotiation, in my setting there is no bargaining between borrowers and lenders or buyers and sellers, and there is no concern about the endogenous timing of the choice with respect to the nominal loss. Moreover, the large effects of reference points that I estimate are particularly puzzling given the large amount of money left on the table: between 2013 and 2017, households that do not refinance pay on average an interest rate 2.26 percentage points higher than current market rates.

Reference points and deviations from them arise from the design of the typical mortgage in the UK. Unlike in the United States, long-term fixed rate mortgages are not available in the UK. In fact, most borrowers are on an initial fixed rate mortgage for a short period of time

[2] For a comprehensive survey of the literature see e.g. Barberis (2013), Beshears et al. (2018), DellaVigna (2009), Hirshleifer (2015).

Figure 1: Conditional Refinancing Probability

The figure shows average refinancing probability conditional on the relative gain in case of inaction, expressed in percentage of the outstanding loan balance. This is the difference between the rate on the expired initial deal and the reversion rate (SVR) that applies after the reset. In the positive region, borrowers that do not refinance experience a decrease in monthly payments if they revert to the SVR. The relative gain is instead negative for borrowers who would experience an increase in monthly payments by reverting on the SVR at the end of the initial fixed period. For this figure, I restrict my sample to mortgages that have a LTV between 60% and 75%, and an outstanding balance between £100,000 and £250,000 at reset. This corresponds to 7,594 observations. The red bars show 95% confidence intervals for the conditional mean.



(typically 2 or 5 years), after which the mortgage reverts to a variable rate for the remainder of the term. Once the fixed period ends, borrowers can refinance to a new initial deal without incurring a prepayment penalty. Paired with the fact that reversion rates tend to be much higher than current market rates, this creates a strong incentive to refinance around the reset date. While reversion rates and current market rates determine the savings foregone by households that fail to refinance, the *change* in mortgage payments experienced in case of inaction depends on the just expired initial fixed rate. I posit that borrowers evaluate the benefits from refinancing relative to this expired fixed rate, which is a natural candidate for a reference point in this context. I test this hypothesis using loan-level data where I can follow borrowers' refinancing behavior after the initial fixed period ends, and which allows me to observe both the matured fixed rate as well as the reversion rate that applies by default. I find that the difference between the matured fixed rate and the reversion rate is a significant predictor of the heterogeneity in refinancing decisions among borrowers, after controlling for differences in potential savings, mortgage characteristics and observable demographics.

The empirical strategy I propose in this paper leverages different institutional features of the UK mortgage market to identify the causal effect of reference points on refinancing decisions. The main advantage of using UK data is that the design of mortgages implies that the *status quo* level of payments is not preserved in case of inaction. This induces cross-sectional variation in gains and losses with respect to the reference point that is essential to test for reference dependence in how borrowers refinance. A second key feature is that in the UK there is no ex-post price discrimination based on borrower-specific characteristics, including credit scores and income. This rules out obvious endogeneity concerns about past mortgage rates with respect to refinancing opportunities. One would otherwise worry that borrowers who were paying higher rates in the past will naturally face higher rates upon refinancing as well. Crucially, mortgage rates in the UK are quoted by lenders as a discrete schedule at maximum Loan-to-Value (LTV) ratio in steps of 5 to 10% (Best et al., 2018) and apply to all eligible borrowers at a given point in time. I will therefore argue that lender $\times$ reset time $\times$ LTV-buckets fixed-effects absorb all hetereogeneity in rational refinancing incentives across borrowers, after controlling for mortgage size and remaining time to maturity. The reason for this is that borrowers who reset at the same time, with the same lender and have a similar LTV face the same reversion rate and the same set of refinancing rates.

Unlike other studies, I can rely on cross-sectional identification because there is a well-specified time window in which refinancing becomes a salient choice and where one can therefore easily compare decision outcomes across people. This would clearly not be possible in the case of pre-payable long-term fixed rate mortgages, where borrowers can refinance at any time. In such cases, researchers have to compare actual behavior with a model implied optimal benchmark, which can be hard to compute and has to rely on a number of assumptions. Instead, the cross-sectional approach in this paper is based on a simple argument. Since refinancing is optimal if and only if the saving is larger than the sum of the upfront cost and the option value of refinancing in the future, borroweres with comparable mortgage debt, who face the same rate in case of inaction, the same available market rates and the same fees, should all optimally either refinance or stick with the reversion rate. Showing that there are systematic differences in refinancing behavior predicted by backward-looking information provides evidence of reference dependent decisions. Importantly, this statement holds regardless of whether refinancing is actually optimal or not.

In my analysis, I assume that the rate on the initial fixed period is the relevant reference point for refinancing decisions. Anecdotal evidence suggests that people do take their current fixed rate into consideration when they evaluate the benefits from refinancing. Numerous articles in the popular press warn borrowers about the possible jump in mortgage payments at the end of the fixed period.[3] An article in the Financial Times (2017) even refers directly to the large difference between the reversion rate and the maturing fixed rate as a determinant of refinancing incentives ("So there's motive for people to remortgage? Precisely."). However, while the status quo seems to predict people choices in many settings, including this one, it is less clear what should determine reference points in theory. Kőszegi and Rabin (2006, 2007) argue that expectations determine reference points and that the status quo only matters when people expect to preserve it in the future. In the context of this paper, it is hard to tell whether the expired rate matters through the current level of payments or because people extrapolate current borrowing costs into the future. Since the reset of the mortgage rate happens on a pre-determined date and reversion rates are observable over time, the change in mortgage payments is predictable. However, it is still plausible to think that borrowers did not budget for the predictable change in payments and would find themselves forced to cut consumption unless they manage to refinance their mortgage. An alternative explanation is that the sudden jump in payments serves as a wake-up call for borrowers, who will check the current level of interest rates if and only if the interest rate increase. Otherwise, if interest rates decrease, borrowers will not make the effort of looking at the new available rates and will not realize that savings can be made.

The analysis faces three main identification challenges due to the lack of random assignment of reference points. The variation in past rates that I use to estimate the effect of reference dependence on refinancing decisions comes primarily from differences in borrowers' choices about the length of the initial fixed interest rate period. While this would not be problematic in general, during the sample period there is a strong positive correlation between past rates and the length of the fixation period because of steadily falling mortgage rates since the financial crisis. The first concern is that unobserved borrower characteristics that simul-

[3] "Every month hundreds of thousands of borrowers reach the end of their fixed-rate mortgage deal. In most cases, that means their mortgage payments are set to rise - in some cases by a lot. But you can take action to avert these higher costs." (The Telegraph, 2019)

taneouly explain both a preference for less duration risk and a lower propensity to respond to financial incentives might be driving my results (Koijen et al., 2009). I present a battery of results to show that confounding unobserved heterogeneity in preferences for initial deal duration are unlikely to explain my findings. First, I show that at least in terms of observable characteristics, borrowers that at the same point in time choose different fixation periods are largely similar. Then, I use data from the BOE/NMG Survey of Household Finances to shows that in a period where longer fixation did not imply higher reference rates, borrowers that are expected to have a preference for bearing less duration risk were refinancing more frequently than the average borrower. Lastly, from a placebo regression on a subsample of loans that reset with similar past rates, I demonstrate that initial mortgage duration has no significant effect on refinancing probabilities. The second concern is that borrowers that choose shorter fixation periods are faced with refinancing decisions more frequently. This might both introduce survivorship bias and make borrowers on shorter fixation periods more experienced due to learning through repeated refinancing. I address both issues looking at borrowers that are faced with a rate reset for the first time. I show that the effect of reference points on refinancing decisions is still strong in a subsample where survivorship is ruled out and borrowers are expected to be equally experienced. Third, an alternative explanation for my findings is that borrowers that select into longer maturities face a higher probability of being denied refinancing. This is a concern given the results in Hertzberg et al. (2018), which shows from the peer-to-peer lending market in the US that borrowers with higher unobservable repayment risk tend to self-select into longer maturity contract based on private information. I show that results do not change when I control for the incentive to self-select based on unobservables using the estimated difference in term-premia between 2 and 5-years maturities at the time of the origination of the mortgage.

Refinancing decisions play a key role for the effectiveness of monetary policy in stimulating aggregate consumption by reducing the cost of debt servicing. Reflecting this policy importance, there has been a surge of papers in recent years that investigate frictions to refinancing. After accounting for the effect of negative equity (Beraja et al., 2018, Agarwal et al., 2015a), upfront costs and documentation requirements (DeFusco and Mondragon, 2018) in inhibiting refinancing especially during recessions, a number of papers document that households do not refinance optimally (Andersen et al., 2015, Agarwal et al., 2016, Bajo and Barbi, 2018, Campbell, 2006, Johnson et al., 2019). In particular, Keys et al. (2016) show that more than

20% of households in the US are paying too much for their mortgage, incurring a median loss of more than $10,000 in present value terms. Some papers then investigate the determinants and the heterogeneity of sluggishness in refinancing. Using Italian data, Bajo and Barbi (2018) find that this "financial apathy" is strongly related to socio-demographic characteristics and household financial literacy. Andersen et al. (2015) use loan-level data on mortgages in Denmark to try to quantify the relative importance of two sources of inactivity, namely inattention and inertia. While inertia is supposed to disappear when interest rate incentives are sufficiently large, inattention can prevent people from refinancing even when the incentive to do so is strong. The paper exploits the difference in implied refinancing dynamics to quantify the relative importance of these two channels. While both drivers appear to be important, inattention seems to be the main determinant of low refinancing among households with a low socio-economic status. Johnson et al. (2019) analyze administrative data on pre-approved offers and argue that time preferences and lack of trust are leading factors explaining the low refinancing rates observed in their sample. While suspicion towards financial institutions seems to be one of the motives that prevent households from refinancing, Maturana and Nickerson (2018) show that peer effects can strongly increase refinancing rates. The results in my paper make several contributions to this literature. First, my paper is the first to provide empirical evidence that the fact that missing out on a saving opportunity does not constitute a nominal loss significantly decreases households' propensity to refinance. Second, my results imply that the responsiveness of a borrower not only depends on individual attributes such as financial literacy, but is crucially affected by the "framing" of the refinancing gains. Third, a lot of the engagement in the refinancing market in the UK seems to be motivated by the desire of avoiding a nominal loss, and this can be easily misinterpreted as a sign of financial sophistication. This could lead to wrong estimates about the actual responsiveness of mortgages when interest rates go down in a recession and thus overestimate the stimulating potential of expansionary monetary interventions. This paper fits therefore more broadly in the rapidly growing literature on the role of mortgage markets and security design in the transmission of monetary policy through the refinancing channel (Abel and Fuster, 2018, Auclert, 2019, Berger et al., 2018, Di Maggio et al., 2016, Eichenbaum et al., 2018, Fuster and Vickery, 2014, Greenwald, 2018, Wong, 2019). I establish an important complementarity between monetary policy and the decisions of mortgage lenders in the UK about where to set reversion rates, which appear to be crucual in amplifying refinancing frictions coming from behavioral biases. In a similar spirit to Berger et al. (2018), who argue that the average outstanding rate on fixed-rate mortgages leads to a path-dependent effectiveness of monetary policy through the incentives to prepay, my results show that in the UK the effectiveness of the refinancing channel of monetary policy depends on the distribution of reference points and, more precisely, of the expected nominal gain in case of inaction. Finally, the evidence provided in this paper about borrowers' reluctance to taking action also relates to the literature on the effects of default options on economic outcomes (Beshears et al., 2009, 2015) which finds, in a number of different settings, a strong tendency of people against opting out that is hard to reconcile with any plausible value of transaction costs.

The rest of the paper is organized as follows. Section 2 describes the institutional backround of my analysis. Section 3 introduces the theoretical framework. Section 4 presents the empirical strategy. Section 5 describes the data and sample I use. Section 6 presents the main empirical results and Section 7 addresses a number of identification challenges. Section 8 concludes.

2 Mortgage Design and Reference Points in the UK

Unlike in the United States, where the most common product is a 30-years fixed rate mortgage, homeowners in the UK can lock in their mortgage rate only for limited periods of time. The typical mortgage charges an initial fixed rate for a period of 2-5 years, at the end of which the mortgage automatically reverts onto the current *Standard Variable Rate (SVR)* of the lender. At the end of the initial fixation period, the borrower has the option to refinance to a new initial deal at current market rates without penalty. Borrowers rarely prepay before the end of the introductory deal since most contracts feature large early repayment fees, typically 5 percent of the outstanding loan amount (Best et al., 2018, Cloyne et al., forthcoming). At the end of the fixed rate period, the incentive to refinance is strong for most borrowers. In fact, SVRs charged by lenders are usually susbtantially higher than new fixed or variable market rates quoted at the same point in time. Reversion rates are therefore *expensive* relative to market rates and households who do not refinance might be missing out on considerable savings. Moreover, even though the SVR is a variable rate and is therefore expected to go up when interest rates increase, there is no guarantee that it will fall if interest rates decrease. This is because each mortgage lender sets its own SVR and can revise it at any time, with no obligation to follow the BOE's base rate or any wholesale rate.

This mortgage design implies that, on pre-determined dates, borrowers come off the fixed rate that they have been paying for the previous 2 to 5 years and are faced with the choice whether to refinance to a new fixed rate or to stay on the SVR of their lender. While lenders usually set their SVR above market rates, whether the SVR is above or below a given borrower's matured fixed rate at the end of her initial period also depends on the path of interest rates between the origination and the expiration of the fixed deal. This means that by reverting onto the SVR some borrowers might see their monthly mortgage payments go down. For these borrowers, the expensive SVR is therefore *cheap* relatively to their own past rate. On the contrary, for borrowers who expect their mortgage payments to go up at the end of the initial period, the SVR is expensive both relative to market rates and relative to the expired fixed rate. In the data, the distribution of matured fixed rates around the SVR varies over time and, at any given point in time, we can observe substantial cross-sectional heterogeneity.

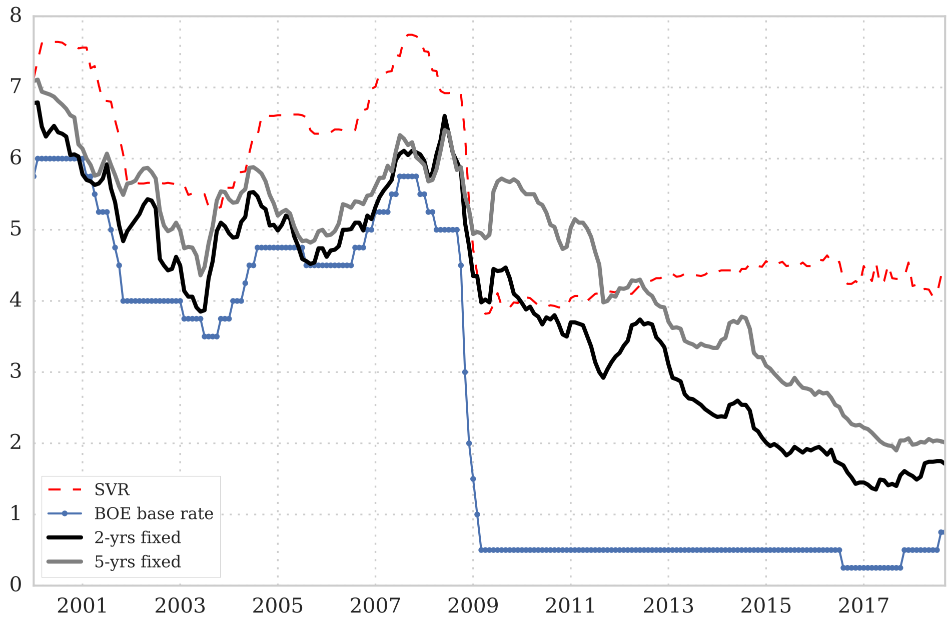
Figure 2 plots average quoted 2-years and 5-years fixed rates (solid lines), as well as the average SVR applied by mortgage lenders (dashed line) from 2000 to 2017. I focus on these two maturities (fixation periods) because they are by large the most common in the UK. The cut of the base rate by the BOE at the end of 2008 led to a visible structural break in the relationship between mortgage market rates and reversion rates. Historically, SVRs have been moving at a almost constant spread over market rates, but lenders stopped adjusting their SVRs downward as soon as the policy rate hit the zero-lower bound. Under considerable public and political pressure to pass-through the interest rate cut (The Guardian, 2008), lenders initially decided to lower SVRs. They did not however follow through once the BOE cut the base rate further by 150 basis points. Despite falling interest rates, average SVRs remained solid around 4%, and even increased in the following years.[4] As a consequence, reversion rates and rates on newly originated mortgages started to diverge and by the second half of 2013 the implied spread was higher than it had been before the crisis.

In the left panel in Figure 3, I plot the difference in annual payments between staying on the SVR and refinancing to a new 2-years fixed rate deal for a typical mortgage with a £100,000 remaining balance, 20 years left to pay down the principal and a LTV of maximum 75%. For around two years after the crisis, reversion rates were at the same level of market rates, or even cheaper. As financial markets recovered and risk premia went down, foregone savings

[4] A similar pattern to the one observed in the UK is documented in Goggin et al. (2012) for the Irish market and the authors attribute the unwillingness of banks to pass-through interest rate cuts onto their reversion rates to increased market funding costs.

Figure 2: Mortgage Rates

The figure shows monthly time series of average quoted interest rates for different mortgage products and of the Bank of England base rate. The dark solid lines is the interest rate on a 2-year fixed initial period for a maximum loan-to-value of 75%. The lighter solid line is the corresponding rate for a 5 years initial duration. The dashed line is the average standard variable rate (SVR) applied by financial institutions. All mortgage rate series are taken from the Bank of England Interactive Database.

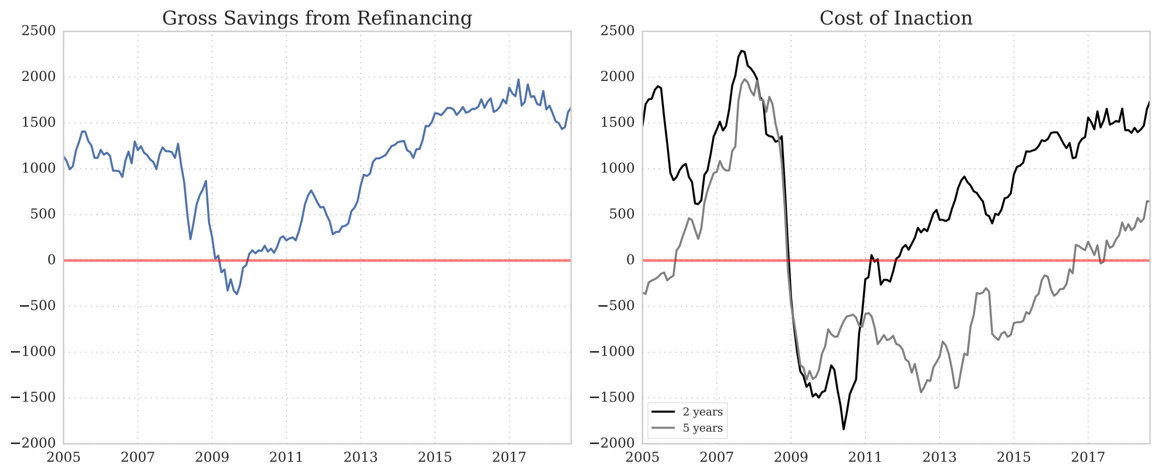


for households that failed to refinance began to grow larger. Between 2013 and 2016, which is the period covered by my data, the average SVR was 4.44% against an average 2-years fixed rate of 2.18%, corresponding to an average annual difference in mortgage payments of £1,424.

The right panel of Figure 3 shows the change in mortgage payments implied by inaction relative to the expired deal. Right after the crisis, not only the incentive to refinance plotted in the left panel was small or negative, but borrowers reverting to the SVR would see their mortgage payments decrease substantially. From 2011, two things happen. First, the expected change in mortgage payments in case of inaction began to increase, and more and more borrowers reverting to the SVR would experience a jump in mortgage costs. Second, we observe a large difference in the experienced change in payments at reset for 2-years versus 5-years mortgages. On average, in the period 2013-2016, borrowers coming off a 2-years fixed deal saw their payments go up by £931 per year. At the same time, the rate reset meant a

Figure 3: Incentives to Refinance

This figure shows the evolution of the incentives to refinance over time, decomposed into the potential savings from refinancing (left) and the cost of staying on the SVR (right). Calculations consider a borrower with a repayment mortgage, £100,000 remaining balance and 20 years left until maturity. Specifically, the line in the left panel shows the change in annual payments when switching from the SVR to a new 2-years fixed rate initial deal, computed as $P(\text{SVR}_t) - P(r_t^{2yr})$. The right panel shows the change in annual payments when moving onto the SVR for mortgages coming off a 2-years (darker line) or a 5-years (lighter line) fixed deal, i.e it plots $P(\text{SVR}_t) - P(r_{t-2}^{2yr})$ and $P(\text{SVR}_t) - P(r_{t-5}^{5yr})$, respectively. At each point average quoted rates for mortgages with a maximum LTV of 75% are considered.



decrease in annual payments by £565 if the borrower had instead locked in the fixed rate five years before for five years. Because of steadily falling interest rates and high term premia after the crisis, borrowers on a 5-years contract were paying on average 2.3% points more in interest charges than borrowers on a 2-years contract resetting at the same time.

Standard models of optimal refinancing would predict no difference in refinancing behavior across borrowers that experience an increase versus a decrese in mortgage payments relative to the expired fixed rate. However, finding that this dimension matters in borrowers decisions, has implications for the effectiveness of monetary policy in reducing mortgage payments and stimulating household consumption. The pass-through of monetary policy is stronger on rates on newly originated mortgages due to competition among lenders (Scharfstein and Sunderam, 2016), thus the central bank has traction on refinancing incentives through the level of foregone savings. On the contrary, the cost of inaction, defined as the difference between current SVRs and past market rates, responds less and with a delay to monetary policy interventions. First, because it depends on the path of interest rates in the past and, second, because the pass-through of interest rates is limited by lenders' market power on their current clients.

3 The Theoretical Framework

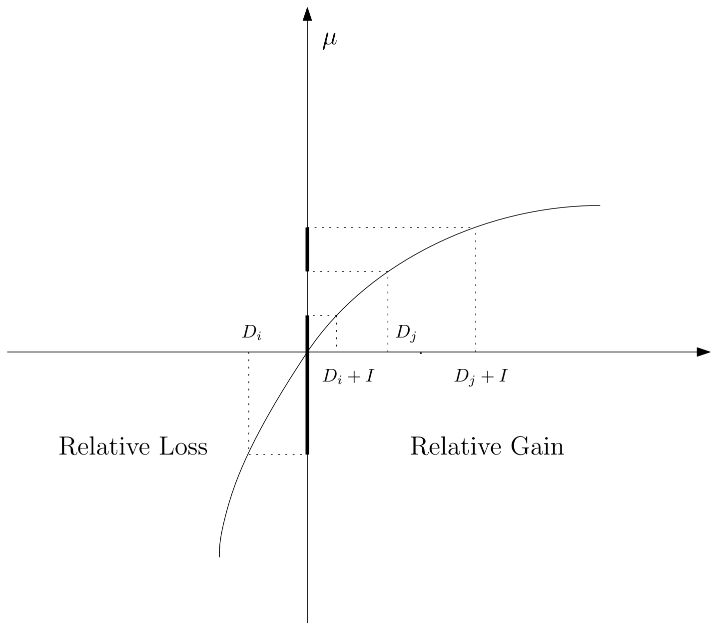
Following the literature on optimal mortgage refinancing (e.g. Agarwal et al., 2013, Andersen et al., 2015), we can write the incentive to refinance as

$$I = r^0 - r^1 - x^* \tag{1}$$

where r^0 is the interest rate in case of inaction, r^1 is the interest rate on the new mortgage and x^* is a threshold level that captures the fixed cost of refinancing and the option value of refinancing in the future. All variables are time varying, but I drop the time subscript for convenience. A borrower that maximizes the utility in the outcome state will refinance if and only if the incentive to do so is positive, i.e. when $I > 0$. Agarwal et al. (2013) are the first to derive a closed form solution to the household's refinancing problem under a plausible set of assumptions, which other authors have used as rational benchmark against which to define refinancing mistakes (Keys et al., 2016). Andersen et al. (2015) extend this rational model to incorporate inertia to generate heterogeneous responses to identical financial incentives. In particular, they allow the psychological cost that borrowers' associate with refinancing to vary across-borrowers, resulting in borrower-specific threshold levels x^*. The authors investigate how the estimated inertia covaries with borrower and mortgage characteristics and find it increasing in households' socio-economic status.

In this paper, I posit that borrowers have reference dependent preferences and evaluate the benefits from refinancing relative to individual reference points. Under this assumption, heterogeneous reactions to the same financial incentive may result from differences in reference points, even after controlling for borrower characteristics to proxy for financial literacy. This hypothesis is consistent with a model that assumes that household's utility function $u(C|R)$ depends on the consumption level C and a reference level of consumption R. Reference dependence is a fundamental principle in prospect theory and it is captured by the value function defined on the difference $C - R$ in Kahneman and Tversky (1979). Building on this theoretical framework, I specify a borrower's utility function in terms of interest rates as

Figure 4: Value Function



$$u(r|r^R) = \mu(r^R - r - \kappa(r^R, r)) \tag{2}$$

where r is a mortgage rate, r^R is the reference mortgage rate and $\kappa(r^R, r)$ is the potential cost involved with moving from the reference state to the new state, which reduces consumption in the outcome state. $\mu(\cdot)$ is a gain-loss function that satisfies the following properties:

A0. $\mu(x)$ is continuous for all x, twice differentiable and $\mu(0) = 0$

A1. $\mu(x)$ is strictly increasing.

A2. $\mu''(x) \leq 0$

Notice that I am not assuming a kink at the reference point, as in the well-known S-shaped value function in prospect theory. Because of the diminishing marginal utility resulting from concavity, the disutility from a loss is still larger in absolute value than an equally sized gain. What this specification does not assume, is diminishing sensitivity to losses, i.e. that the marginal disutility of a further loss in consumption decreases as the loss grows larger.

Assuming a strictly positive psychological cost of taking action ζ, a borrower i with reference rate r_i^R will refinance if and only if the change in utility is large enough to compensate for the hassle of refinancing, i.e.

$$\mu(r_i^R - r^1 - x^*) - \mu(r_i^R - r^0) = \mu(D_i + I) - \mu(D_i) > \zeta \tag{3}$$

where

$$D_i \equiv r_i^R - r^0 \tag{4}$$

is the distance of the reversion rate from the reference rate, expressed as a gain. I introduce the subscript i to stress that the reference point can vary across households for given r^0 and r^1. In the first term of the equation, $\kappa(r^R, r^1) = x^*$ captures the financial cost of refinancing that enters (1). By definition, there is no cost involved in reverting to the reversion rate r^0, so $\kappa(r^R, r^0) = 0$ in the second term.

Equation (3) implies that a positive rational incentive $I > 0$ is a necessary condition, but not a sufficient for $\zeta > 0$. Moreover, given concavity of μ, the propensity to refinance is negatively related to D_i. In other words, the higher the relative gain (or the smaller the relative loss) of reverting to r^0, the smaller the increase in utility from refinancing to a lower r^1. The intuition is visualized in Figure 4, where I draw an hypothetical value function to sketch the refinancing problem for two borrowers i and j with two different reference rates. D_i and D_j on the x-axis indicate the change in interest rates in case of inaction and determine the experienced change in monthly payments. D_i is negative meaning that $r_i^R < r^0$. In this case, inaction implies a loss in consumption and therefore a lower utility relative to the reference point. On the contrary, D_j is positive since $r_i^R > r^0$. Thus, even by doing nothing, borrower j experiences a drop in monthly payments once the mortgage rate resets. Given the same incentive I, refinancing implies an increase in utility indicated in bold on the y-axis for the two borrowers. However, notice that for borrower i, the perceived benefit from refinancing is much larger. This is because refinancing includes an additional increase in utility coming from avoiding a out-of-pocket loss relative to the reference point. The utility increase from gaining I, is instead much smaller for borrower j since, from her point of view, action only implies realizing an additional saving. Because of the assumption of decreasing sensitivity to gains, the same level of I might therefore not be enough to motivate borrowers who do not see the inaction state as a loss state into refinancing to a lower rate. The following testable hypothesis summarizes this idea:

Hypothesis (Reference Dependence)**.** *Given an action state and an inaction state, the incidence of refinancing in the cross-section of borrowers is negatively related to the difference D between the rate on the expired deal (reference rate) and the rate in the inaction state.*

4 Empirical Strategy

To test the hypothesis of reference dependence in refinancing decisions, I exploit the variation in reference points across borrowers whose fixed rate resets at a pre-determined date. Formally, I run the following specification

$$Refinance_i = \alpha_{t,l,\text{LTV}} + \beta D_i + \gamma' W_i + \varepsilon_i \tag{5}$$

where $Refinance_i$ is an indicator variable denoting whether loan i refinances after the reset and D_i is the distance between the reference rate and the reversion rate defined in equation (4). $\alpha_{t,l,\text{LTV}}$ is a time*lender*LTV fixed effect and W_i is a vector of loan-level observables.

A key challenge to identify the effect of reference points on refinancing behavior is to control for differences in refinancing incentives. I leverage on three specific institutional features of the UK mortgage market to overcome this issue. In particular, I take advantage of the fact that (i) borrowers at the same lender face the same reversion rates at any point in time, (ii) mortgage pricing does not depend on borrowers' characteristics and (iii) borrowers can refinance to a different product with their current lender at a minimal hassle. As I explain in detail in the next paragraph, it follows that including granular three-way fixed effects for the time of the reset, the lender and the LTV of the mortgage at reset absorbs observable and unobservable heterogeneity in monetary incentives as defined in equation (1).

Rational incentives to refinance are positively correlated with the rate r_i^0 that the borrower is charged if she decides not to refinance. In the present context, this is the SVR to which the borrower automatically reverts at the end of the deal. This rate is constant for borrowers who have a loan with the same lender and whose initial rate resets at the same time, and it is observable. The second term r_i^1 in equation (1) is determined by the current level of interest rates and more precisely by the set of interest rates that are available to a given borrower at a given time. Mortgage products in the UK are very standardized and for any given product lenders offer the same interest rate to all borrowers that meet their lending standards. In particular, interest rates do not depend on individual borrowers' creditworthiness or other characteristics. Differently from the United States, where mortgage rates are quoted to borrowers individually and are a function of their credit score, default risk in the UK is priced based on the LTV ratio. Best et al. (2018) confirm in the data that after controlling for bank, time, interest rate (fixed or tracker), length of the initial deal and type of repayment (interest only or principal amortization), what determines the interest rates is the LTV ratio. In particular, the average mortgage interest rate is a step function of the LTV ratio, with sharp jumps (notches) at LTVs of 60%, 70%, 75%, 80% and 85%, and flat in between. Moreover, unlike in the US where many lenders offer different interest rates across states[5], in the UK mortgage rates do not vary across zipcodes or regions. Most products are available throughout the UK, even though some providers have limited lending areas. It is possible that some products are only available online, in branch or via an intermediary (MoneyFacts.com[6]). It follows that the same set of interest rates is in principle available to all borrowers that reset at a given time and whose LTV ratio falls within a given range, so that r_i^1 is constant within this cluster. The last term x_i^* is both increasing in the up front cost of refinancing and in the option value of waiting and refinancing at a future date. Refinancing is costly, both in terms of money and time. There is however a substantial difference between refinancing with the current lender (product transfer) or with a new lender. When transferring to a new mortgage with the current lender, no fees are usually charged and the procedure is commonly a matter of days and can be done entirely online. This is because for existing clients lenders usually do not require a new valuation of the property nor updated affordability checks, provided that the terms of the contract are unchanged. If the borrower wishes to modify the length of their term, increase the borrowed amount or change the repayment type of the loan, the lender will request a new assessment of both the financial situation and the value of the house. Figure A.1 in the Appendix shows examples of lenders' guidelines on product transfers. Thus, the cost of refinancing to the same product implies a different cost for new and existing clients of the mortgage provider. In turn, this affects refinancing incentives across borrowers, even though in principle they face the same set of available market rates. Lender fixed effects absorb this heterogeneity across borrowers at different lenders in accessing the same rate.

[5]https://www.consumerfinance.gov/about-us/blog/7-factors-determine-your-mortgage-interest-rate/

[6]Moneyfacts is one of the most commonly used financial price comparison websites in the UK.

Including lenders fixed effects also controls for differences in average refinancing probability, which may result from some lenders having more stringent requirements, higher fees, lenghtier procedures and different clienteles. Finally, the option value of waiting and to refinance in the future depends on the stochastic process of interest rates. I assume that, after including time fixed effects, borrowers expectations about future interest rates are unrelated to reference points.

The vector W_i includes control variables that are expected to influence borrowers incentive to refinance and that are not absorbed by the fixed effects. In particular, I control for the remaining balance on the mortgage given that, since interest savings from refinancing scale proportionately with mortgage size but refinancing cost is fixed, x^* is decreasing in mortgage size. Moreover, since the remaining time until maturity of the loan affects the option value of waiting, I include it as a control in the regression. Given the extensive set of fixed effects required to make robust inference, I first estimate a linear probability model.

At each point in time, the distribution of reference points across borrowers depends on the path of interest rates up to that point. Because of steadily declining interest rates, the right panel in Figure 3 shows that in the sample period D_i is positively related to the length of the fixation period of the maturing deal. The key identifying assumption for equation (5) to estimate the causal effect of D_i on refinancing decisions is that preferences for duration risk are uncorrelated with borrowers' propensity to show inertia or inattention or with other characteristics that may explain sluggishness in refinancing behavior. Borrowers' age and income have been shown in the literature to correlate with borrowers' responsiveness to refinancing incentives. Using data from the American Housing Survey (AHS), Campbell (2006) shows that most active refinancers are younger, better educated, white households with higher-priced houses. Andersen et al. (2015) find similar results studying the Danish mortgage market. I can observe borrowers' age and income in the data, so I include them as controls in the regression. While age and income may affect the probability of refinance, they should not change the coefficient of interest since in the UK interest rates are not related to borrower characteristics. Still, since D_i is not exogenously assigned, I need to assume that there are no unobserved characteristics that are correlated with both D_i and refinancing decisions. In Section 7.1, I provide a set of additional results to rule out that my findings are driven by unobserved borrower characteristics simultanously driving duration and refinancing choices.

5 Data and Sample

5.1 Data Sources

For the main analysis I use a novel loan-level panel dataset on more than 2 million securitized residential prime mortgages in the UK provided by the European DataWarehouse (ED).[7] Data start in January 2013 and my sample ends in August 2017. In terms of coverage, the loans in the dataset correspond to roughly 10% of the total amount outstanding of mortgages in the UK over the period.[8] The dataset contains detailed information on the loans, including the name of the loan originator, the loan size, the origination date, the interest rate charged, whether the mortgage payments include amortization of the principal, the valuation of the property, the mortgage term over which the loan will be fully repaid, as well as the geographical location of the property at county level (NUTS3). The data also provides information on the purpose of the loan (purchase, re-mortgage, renovation, equity release, etc.), if it is a first or second mortgage and whether the mortgage is buy-to-let or owner-occupied. The data includes a number of borrower characteristics as of loan inception, namely age, income, income verification, employment status, credit score and whether the borrower is a first-time buyer.

The frequency of the data is either monthly or quarterly.[9] At each submission, I observe updated information on the payment history (current, in arrears, defaulted or prepaid) as well as the type of the mortgage and the interest rate charged. In particular, I know if the loan is currently on an initial (fixed or floating) rate, on the lender's SVR or on another rate (e.g. lifetime BoE base rate tracker, capped or discount). For introductory deals I observe the date when the deal ends and the loan reverts onto the follow-on rate unless the borrower refinances. In case the reset date is missing in the data, I recover it from the changes in the interest rate and the interest rate type across submissions. The dataset contains a variable

[7] ED collects loan-level information on the pool of loans backing RMBS that financial institutions pledge as collateral in Eurosystem refinancing operations. Following the eligibility requirements set by the ECB, since January 2013 participants to the Eurosystem have to submit updates on the underlying loans at least on a quarterly basis. As part of a measure to preserve collateral availability and market functioning, on September 6, 2012, the ECB extended eligibility to be used as collateral in Eurosystem credit operations to marketable debt instruments denominated in GBP (or US dollar or Japanese yen). Disclosure of loan-level information is also one of the eligibility requirements for credit operations with the Bank of England since November 2012. Since the Bank of England has access to the ED platform, many UK issuers use it to fulfill the disclosure requirements. Some issuers prefer alternative ways. Over the period 2013-2019, coverage of the UK RMBS market by the ED dataset varies between 30 and 60%.

[8] Data on total balances outstanding are from the Bank of England and the FCA.

[9] The frequency at which data are submitteed to ED depends on the RMBS coupon schedule.

that indicates the type of follow-on rate, whether it is the lender's SVR or another tracker rate.

Once the introductory period ends, I see from the following submissions if and when the borrower decides to refinance. If the borrower does not refinance, the loan appears on the lender's SVR. If the borrower decides to switch to a new product with the current lender, I observe the selected mortgage type and the new interest rate. Usually, borrowers that refinance after being on a fixed rate opt for a new initial fixed rate deal. If, instead, the borrower decides to remortgage with a different lender, refinancing appears in the data as a prepayment, after which the loan stops being reported.

The dataset contains updated information on loans' current balance and current loan-to-value ratio. For property values reported in the data and used to compute the current loan-to-value, I observe two reporting practices that vary across, but are consistent within, lenders. Most lenders update the value of the property at each submission according to an internal indexing methodology.[10] Other lenders, instead, report an updated property value only upon refinancing of the loan and usually only if the balance of the loan increases. Both behaviors are consistent with the fact that lenders usually do not require a new full valuation of the property in case of internal refinancing, except in case of modification of the loan terms. It is possibile that also lenders that report constant property values may use an indexing methodology before granding a product transfer to an existing client. For my analysis, I assume that the reported loan-to-value is the relevant one to determing the available set of refinancing rates. For robustness, I will include county fixed effects in some specifications in order to control for heterogeneity in house price growth across counties.

5.2 Sample Selection and Summary Statistics

Table 1 shows a snapshot of the cross-section of mortgage types as they are observed at the beginning of the sample in 2013. I see that a large fraction of borrowers (61%) are paying the SVR, which is surprising given that market rates in 2013 were already significantly cheaper. Since for borrowers with a small balance or few years left to maturity the potential savings might not justify the cost and hassle of refinancing, in the second row I restrict the sample to borrowers with a remaining balance higher than £100,000 and more than ten years to

[10] The data contain information on the valuation type used at each submission. Most of the properties are valued according to a full internal and external inspection at origination of the loan. On subsequent dates, if the property value is updated the valuation method is typically indicated as *Indexed*.

Table 1: Distribution of Interest Rate Types (2013)

This table shows the fraction (in %) of mortgages by interest rate type at the beginning of the ED sample (2013). In the first row, reported figures are computed over all mortgages in the sample except for those on a lifetime tracker rate, which mostly indicates mortgages on a reversion rate that was guaranteed not to rise more than a small margin (usually 2%) above the BOE base rate. The second row only considers borrowers who have a remaining balance higher than £100,000, more than ten years left until maturity and a LTV ratio at reset not larger than 75%. The column SVR indicates the fraction of borrowers that are on their lender's Standard Variable Rate as of the first time they are observed in the data. Initial Fixed (Floating) indicates mortgages that are on an initial fixed (variable) rate and that will automatically revert to the SVR at the end of the deal. Other includes capped and discount mortgages.

	SVR	**Initial Fixed**	**Initial Floating**	**Other**	**N**
*All borrowers**	61.05	26.12	5.71	7.11	1'478'446
Borrowers with a strong incentive	43.18	42.13	8.07	6.62	227'424

term. Since premia charged to highly leveraged borrowers increased substantially after the crisis, I also exclude mortgages with a LTV ratio higher than 75% to compute these figures. The fraction of mortgages on the SVR drops substantially to 43%, but it is still very large considering that borrowers in this subsample are foregoing substantial amount by failing to refinance to a new initial deal. To study reference dependence in refinancing decisions, I focus on mortgages on an initial fixed rate period.

In the early 2000s two major lenders guaranteed to their clients that their SVR would never rise more than 2% above the BoE base rate. Since the cut of the base rate in 2009, these reversion rates have been below most available market rates, which led the lenders in question to introduce a second, more expensive SVR for the newly originated mortgages. Since most mortgages in the dataset were originated before 2010, 30% of the loans in ED are on a low reversion rate as of their first submission. These loans are not considered in Table 1 since they imply low or negative incentive to refinance. Mortgages that are first observed on an initial fixed rate, but which are meant to revert to a low reversion rate, are also excluded from the analysis.

Like in most studies on the failure to refinance, one concern is that some borrowers might want to switch to a lower rate but cannot because ineligible to do so. The distribution of housing equity and unemployment might contribute to explain some of the observed sluggishness in refinancing behavior, since borrowers are likely to be denied refinancing if the account is in arrears, they have little or no equity, or there have been material changes in their circumstances (Agarwal et al., 2015a, Beraja et al., 2018). In order to exclude from the sample borrowers that may be unable to qualify for a new mortgage due to bad performance or negative equity, I restrict my analysis to borrowers that were never reported late on their payments and who reset with a loan-to-value ratio below 90%. Still, these criteria cannot identify borrowers who are excluded from refinancing despite having positive equity and never missed a payment because they no longer meet lenders' eleigibility requirements, which have become stricter after the crisis and, in particular, since the introduction of the Mortgage Market Review in April 2014 in the UK. The cases of borrowers trapped in expensive reversion rates have attracted considerable attention in the popular press. According to those accounts, these so-called *mortgage prisoners* appear to be mostly self-employed or elderly people, who took out interest-only or self-certified mortgages. Moreover, as also reported in the FCA 2019 Mortgage Market Study, most of these mortgages are with unauthorized or inactive lenders, who do not offer any new deals. I do not expect this to be a major issue for my analysis for two reasons. First, there are no mortgages originated by currently inactive lenders in the data and servicer and originator are the same for the vast majority of loans. Second, in the regressions I control for income certification, repayment method, dummy for first-time buyers and age of the borrower, which I require to be non-missing. I also drop loans for which there is no information about the location of the property to rule out that my results are capturing heterogeneity in regional house price growth. In Section 6.3, I show that my results are robust to these restrictions.

The final sample constains 85,830 reset events distributed fairly homogeneously between January 2013 and August 2017. Table 2 presents summary statistics for the mortgages in the sample. The first four columns show number of observations, mean, standard deviation and median for loans that reset to a SVR that is lower than the rate on their past fixed deal. The next four columns present the same summary statistics for borrowers that instead reset to a SVR that is higher than their expired fixed rate. 35% of the mortgages in the sample reset with $D_i > 0$, i.e. their mortgage payments are lower on the SVR than on the introductory rate. Figure A.4 in the Appendix shows the time series of SVRs by lender.

Table 2: Summary Statistics for Mortgages that Experience a Rate Reset

This table shows summary statistics for the mortgages in the analysis sample, which includes only mortgages that see their initial fixed rate reset at some pre-determined date during the sample period. I report number of observations, mean, standard deviation and median of the control variables separately for mortgages that experience an automatic drop in monthly payments at reset (GAIN) and those who see their payments increase when falling on the reversion rate (LOSS). All variables in Panel A and B are measured at the end of the introductory deal, except for gross income and credit score which are as of the inception of the loan. Loan-to-income is current balance divided by income at inception. Income verification indicates whether the income of the borrower has been verified by the lender when the loan was granted. Reported credit scores in the ED data follow different scales depending on the score provider: Callcredit, Experian or Equifax. To allow comparability, I standardize the score by the maximum value in each score system. For lenders that assign credit scores according to internal systems, I standardize using the maximum assigned value in sample. Panel C reports original loan amount, LTV ratio and term of the loan (in years) as of the origination of the mortgage.

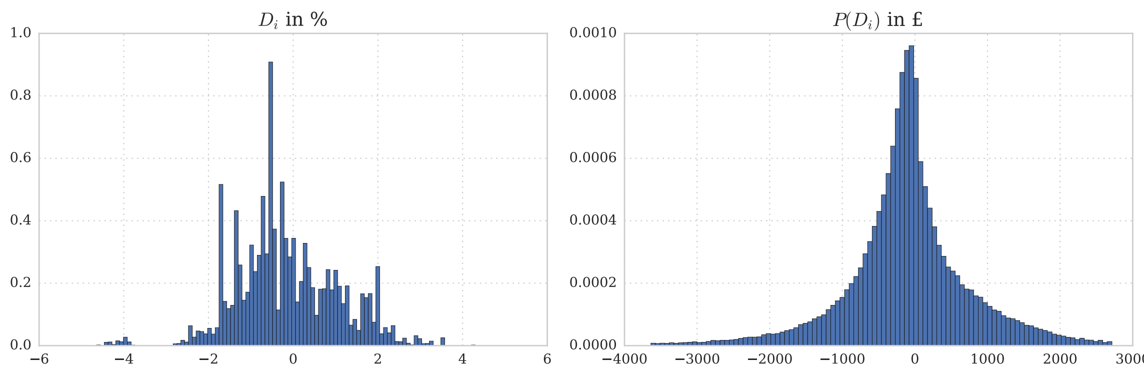
	Reset implies GAIN ($D_i > 0$)				Reset implies LOSS ($D_i < 0$)			
	N	Mean	SD	Med	N	Mean	SD	Med
Panel A: Loan Characteristics at Reset of the Current Initial Fixed Deal								
Interest Rate (%)	30336	5.32	0.83	5.19	55494	3.15	0.58	3.24
Loan Value (1000)	30336	93.62	66.52	81.18	55494	105.24	92.27	81.86
Loan-to-Value (%)	30336	59.32	25.67	67.47	55494	43.84	19.64	44.61
Years to Maturity	30336	17.49	7.85	17.92	55494	13.92	6.62	13.67
Interest Only	30336	0.10			55494	0.22		
Panel B: Borrower Characteristics								
First-Time-Buyer	30336	0.41			55494	0.19		
Gross Income (1000)	30336	38.78	23.50	33.32	55494	46.64	31.59	38.00
Age at Reset (Years)	30336	43.21	10.88	42.00	55494	47.46	9.62	47.00
Loan-to-Income	30336	2.51	1.17	2.48	55494	2.34	1.28	2.21
Income Verification	30336	0.62			55494	0.52		
Credit Score	15475	0.75	0.12	0.75	23371	0.78	0.14	0.77
Panel C: Loan Characteristics at Origination								
Original Loan Value	30336	106.81	68.39	93.00	55494	126.61	95.83	102.00
Original Loan-to-Value	30331	70.24	23.38	78.40	55481	59.99	21.45	63.60
Original Loan Term (Years)	30336	23.67	6.38	25.00	55494	20.99	6.04	22.00

5.3 Distance from the Reference Point

The main explanatory variable of interest is the distance D_i between the reversion rate and the reference rate, defined in equation (4). The left panel of Figure 5 plots the distribution of this measure in the data. Recall that D_i is the difference in percentage points between the interest rate charged on the introductory deal and the SVR charged in case of inaction. A negative value thus means that reverting to the SVR implies an increase in mortgage payments relative

Figure 5: Variation in D_i

The left panel plots the distribution of D_i defined in equation (4) as the percentage point difference between the rate paid on the introductory period and the reversion rate (SVR). The right panel shows the distribution of the change in annual mortgage payments implied by D_i (in £).



to what the borrower has been paying until that moment. In other words, staying on the SVR implies a loss in disposable income from the perspective of the reference point. In my sample, about 40% of resets happen when this distance is negative. The average distance is 9.5 basis points. Since interest rates have been going down over the period under consideration, the fraction of borrowers with a negative distance decreases over time, dropping from 53% in 2013 to 32% in 2017. In the right panel, I plot the change in annual disposable income in the inaction state relative to the reference state in the right panel for the borrowers in the sample, which are roughly normally distributed between minus and plus £2,000.

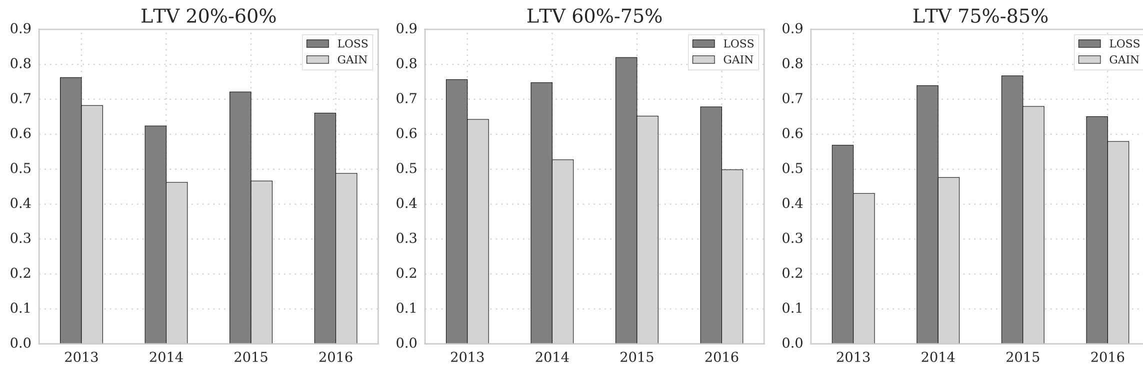
6 Results

6.1 Graphical Evidence: Losses versus Gains

In this section, I provide preliminary evidence that reference points matter for borrowers' refinancing decisions. To do so, I group households based on whether the SVR is higher (LOSS) or lower (GAIN) than the rate on the fixed deal. Figure 6 plots the fraction of households that have refinanced their mortgage within six months from the end of the introductory fixed deal, by year of the reset. The left panel considers mortgages with a LTV at reset between 20% and 60%, the center panel mortgages with a LTV between 60% and 75% and the right panel mortgages with a LTV between 75% and 85%. The average refinancing rate across

Figure 6: Reference Points and Refinancing Activity

The figure shows the fraction of households (with at least five years left until maturity) that refinance within six months from the end of the introductory fixed deal by year and LTV class. The color of the bar indicates whether inaction implies a loss (dark grey) or a gain (light grey) relative to the state before the rate reset.



observations is 62.5%.[11] The reference dependence hypothesis posits that we should observe a higher refinancing rate among households for which inaction implies a loss in disposable income relative to the pre-reset period. Consistent with this prediction, the average refinancing rate among this group of borrowers is 18.5% points higher than for mortgages with a maturing fix rate lower than the reversion rate. Households for which the inaction state implies a loss refinance more in each year under consideration and in each LTV group. For 40% of the loans I can observe their performance over two years after they reset. The difference between the two groups is still large and significant (14.0%).

6.2 Regression Results

Table 3 presents estimation results of the model specified in equation (5). The dependent variable $Refinance_i$ is set equal to one if borrower i has refinanced within six months from the end of the introductory period.[12] The first regression demonstrates that the negative relationship between reference points and refinancing decisions observed in Figure 6 is statistically significant. The coefficient of -0.066 (t-stat = -5.76) indicates that an increase by 1 percentage point of the difference D between the reference rate and the reversion rate is associated with a 6.6 percentage point decrease in the individual's probability of refinancing

[11] Using a comprehensive dataset on the universe of UK mortgages, the Financial Conduct Authority (FCA) finds that in the period 2015-2016 more than 75% of the mortgages have been refinanced within six months from the reset. For the same period, the refinancing fraction in my sample is lower, 65.8%. The FCA 2019 Mortgage Market Study can be found at https://www.fca.org.uk/publication/market-studies/ms16-2-3-final-report.pdf.

[12] I show the robustness of the results to alternative choices of the refinancing horizon in Section 6.3.

Table 3: Reference Point Effects on the Decision to Refinance

The table shows OLS regressions of different variants of equation (5). The dependent variable is a 0/1 indicator for whether the mortgage is refinanced within six months from the end of the initial fixed period. The explanatory variable of interest is the distance from the reference rate D, defined for each individual borrower facing a rate reset as $D_i = r_i^R - SVR_i$ (in percentage points). r_i^R is the expired fixed rate of mortgage i and SVR_i is the corresponding reversion rate, i.e. the SVR of loan's lender l. Reported t-statistics in parentheses are clustered at the month when the rate resets and at the region (nuts-2) where the property is located. Key: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D	-0.066***	-0.079***	-0.063***	-0.062***	-0.062***	-0.059***	-0.066***	
	(-5.771)	(-13.679)	(-9.860)	(-9.736)	(-9.812)	(-9.252)	(-10.346)	
GAIN Dummy ($D > 0$)								-0.134***
								(-10.011)
Controls								
Log Balance			0.077***	0.100***	0.115***	0.112***	0.144***	0.150***
			(7.248)	(9.567)	(16.731)	(16.454)	(17.159)	(18.994)
Years to Maturity			0.006***	0.003***	0.003***	0.003***	-0.000	-0.000
			(6.946)	(3.384)	(3.444)	(3.194)	(-0.375)	(-0.298)
LTV			0.002***	0.001**	0.001	0.000	0.001*	0.001
			(3.502)	(2.175)	(1.090)	(0.760)	(1.883)	(1.513)
Borrower's Age				-0.003***	-0.003***	-0.003***	-0.003***	-0.003***
				(-4.048)	(-4.529)	(-4.621)	(-3.859)	(-4.305)
Log Income				-0.023***	-0.024***	-0.025***	-0.047***	-0.047***
				(-4.173)	(-4.206)	(-4.341)	(-7.178)	(-7.379)
Repayment Mortgage							0.156***	0.155***
							(11.523)	(11.486)
Income Verified							-0.036***	-0.037***
							(-7.303)	(-6.853)
Firsttime Borrowers							-0.034**	-0.037***
							(-2.498)	(-2.760)
Month * Lender * LTV bin FE		✓	✓	✓	✓	✓	✓	✓
County FE					✓	✓		
Origination Year FE						✓		
Observations	79,468	79,468	79,468	79,468	79,467	79,467	79,468	79,468
R-squared	0.028	0.126	0.148	0.151	0.155	0.156	0.162	0.160

after the initial fixed rate period ends. The unconditional probability of refinancing within six months from the rate reset is 59.1% and the standard deviation of D is 1.25 percentage points in the sample. Therefore, a 1-standard deviation increase in the perceived gain from moving to the reversion rate decreases the probability of refinancing by 14% of its unconditional value.

From column (2) all specifications include reset month × lender × LTVbin fixed effects to control for unobserved heterogeneity in financial incentives to refinance across borrowers. As I explain in detail in Section 4, given mortgage pricing in the UK available refinancing rates, refinanging costs and eligibility criteria are assumed to be constant within borrowers at a given lender with a similar LTV whose initial deal ends at the same time. The coefficient on D becomes more negative, dropping to $-.079$ (t-stat = -13.69). In the third specification I control for the log of the outstanding loan balance, the remaining years to maturitiy, the age of the borrower, the log of the household's income and the LTV. Notice that outstanding balance, years to maturity and LTV are all measured prior to the reset of the rate to make sure that they do not capture potential ex-post decisions to increase the borrowed amount or to extend the maturity of the loan upon refinancing. The inclusion of the controls reduces the estimated effect of reference points on refinancing choices slightly. The coefficient on D changes to $-.062$ (t-stat = -9.75) indicating that differences in mortgage and borrower characteristics also help explain differences in refinancing behavior. I verify that most of the change is driven by the inclusion of log balance, while age and income leave the coefficient essentially unchanged in column (4).This indicates that reference points do not covary significantly with demographics, which mitigates the concern that the results might be explained by unobserved borrower heterogeneity. Column (5) additionally controls for county fixed effects and column (6) for origination year fixed effects. Both the sign and the significance of the coefficient on D are unaffected across columns, indicating that the results are not driven by a particular combination of fixed effects. In column (7) I include a set of dummies for repayment mortgage, income verification and first-time buyer. Controlling for these factors might be potentially important since they may both affect the observed rate on the mortgage and the probability that a borrower is able to refinance. In particular, individuals whose income was not been verified during the mortgage application are usually self-employed people who self-certified their income and who are therefore more likely to be denied refinancing. Including them in the regression makes the result, if anything, stronger. Finally, column (8) estimates the regression on a binary variable GAIN that takes the value of one when $D_i > 0$, and zero otherwise. The coefficient indicates that the average refinancing probability of borrowers whose mortgage payments are expected to go down regardless of their actions at the end of the fixed rate period is 13.4 percentage points lower than that of borrowers who would experience an actual loss in disposable income if they did not refinance.

Table 4 examines this mechanism further by estimating the model across subsamples based on quintiles of borrower age, borrower income and loan balance. The literature finds that refinancing mistakes are related to proxies for financial literacy and are more common among older borrowers and households with a lower income. Estimating the relationship separately within age and income groups allows me to test whether reference point effects weaken as borrowers are expected to be more financially savvy. There is a large debate about whether individuals make behavioral mistakes only when the financial consequences are negligible (Agarwal et al., 2015b, Pope and Schweitzer, 2011). Since potential savings are higher for borrowers with a larger outstanding debt, I check if behavioral biases disappear when the stakes are high. Before looking at the regression results, notice that the fraction of refinancers reported in the last row of each panel shows patterns consistent with previous findings in the literature: The probability to refinance is decreasing in age and increasing in both income and outstanding balance. Turning to the coefficient on the GAIN dummy, we see that overall the Table show that the heterogeneity in refinancing behavior related to differences in reference points exists over and above any effect from demographics. The coefficient is always negative and significant, and shows little variation across quintiles of the covariates. The last column in each panel reports the estimated differential effect of going from the bottom quintile to the top quintile of the distribution of the relevant grouping variable. In particular, the table shows the estimate and the respective t-statistic of the coefficient on GAIN $\times$ Q5 from a regression of $Refinance_i$ on levels and interactions of GAIN dummy and quintile dummies. While young mortgagors appear to be less affected by reference points and the difference between the first and last age quintile is statistically significant, the effect is not linear across quintiles. The effect of the reference mortgage rate is instead unchanged across income groups, while it decreases with the size of the outstanding balance.

So far, the analysis has relied on within lender, time and LTV bucket variation to control for potential omitted variable bias coming from heterogeneity in savings from refinancing. An alternative way of doing this would be to include on the right-hand side of the regression both the relative gain D and the actual average saving, namely the difference between the SVR and current market rates. I do this in Table 5. The advantage of this specification compared to the fixed-effect regression is that it allows to estimate the sensitivity of borrowers to both actual and relative gains. The disadvantage is that incentives to refinance are not determined solely by the interest rate saving but also depend on expectations about future changes in interest rates. These expectations are likely to change over time and depend on macro events and policy announcements.

From the specification in column (1), I estimate that a 1% increase in the relative gain decreases *ceteris paribus* the probability of refinancing by 5.1 percentage points. This is lower than the 6.6 percentage points estimated from the within groups regression in Table 3, but still negative and strongly significant. The coefficient on $SVR_i - \overline{r^{2yr}}$ indicates that a 1%

increase in the savings from switching to a lower market rate increases the probability to refinance by 9.6 percentage points. The relative magnitude of the coefficients shows that the impact of reference points is roughly half as large as the impact of rational incentives. Said differently, these estimates imply that in order to produce the same effect on refinancing, the stimulus coming from lower interest rates has to be 1.5 times stronger in the presence of reference dependence, than without it. Column (2) includes additional controls for the type of mortgage, and the result becomes even stronger. In column (3), I control for the savings coming from refinancing to a 5-years fixed rate mortgage. The coefficient is still positive, but is not statistically significance. Columns (4) and (5) provide a robustness test for the results in columns (2) and (3), respectively. Instead of using the actual SVR that applies to individual loans, I use the average SVR at that time. The coefficient on the saving from switching in column (4) is slightly smaller and losses some significance. All specificantions include lender and LTV buckets fixed-effects.

Table 4: Effect by Quintile of Age, Income and Loan Balance

The table reports estimation results of specification (8) in Table 3 across different subsamples. The dependent variable is a 0/1 indicator for whether the mortgage was refinanced within six months from the end of the initial fixed period. GAIN dummy is equal to one when $D_i = r_i^R - SVR_i > 0$, which indicates that borrower i will experience a drop in mortgage payments if she does not refinance and stays on the lender's SVR. The table shows how the coefficient on the GAIN dummy changes across age quintiles (Panel A), income quintiles (Panel B) and loan value quintiles (Panel C). Included control variables in each panel are log balance, years until maturity, age of the borrower, log income, LTV, repayment method dummy, income verification dummy and a dummy for whether the borrower is a first-time buyer. In each panel, the second to last row indicates the average value of the grouping variable in each quintile and while the last row reports the respective refinancing frequency. In the last column, GAIN*ΔQ reports the coefficient on the interaction term of GAIN dummy and Q5 estimated from a regression with interaction terms between GAIN dummy and quintile dummies and where the base quintile is Q1. Reported t-statistics in parentheses are clustered at the month when the rate resets and at the region (nuts-2) where the property is located. Key: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	Low Q	Q2	Q3	Q4	High Q	GAIN*ΔQ
Panel A: Age Quintiles						
GAIN Dummy	-0.087***	-0.140***	-0.146***	-0.145***	-0.135***	-0.071***
	(-4.981)	(-10.955)	(-9.632)	(-7.529)	(-7.774)	(-4.746)
Observations	15,773	16,542	18,202	13,371	15,426	79,477
R-squared	0.161	0.158	0.153	0.152	0.187	0.163
Age (mean)	32.0	40.2	46.5	51.9	60.8	
Refi Fraction (%)	61.1	63.3	62.3	59.7	47.2	
Panel B: Income Quintiles						
GAIN Dummy	-0.131***	-0.139***	-0.137***	-0.131***	-0.131***	-0.003
	(-11.071)	(-7.367)	(-7.409)	(-6.724)	(-8.131)	(-0.196)
Observations	15,882	15,764	15,762	15,846	16,070	79,477
R-squared	0.168	0.165	0.167	0.158	0.170	0.161
Income (mean in £1000)	17.9	27.6	36.3	48.3	89.4	
Refi Fraction (%)	50.7	57.3	60.1	62.5	63.9	
Panel C : Loan Balance Quintiles						
GAIN Dummy	-0.143***	-0.147***	-0.127***	-0.118***	-0.123***	0.027**
	(-11.579)	(-7.395)	(-8.354)	(-6.548)	(-8.271)	(2.039)
Observations	15,572	15,893	15,714	15,934	16,208	79,477
R-squared	0.122	0.119	0.145	0.162	0.182	0.162
Loan Balance (mean in £1000)	27.2	56.0	82.0	116.0	224.0	
Refi Fraction (%)	41.3	58.2	62.3	65.1	67.1	

Table 5: Horse Race Regression: Actual versus Relative Gains

The dependent variable is a 0/1 indicator for whether the mortgage is refinanced within six months from the end of the initial fixed period. The explanatory variable of interest is the distance from the reference rate D, defined for each individual borrower facing a rate reset as $D_i = r_i^R - SVR_i$ (in percentage points). r_i^R is the expired fixed rate of mortgage i and SVR_i is the corresponding reversion rate, i.e. the SVR of loan's lender l. $\overline{r^{2yr}}$ is the average rate on a newly originated 2-years initial fixed deal at the time of the reset. Similarly, $\overline{r^{5yr}}$ is the rate on a newly originated 5-years initial fixed deal at the same time. $\overline{SVR}$ is the average quoted SVR across all lenders. The first set of control variables includes log balance, years until maturity, age of the borrower, log income and current LTV. The second set of controls corresponds to a repayment method dummy, an income verification dummy and a dummy for whether the borrower is a first-time buyer. Reported t-statistics in parentheses are clustered at the month when the rate resets and at the region (nuts-2) where the property is located. Key: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
D_i	-0.051***	-0.054***	-0.066***
	(-6.445)	(-6.788)	(-10.717)
$SVR_i - \overline{r^{2yr}}$	0.096**	0.097**	0.049***
	(2.039)	(2.040)	(4.481)
$SVR_i - \overline{r^{5yr}}(\perp)$			0.040**
			(2.102)
Controls	Yes	Yes	Yes
Lender FE	Yes	Yes	Yes
LTV Bucket FE	Yes	Yes	Yes
Observations	79,468	79,468	79,468
R-squared	0.113	0.124	0.129

6.3 Robustness: Alternative Horizons, Sample and Estimation Approach

I start by ensuring that the results presented in Table 3 are robust to alternative refinancing horizons. For the main analysis, I define the dependent variable to be equal to one if the loan is refinanced in the 6-months period from the reset date. Table A.1 repeats the previous analysis for different event windows. The first column defines refinancing over a 3-months period, while the third and fourth columns consider refinancing within 9 and 12 months, respectively. For convenience, in the second column I report again the results for the 6-months period. Results are robust to all choices of horizon. Moreover, the analysis shows that the effect of the distance from the reference point is persistent and even becomes stronger over time. The last row of the table reports the fraction of borrowers who refinance and shows that most borrowers that decide to refinance do so within the first 3 months from the reset date. The refinancing fraction increases by an additional 10% over the following 9 months, indicating that some borrowers might need more time before becoming active, possibly because they were not paying attention and did not immediately realize that the interest rate has changed and that refinancing might be optimal. Taken together, these results show that refinancing in later months mostly comes from borrowers who see their mortgage payments increase automatically, rather than from those borrowers who face a gain and whose refinancing activity is catching up.

Recall from Section 5 that to be included in the analysis, I require loans to have non-missing information about several borrower and contract characteristics in order to address a potential omitted variable bias. I relax this restriction in Table A.2, increasing the sample size by 50%. Specifically, I allow for age of the borrower, location of the property, repayment type and income verification to be missing. For the sake of comparison I repeat the analysis in the restricted sample, dropping age as a control and without including regional fixed effects. The main results are robust to this increased sample.

In the main analysis, I rely on an OLS framework to estimate the effect of reference points on the refinancing decision. This is done to ensure robust inference by including a large number of fixed effects. Table A.3 presents results from a Logit model and confirms the previous finding that reference points are an important determinant of the refinancing outcome. The Table reports average marginal effects and indicates that a one percent increase in the distance from the reference point D is associated with a decrease in the probability of observing a refinancing within six months between 6.5% and 7.9%.

7 Addressing Identification Concerns

To test for reference point effects on refinancing decisions, ideally one would randomly assign reset dates and hence reference rates to borrowers. The empirical analysis in the previous section exploits cross-sectional variation in reference points that comes from borrowers' choices about the fixation period. Given steadily falling interest rates, the sample period contains little variation in the distance from the reference point that is orthogonal to the length of the fixation period. In particular, in 2013-2017 there is a positive correlation between the reference point and the length of the fixation period, as it is clear from the plot in the right panel of Figure 3. In this section, I address three challenges to my identification strategy that arise from the lack of exogenous variation in reference points.

First, one might be concerned that, despite controlling for borrowers' age and income, the results are explained by unobserved differences in borrowers' propensity to refinance. For example, if borrowers that prefer longer fixation periods are also more likely to be inattentive at reset of the fixed rate or they attach a higher psychological cost to taking action, this would lead to a negative relationship between reference rates and the probability to refinance.

The second identification challenge comes from the fact that mortgagors in the UK usually refinance several times before the principal is paid down: At the end of each introductory period most borrowers switch to a new initial deal so that mortgages basically turn into a succession of short-term contracts. Clearly, a borrower choosing a succession of 5-years contracts will be faced with the decision to refinance less frequently than if she had chosen 2-years contracts. This raises two concerns for my analysis, namely survivorship bias and learning effects from frequent refinancing. Consider two borrowers who took out a mortgage roughly at the same time and whose current initial fixed period expires on the same date. Assume that one of them was on a 5-years contract while the other one on a 2-years contract. If borrowers have time-invariant preferences for a given duration, we expect the borrower with the shorter deal to have refinanced more frequently in the past. On the one hand, this means that there were more occasions in which she could have failed to refinance even when it was optimal to do so. The fact that I observe the borrower in the sample means that she did refinance before, which might introduce selection bias. Moreover, we know from the household finance literature that borrowers appear to learn from repeated financial decision making (Agarwal et al., 2016). Another related concern might therefore be that borrowers with shorter fixation deals are faster at reacting to refinancing incentives because they have more experience with the refinancing process, which reduces the hassle of taking action.

Finally, one may worry that borrowers that select into longer maturities have a higher probability of being denied refinancing. This is a concern given that Hertzberg et al. (2018) show from the peer-to-peer lending market in the US that borrowers with higher unobservable repayment risk tend to self-select into longer maturity contract based on private information. As a consequence, lenders may use the maturity of the previous loan as a device to screen observationally identical borrowers. While I exclude borrowers that are late on their payments or who are close to negative equity, and I control for mortgage types that are more likely to be refused refinancing, I cannot exclude this channel a priori. To control for the incentive to self-select based on unobservables, I control for the term-premium at the time of the origination of the mortgage. The idea is that the larger the difference in term premia between 5-years and 2-years maturities, the worse the adverse selection problem gets. I show that the impact of the relative gain remains strong and significant after including controls for the incentive to self-select.

In Sections 7.1 to 7.3, I present evidence that mitigates the concern that these alternative explanations might be driving the results.

7.1 Endogenous Fixation Period

The first identification concern is that borrowers who prefer higher duration risk are also *ceteris paribus less likely* to refinance at the end of the fixed deal. Theory predicts that households with a large mortgage, uncertain labor income, high risk aversion, high cost of default, and low probability of moving should choose to bear less interest rate risk (Campbell and Cocco, 2003). If anything, risk averse borrowers should be relatively *more* careful not to fall on the variable rate of the lender, and households that do not plan to move in the near future should find the flexibility of the SVR *less* attractive. Admittedly, however, the household finance literature on mortgage choice finds that borrower's age, which is often associated with sluggishness in refinancing behavior, also suggests a preference for fixed rate mortgages over variable rate ones.[13] Overall, this assumption is inherently untestable and given the data I cannot rule out with certainty its effect on my results. Nevertheless, the results presented in the following sections show that a preference for longer fixation periods are not generally associated with lower propensities to refinance.

In Section 7.1.1 I first show that at least in terms of observable characteristics, namely age and income, people that choose two versus five years contracts are largely similar. Then, in Sections 7.1.2 and 7.1.3, I show using two distinct approaches that, in the absence of differences in reference points, a higher fixation period does not seem to be associated with a lower probability to refinance.

7.1.1 Mortgage Duration Choice and Borrower Characteristics

There is substantial evidence that older and lower income borrowers tend to react less to refinancing incentives (Bajo and Barbi, 2018, Andersen et al., 2015, Keys et al., 2016). A first indication that differences in unobserved characteristics are unlikely to explain my findings is the fact that the estimated coefficient on D_i in Table 3 is virtually unchanged when I include age and income in the regression. If the choice of mortgage duration was correlated with the probability that a borrower is subject to behavioral biases such as inattention and

[13] Paiella and Pozzolo (2007) find using Italian survey data that household head's age is negatively related to the probability of taking out an ARM versus a FRM.

inertia, we would expect to observe a strong correlation between reference rates and these demographics.

In this section, I compare observable characteristics of borrowers that take out a mortgage in the same month, but choose different fixation periods. There are several data limitations that I have to overcome for this purpose. First, while I know the end date of the introductory deal, the data do not contain information on loans fixation period. I can however recover the fixation period from the time series of submissions, provided that the loan has enough observations prior to the event or was originated not more than two years before the first submission to ED. Second, to answer the question at hand I would need to observe income as of when the choice about the fixation period was made. However, income in the database is at inception of the loan. The longer the time gap between loan origination and the latest fixation choice, the less accurate this information is going to be. I therefore restrict the analysis to loans that were originated in 2011, for which I know that the first observed reset corresponds to the first reset since origination and that the reported income is the income at the moment of the decision about duration. The sample contains roughly 6,000 observations. 75% of the loans have an fixation period of two years, 17% of five years and the rest is split between three and four years. This dominance of short fixation contracts is consistent with Koijen et al. (2009) who find that when term premia are high households tend to bear more interest rate risk.

Table 6 shows the distribution of borrowers' age and income separately for 2-years and 5-years initial deals. Despite a much smaller number of observations for the 5-year deal, borrowers look very similar across the two groups. The last column shows the average differences and associated t-statistics for borrowers that choose a 5-year deal relative to those that choose a 2-year deal, estimated in a regression where I additionally control for mortgage characteristics as well as month and region fixed-effects. I find that borrowers with that choose the longer fixation period are 2.4 years older and have a gross annual income that is £1,860 lower on average. Even though the coefficients are statistically significant (for income only at the 10% level) and the sign indicates that this channel might amplify my results, the differences are small in magnitude confirming the result from the unconditional distribution.

Table 6: Age and Income by Fixation Period

This table shows number of observations, mean, standard deviation as well as the 25th, 50th and 75th percentile of the distribution of age and income of borrowers that chose either a 2-years or a 5-years initial deal. The number of observations is much smaller than in the full sample because the ED data do not explicitely report the fixation period of each loan. Whenever possible, the length of the fixation period is recovered from the time-series of the submissions, as I explain in detail in section 7.1.1. Moreover, to make sure that income reflects borrower income at the time of the choice about the fixation period, I only consider mortgages that were originated in 2011. The last column reports the estimated coefficient on the 5-years indicator in the regression $Characteristic_i = \alpha_t + \alpha_k + \delta 5yrs_i + \gamma Controls_i + \varepsilon$ for loan i originated in month t in region k. For this regression, I include Loan-to-Value, Loan-to-Income and loan term as control variables. t-statistics are in parenthesis. Standard errors are clustered at the region level.

	2 years						5 years						δ
	N	Mean	SD	25%	50%	75%	N	Mean	SD	25%	50%	75%	
Age (Years)	4266	34.7	8.7	28.0	33.0	40.0	999	35.6	9.4	28.0	33.0	43.0	2.409*** (15.450)
Income (£1000)	4266	43.1	26.9	26.3	36.2	50.8	999	41.0	28.2	24.2	33.5	47.7	-1.859* (-1.917)

7.1.2 Evidence from the 2007-2008 NMG Survey

The evidence presented in the previous paragraph that borrowers are similar across fixation periods is reassuring. However, the concern remains that observationally identical borrowers who self-select into different contract lengths differ along unobservable and hard-to-measure dimensions that explain different refinancing behavior. Ideally, we would like our sample to contain periods when reference rates are the same or lower for 5-years deals and 2-years deals. In this way, one would be able to directly test whether differences in fixation periods may be amplifying the effect of reference points. Observing that borrowers who choose to fix the interest rate for longer tend to refinance just as often or more often than the average borrower would provide support for our assumption, and strengthen the evidence in favour of the reference dependence hypothesis.

The right panel in Figure 3 shows that in the years 2007-2008 fixed rates were almost identical for borrowers coming off a two or five years introductory deal. Since these years are not in the ED database, I use data from the *NMG Survey of Household Finances* that the BoE carries out on an annual basis since 2004 to get information about refinancing activity during that period. At the end of 2007 and 2008, 908 respondents with a fixed rate mortgage on their house were asked whether their initial deal had expired within the previous twelve months. Out of these, 219 households did report a positive answer. For these households, I can infer whether the mortgage was refinanced from the type of interest rate the household reports to be currently paying (fixed, variable, SVR, etc.). Because the survey does not provide information on the length of the initial period nor the interest rate paid on the recently ended deal, I use the presence of dependent children (aged below 15) in the household as a proxy for having a longer initial fixation period. While the literature on mortgage choice finds little explanatory power of borrowers characteristics in predicting the preference for ARMs versus FRMs, a notable exception next to the age of the borrower is that families with children tend to insure more against interest rate risk (Paiella and Pozzolo, 2007). More generally, there is evidence in the literature that households with children tend to be more risk averse. The survey also contains information about the age of the respondent, the remaining balance on the mortgage, the current value of the property[14], total (secured and unsecured) outstanding debt, income and level of education. Figure A.2 in the Appendix plots income and age distributions of borrowers in the survey and in the ED loan-level data. Average annual household income in ED is £43,877, but higher among survey respondents (£49,750). Homeowners in the survey are also younger, with an average age of 42 years compared to 46 years in ED.

In Table 7 I report estimated difference in average refinancing probability of families with children relative to families without children. I find that the presence of children is associated with a higher propensity to refinance at the end of the fixed deal across all specifications. The average marginal effect (AME) reported in the table is positive though not significant in the specification without controls. While the sample size is limited, these results show for a period when differences in reference points across fixation periods are negligible on average, borrowers that are expected to have a preference for longer fixation periods do not show a tendency to refinance less, rather they appear to be relatively more active. This evidence mitigates the concern that unobserved borrower characteristics associated with the choice of the fixation period are confounding my results.

7.1.3 The Effect of Maturity when Reference Points are similar

In this section, I propose a way to use the loan-level data to test whether differences in fixation period are related to lower refinancing activity for reasons other than through the effect on reference points. I show that when borrowers have similar reference rates at reset, a longer

[14] The value of the house is the one reported to the question: "About how much would you expect to get from your main home if you sold it today?". The question is asked only if the respondent is mainly or jointly responsible for financial decision making.

Table 7: Households with Children

This table reports the average marginal effect (AME) estimates from a logit regression of a dummy variable indicating whether the mortgage has been refinanced after the end of the fixed deal on a dummy for whether there are children (aged less than 15 years old) living in the household. Education is a discrete variable that measures the level of respondent's formal educational attainment. tstatistics are reported in parentheses. Key: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	Average Marginal Effect				
Dependent Variable: Refinance Dummy	(1)	(2)	(3)	(4)	(5)
With Children	0.069	0.112*	0.145**	0.117*	0.270**
	(1.485)	(1.822)	(2.214)	(1.653)	(3.268)
Controls					
Age		✓	✓	✓	✓
Loan-to-Value		✓	✓	✓	✓
Total Debt-to-Income			✓	✓	✓
Log Income				✓	✓
Education					✓
Observations	218	160	140	115	77

fixation period is not associated with a lower probability of observing refinancing.

Even though average interest rates on 5-years contracts are consistently higher than those on 2-years contracts over the period considered in this analysis, there is still considerable variation in the rate spread between 5-years and 2-years mortgages resetting at the same time. Even though the same rate applies to all borrowers that select into the same product, term premia, i.e. the rate differential charged to fix the rate for 5 years rather than 2 years, vary across lenders, time and loan leverage. I exploit this variation to compare the refinancing rates across borrowers with different fixation periods as a function of the difference in refinancing rates. In particular, under my key identifying assumption, if rates for long and short fixation contracts are similar, I should not observe significant differences in refinancing rates.

For the subsample of loans for which I can determine the length of the expired introductory period, I compute the difference in reference rates between 5-years and 2-years mortgages within lender, reset month and LTV class. I then estimate the effect of having a longer fixation period on the probability to refinance in subsamples based on the difference in average reference rates. Estimation results are reported in Table 8. In the first column the effect is estimated only considers observations where the average difference in reset rates is small,

Table 8: Isolating Fixation Period Choice from Reference Point Differences

For this regression I exploit the variation in average rates on 5-years and 2-years mortgages across lender*event month*LTVbin clusters to test whether fixation periods affect refinancing decisions beyond the effect through reference points. I first compute the average expired fixed rate over mortgages resetting in the same month, with the same lender and within the same LTV range for 5-years loans and for 2-years loans separately. The difference $\bar{r}^{5yr}_{l,t,LTV} - \bar{r}^{2yr}_{l,t,LTV}$ between these averages reflects how far apart reference points of mortgages with different fixation period are in a given cluster. I run a regression of $Refinance_i$ on an indicator for whether the loan is a 5-years fixed deal on subsamples based on the distribution of this measure. In the columns headers, $p10$, $p25$, $p50$ and $p75$ are the 10th, 25th, 50th and 75th percentile, respectively. Reset events in the $< p10$ group may differ in terms of fixation period but have fairly homogeneous reference points. Regressions include controls for the log of the loan balance at reset, remaining term (in years), borrower's age, log income and dummies for whether the mortgage is a repayment mortgage, the borrower is a first-time buyer and the income was verified upon origination. All specifications also include month, lender and LTV bin fixed effects. tstatistics are reported in parentheses. Key: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	Cutpoints of the distribution of $(\bar{r}^{5yr}_t - \bar{r}^{2yr}_t)$				
	$< p10$	$< p25$	$> p25$	$> p50$	$> p75$
LHS Variable: $Refinance_i$	(1)	(2)	(3)	(4)	(5)
5-yrs dummy	0.010	-0.040***	-0.122***	-0.141***	-0.175***
	(0.578)	(-2.746)	(-14.188)	(-12.148)	(-9.465)
Controls	✓	✓	✓	✓	✓
Month FE	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓
LTV bin FE	✓	✓	✓	✓	✓
Observations	1,831	3,998	12,585	9,171	4,235
R-squared	0.078	0.127	0.131	0.113	0.144

namely below the 10th percentile of the distribution. The coefficient on the 5-years dummy shows that there is no significant difference in propensity to refinance across borrowers with different fixation periods. Columns 2-5 repeat the same exercise over different samples based on the difference in reference rates. The results show that the larger the difference in reference rates, the more negative the coefficient, i.e. the larger the difference in refinancing frequency between borrowers on a 5-years contract versus those on a 2-years contract. These results confirm our hypothesis that differences in fixation periods lead to different refinancing probabilities through the effect on the reference rate. Instead, I find no evidence that borrowers that prefer to bear less interest rate risk are also less inclined to refinance at the end of the introductory period through other channels.

7.2 Sample Selection Issues and Learning from Repeated Refinancing

I address concerns about learning from repeated refinancing by restricting the analysis to a sample of borrowers that have little or no experience with refinancing. When I look at borrowers that face a rate reset for the first time I simultanously take care of the sample selection issue.

The data contains a variable that indicates the purpose of the mortgage. The two most common values are *Purchase* and *Remortgage*. Remortgage indicates that the borrower previously had a mortgage with a different lender and decided at some point to remortgage with the current lender (so called external remortgagors). Everytime that the intorductory deal ends, a borrower can decide to stay with her current lender or remortgage to a new one. More frequent resets give more opportunities to shop around and take advantage of the lowest rates on the market. As a first way to control for experience with refinancing, in Column (1) of Table 9 I run the baseline specification excluding external remortgagors. The coefficient on the dummy GAIN ($D_i > 0$) indicates that reference dependence affects refinancing decisions also among borrowers that were always with the same lender.

I then restrict the analysis to borrowers that face a rate reset for the first time. I take two different approaches to identify mortgages that did not reset before. First, while the field indicating the purpose of the loan is supposed to be static according to the ED guidelines to the data providers, two lenders report it dynamically, changing it from purchase to remortgage when borrowers refinance internally, i.e. with the same lender, and therefore keep being reported afterwards. This lucky occurrence allows me to clearly identify first time refinancers for these two mortgage lenders. Results are reported in column (2). I then identify first time resets among mortgages that have been originated at most five years before the observed reset event and for which I observe at least two years of submissions prior to the event.

The estimated coefficient is again negative and significant, suggesting that my findings are not driven by sample selection issues or differences in how experienced borrower are with the refinancing process that correlate with the choice of the fixation period.

7.3 Self-selection into Maturities based on Private Information

To control for the incentive of high-risk borrowers self-selecting into longer maturities, I run a regression similar to the one in 5 where I additionally control for the difference in term

Table 9: Evidence from the First Reset Date

This Table shows regression results for three different subsamples of borrowers. Column (1) excludes external remortgagors, i.e. borrowers that were previously with another lenders and that refinanced to the current one before entering the dataset. Columns (2) and (3) take two different approaches to identify mortgages that reset for the first time.

	Exclude External Remortgagors	First Time Resets	
		Reported Directly	Identified from the time series
	(1)	(2)	(3)
GAIN dummy	-0.128***	-0.094***	-0.090***
	(-22.871)	(-3.948)	(-7.493)
Controls	✓	✓	✓
Lender Fe	✓	✓	✓
Reset Month FE	✓	✓	✓
LTV bin FE	✓	✓	✓
Observations	45,647	2,527	15,898
R-squared	0.138	0.081	0.123

premia between 5-years and 2-years maturities at the time of the origination of the loan.[15] Specifically, I estimate the following specification

$$Refi_i = \alpha + \beta D_i + \gamma_1 \mathbb{1}(2yrs) TermPremium_{t-2} + \gamma_2 \mathbb{1}(5yrs) TermPremium_{t-5} + \gamma_3 W_i + \varepsilon_i \tag{6}$$

where $\mathbb{1}(2yrs)$ in a dummy variable that equals 1 if loan i is a 2-years fixed rate deal and $TermPremium_{t-2}$ is the term premium two years prior to the reset. $\mathbb{1}(5yrs)$ and $TermPremium_{t-5}$ are defined similarly for 5-years mortgages. W is a set of controls. Mortgages are approximately classified into 2 and 5 years fixations based on whether the interest rate on the resetting mortgage is below or above the midpoint of average interest rates two and five years prior. This specification makes sure to control for the term premium that is relevant at the moment of the origination of the loan.

Estimation results are reported in Table 10. Under the assumption that borrower do self-select based on their privately known risk and that refinancing is denied as a function of

[15] Appendix B describes the estimation procedure for term premia.

this, we would expect γ_1 positive and γ_2 negative. Everything else constant, the higher the premium of 5-years contracts over 2-years contracts at $t-2$ indicates a better risk-pool of resetting borrowers with 2-years loans. The same intuition but in the opposite direction, is true for the term premium at $t-5$. Columns (1)-(2) simply show that this may be a plausible explanation. However, when in columns (3)-(4) I include the distance from the reference point D, the coefficients on the gammas turn insignificant and are of the wrong sign. Moreover, the coefficient on D remains negative and significant, indicating that self-selection is unlikely to explain difference in refinancing behavior. In columns (5)-(6) I repeat the analysis using moving averages of term premia, computed over a rolling 6-month window to control for some of the noise in the estimation of term premia.

8 Conclusion

Using loan-level data on fixed rate mortgages that automatically reset to reversion rates on pre-determined dates, I present evidence that borrowers' evaluate the benefits from refinancing relative to reference points that determine whether failing to refinance is perceived as a loss or as a gain. I show that perceived changes in monthly mortgage payments significantly affect the probability of refinancing in the cross-section of borrowers, imposing a severe friction to the pass-through of monetary policy relative to a rational model of mortgage refinancing in which refinancing responds solely to the future effective cost of borrowing. While average refinancing rates positively correlate with proxies for financial literacy, reference point effects are robust and stable in magnitude across income and age groups, thus providing a possibile explanation for heterogeneity in refinancing choices across similar borrowers. Overall, my results show that the current design of mortgages in the UK implies that the ability of the central bank to stimulate household consumption in a recession depends on the path of interest rates in the past through the distribution of households reference points and on reversion rates set by lenders with market power on their current customers.

Table 10: Addressing Loan Maturity as a Screening Device

This table presents estimation results from the regression specification in equation (6). The dependent variable is a 0/1 indicator for whether the mortgage is refinanced within six months from the end of the initial fixed period. The distance from the reference rate D, defined for each individual borrower facing a rate reset as $D_i = r_i^R - SVR_i$ (in percentage points). r_i^R is the expired fixed rate of mortgage i and SVR_i is the corresponding reversion rate, i.e. the SVR of loan's lender l. $\overline{r^{2yr}}$ is the average rate on a newly originated 2-years initial fixed deal at the time of the reset. $\mathbb{1}(2yrs)$ in a dummy variable that equals 1 if loan i is a 2-years fixed rate deal and $TermPremium_{t-2}$ is the term premium two years prior to the reset. $MATermPremium_{t-2}$ is a moving average computed over a rolling window of 6 months. The first set of control variables includes log balance, years until maturity, age of the borrower, log income and current LTV. The second set of controls corresponds to a repayment method dummy, an income verification dummy and a dummy for whether the borrower is a first-time buyer. Reported t-statistics in parentheses are clustered at the month when the rate resets and at the region (nuts-2) where the property is located. Key: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
D_i (relative gain)	-0.066***	-0.085***	-0.092***	-0.090***	-0.078***	-0.067***	-0.077***
	(-9.652)	(-10.975)	(-8.602)	(-9.277)	(-9.537)	(-7.428)	(-7.970)
$\mathbb{1}$(2yrs) × Term Premium$_{t-2}$		-1.479	-2.771*	-2.879*	-1.095		
		(-1.431)	(-1.954)	(-1.867)	(-1.236)		
$\mathbb{1}$(5yrs) × Term Premium$_{t-5}$		0.734	0.515	0.373	-0.124		
		(1.404)	(1.647)	(1.332)	(-0.496)		
$\mathbb{1}$(2yrs) × MA Term Premium$_{t-2}$						-3.856***	-2.334***
						(-3.546)	(-3.047)
$\mathbb{1}$(5yrs) × MA Term Premium$_{t-5}$						-2.305**	-0.805**
						(-2.453)	(-2.267)
$SVR_{it} - \overline{r_t^{2yr}}$	0.070**	0.065**	0.217**	0.211***	0.081**	0.059*	0.082**
	(2.100)	(2.077)	(2.680)	(2.869)	(2.159)	(2.004)	(2.170)
$slope_t$			12.100	12.218			
			(1.667)	(1.692)			
$bondpremium_t$				-1.960			
				(-0.694)			
Constant	-0.765***	-0.738***	-1.220***	-1.197***	-0.737***	-0.671***	-0.720***
	(-6.322)	(-6.710)	(-4.350)	(-4.737)	(-5.646)	(-6.570)	(-5.437)
Controls	✓	✓	✓	✓	✓	✓	✓
Lender FE	✓	✓	✓	✓	✓	✓	✓
LTV bin FE	✓	✓	✓	✓	✓	✓	✓
Month FE					✓		✓
Observations	66,486	66,486	66,486	66,486	66,486	66,486	66,486
R-squared	0.139	0.140	0.144	0.144	0.156	0.143	0.156

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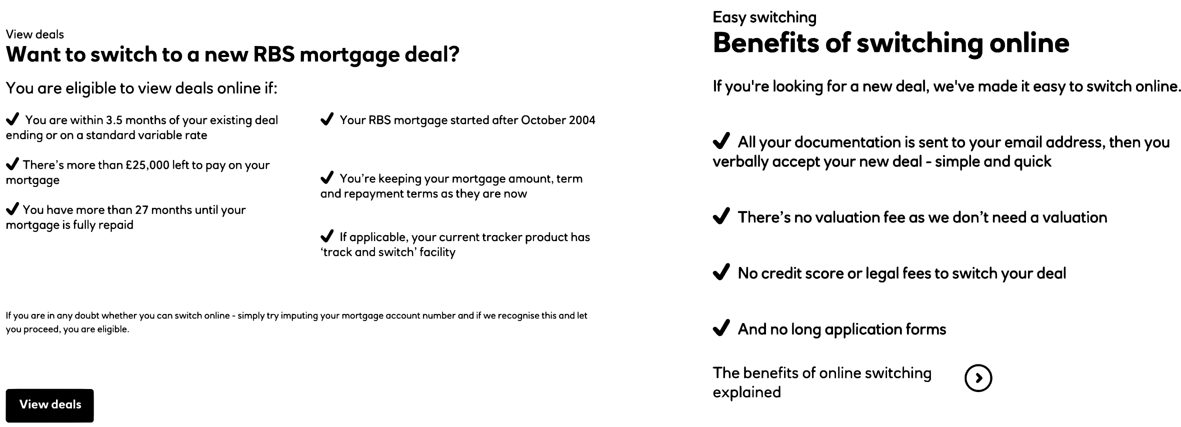
Appendix

A Additional Material

Figure A.1: Product Transfer Descriptions

Below I report a snapshot of the description of product transfers taken from three different lenders' websites. Switching to a different mortgage product by the same lender appears to impose low requirements and fees on borrowers.

(a) Royal Bank of Scotland (RBS)



View deals

Want to switch to a new RBS mortgage deal?

You are eligible to view deals online if:

- ✔ You are within 3.5 months of your existing deal ending or on a standard variable rate
- ✔ There's more than £25,000 left to pay on your mortgage
- ✔ You have more than 27 months until your mortgage is fully repaid
- ✔ Your RBS mortgage started after October 2004
- ✔ You're keeping your mortgage amount, term and repayment terms as they are now
- ✔ If applicable, your current tracker product has 'track and switch' facility

If you are in any doubt whether you can switch online - simply try imputing your mortgage account number and if we recognise this and let you proceed, you are eligible.

View deals

Easy switching

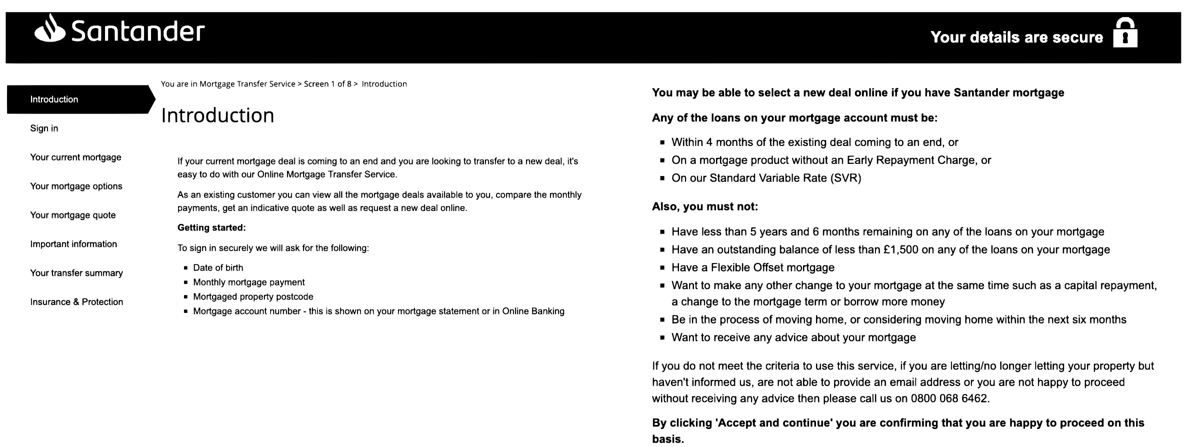
Benefits of switching online

If you're looking for a new deal, we've made it easy to switch online.

- ✔ All your documentation is sent to your email address, then you verbally accept your new deal - simple and quick
- ✔ There's no valuation fee as we don't need a valuation
- ✔ No credit score or legal fees to switch your deal
- ✔ And no long application forms

The benefits of online switching explained

(b) Santander UK



Santander

Your details are secure

Introduction
Sign in
Your current mortgage
Your mortgage options
Your mortgage quote
Important information
Your transfer summary
Insurance & Protection

You are in Mortgage Transfer Service > Screen 1 of 8 > Introduction

Introduction

If your current mortgage deal is coming to an end and you are looking to transfer to a new deal, it's easy to do with our Online Mortgage Transfer Service.

As an existing customer you can view all the mortgage deals available to you, compare the monthly payments, get an indicative quote as well as request a new deal online.

Getting started:

To sign in securely we will ask for the following:

- Date of birth
- Monthly mortgage payment
- Mortgaged property postcode
- Mortgage account number - this is shown on your mortgage statement or in Online Banking

You may be able to select a new deal online if you have Santander mortgage

Any of the loans on your mortgage account must be:

- Within 4 months of the existing deal coming to an end, or
- On a mortgage product without an Early Repayment Charge, or
- On our Standard Variable Rate (SVR)

Also, you must not:

- Have less than 5 years and 6 months remaining on any of the loans on your mortgage
- Have an outstanding balance of less than £1,500 on any of the loans on your mortgage
- Have a Flexible Offset mortgage
- Want to make any other change to your mortgage at the same time such as a capital repayment, a change to the mortgage term or borrow more money
- Be in the process of moving home, or considering moving home within the next six months
- Want to receive any advice about your mortgage

If you do not meet the criteria to use this service, if you are letting/no longer letting your property but haven't informed us, are not able to provide an email address or you are not happy to proceed without receiving any advice then please call us on 0800 068 6462.

By clicking 'Accept and continue' you are confirming that you are happy to proceed on this basis.

Figure A.1: Product Transfer Descriptions (continued)

(c) Halifax UK

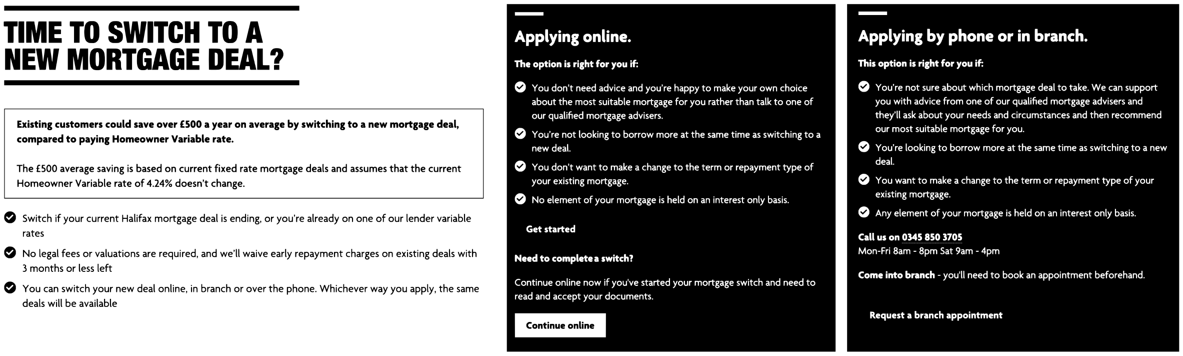


Figure A.2: Sample Representativeness - Borrowers Characteristics

This figure compares borrowers characteristics in the BoE/NMG Survey of Households Finances and in the ED loan-level database. I plot estimated kernel densities of household's pre-tax income on the left and of borrower's age on the right. Income is reported as of loan origination in the ED database, while it is current income in the survey. Age in the ED data is the age of the primary borrower when the fixed rate deal ends. Among survey respondents, I consider only homeowners that have a mortgage on their house. This restricts the sample to 8,880 observations with non-missing information about income and age over the period 2014-2018. The ED sample refers only to loans used in the analysis, namely hybrid loans that reset in the sample period.

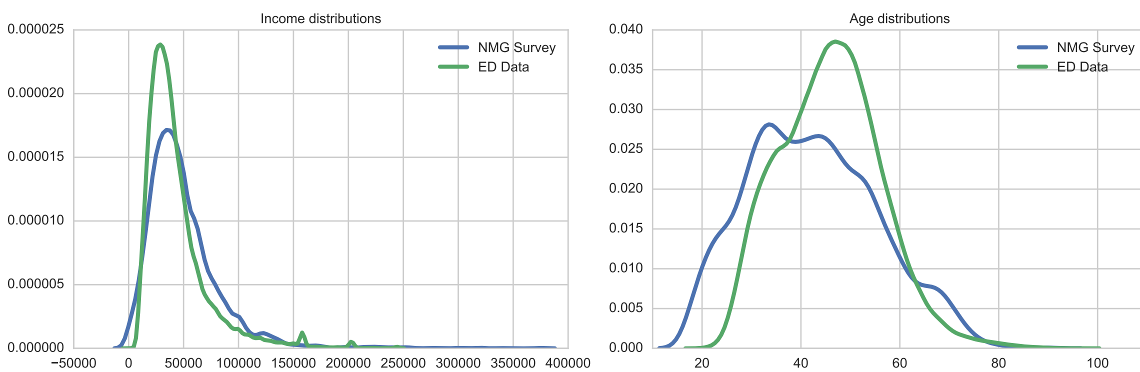


Figure A.3: Reset Events and Rifinancing Rate

The figure provides descriptive statistics about the number of initial deal ends that we observe in our sample and of the corresponding refinancing frequency. The blue bars indicate the number of loan resets aggregated by quarter (left axis). The red line plots the average refinancing rate in each quarter (right axis).

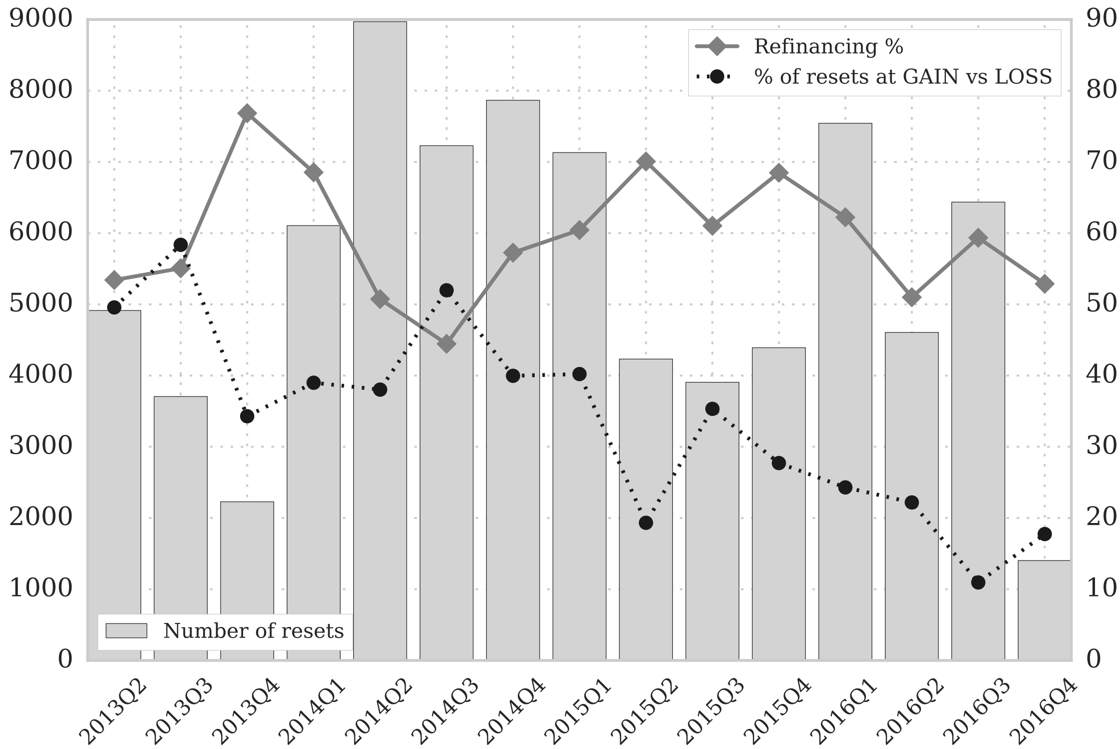


Figure A.4: Lenders' SVRs

The figure shows UK lenders' historical standard variables rates (SVRs). This is the rate to which most fixed rate mortgages revert at the end of the introductory period.

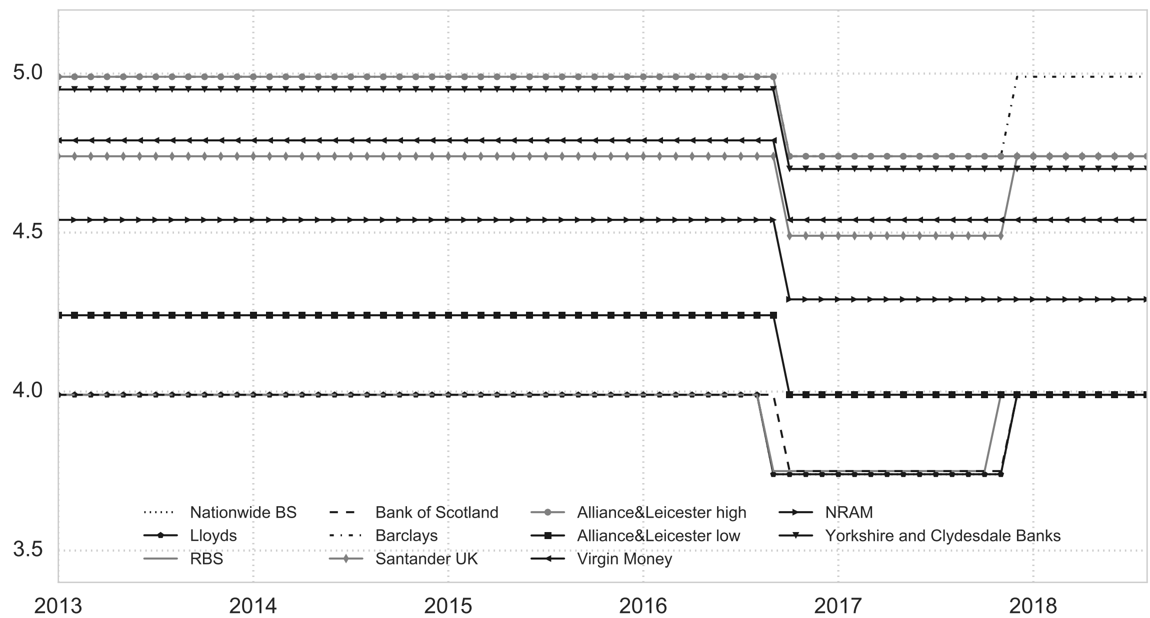


Table A.1: Robustness for Table 3: Alternative Refinancing Horizons

The table shows OLS regressions like those in column 3 of Table 3 using different horizons over which refinancing is defined. In the first specification, the dependent variable is a 0/1 indicator for whether the mortgage is refinanced within three months from the end of the initial fixed period. The second columns reports the baseline specification where refinancing is defined over a 6-months period. The third and fourth columns look at refinancing over a period of 9 and 12 months, respectively. The main explanatory variable of interest is the distance from the reference rate D, defined for each individual borrower facing a rate reset as $D_i = r_i^R - SVR_i$ (in percentage points) and standardized. r_i^R is the expired fixed rate of mortgage i and SVR_i is the corresponding reversion rate, i.e. the SVR of loan's lender l. Reported t-statistics in parentheses are clustered at the month when the rate resets and at the region (nuts-2) where the property is located. Key: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1) 3 months	(2) 6 months	(3) 9 months	(4) 12 months
D (standardized)	-0.072***	-0.078***	-0.081***	-0.084***
	(-9.113)	(-9.736)	(-8.967)	(-9.688)
Log Balance	0.092***	0.100***	0.105***	0.109***
	(9.614)	(9.567)	(10.003)	(10.897)
Years to Maturity	0.004***	0.003***	0.002**	0.002**
	(4.778)	(3.384)	(2.740)	(2.435)
Borrower's Age	-0.002***	-0.003***	-0.004***	-0.005***
	(-3.082)	(-4.048)	(-4.706)	(-5.834)
Log Income	-0.029***	-0.023***	-0.017***	-0.011*
	(-5.159)	(-4.173)	(-3.583)	(-1.988)
LTV	0.001*	0.001**	0.001*	0.001
	(1.935)	(2.175)	(2.029)	(1.186)
month x lender x ltv	Yes	Yes	Yes	Yes
Observations	84,317	79,468	71,873	58,047
R-squared	0.146	0.151	0.158	0.164
Refi Fraction	53%	59%	61%	62%

Table A.2: Robustness for Table 3: Increased Sample

The table shows OLS regressions like those in columns 1-4 of Table 3 using a larger sample. Specifically, I add back to the sample those observations with missing borrower's age, property location, repayment type and income verification information. The right panel reports the results on the restricted sample used for Table 3 without including controls for borrower's age to allow comparability. The dependent variable is a 0/1 indicator for whether the mortgage is refinanced within three months from the end of the initial fixed period. The main explanatory variable of interest is the distance from the reference rate D, defined for each individual borrower facing a rate reset as $D_i = r_i^R - SVR_i$ (in percentage points) and standardized. r_i^R is the expired fixed rate of mortgage i and SVR_i is the corresponding reversion rate, i.e. the SVR of loan's lender l. Reported is the effect of one standard deviation change in D, and t-statistics in parentheses are clustered at the month when the rate resets. Key: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	Unrestricted sample				Restricted sample			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
D (standardized)	-0.083***	-0.086***	-0.071***	-0.068***	-0.083***	-0.099***	-0.079***	-0.076***
	(-6.314)	(-13.878)	(-10.706)	(-9.320)	(-5.649)	(-13.592)	(-9.888)	(-9.385)
Log Balance			0.064***	0.064***			0.091***	0.089***
			(11.597)	(11.688)			(13.016)	(12.547)
Years to Maturity			0.006***	0.006***			0.006***	0.006***
			(10.327)	(10.095)			(6.917)	(7.147)
Log Income			-0.000	-0.003			-0.020***	-0.021***
			(-0.155)	(-0.986)			(-2.890)	(-2.994)
LTV			0.001***	0.001***			0.002***	0.002***
			(4.188)	(3.775)			(3.561)	(3.132)
month x lender x ltv	No	Yes	Yes	Yes	No	Yes	Yes	Yes
loy FE	No	No	No	Yes	No	No	No	Yes
Observations	118,608	118,608	118,608	118,608	79,467	79,467	79,467	79,467
R-squared	0.028	0.194	0.210	0.212	0.028	0.126	0.149	0.150

Table A.3: Robustness for Table 3: Logit Regression

The table reports the average marginal effect (AME) estimates from a logit regression of a 0/1 indicator for whether the mortgage is refinanced within six months from the end of the initial fixed period. The main explanatory variable of interest is the distance from the reference rate D, defined for each individual borrower facing a rate reset as $D_i = r_i^R - SVR_i$ (in percentage points). r_i^R is the expired fixed rate of mortgage i and SVR_i is the corresponding reversion rate, i.e. the SVR of loan's lender l. Reported t-statistics in parentheses are clustered at the month when the rate resets. Key: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
D	-0.065***	-0.070***	-0.065***	-0.079***
	(-5.746)	(-6.707)	(-6.353)	(-13.202)
Log Balance		0.148***	0.206***	0.171***
		(11.193)	(22.235)	(29.287)
Years to Maturity		0.002	-0.002*	-0.002***
		(1.226)	(-1.946)	(-2.751)
LTV		-0.001**	-0.002***	-0.001***
		(-2.204)	(-3.941)	(-2.734)
Borrower's Age		-0.004***	-0.003***	-0.003***
		(-5.868)	(-5.170)	(-4.985)
Log Income		-0.059***	-0.085***	-0.069***
		(-5.298)	(-8.418)	(-7.765)
Repayment Mortgage			0.168***	0.162***
			(11.560)	(12.739)
Income Verified			0.084***	-0.029***
			(3.017)	(-4.741)
First Time Buyer			-0.035**	-0.035**
			(-2.169)	(-2.437)
Month Dummies	No	No	No	Yes
Lender Dummies	No	No	No	Yes
Observations	79,468	79,468	79,468	79,463

B Term Premia Estimation

To control for the incentives of selecting into different loan maturities based on private information about one's ability to repay (Hertzberg et al., 2018), I include estimated term premia at the time of the choice about the fixation period in regression (6). For the purpose of this exercise, I estimate risk premia from a OLS regression of excess one-year log returns of two and five maturities bonds on the level, slope and "CP factor" (Cochrane and Piazzesi, 2005). The level and slope factors are, respectively, the first and second principal component from the correlation matrix of bond yields with maturities from 1 to 10 years. As the "CP Factor" I use the predicted value from a regression of average future excess returns of two to ten-year bonds on average forward rates. Specifically, I first estimate the following regression

$$\overline{rx}_{t+1} = \gamma' \overline{f}_t + \varepsilon_{t+1} \tag{7}$$

I then run a regression on contemporaneous excess returns on level, slope and the predicted value from equation (7):

$$rx_t^{(n)} = c_1 \text{level}_t + c_2 \text{slope}_t + c_3(\widehat{\gamma}' \overline{fs}_t) + \eta_{t+1} \tag{8}$$

I calculate the difference in term premia of a five-year and two-year bonds as $\widehat{rx}_t^{(5)} - \widehat{rx}_t^{(2)}$. Data are from Thomson Reuters Datastream.