# The Last Mile of Monetary Policy:
# Inattention, Reminders, and the Refinancing Channel[*]

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## Abstract

Despite mandatory disclosures of attractive refinancing opportunities, under-refinancing limits the transmission of monetary policy to the household sector and costs mortgage holders in many countries a significant fraction of income annually. To address the role of consumer inattention in explaining sluggish refinancing, we partner with a large bank to analyze a field experiment testing disclosure designs sent to 12,000 Irish households. While we find only small effects of disclosure design improvements, a simple reminder letter increases refinancing by 76%, from 8.9% to 15.7%. To interpret this reminder effect, we extend and estimate a mixture model of inattentive financial decision-making to allow for disclosure treatment effects. We find that a reminder decreases the likelihood mortgage holders are inattentive by 15 percentage points from 76% to 61%. A back-of-the-envelope calculation implies that each reminder letter generated an average of €42 of mortgagor consumption (average of €605 for refinancing households). Our results suggest that reminders could have a larger effect on household refinancing than a standard rate cut. Reminders could further strengthen the refinancing channel and stimulate local consumption even when policy rates are at the zero-lower bound or set in a monetary union.

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# 1 Introduction

Across many countries, researchers have documented a widespread "failure to refinance," where substantial savings available to mortgage holders through refinancing remain unclaimed.[1] While a growing body of work diagnoses inattention as a key driver of suboptimal financial decisions, we demonstrate experimentally how an inexpensive and simple intervention can actually address inattention and have substantial effects supporting refinancing decision-making. From a microeconomic perspective, suboptimal refinancing implies many households are overpaying mortgage interest and foregoing current or future consumption as a result (Financial Conduct Authority, 2019). From a macroeconomic perspective, suboptimal refinancing may significantly limit the power of the refinancing channel of monetary policy transmission (Greenwald, 2018; Di Maggio et al., 2020; Cloyne et al., 2020). The modulation of monetary policy transmission by refinancing frictions is an example of what we term the "last-mile problem" of monetary policy. [2] To illustrate this transmission friction, we document in the time series the extent to which US outstanding mortgage interest rates react to monetary policy rates slowly and incompletely relative to interest rates on new mortgages.

In this paper, we analyze a field experiment conducted with a large retail bank in Ireland testing whether design changes to mandatory consumer disclosures prompt borrowers into greater take-up of beneficial internal refinancing opportunities.[3] We see only modest improvements from most disclosure design enhancements, consistent with overall inattention to disclosure (similar to Adams et al. (2021)). However, we also find that a reminder follow-up letter significantly increases the probability of internal mortgage refinancing by 76%, from 8.9% to 15.7%.[4] Against the backdrop of overall low responsiveness of refinancing to rates, a back-of-the-envelope calculation suggests that reminder letters are a cost-effective way to help policy rates reach the household sector directly. Refinancing reminders also have the potential to be effective even when conventional monetary tools are constrained by a zero-lower bound or a monetary union.

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[1]See evidence of mortgage borrowers' low take-up of seemingly advantageous refinancing opportunities in the US (Campbell, 2006; Keys et al., 2016; Johnson et al., 2019), Italy (Bajo and Barbi, 2018), Denmark (Andersen et al., 2020), the UK (Financial Conduct Authority, 2019), and Australia (Australian Competition and Consumer Commission, 2018)

[2]A growing body of research documents other last-mile problems for monetary policy transmission, including firms not updating their hurdle rates (Gormsen and Huber, 2022), households having high information frictions (Kim, 2022), and a lack of household financial literacy (Binder et al., 2022).

[3]Our redesign treatments are constructed to more saliently highlight advantageous internal refinancing options by addressing biases which can affect the household financial decision process and inhibit engagement with refinancing opportunities (e.g., inattention, status quo and present bias).

[4]We find no evidence of an impact on an unintended but plausible secondary channel—external switching across mortgage providers.

This effort is the first mortgage refinancing field experiment outside of the United States and the first large-scale refinancing experiment targeted at at the wider population of outstanding mortgage holders instead of distressed or low-income mortgage borrowers. To our knowledge, only two previous papers undertake field experiments in the domain of mortgage refinancing. Johnson et al. (2019) carry out a series of field experiments to encourage uptake of preapproved refinance mortgages under the US Home Affordable Refinance Program, a 2009 federal program to help underwater and near-underwater homeowners refinance their mortgages. Keys et al. (2016), among other things, test for effects of mailed notices to 193 borrowers from lower-income communities in Chicago. Among these peer efforts, our trial is the first to show a statistically and economically meaningful impact from experimental treatment arms.

We interpret our treatment effects through the lens of the Andersen et al. (2020) behavioral model of inattentive refinancing, which itself builds on the optimal refinancing model of Agarwal et al. (2013),(ADL hereafter) that models fully attentive refinancing as an optimal options exercise problem. We use maximum likelihood estimates from the model to measure the relative effectiveness of cutting interest rates versus sending a reminder. We find that when the average incentive to refinance is roughly zero, mortgage interest rates would have to fall by 200 basis points to generate the same amount of refinancing as the reminder letters.[5] This exercise is particularly policy relevant when monetary policy rates are de facto constrained by a lower bound, complicating efforts to decrease interest rates through conventional monetary policy.

The failure to refinance puzzle continues to attract considerable academic and policy attention for at least three reasons. First, recent work shows the refinancing channel of monetary policy transmission to be quite significant such that frictions impeding refinancing have first-order implications for effective monetary stimulus. For example, see Amromin et al. (2020) for a review and Altavilla et al. (2020) for evidence of subdued pass-through of ECB policy rates to retail interest rates. To connect this work on pass-through to refinancing frictions and the last-mile problem, we construct the time series interest rates on new and outstanding mortgages in the US using the CRISM data used in Di Maggio et al. (2020). Figure 1 plots these interest rates against US policy rates (the effective Federal Funds Rate). All three series are highly correlated in levels. However, the figure shows that while the interest rates on new originations follow policy rates reasonably closely, outstanding interest rates move slowly and incompletely with policy rates. At the quarterly frequency, while changes in the Federal Funds Rate have a pass-through coefficient to changes in new interest

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[5]The incentive to refinance is measured in interest-rate points above an individualized optimal refinancing threshold—see Section 6.

rates of 0.35 with an $R^2$ of 0.24, FFR changes have a pass-through coefficient to outstanding mortgage rates of 0.03 with an $R^2$ of 0.05. Our experimental results highlight the potential of non-monetary interventions by policymakers, including national central banks in a currency union, to stimulate the refinancing channel. A conservative back-of-the-envelope calculation suggests that our reminder treatment generates €42 of consumption for every €1 spent on disclosure reminders, highlighting the value of improving what we term the last mile of monetary policy.

Second, there are financial stability implications which potentially arise from low mortgage switching rates. When borrowers stand to make substantial savings on mortgage repayments from switching (within or between providers) but fail to do so, they carry an elevated debt service ratio above what would be carried in a scenario where switching was more frequent, leaving such borrowers more vulnerable to mortgage distress arising from more modest income shocks (e.g., Giordana and Ziegelmeyer (2020).[6] Market-wide, this would imply that the resilience of the household sector is undermined by the failure of borrowers collectively to demonstrate mortgage mobility (see also European Commission (2015, 2019)).

Third, an observably low propensity of customers to switch mortgage providers could both diminish the incentive for providers to compete on the basis of price and send a discouraging signal to potential entrants who might bring competition to the market (Farrell and Klemperer, 2007).[7] Potential entrants may be discouraged from the observation that mortgage holders are insensitive to competitive price offerings and unwilling to encourage competition by demonstrably rewarding and punishing institutions by voting with their feet.

There are several reasons why not switching or refinancing a mortgage might be a perfectly rational financial decision for mortgage holders even if they stand to save money by switching or refinancing.[8] First, mortgage holders might deem the available savings insufficient to justify actual or psychological switching costs. Second, mortgage holders might be ineligible to switch as a consequence of their loan-to-value positions or their repayment history. Third, if they intend to move house in the near-term, they might decide not to switch or refinance because they will not be in the home long enough to recoup the fixed costs of switching or refinancing. However, given the sizable fraction of consumers with sufficient

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[6]See Gerardi et al. (2013) for evidence on the empirical relationship between ability to repay and mortgage default (as distinct from strategic default arising from negative equity).

[7]Industrial organization theory has treated in detail the topic of switching costs as a barrier to potential entry. Aghion and Bolton (1987) show how firms may use contracts with customers to create switching costs which act as a deterrent to new market entry.

[8]Appendix Figure A1 reports mortgage provider switching rates across 28 European Union countries in 2016. Low switching percentages are not necessarily a cause for concern themselves, as they could indicate a market where price competition is such as to eliminate the need to switch providers in equilibrium. However, when viewed against a backdrop of widespread opportunities for financial savings, rates of mortgage switching and refinancing have persistently preoccupied regulatory and academic attention.

equity and good credit who stand to realize substantial interest savings, it seems plausible that behavioral factors are systematically inhibiting borrowers from optimally navigating the mortgage market and obtaining the best available debt contract.

The paper proceeds as follows. In Section 2, we review relevant literature. Section 3 provides relevant Irish mortgage market background, including a description of the relevant regulation. Section 4 presents our experimental design and data. Section 5 reports treatment effects. In Section 6, we extend the inattentive refinancing model of Andersen et al. (2020) to allow for disclosure effects, estimate treatment effects on attention, and conduct several counterfactual exercises. Section 7 concludes.

# 2 Literature

To contextualize our contribution, we summarize the literature on monetary policy transmission to the household sector, which generally finds pass-through to the household sector is imperfect and sluggish. Next, we examine the literature on current and past central bank monetary policy communications and find that household actions are unlikely to be significantly bolstered by such communications alone. The backdrop of imperfect pass-through of monetary policy to the household sector heightens the importance of last-mile studies such as ours that document policy interventions that strengthen monetary policy transmission. We move next to identify those factors that do impact household engagement with interest rate changes by examining the literature on demand- and supply-side factors why households can be slow to respond to interest rate changes. We identify a number of reasons, particularly from a behavioral perspective, that require consideration when designing interventions to foster stronger engagement by households with beneficial refinancing opportunities. Finally, we consider the literature on the effectiveness of consumer-facing disclosures, which shows that the design of communications matters for its capacity to trigger consumer engagement.

## 2.1 Incomplete interest rate pass-through

The degree to which monetary policy decisions transmit to tangible interest rate changes for households has been explored in detail over recent decades. In general, the literature documents sluggish and heterogeneous policy interest rate pass-through across financial products and across countries, motivating research into policies that can successfully improve pass-through.

Early research by De Bondt (2002) for the Euro area points to a typical pass-through rate of about 30% (from policy rate changes to retail interest rates) in the first month following a

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change, approaching 100% in the long term. The average speed for retail bank interest rates to fully adjust to policy rate changes is typically between 3 and 10 months, with rates on loans to businesses converging faster than on lending to households. Other work finds similar sluggish and incomplete adjustment, affected by the degree of competition, fragmentation, and the lack of integration of local retail banking sectors (Sørensen and Werner, 2006). Our work helps explain why monetary policy pass-through is often limited in its effectiveness, demonstrating with experimental evidence that household attention frictions and the need to actively refinance fixed-rate debt inhibit transmission.

Altavilla et al. (2020) investigate why the interest rate channel of monetary policy in the Euro area has weakened over the last decade, outlining how unconventional measures may have helped to mend the link between monetary policy and real activity. They show that non-standard measures such as quantitative easing and targeted longer-term refinancing operations contributed to normalising the dynamics of lending rates to households. While the impact of standard measures produced median instantaneous pass-through of 0.25 and the median medium-run pass through of about 0.65, this was much lower than what was estimated prior to the financial crisis. Andries and Billon (2016) survey estimates of retail bank interest rate pass-through in euro zone countries over the past thirty years. Across a variety of time periods and estimators, the literature has generally documented incomplete short-run pass-through and a heterogeneous adjustment of interest rates across bank products and euro zone countries. In Ireland, retail interest rates remain among the highest in Europe, with research linking Ireland's lower pass-through of monetary policy changes to limited competition in retail lending and high levels of post-crisis financial stress (Makhlouf, 2020). Relative to this motivating literature documenting conditions that may be inhibiting monetary policy transmission, our contribution is to document an intervention that has potential to significantly improve refinancing responsiveness and thus the pass-through of monetary policy to the household sector.

## 2.2 Central bank communications

Central bank communications have for long been the primary means through which interest rate expectations were set for both industry experts and the general public. From the Federal Open Market Committee meetings to European Central Bank (ECB) monetary policy announcements, the impacts on both financial markets and consumer lending rates have been assumed to be a powerful one.[9] However, recent research has explored not only the strength of this guidance but also how these communications ultimately feed through to

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[9]McKay et al. (2016) show that forward guidance—a particularly salient form of communication—can be powerful but is highly sensitive to borrower income risk and borrowing constraints.

the general public.

Blinder et al. (2008) provide a substantive overview on the topic of forward guidance and how it has formed an increasingly important element of monetary policy. From shrouds of secrecy to structured predictability and transparency, evidence shows differing communication methods can be useful element of a central bank's toolkit. Two aims are identified in "reducing noise" and "creating news." The first increases the predictability of central bank actions, which should in turn reduce volatility in financial markets. The second covers how central bank announcements influence expectations and, therefore, move market prices and rates. They state that the optimal means on how to deliver on these aims has yet to be established with distinct differences in communication strategies across institutions.

Haldane and McMahon (2018) outline how central banks have not made their main communications accessible to a particularly wide audience. One reason for this is linguistic complexity, with typical central bank publications having reading grade levels equivalent to college-level. A monetary policy knowledge index is constructed by the authors based on survey data and shows understanding of monetary policy to have been largely unreached by central bank communications. There are also differences across cohorts, with young, less well-educated and poor individuals being less knowledgeable to monetary policy. Lamla and Vinogradov (2019) explore the impact of consumers' perceptions and that FOMC announcements have little impact on consumers' perceptions and expectations of either inflation or interest rates but do identify an increase in the proportion of people who have heard monetary policy news. On average only 35% of consumers in their data are aware of the FOMC announcement during the announcement week, which grows by 10% after the announcement.

Recent work by Ehrmann et al. (2021) demonstrates widespread consensus among former members of the Governing Council of the ECB that enhancing credibility and trust should be the most important objective of central bank communication. While respondents prioritized communication with financial markets and experts, which was deemed to be at an adequate level, clear and targeted communications with the general public were flagged as being key to reaching a wider audience in the future. One of the potential suggestions for change include an increased presence on social media. As part of a recent monetary policy strategy review, the ECB has acknowledged the need for credibility, clarity and consistency in its communications.[10]

Blinder et al. (2022) survey the literature on central bank communications with the public. Such communications have developed into multi-layered strategies, with different scales of complexity from social media to listening events to reach different stakeholders and reduce the cost of acquiring information. Despite this, households have a low desire to

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[10]https://www.ecb.europa.eu/home/search/review/html/monpol-communication.en.html

be informed about monetary policy and are inattentive to news linked to it. They will be less likely to pay attention if they do not understand how policies affect them personally. Focus is only provided when adverse conditions arise, or when there is media coverage on television and in newspapers. The paper shows that while several central banks are making active efforts to educate the broader public, their efforts focus mostly on personal financial management, not on monetary policy. Such matters are more accessible than policy issues, but it remains to be seen if it contributes to a better understanding of monetary policy.

## 2.3 Barriers to refinancing

Both supply- and demand-side barriers to refinancing can inhibit the final delivery of monetary policy to the household sector. Supply-side barriers can result from underwriting constraints that are binding for households most acutely during a recession (Beraja et al., 2019; DeFusco and Mondragon, 2020; Di Maggio et al., 2020). From a demand-side perspective, low refinancing rates are often explained with reference to the actual or perceived cost associated with refinancing, including financial and time costs, and the extent to which these costs exceed the benefit of reduced debt repayments that would result from a refinance. This cost-benefit relationship may create an inaction range within which a household optimally foregoes refinancing until such time as the monetary gains from refinancing exceed an optimal threshold which justifies the expected effort to refinance (Andersen et al., 2020).

While available financial savings will naturally be an important determinant in a household's refinancing decisions, research has also focused upon some of the socio-economic drivers of refinancing behavior. For example, Bajo and Barbi (2018) investigate the effect of a 2007 Italian mortgage market reform allowing borrowers to refinance their loans at no cost. They find that few households respond to the program overall and that the propensity to refinance correlates with key mortgage and socio-demographic characteristics. Larger loans and loans with a longer time to maturity are more likely to be refinanced. Those borrowers experienced with financial products and those with an educational background in finance or economics are more likely to refinance. Men, and the more highly educated are more likely to avail of refinancing opportunities, while immigrants are less likely to do so. Similarly, older and wealthier borrowers are less inclined to refinance. Notably, those with lower recorded financial literacy are less likely to avail of beneficial refinancing opportunities.[11]

Similarly, Andersen et al. (2020) show that older households in Denmark with lower

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[11]This is also in line with the work of Gerardi et al. (2013) illustrating that individuals with limited numerical ability default on their mortgage due to behavior unrelated to the initial choice of their mortgage, namely spending and savings patterns or sub-optimal investments made with respect to other financial contracts that impact borrowers' ability to repay their mortgages.

education, income, housing wealth, and financial wealth are less likely to consider refinancing, irrespective of the financial incentive to do so. These results point to the potential interaction between pre-existing sources of financial vulnerability and the additionally costly failure to avail of the opportunity which refinancing presents. More broadly, financial literacy has been shown to be closely associated with saving, retirement planning, the likelihood of stock ownership, and household wealth (Lusardi and Mitchell, 2007; Van Rooij et al., 2012).

A further body of evidence suggests that at least some of the the lack of refinancing is behavioral in nature. For example, Andersen et al. (2020) document a widespread failure to refinance even when the optimal threshold to do so is exceeded. Inaction beyond the threshold suggested by the stylized optimal refinancing model, it is argued, must be justified by additional barriers relating to the 'psychological costs of refinancing' and behavioral present bias, which discourages households from incurring time costs today for benefits realized in the future. Johnson et al. (2019) document how traditionally cited factors such as numerical ability are less important in driving refinancing decisions, but instead outline the role played by a borrower's time preferences and feelings of suspicion. They show that those borrowers who are more suspicious of the motives of financial institutions are less likely to engage in refinancing, and that more attractive offers are required to motivate present biased borrowers to apply.

A further strand of the literature highlights an important role for inattention in affecting household decisions. Inattention can explain a wide range of behavioral biases such as inattention to the future (hyperbolic discounting), inattention to the true probability (prospect theory) and inattention to true ability (overconfidence) (Gabaix and Laibson, 2006). Studies show, for example, that consumers fail to weigh non-salient information such as eBay shipping fees (Brown et al., 2010; Einav et al., 2015) and demonstrate inattention to taxes not included in the posted prices (Chetty et al., 2009). For mortgages, King et al. (2018) find evidence that consumers who demonstrate limited attention bias choose more expensive cashback mortgages that are financially equivalent at the point of drawdown. In an experimental setting, the UK Financial Conduct Authority demonstrates the significant effect that the issuance of reminders can play in prompting consequential financial actions, pointing to the role of procrastination and inattention in shaping the course of our financial lives.[12]

In our setting, inattention to potential mortgage savings can take a number of forms. First, inattention in a moment may be considered rational for the stressed consumer unable to process all available information. Second, a consumer may simply overlook the potential savings in the moment they receive the information. Third, following an appreciation of the contents of a letter or other communication, inattention may occur as absent-mindedness,

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[12]See for instance Adams and Hunt (2013); Adams et al. (2015, 2016).

described by Schacter (1999) as shallow processing contributing to weak memories of key information and a related to-do action. Related to this third form of inattention is procrastination. Procrastination involves a postponing, delaying, or putting off a task or a decision in a way that is problematic rather than strategic.[13]

In our experiment, we consider our behaviorally informed treatments as addressing the second type of inattention as failure to appreciate or notice the potential savings in the moment, while a reminder notification deals with the third type as absentmindedness. Related to the concept of procrastination, there may be numerous reasons for subsequent absentmindedness to occur such as i) absence of a deadline and a self-regulating time-management strategy that allows working under pressure and meeting deadlines successfully, also known as active procrastination (Steel and König, 2006; Chun Chu and Choi, 2005), ii) underestimation of future self-control problems (O'Donoghue and Rabin, 2001) and iii) the scale of the decision leading to inaction (O'Donoghue and Rabin, 2001). In this paper, we do not differentiate between these different forms, considering instead that our reminder treatment deals with the overarching issue of absentmindedness/procrastination.

## 2.4 Consumer disclosures and reminders

This paper is also part of a growing body of evidence on behavioral market failures (Sunstein, 2012), arguing that behaviorally-informed policy responses can deliver meaningful impacts on various public policy challenges (see Adams and Hunt (2013); Duke et al. (2014); Adams et al. (2015, 2021); Financial Conduct Authority (2016)). In many settings, the policy response to potentially suboptimal consumer choice has been to provide additional information, leading to a proliferation in mandatory disclosures (Ben-Shahar and Schneider, 2014; Kell, 2016). The potential of behaviorally informed disclosures to enhance mandatory actions has been shown in many cases (e.g., Lee and Hogarth (2000); Bar-Gill (2012)). For example, recent quasi-experimental work by Wang and Burke (2022) shows that behaviorally motivated payday disclosures had a significant effect on loan volumes in Texas. Adams et al. (2021) find that prominent front-page information about higher available savings rates led to an increase in switching from a baseline of 3% to 6% of consumers, while non-front-page disclosures had no effect. In the insurance market, Adams et al. (2015) estimate that putting last year's premium on renewal notices led to between 11% and 18% more consumers to switch or negotiate their home insurance policy.

Using a theory of how limited memory and procrastination affects task completion, Er-

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[13]Studies suggest that procrastination chronically affects 15-20% of adults, and that approximately 25% of adults consider procrastination to be a defining personality trait for them (Steel and König, 2006; Nguyen et al., 2013).

icson (2017) argues that for time-consistent and present-biased individuals, unanticipated reminders always increase the likelihood the task will be completed, whereas anticipated reminders may have ambiguous effects. It seems there is a near universal view that reminder letters have a small positive impact on the outcome of interest. However, questions remain over who the reminder works for and, why in most cases, the vast majority of recipients remain reluctant to engage.

Reminder letters have a long history in health sciences, with evidence that such letters increase vaccination take up and cancer check-up rates (Hirani, 2021; Mayer et al., 2000). In financial markets, research on reminder letters from the FCA found that well-timed reminder letters boosted switching rates by 8% when bonus interest rate periods expired in the cash savings market (Adams et al., 2016). Furthermore, Adams and Hunt (2013) in an experiment to encourage customers to avail of a redress scheme, found that reminder letters produced higher results when sent three weeks after the initial communication, while middle-aged consumers were the least likely to respond to redress letters. A UK study on pawnbrokers found that a behaviorally designed reminder letter, delivered to customers 2 weeks after incurring a surplus due to their item being sold, almost doubled surplus collection rates within 30 days (Adams et al., 2021).

# 3 Context

## 3.1 Irish mortgage market

There are three primary types of mortgages in Ireland: fixed-rate mortgages, variable-rate mortgages, and tracker mortgages, accounting for approximately 55%, 20%, and 25% of current outstanding balances respectively.[14] Fixed-rate mortgages in Ireland are similar to those in the UK and to adjustable-rate mortgages in the US; they are fixed for an initial term, typically of 1-5 years and convert to a variable-rate mortgage thereafter. There is generally a prepayment penalty of approximately 2% of the outstanding balance if a borrower prepays their mortgage during the fixed-rate period. Variable-rate mortgages adjust periodically at the discretion of the lender (as opposed to floating debt elsewhere that is usually indexed to an interest-rate benchmark). There is no penalty for prepayment of a variable rate mortgage and refinancing internally (with the current lender) is allowed without a fee, unless the borrower wishes to pay for an appraisal to justify a lower loan-to-value ratio bracket. Refinancing in Ireland generally maintains the original maturity at origination and does not extend a

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[14]Appendix Figure A6 provides a time series of this breakdown, highlighting the growing prominence of fixed rate mortgages in recent years.

mortgage's term. Tracker mortgages in Ireland generally track the ECB refinancing rate plus a spread of approximately 100 basis points. However, Irish lenders stopped originating new tracker mortgages in 2008.

Refinancing activity in the Irish mortgage market is notably subdued when seen against a backdrop of widespread and substantial opportunities for financial savings from refinancing available in the Irish market. Nearly one in three Irish households has an outstanding mortgage on their main residence (Central Statistics Office, 2020b). Among these households, mortgage debt is significant, accounting for 71.6% of total debt outstanding. Recent studies show that, after signing their mortgage contract, very few Irish households refinance or switch their mortgage type. For example, Byrne et al. (2020) report that three in every five eligible mortgages could save over €1,000 within the first year if they switch and more than €10,000 over their remaining term but that just 2.9% of mortgages switched provider during the second half of 2019.[15]

A survey of Irish mortgage holders undertaken by the Central Bank of Ireland in 2016 suggests that many consumers believe that the mortgage switching or refinancing process would be too complex to engage in or that the process would be too costly in terms of time and effort (Central Bank of Ireland, 2017c). However, over half of consumers agreed that they would consider switching their mortgage for an interest rate saving. Despite this, approximately 52% of surveyed consumers said that they were uncertain about the amount of money that could be saved by switching their mortgage.

Provision 6.5(g) of the Central Bank's Consumer Protection Code requires that regulated entities provide variable-rate mortgage holders, at least annually, with a summary of other mortgage products that could provide them with savings on their mortgage at that point in time. As such, whether a mortgage was originated as a variable-rate mortgage or originated as a fixed-rate mortgage and then automatically converted to variable rate after its fixed-rate period ended, many borrowers will receive these disclosures. It does not currently stipulate how such information should be presented. It is this mandatory annual disclosure document which forms the starting point for our experimental treatments.

Notwithstanding this and other regulatory initiatives, as well as energetic commercial switching campaigns over recent years, the rate of mortgage switching and refinancing remains notably subdued in the Irish market. With this field trial, we harness insights from behavioral economics to reshape regulatory policy in an effort to empower consumers to make better choices for themselves.

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[15]Appendix Figure A7 extends this study to show that there was no significant increase in the levels of mortgage switching during the pandemic in 2020. The highest level reached was 3.9% in H2 2021.

# 4   Experimental Design

We partnered with a large retail bank in the Irish mortgage market to test a series of behaviorally enhanced versions of the existing mandatory financial disclosures delivered by mail among a representative subset of 12,050 variable rate mortgage holders in January 2020. Trial subjects were tracked in terms of their subsequent propensity to refinance. We gathered detailed loan-level data on each of the participants in the trial in the period prior to the intervention and again in the period following the intervention. We assess the impact of the intervention using a data snapshot that was provided by the partnering institution at three months after the disclosure distribution.

To avoid the potential for observer effects that would jeopardize the integrity of our experimental design, trial participants were not made aware that the version of the mandatory disclosure they received formed part of a behavioral field trial. As such, it was essential that all versions were rigorously evaluated to ensure that they were at least in keeping with the baseline informational requirement stipulated by the Consumer Protection Code (e.g., no key information was removed, which might lead to a mortgage holder having less information available than they would under the baseline scenario). Further, our trial was subject to rigorous legal and data protection assessment to ensure it was in keeping with these standards, and was overseen by a robust internal governance framework within the Central Bank.

The loan-level dataset recorded detailed loan characteristics such as the interest rate prevailing on the loan, the interest rate type, the initial and outstanding loan balance and loan-to-value ratio, the current monthly repayment, the pre-trial available savings on the mortgage (with respect to the best available alternative product option). Additional indicators were also collected in the post-disclosure data drop, to allow easy identification of those loans that had reached maturity, switched externally, otherwise exited the book, and most importantly, refinanced internally with the mortgage provider. These data allow us to assess the differential impact of our treatments on borrowers' mortgage management.

Our research design is informed by power analysis which allowed us to determine the number of customers required to participate in the experiment. We estimate the minimum effect size (i.e. the minimum increase in mortgage refinancing) that is likely to be detected for a given number of customers under examination. With a sample of 12,000 and six treatments, our power analysis indicated that we would have statistical power to detect treatment effects as small as a 1.56 percentage point improvement over the baseline rate of refinancing, equivalent to an increase of 13%.

A total trial sample of 12,050 were randomly drawn from the population of variable rate mortgage customers with the partnering institution and randomly allocated into one of

seven treatment cells (the control group plus six treatment arms). This procedure results in a split of approximately 1,700 customers per cell. As a further experimental manipulation, within each treatment arm, the sample was randomly divided in half, with one half receiving an additional follow-up reminder notification by post 4-6 weeks after the original communication.

## 4.1 The treatment arms

The literature on mortgage and non-mortgage field trials designed to encourage household financial engagement finds a broad range of factors may act to inhibit the take-up of mortgage refinancing opportunities – including informational, procedural, financial, and behavioral obstacles. In this paper, we target five such potential obstacles: process complexity, inattention, incomprehension of the price differential, procrastination, and present bias. Within the parameters of the baseline mortgage refinancing disclosure we are working with, we test a series of corresponding refinements that have shown promise in the encouragement of consumer engagement in other settings. Table 1 provides an overview of the treatment arms.

*Simplification:* Each treatment communication included a box on the front page of the letter with key points highlighted, including the current interest rate and monthly repayment that was payable on the customer's mortgage, in addition to the lowest alternative interest rate and associated monthly repayment available to the customer. The box was designed to engage customers and to ensure that key information could be accessed quickly. Simplification is an experimental technique that can be used to target customer inattention and information overload, both of which have been found to affect the ability of consumers to make informed choices (e.g., Lunn et al. (2016); Adams and Hunt (2013)). A key insight from behavioral economics concerns consumer's bounded capacity to process large volumes of complex information and distill key actionable messages.

*Personalized Savings:* The retail bank's standard communication (the control) included a table that noted the interest rate associated with each alternative product option available to the customer, but there was no translation of the associated monthly repayment amounts. In each of the treatments, we supplemented the table with the monthly repayment amount associated with each option, and the savings (where available) relative to the current monthly repayment. This technique targets ambiguity aversion and present bias, whereby individuals who place more weight on the present over the future would forego long-run payoffs in order to avoid short-run administrative burdens. Financial Conduct Authority (2016) use the setting of the UK annuities market to illustrate link between the presentation of personalized savings and the extent of customer shopping around.

***Prominent Subject Line:*** The subject line in the control letter stated, *"You may be able to save money on your mortgage"*. To increase the likelihood that customers would perceive the letter to be important, we trialled the use of color, increased font size and emboldened the text in three of our interventions. In a similar vein, BIT (2015) report that printing the call to action prominently on official communication significantly increased payment rates across a range of fines, debts and taxes.

***Framing:*** A central insight from behavioral economics relates to the potential for choices to be influenced by the way in which they are framed for the decision maker (Kahneman and Tversky, 1984). The presentation of financial savings in a loss frame would aim to counteract loss aversion, which is the tendency for people to prefer avoiding losses to acquiring equivalent gains. This is a central proposition of prospect theory, which is a theory of consumer choice developed as a behavioral alternative to the more traditional expected utility theory. The theory predicts that since the disutility associated with losses exceeds the utility associated with equivalent gains, people are more willing to take risks to avoid incurring the loss. In the current context, refinancing represents the risky prospect as against the known status quo. Genakos et al. (2015) and Adams et al. (2015) provide evidence for the relative efficacy of loss-framing in the presentation of financial savings to nudge consumer behavior.

We trialled presenting the refinancing opportunity with a gain frame and separately with a loss frame. We changed the language to read either *"With a different rate, you could save up to €X a year on your mortgage"* or *"You could be missing out on savings of up to €X a year by not choosing a lower mortgage interest rate"*. To complete the comparison, other letters adopted a more neutral tone.

***Color:*** The use of color can help to draw attention to salient information. Treatment group 1 received the same communication as treatment group 2, but the former employed color at key junctures in the letter. The UK Cabinet Office behavioral Insights Team (Behavioural Insights Team, 2014) proposes the use of color as a means of making communications attractive to consumers, in the context of their EAST framework for the application of behavioral insights to encourage action (make it Easy, Attractive, Social, and Timely).

***Next Steps Clarified:*** A core lesson from behavioral economics is that the removal of even the smallest frictions to a process can have a large impact in prompting action (Behavioural Insights Team, 2014). Ambiguity aversion can cause an avoidance of uncertain prospects in favor of known prospects, even when the known prospect may not be particularly favorable. In an effort to mitigate these potential influences, we added for treatment group 6 a clarified process box, which clearly delineated the steps required for a mortgage holder to take action and move onto a lower cost interest rate option.

***Reminder***: Reminders target customer inattention, procrastination, and forgetfulness.

We hypothesize that one of the important obstacles to optimal household financial decision-making is procrastination, which may be the result of time-poverty. Time-constrained households may queue financial tasks which are subsequently forgotten, or simply delayed so that opportunities are missed. In an experimental setting, Adams et al. (2015) find that reminders increase the rate of switching in savings accounts in the UK by at least 8%.

## 4.2 Descriptive statistics

Table 2 reports summary statistics for several mortgage and borrower characteristics in our data across trials. In order to attribute any observed difference in refinancing rates across customer groups to the impact of our intervention, it was essential that we randomly allocated our customer sample into each of the different groups (i.e., to receive the existing standard disclosure – the control group – or to receive one of the enhanced alternative versions – the treatment groups). To test that this randomization exercise was effective, and to be confident that other factors are not driving any impact we observe at the evaluation stage, we must check that our groups are in fact well-balanced in terms of key covariates at the outset.

Following McKenzie (2015), Table 3 shows a pairwise regression of treatment status (control vs. each of our treatment groups) on a vector of covariates which may be correlated with our outcome variable of interest, to ascertain whether these factors differ systematically and help to predict treatment status. We find a high degree of statistical balance. However, where we observe any evidence of statistical difference, such as in the years to maturity variable, we run supplementary regression analysis in our evaluation of treatment effects to control for any potential imbalance and ensure our treatment effects are robust to this.

Our trial sample of loans consists of a random subsample of outstanding variable rate mortgages held by the partnering institution. Our sample is restricted to variable rate mortgages as this is the cohort that is eligible for receipt of the mandatory disclosure from which we build our experimental treatment arms. Our total sample of 12,050 reduces to an estimation sample of 11,200 following the attrition of 850 observations which exited the loan book, reached maturity during the trial period, or were excluded from estimation due to mortgage arrears history. Of our estimation sample, 1,345 go on to refinance internally, and 373 switch externally. Estimating potential 1-year savings (calculated with reference to the lowest applicable interest rate available internally to the mortgage holder) among our trial sample with respect to the prevailing interest rate and the outstanding balance at the individual loan level, we notice two patterns. First, we observe a weakly positive relationship between potential savings and the borrower's current interest rate. Second, we see a much

more strongly positive association with the current outstanding balance, suggesting that the loan balance is a more important feature than the point in time interest rate gap in influencing the relative attractiveness of a refinancing opportunity.

# 5   Results

In this section, we outline the impact that our alternative treatment arms had on the observed rate of mortgage refinancing, compared against the baseline standard which is represented by our 'Control' group. Our impact analysis is based on data reported in June 2020 (+3 months after the distribution of disclosure letters).

Before turning to a stepwise sequential analysis of our pre-specified research questions, we find at an aggregate level that all of the treatment arms produced higher refinancing rates than the existing standard, with these differences all being statistically significant at the 1% level (see Table 4 for regression output and Figure 2 for equivalent graphical representation). We see in Figure 2 that of those customers who received the existing standard disclosure, 8.9% went on to take up a refinancing offer, whereas between 12.1% and 13% of customers who received one of the enhanced disclosures went on to refinance. This represents an increase in mortgage refinancing of 43% with the strongest alternative (Version 4). Table 4 equivalently reports these same treatment effects obtained from ordinary least squares regression of refinancing probability on treatment status, compared against the base category which is the Control group. Our results compare favorably against those found in two preceding mortgage refinancing experiments. Keys et al. (2016) found no statistical differences in take-up within three treatment arms which, inter alia, drew attention to the amount of savings that mortgage holders could achieve.[16] Similarly, Johnson et al. (2019) found that none of the experimental interventions had a positive impact on refinancing take-up rates.

Our regression estimation shows that our main treatment effects are robust to the addition of select controls added to address observed statistical imbalances reported previously in Table 3.

To evaluate whether personalized savings estimates will increase take-up of refinancing opportunities, in Figure 3 we focus on those customers that received only the enhanced notifications but no further reminder. Version 1 represents the smallest amendment to the existing standard, with the addition of personalized savings estimates but none of the additional refinements incorporated in subsequent versions. As such, we can attribute this pairwise comparison to the pure treatment effect of the personalized savings estimates, but

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[16]However, a much smaller small sample sizes (N=193) (fewer than 10 households refinanced in each group), meant that the authors were unable to reject the possibility of economically meaningful results.

no such statistical difference is found.

In the same figure, we can examine whether targeted behavioral refinements over and above the presentation of personalized savings will have an additional impact on refinancing probability (for the sample with no reminder). We incorporate these additional refinements in all versions subsequent to Version 1, and include the use of color, a loss frame, a gain frame, a more prominent subject line, and clarified next action steps. In two cases, we do observe statistically significant increases in refinancing rates, but these are comparatively modest to what we report for the aggregate sample (no reminder group plus reminder group). In the strongest version, we observe a statistically significant 34% increase in the rate of refinancing as against the group who received the existing standard (that is, an increase in the probability that the recipient actually refinanced from 8.9% to 11.9 per cent).

We find strong evidence from the results above that reminders are consequential, most clearly evident in Figure 4, which reports the differential treatment effect between the treated customers who additionally received a reminder, and those who only received a single enhanced notification. On average across treatment versions, we observe a statistically significant reminder bonus of a 35% increase in refinancing probability over and above the average refinancing probability following an enhanced original notification. In Figure 5 we report the refinancing rate for each treatment group for mortgagors that received a reminder (except for the control group). We observe refinancing rates of between 13.1% and 15.7%, an increase of 76% in the strongest combination.

Next, we test whether the strength of observed treatment effects varies along relevant loan and borrower dimensions – the volume of debt outstanding, the amount of savings available, borrower type (i.e. first time buyers (FTBs) versus second and subsequent buyers (SSBs)), and take-up of COVID-19 mortgage repayment forbearance. We can hypothesize that borrowers with greater amounts of debt outstanding and larger interest rate gaps to the best available rate (implying higher potential savings) will be more responsive to enhanced notifications which draw greater attention to lower cost mortgage options. More theoretically ambiguous is the differential treatment effect for FTB and SSBs. On the one hand, we might expect that FTBs being on average younger and with expected higher levels of digital literacy, should be more responsive to treatment. On the other, SSBs being by definition more experienced in financial decision making and mortgage origination and management, should be less intimidated by renegotiation and therefore more responsive to our enhanced notifications.[17] For the relationship with COVID-19 repayment breaks, we might suppose that selection of a repayment break serves as an indicator of household financial pressure, or

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[17]Andersen et al. (2020) find that older households are less likely to consider switching or refinancing. Bajo and Barbi (2018) report a relationship between financial product experience and refinancing take-up.

alternatively evidence of active attention and engagement with advantageous household financial options under crisis conditions, both of which may render a borrower more responsive to lower cost mortgage refinancing opportunities.

In Table 5, we find no consistent evidence of statistically significant interaction effects on these dimensions, though we observe some tentative evidence that FTBs respond more strongly to treatment than SSBs in the reminder group (final column). Intuitively, and echoing a result found in Keys et al. (2016) and Bajo and Barbi (2018), those with higher potential savings are significantly more likely (11.7%) to take up a refinancing opportunity irrespective of their treatment status. While loan balances are a significant component of first-year savings amounts, the level of loan balance is not statistically significant conditional on the first-year savings, suggesting that the effect of debt levels on refinancing behavior operates mostly through the amount of savings available.

To examine whether enhanced disclosures drawing greater attention to internal refinancing opportunities may additionally impact upon the probability of external switching across providers, we evaluate whether any treatment effect can be observed in terms of this unintended but plausible secondary channel in Table 6. In a series of regression specifications that mirror our main regression analysis in Table 4, we find no evidence for this effect.

Finally, we address the possibility that our treatment effects are driven by borrowers in sectors of employment where workers are more likely to be at home with an atypical surplus of time due to COVID lockdown measures during our estimation window. Such circumstances might plausibly facilitate, for certain households, a greater degree of attention to administrative mail communications than they would ordinarily allocate. To evaluate this, we split our estimation sample into sectors of employment that are more likely to be working from home (WFH), experiencing business as usual (BAU), and at home but not working (AHNW), using information on the borrower sector of employment at point of loan origination.[18] We report results from this subgroup analysis in Table 7, and in Figure A5. We find consistency in treatment effects, with no significant divergence in coefficient estimates across these sector classifications.

## 5.1 Financial impact of the observed treatment effects

In our most impactful treatment combination, the refinancing rate increased by 76% (from the baseline refinancing rate of 8.9 per cent to 15.7% in Treatment Group 2. We estimate

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[18]The WFH category includes those employed in 'information and communication', 'financial and insurance', 'professional, scientific, and technical', 'public administration', and 'other service activities' sectors. The BAU category includes those employed in 'agriculture, forestry, and fishing', 'electricity and gas supply', and 'transport and storage' sectors. The AHNW category includes those employed in manufacturing, construction, 'wholesale and retail trade, and vehicle repair', and 'accomodation and food services' sectors.

the potential impact of this trial on the broader market as follows: the latest loan-level dataset collected by the Central Bank and covering the five main retail banks in Ireland shows approximately 240,000 outstanding variable rate mortgage loans at end-June 2020. If we assume that the baseline refinancing rate on foot of the existing standard notification of 8.9% applies market-wide, an increase in refinancing of the magnitude we achieve in our best trial would imply that an additional 16,320 mortgages would realize mortgage repayment savings on foot of this enhanced annual notification. In this context, we note that the average 12-month savings realized on mortgages that did refinance in our trial was €1,209, albeit the equivalent market-wide figure could differ given alternative product offerings at other institutions.

# 6 Inattention Estimates

In this section, we interpret our treatment effects through the lens of the Andersen et al. (2020) model of inattentive refinancing. We adapt and build upon this existing work to introduce a model of refinancing behavior adjusted to the Irish context and our experimental setting. First, we assess the degree to which inattention helps a model of refinancing fit the data with realistic and reasonable fixed cost parameters. Second, because attention is unobservable in our setting, we use the model to estimate the degree of inattention and the extent to which the effects of the disclosure treatments and reminder letters are consistent with a mechanism that operates through reducing inattention. This exercise also allows us to benchmark estimates of attention treatment effects against equivalent changes to refinancing induced by monetary policy.

The baseline model builds on the optimal refinancing model of Agarwal et al. (2013), which assumes that households are fully attentive to the task of refinancing and refinance their mortgages if the expected net benefits of refinancing now are positive. There are two components to the net benefits of refinancing: the incentive to refinance $I(x_i, \varphi)$ that depends on an idiosyncratic random shock to the net benefit of refinancing $\epsilon_i$ and certain observable mortgage characteristics $x_i$ through parameter vector $\varphi$. The incentive to refinance $I(x_i, \varphi)$ is a function capturing a household's incentive to refinance in interest-rate points

$$I(x_i, \varphi) = \left(r_i^{old} - r_i^{new}\right) - O_i(x_i, \varphi) \tag{1}$$

where $r^{old}$ is the household's current mortgage rate, $r^{new}$ is the best prevailing mortgage rate available to the household, and $O_i$ is the household's optimal refinancing threshold, calculated using the Agarwal et al. (2016) solution to optimal refinancing option exercise,

which in turn depends on certain current mortgage terms $x_i$. Each household in the model has a minimum decrease in interest rates ($O_i$) they require to be willing to refinance, and $I(\cdot, \cdot)$ measures how far above that threshold they are currently. In the baseline full attention model, the household refinances if

$$e^\beta I(x_i, \varphi) + \epsilon_i > 0$$

where $\beta$ measures the household's responsiveness to the incentive.

For estimation, $\epsilon$ is assumed to be distributed logistic, in which case the probability a mortgage borrower refinances is

$$
\begin{aligned}
\Pr(refinancing_i = 1 | x_i; \beta, \varphi) &= \Pr\left(e^\beta I(x_i, \varphi) + \epsilon_i > 0\right) \\
&= \Lambda(e^\beta I(x_i, \varphi))
\end{aligned}
$$

where $\Lambda(\cdot)$ is the inverse logistic function $\Lambda(x) = e^x/(1 + e^x)$. We can then estimate $\beta$ and $\varphi$ by maximum likelihood, finding the parameters $\beta$ and $\varphi$ that maximize the likelihood that we would observe the vector of refinancing decisions in the data.

## 6.1 Inattention model

To allow for the possibility that a household is inattentive and thus not paying any attention to their refinancing incentive or refinancing shock, Andersen et al. (2020) use a mixture model with each household inattentive in a given period with some probability. Inattentive households do not refinance ever. Households are inattentive if $\delta' w_i + \eta_i > 0$ where $\eta$ is a random shock to a household's attention each period and $\delta' w_i = \delta_0 + \delta_1 Treatment_i + \delta_2 Reminder_i$. If $\eta$ is also distributed logistic, then the probability that a given household is inattentive in any given period can be written as

$$\Pr(\delta_0 + \delta_1 Treatment_i + \delta_2 Reminder_i + \eta_i > 0) = \Lambda(\delta' w_i). \tag{2}$$

To refinance, households need to both be attentive (probability $1 - \Lambda(\delta' w_i)$) and have positive net benefits of refinancing (probability $\Lambda(e^\beta I(x_i, \varphi))$). Households that do not refinance are either inattentive or attentive but do not have sufficient incentive to refinance. The likelihood that a household refinances at time $t$ is then $(1 - \Lambda(\delta' w_i))\Lambda(e^\beta I(x_i, \varphi))$. The overall likelihood of observing a sample of refinancing given covariates $x$ is then the product of the relevant

probabilities for the refinancers and the non-refinancers

$$\mathcal{L}(\beta, \delta, \varphi | x_i) = \prod_{refi_i=1} (1 - \Lambda(\delta' w_i))\Lambda(e^\beta I(x_i, \varphi)) \prod_{refi_i=0} \Lambda(\delta' w_i) + (1 - \Lambda(\delta' w_i))\Lambda(-e^\beta I(x_i, \varphi))$$

To estimate the model, we first calibrate certain parameters in $\varphi$ following Andersen et al. (2020) and estimate several parameters likely to be different in the Irish context. See Table 8 for details. The maximum likelihood estimates $\left(\hat{\beta}, \hat{\delta}, \hat{\varphi}\right)$ maximize the log of this likelihood function. These parameters estimate the importance $\beta$ of the refinancing incentive, the importance $\delta$ of the covariates in shifting attention, and the importance $\varphi$ of the covariates in determining private refinancing costs. Estimating this model in our setting with exogenous treatment variables corresponding to the reminder arm allows us to characterize how valuable a given treatment is at cueing consumer attention.

Table 9 reports estimates of this model using Maximum Likelihood along with robust standard errors. In column 1, we essentially constrain the model to follow only the ADL model of refinancing without any fixed cost of refinancing or possibility of borrower inattention. In this specification, we estimate a strongly negative $\beta$ such that the coefficient $\exp(\beta)$ on the incentive to refinance is approximately 0. Without allowing for fixed costs of refinancing or inattention, it appears as though borrowers are completely insensitive to the incentive to refinance. Starting in column 2, we allow for there to be a fixed cost of refinancing $\gamma_0$ such that borrowers refinance when their expected gain from refinancing (including their logit private shock to refinancing costs) exceeds this threshold. Once we model these unobserved refinancing costs with $\gamma_0$, estimates of $\beta$ increase significantly. The estimates of $\beta$ in columns 2-5 imply that a 10 bp decrease in rates increases refinancing conditional on being attentive by approximately 50 bp.

However, the implied estimate of fixed costs in column 2, which does not allow for attention effects, is implausibly high ($\exp(\gamma_0) \approx €514,000$). Even allowing for the interpretation of this fixed cost to include the psychological, time, and hassle costs of refinancing, the large estimates are perhaps more consistent with mortgage borrower inattention, which the specification in column 2 is constrained to attribute to borrowers being insensitive to the incentive to refinance as them behaving as if their costs of refinancing were incredibly high. When we allow for attention effects in column 3, the fixed cost parameter is reduced substantially from 13.2 to 6.4, demonstrating how allowing for a certain fraction of mortgage borrowers to be inattentive to refinancing improves the model's fit of the data. The estimate of $\gamma_0$ in column 3 implies a cost of refinancing of approximately €620.

The estimate of the probability of being inattentive is $\Lambda(\delta_0) \approx 78\%$ in column 3. Although consistent with a substantial likelihood of being inattentive, this estimate pools the control

group and the treatment group. Columns 4 and 5 allow mortgage borrowers who received disclosure letters with design improvements and those that additionally received follow-up reminder letters 4-6 weeks later to have different levels of attention. The estimates in column 4 imply that the treatment letters decreased inattention by 6 percentage points and the reminder letters decreased inattention by an additional 10 percentage points. The fixed cost estimate increases when we allow for treatment effects on inattention, with the estimate of $\gamma_0$ in column 4 implying a €6,000 cost of refinancing. This higher cost of refinancing in column 4 than column 3 suggests that the specification in column 3 was misattributing some of the more responsive refinancing of the treatment groups to having a lower cost of refinancing. Once allowing for the treatment groups to have lower inattention in column 5, it is clear that the control group still behaves as if they have high costs of refinancing, consistent with overall pessimistic beliefs about the time and effort required to refinance a mortgage (Central Bank of Ireland, 2017c). Column 5 adds controls that allow for heterogeneity in refinancing costs along observable dimensions to test whether certain groups have stronger inertia. The estimates of the treatment effects on attention and the fixed cost estimates are similar to column 4, with refinancing inertia in age, first-time homebuyer status, and decreasing in COVID-19 forbearance. Overall, the redesigned disclosure treatment and subsequent follow-up reminder decrease the probability of being inattentive by 20 percentage points from 76% to 56%.

The estimates are consistent with the reminders having a large effect on refinancing by increasing the probability that a given borrower is attentive. Reconciling the nontrivial effects of the treatments without reminders on inattention in Table 9 with the more modest effects in Figure 3, recall that the total effect of the treatment on refinancing is the increase in the probability of attending to the task of refinancing times the probability of refinancing for a given refinancing incentive conditional on paying attention. Because this second term is low, the total effect of improving attention by a few percentage points is still somewhat muted, consistent with the modest implied fixed cost of refinancing $\gamma_0$ in columns 2-4.

We use our estimates of the model to measure the relative effectiveness of cutting interest rates (which increases the refinancing incentive $I$ by lowering $r^{new}$) versus sending a reminder as effective as our field experiment reminders that increased $w_i$. This exercise is particularly policy relevant when monetary policy is de facto constrained by a zero lower bound, complicating efforts to decrease interest rates through conventional monetary policy. Counterfactual estimates suggest that there is significant scope for direct-to-household communication from the central bank in the form of reminder notices to provide monetary stimulus by spurring refinancing. When the average incentive to refinance is approximately 0, reminders increase refinancing by 7 percentage points. However, reminders and lower in-

terest rates are complementary. When the average incentive to refinance is 100 basis points reminders increase refinancing by 8-12 percentage points.

We can further use the model to estimate the size of the decrease in mortgage interest rates needed to induce the same amount of refinancing as a reminder letter. When the average incentive to refinance is roughly zero, mortgage interest rates would have to fall by 200 basis points to generate the same amount of refinancing. Furthermore, we note that decreasing *mortgage* rates by 200 basis points is more challenging than decreasing monetary policy rates by a set amount, especially given the limited pass-through from ECB policy rates to mortgage interest rates in Ireland and the apparent lower bounds on nominal policy rates. A caveat worth exploring in future work is that large aggregate changes in interest rates may increase attention directly.

# 7    Conclusion

In this paper we report results that illustrate the potential to significantly impact consumer engagement through small, complementary changes to an existing financial disclosure. We find that our enhanced package of disclosure measures are successful in prompting engagement among mortgage customers. In particular, we find that a follow-up reminder communication is especially worthwhile. Consumers who additionally received a reminder after the initial communication engaged with the beneficial refinancing opportunities in greater numbers, consistent with inattention to disclosure being one of the most significant impediments towards its effectiveness. Our best combination of treatments yielded a 76% increase in the probability that a borrower refinanced to a lower available interest rate. Future work could explore whether marketing experts could improve upon the simple design enhancements we tested here.

We find that the average 12-month savings realized by refinancing mortgagors was €1,209. Furthermore, we estimate that if our results were replicated in the wider population of outstanding variable rate mortgages in Ireland, it would yield an additional 16,320 refinanced mortgages in the year, resulting in millions of euros of reduced debt repayment burdens for mortgage holders. Using the MPC out of interest rate changes among UK mortgage holders estimated by the Bank of England of 0.5 (Anderson et al., 2014), we estimate that refinancing households increased their consumption by €605.[19] Averaged across all households receiving a reminder letter, this suggests that the redesigned disclosure letter and accompanying

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[19]We caveat that the Bank of England estimate relates to the MPC of borrowers out of higher mortgage interest payments instead of the mortgage repayment savings we study here. However, this choice of MPC may be conservative. In the US, Di Maggio et al. (2017) estimate an MPC out of interest savings of 0.75.

reminder increase consumption by an expected €42 per household. Conservatively assuming that the redesigned disclosure and reminder letter cost €0.50 to produce and deliver, this implies a cost-effectiveness measure of €84 for every €1 spent on communication to households about the opportunity to refinance.

Estimates of an extended version of the Di Maggio et al. (2017) model of inattentive refinancing suggest that the reminder disclosures had large effects precisely because they increased the probability that a given consumer was attentive to the task of refinancing. Using our model estimates to simulate counterfactuals, we find that central bank communication to consumers reminding them of refinancing opportunities has significant potential to be an effective monetary policy tool to complement or substitute for lowering rates. We estimate that mortgage interest rates would have to decrease by 200 basis points in Ireland to have the same effectiveness as the reminder letters we study. Given limited pass-through of the ECB refinancing rate to retail interest rates in Ireland, such a large decrease in mortgage interest rates would require extraordinary monetary stimulus to achieve.

Several caveats apply to our estimates. Repeated reminders may be more or less effective than the one-shot reminder we studied here. Repeated reminders may lose their salience if households learn to rely on them instead of proactively acquiring their own information on refinancing activities, and as the households with the largest incentive to refinance or the lowest cost of attention to refinancing attrit from the sample of mortgage borrowers with large refinancing incentives, the effect of an additional reminder may decrease. However, it's also possible that as consumers become attuned to reminder letters, they trust them more and their refinancing spills over through peer effects and social learning. We also note that reminders are more effective when rates have fallen and may not be as successful in a rising rate environment. However, broadly speaking, policymakers are generally not keen to stimulate refinancing in such an environment anyway. The treatment effects we study here are likely to be more effective when the status-quo disclosure letter is less transparent to begin with. Streamlining, personalizing, simplifying, and highlighting are more valuable in the context of confusing, onerous, and overly detailed disclosures. The success of the communication also depends on the trust households place in the disclosing entity. It may be advantageous for the communication to be sent directly by a government agency or central bank than from a for-profit bank, although emphasizing that the letter itself is mandated could help. Finally, it's possible that the need for reminders would decrease in equilibrium if more attentive refinancing led banks to decrease the spread between their offered variable rates and policy rates in the first place.

Communication with mortgage holders about refinancing opportunities may be of interest to monetary authorities at different moments in the business cycle. First, as argued in this

paper, during expansionary monetary phases, offer letters and reminders can improve interest rate pass-through and strengthen the impact of interest rate reductions on the real economy. Second, during contractionary monetary policy phases, central banks may seek to improve household financial stability by encouraging households into fixed rate products as interest rates rise. In addition, several categories of governmental entities could be interested in the policy lever we evaluate here, including fiscal authorities seeking to stimulate refinancing and consumption, competition authorities aiming to improve the competitiveness of the mortgage market, and consumer protection authorities focused on improving households debt service burdens.

Finally, our results can be read in the context of a growing body of evidence that demonstrates the value of behaviorally informed approaches in delivering effective consumer protection in essential product markets. In particular, the results we document here are the first to demonstrate statistically and economically meaningful improvements in the stubbornly persistent puzzle of low take up of advantageous mortgage refinancing opportunities.

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Figure 1: US Policy Rates and New and Outstanding Mortgage Interest Rates
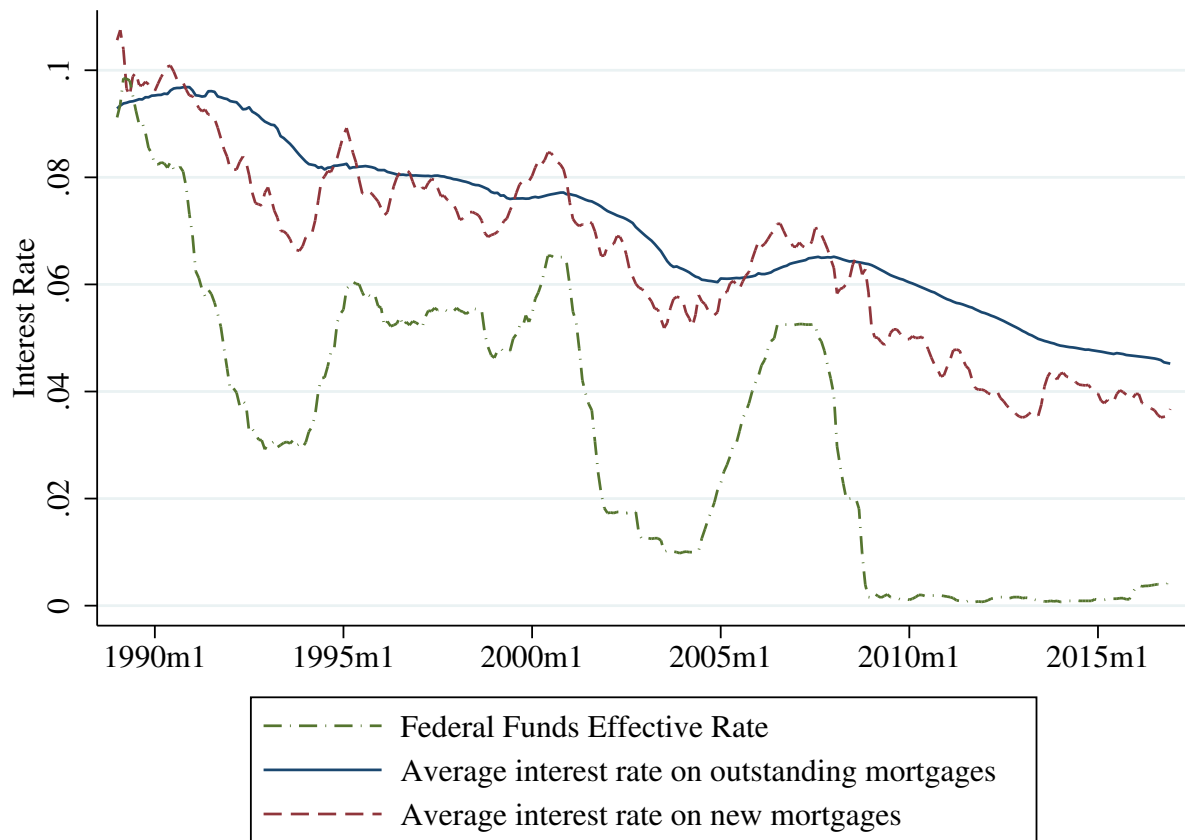


Note: Figure plots average mortgage interest rates by month for outstanding mortgages (solid blue line), newly originated mortgages (dashed red line), and the effective Federal Funds Rate (dashed-dotted green line). Outstanding and new mortgage interest rates are calculated from CRISM (see Di Maggio et al. (2020) for details). Effective federal funds rate is from the Board of Governors of the Federal Reserve System.

Figure 2: Refinancing Rates by Treatment Arm
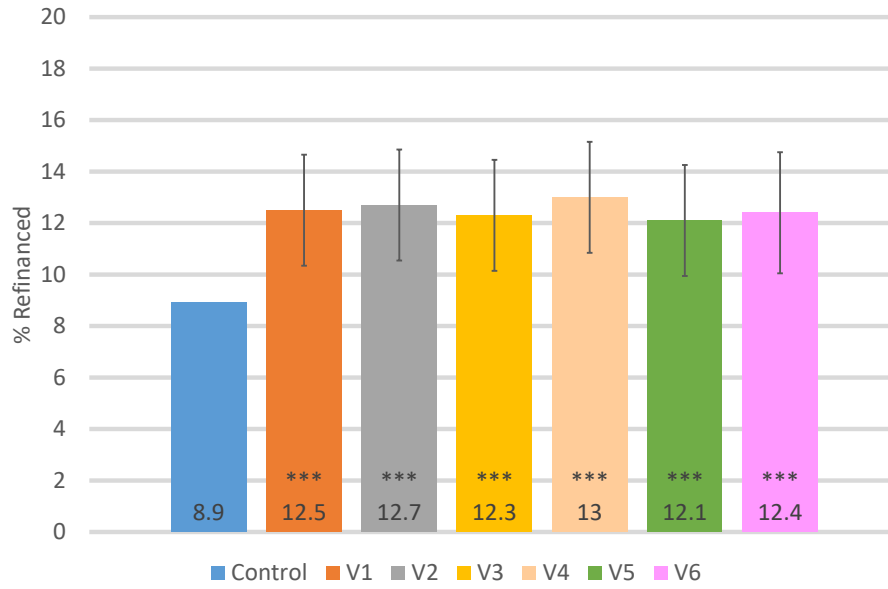


Notes: Figure plots refinancing rates by treatment arm, unconditional on whether a borrower received a reminder. Brackets denote 95% confidence intervals. Asterisks correspond to p-values for a test that a given treatment group's refinancing rate was equal to the control-group refinancing rate. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Figure 3: Refinancing Rates by Treatment Arm: No Reminder Sample
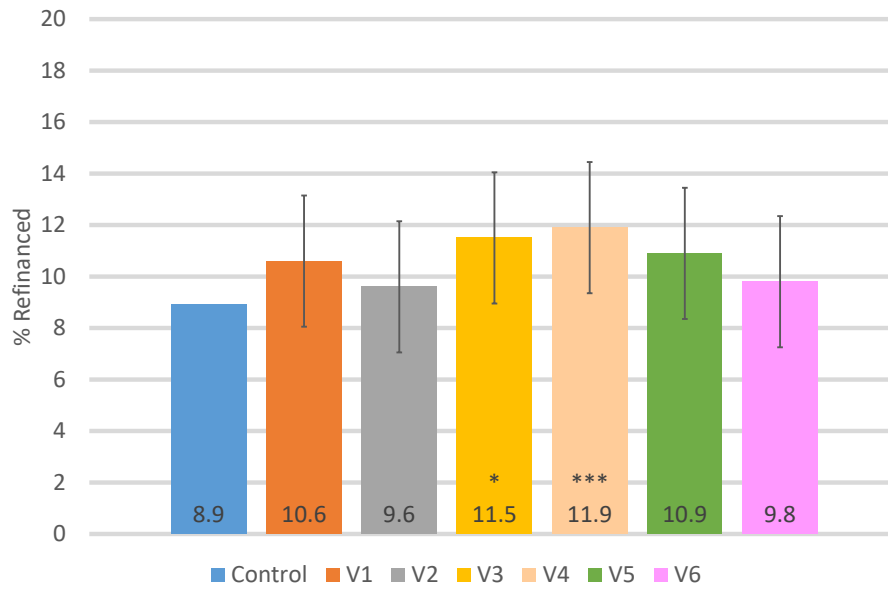


Notes: Figure plots refinancing rates by treatment arm for the subset of the sample that did not receive a reminder letter. Brackets denote 95% confidence intervals. Asterisks correspond to p-values for a test that a given treatment group's refinancing rate was equal to the control-group refinancing rate. *** p<0.01, ** p<0.05, * p<0.1.

Figure 4: Average Treated Refinancing Rates by Reminder Status
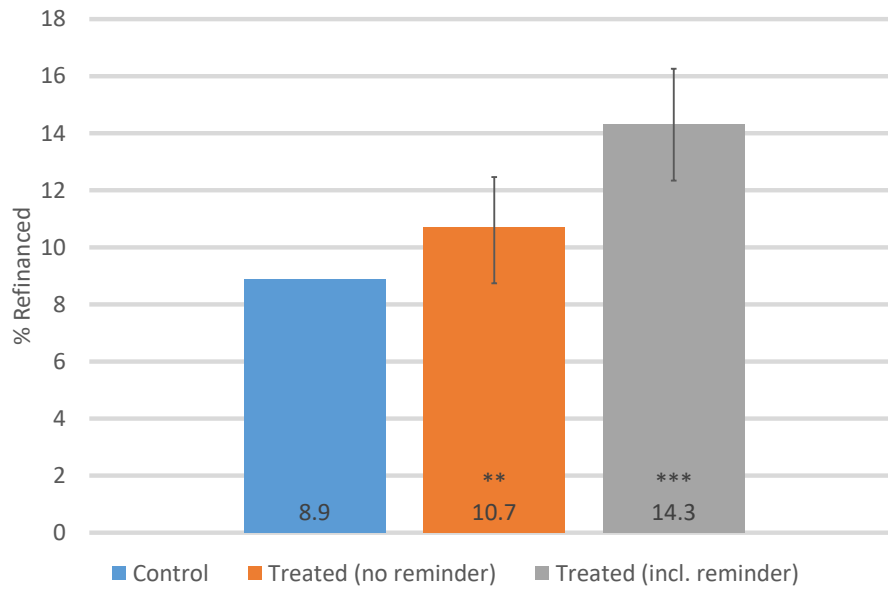


Notes: Figure plots average refinancing rates for treated borrowers who did not (left-hand bar) and did (right-hand bar) receive a follow-up reminder letter. Brackets denote 95% confidence intervals. Asterisks correspond to p-values for a test that the average treated borrower with a reminder letter was more likely than the average treated borrower without a reminder letter to refinance. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Figure 5: Refinancing Rates by Treatment Arm: Reminder Sample
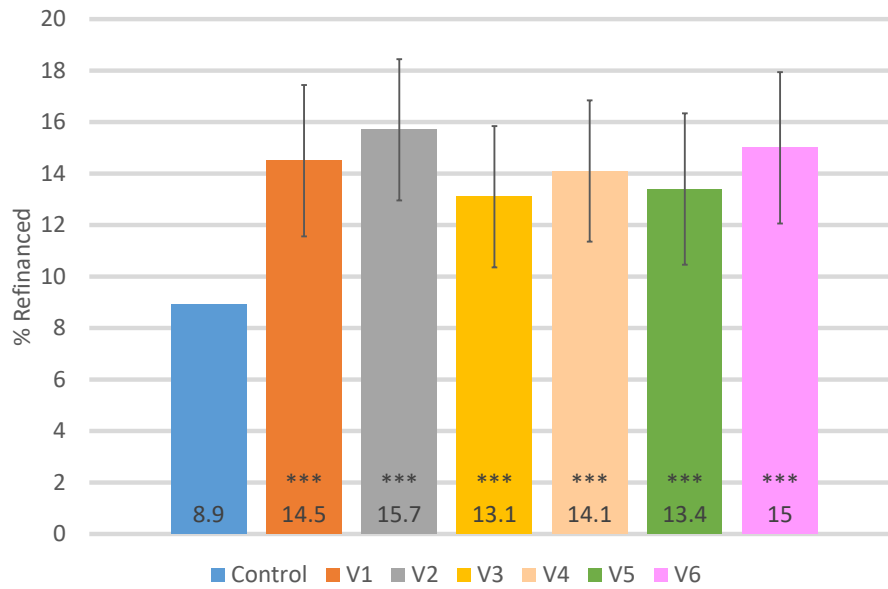


Notes: Figure plots refinancing rates by treatment arm for the subset of the sample that did receive a reminder letter. Brackets denote 95% confidence intervals. Asterisks correspond to p-values for a test that a given treatment group's refinancing rate was equal to the control-group refinancing rate. *** p<0.01, ** p<0.05, * p<0.1.

Table 1: Treatment arms overview

| Versions | Design format | Reference code |
| --- | --- | --- |
| Control | Existing standard | C |
| Version 1 | Neutral-framed personalized savings estimates (quiet salutation) | V1 (Pers) |
| Version 2 | Neutral-framed personalized savings estimates (quiet salutation) in Color | V2 (Pers-Col) |
| Version 3 | Neutral-framed personalized savings estimates and prominent subject line (PSL) | V3 (Pers-Prom) |
| Version 4 | Gain-framed personalized savings estimates with PSL | V4 (Pers-Gain) |
| Version 5 | Loss-framed personalized savings estimates with PSL | V5 (Pers-Loss) |
| Version 6 | Loss-framed personalized savings estimates with clarified process box with PSL | V6 (Pers-Loss-Box) |
| Reminder | 50% of all groups above (excl. Control) additionally receive a reminder communication at +4-6 weeks | R |

Table 2: Descriptive statistics across treatment cells

| Group | Control | V1 | V2 | V3 | V4 | V5 | V6 | Treated (no reminder) | Treated (with reminder) | Market (variable rate) | Market (excl. tracker) | Market (all) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dublin | 0.20 | 0.21 | 0.20 | 0.19 | 0.21 | 0.19 | 0.19 | 0.19 | 0.20 | 0.27 | 0.30 | 0.28 |
| | (0.40) | (0.40) | (0.40) | (0.39) | (0.41) | (0.39) | (0.39) | (0.39) | (0.40) | (0.44) | (0.46) | (0.45) |
| Borrower age | 49.74 | 50.29 | 49.80 | 50.08 | 50.13 | 50.10 | 49.87 | 50.10 | 49.99 | 48.99 | 46.69 | 48.24 |
| | (9.26) | (9.37) | (9.22) | (9.26) | (9.61) | (9.30) | (9.40) | (9.41) | (9.31) | (9.90) | (9.85) | (9.63) |
| First Time Buyer | 0.41 | 0.40 | 0.40 | 0.40 | 0.40 | 0.38 | 0.40 | 0.41 | 0.39 | 0.39 | 0.45 | 0.38 |
| | (0.49) | (0.49) | (0.49) | (0.49) | (0.49) | (0.49) | (0.49) | (0.49) | (0.49) | (0.49) | (0.50) | (0.49) |
| Mortgage balance | 83,503 | 81,425 | 80,098 | 81,530 | 81,020 | 81,351 | 82,548 | 80,617 | 82,027 | 102,688 | 135,011 | 128,238 |
| | (84,125) | (89,826) | (80,088) | (90,834) | (91,867) | (98,831) | (87,424) | (87,748) | (92,103) | (95,037) | (113,618) | (111,522) |
| Interest rate (outset) | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.036 | 0.034 | 0.026 |
| | (0.003) | (0.002) | (0.002) | (0.002) | (0.002) | (0.003) | (0.002) | (0.002) | (0.002) | (0.006) | (0.007) | (0.01) |
| Years to maturity | 13.87 | 13.21 | 13.21 | 13.25 | 13.36 | 13.16 | 13.38 | 13.22 | 13.29 | 14.63 | 17.34 | 15.90 |
| | (8.54) | (8.54) | (8.47) | (8.48) | (8.50) | (8.41) | (8.50) | (8.47) | (8.49) | (8.85) | (9.11) | (8.64) |
| 1-Year savings | 1,044 | 1,037 | 1,007 | 1,021 | 1,022 | 1,018 | 1,037 | 1,019 | 1,028 | 968 | 834 | -60.88 |
| | (1,010) | (1,155) | (980) | (1,137) | (1,101) | (1,178) | (1,065) | (1,115) | (1,093) | (1,120) | (1,007) | (1,827) |
| COVID-19 forbearance | 0.09 | 0.07 | 0.08 | 0.07 | 0.09 | 0.09 | 0.08 | 0.08 | 0.08 | 0.11^ | 0.12^ | 0.13^ |
| | (0.28) | (0.25) | (0.28) | (0.25) | (0.28) | (0.29) | (0.28) | (0.27) | (0.28) | (0.32) | (0.33) | (0.34) |
| Observations | 1,613 | 1,587 | 1,616 | 1,602 | 1,629 | 1,585 | 1,568 | 4,796 | 4,791 | 206,083 | 349,426 | 538,956 |

Notes: The table reports means and standard deviations in parentheses of mortgage borrower characteristics in each treatment and control group. Dublin is an indicator for whether the mortgaged property is located in Dublin. Borrower age of the oldest borrower on the mortgage. First-time buyer indicates whether the borrower is a first time-buyer. Mortgage balance is amount outstanding on loan at the time of experiment in euros. Interest rate is the interest rate applicable on the loan at the outset of the experiment. 1-year savings is the amount in euros of savings available to the borrower in the first year after refinancing to the best available rate. COVID forbearance indicates whether the borrower was using COVID-19 payment break (introduced in Ireland in March 2020 to alleviate short-term liquidity constraints faced by borrowers experiencing financial difficulties due to the impact of the pandemic). Arrears is an indicator for whether the mortgage is 90 days past due at the outset of the experiment. ∧ COVID-19 forbearance shares for the 'market' comparisons are measured from loan-level data collected by the Central Bank of Ireland as at June 2021, while all other variables are measured at the outset of the field trial.

Table 3: Test of Covariate Balance by Treatment

| Treatment group | V1 | V2 | V3 | V4 | V5 |
|---|---|---|---|---|---|
| Dublin | 0.011 | 0.002 | -0.018 | 0.022 | -0.009 |
| | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) |
| Borrower age | 0.001 | -0.002 | -0.000 | 0.000 | -0.001 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| First Time Buyer | 0.007 | 0.000 | 0.001 | 0.003 | -0.026 |
| | (0.020) | (0.020) | (0.020) | (0.020) | (0.020) |
| Mortgage balance | -0.000* | -0.000 | 0.000 | -0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Interest rate (outset) | -6.971 | -0.800 | 2.058 | 0.263 | 2.649 |
| | (4.941) | (4.910) | (4.834) | (4.936) | (4.521) |
| Years to maturity | -0.003* | -0.004** | -0.003* | -0.002 | -0.003** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| 1-Year savings | 0.063** | 0.011 | -0.004 | 0.013 | -0.002 |
| | (0.030) | (0.031) | (0.027) | (0.031) | (0.024) |
| COVID-19 forbearance | -0.072** | -0.013 | -0.071** | -0.002 | 0.010 |
| | (0.033) | (0.032) | (0.033) | (0.031) | (0.031) |
| Constant | 0.790*** | 0.684*** | 0.470** | 0.510** | 0.491** |
| | (0.220) | (0.223) | (0.218) | (0.222) | (0.207) |
| | | | | | |
| Observations | 3,200 | 3,229 | 3,215 | 3,242 | 3,198 |
| R-squared | 0.005 | 0.002 | 0.003 | 0.001 | 0.003 |

Notes: Table shows regression results of a pairwise regression of treatment status (control vs. each of our treatment groups) on a vector of covariates. Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4: Treatment Effects on Refinancing (unconditional on reminder status)

| | (1) | (2) | (3) |
|---|---|---|---|
| V1 (Pers) | 0.036*** | 0.040*** | 0.040*** |
| | (0.011) | (0.011) | (0.011) |
| V2 (Pers-Col) | 0.038*** | 0.042*** | 0.042*** |
| | (0.011) | (0.011) | (0.011) |
| V3(Pers-Prom) | 0.034*** | 0.038*** | 0.038*** |
| | (0.011) | (0.011) | (0.011) |
| V4 (Pers-Gain) | 0.041*** | 0.044*** | 0.044*** |
| | (0.011) | (0.011) | (0.011) |
| V5 (Pers-Loss) | 0.032*** | 0.037*** | 0.037*** |
| | (0.011) | (0.011) | (0.011) |
| V6 (Pers-Loss-Box) | 0.035*** | 0.038*** | 0.038*** |
| | (0.012) | (0.011) | (0.011) |
| Years to maturity | | 0.006*** | 0.005*** |
| | | (0.000) | (0.000) |
| 1-Year savings (€000s) | | | 0.023*** |
| | | | (0.003) |
| COVID-19 forbearance | | | 0.034*** |
| | | | (0.011) |
| Constant | 0.089*** | 0.001 | -0.006 |
| | (0.008) | (0.009) | (0.009) |
| | | | |
| Treatment effect equality $p$-value | 0.984 | 0.988 | 0.987 |
| Observations | 11,200 | 11,200 | 11,200 |
| R-squared | 0.002 | 0.029 | 0.035 |

Notes: Treatment effects are measured relative to the Control group. Column 1 evaluates treatment effects without any additional controls, while columns 2 and 3 add controls where we find minor evidence of statistical difference in our balance analysis from Table 3. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6: Treatment effects on external switching

|  | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Treated | -0.005 | -0.005 | -0.003 | -0.003 |
|  | (0.005) | (0.005) | (0.005) | (0.005) |
| Received reminder |  |  | -0.003 | -0.003 |
|  |  |  | (0.004) | (0.004) |
| Years to maturity |  | -0.000 |  | -0.000 |
|  |  | (0.000) |  | (0.000) |
| 1-Year savings (€000s) |  | 0.003* |  | 0.003* |
|  |  | (0.002) |  | (0.002) |
| COVID-19 forbearance |  | -0.030*** |  | -0.030*** |
|  |  | (0.006) |  | (0.006) |
| Constant | 0.037*** | 0.037*** | 0.037*** | 0.037*** |
|  | (0.004) | (0.005) | (0.004) | (0.005) |
| Observations | 11,200 | 11,200 | 11,200 | 11,200 |
| R-squared | 0.000 | 0.002 | 0.000 | 0.002 |

Notes: Table reports treatment effects on external switching. *** p<0.01, ** p<0.05, * p<0.1

Table 5: Treatment effect heterogeneity

| Treatment group | V1 | V2 | V3 | V4 | V5 | V6 | V1-6 | V1-6 (NR) | V1-6 (WR) |
|---|---|---|---|---|---|---|---|---|---|
| Treated | -0.003 | 0.001 | 0.021 | 0.020 | 0.016 | 0.011 | 0.011 | -0.003 | 0.025 |
| | (0.018) | (0.018) | (0.018) | (0.018) | (0.018) | (0.018) | (0.015) | (0.015) | (0.016) |
| First Time Buyer | -0.008 | -0.008 | -0.008 | -0.008 | -0.008 | -0.008 | -0.008 | -0.008 | -0.008 |
| | (0.016) | (0.016) | (0.016) | (0.016) | (0.016) | (0.016) | (0.017) | (0.016) | (0.018) |
| Treated X    First Time Buyer | 0.030 | 0.033 | 0.007 | 0.051** | 0.023 | 0.002 | 0.025 | 0.017 | 0.033* |
| | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) | (0.023) | (0.018) | (0.018) | (0.020) |
| Loan Balance (€50,000-100,000) | 0.057 | 0.070 | 0.068 | 0.052 | 0.058 | -0.016 | 0.048 | 0.055 | 0.042 |
| | (0.046) | (0.046) | (0.047) | (0.047) | (0.046) | (0.047) | (0.037) | (0.037) | (0.041) |
| Loan Balance Loan Balance (€100,000) | 0.011 | 0.092 | 0.069 | 0.021 | 0.069 | -0.028 | 0.038 | 0.034 | 0.044 |
| | (0.057) | (0.057) | (0.059) | (0.058) | (0.057) | (0.057) | (0.045) | (0.045) | (0.050) |
| 1-Year Savings (€500-1,000) | 0.004 | 0.001 | -0.007 | -0.034 | -0.039 | 0.032 | -0.007 | -0.014 | -0.003 |
| | (0.042) | (0.042) | (0.042) | (0.042) | (0.042) | (0.042) | (0.033) | (0.034) | (0.037) |
| 1-Year Savings (€1,000) | 0.021 | -0.057 | -0.063 | -0.024 | -0.034 | 0.081 | -0.012 | -0.011 | -0.017 |
| | (0.057) | (0.057) | (0.059) | (0.059) | (0.057) | (0.058) | (0.045) | (0.046) | (0.050) |
| COVID-19 Forberance | 0.046 | 0.032 | 0.038 | 0.025 | -0.010 | -0.006 | 0.019 | 0.019 | 0.018 |
| | (0.040) | (0.038) | (0.040) | (0.038) | (0.037) | (0.038) | (0.030) | (0.031) | (0.034) |
| Loan Balance (€50,000-100,000) | -0.032 | -0.032 | -0.032 | -0.032 | -0.032 | -0.032 | -0.032 | -0.032 | -0.032 |
| | (0.032) | (0.033) | (0.033) | (0.033) | (0.032) | (0.032) | (0.034) | (0.032) | (0.035) |
| Loan Balance (€100,000) | -0.012 | -0.012 | -0.012 | -0.012 | -0.012 | -0.012 | -0.012 | -0.012 | -0.012 |
| | (0.039) | (0.040) | (0.040) | (0.040) | (0.039) | (0.039) | (0.041) | (0.039) | (0.043) |
| 1-Year Savings (€500-1,000) | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 | 0.042 |
| | (0.029) | (0.030) | (0.029) | (0.030) | (0.029) | (0.029) | (0.031) | (0.029) | (0.032) |
| 1-Year Savings (€1,000) | 0.117*** | 0.117*** | 0.117*** | 0.117*** | 0.117*** | 0.117*** | 0.117*** | 0.117*** | 0.117*** |
| | (0.040) | (0.040) | (0.040) | (0.040) | (0.040) | (0.040) | (0.042) | (0.039) | (0.043) |
| COVID-19 Forberance | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 | 0.015 |
| | (0.027) | (0.027) | (0.027) | (0.027) | (0.026) | (0.027) | (0.028) | (0.026) | (0.029) |
| Constant | 0.046*** | 0.046*** | 0.046*** | 0.046*** | 0.046*** | 0.046*** | 0.046*** | 0.046*** | 0.046*** |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.013) | (0.014) | (0.013) | (0.014) |
| Treatment effect equality p-value | 0.812 | 0.769 | 0.638 | 0.506 | 0.767 | 0.784 | 0.965 | 0.902 | 0.968 |
| Observations | 3,200 | 3,229 | 3,215 | 3,242 | 3,198 | 3,181 | 11,200 | 6,409 | 6,404 |
| R-squared | 0.041 | 0.037 | 0.028 | 0.033 | 0.036 | 0.042 | 0.035 | 0.036 | 0.036 |

Notes: First Time Buyer interaction term is measured relative to a base category which is Second and Subsequent Buyers. Balance interaction terms are measures relative to a base category which is <€50,000. Savings interaction terms are measured relative to a base category which is <€500. P-values test whether all treatment-control interactions are jointly zero. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7: Treatment effect by employment sector

| Employment sector | WFH | BAU | AHNW |
|---|---|---|---|
| Treated | 0.015 | 0.028 | 0.026 |
| | (0.012) | (0.046) | (0.019) |
| Treated with reminder | 0.046*** | 0.080* | 0.066*** |
| | (0.012) | (0.048) | (0.019) |
| Constant | 0.100*** | 0.079* | 0.075*** |
| | (0.010) | (0.041) | (0.017) |
| | | | |
| Observations | 7,218 | 494 | 2,548 |
| R-squared | 0.003 | 0.008 | 0.006 |

Notes: Aggregate treatment effects are measured relative to the control group. Columns 1, 2, and 3 report effects within the employment sector subgroups more likely to be working from home (WFH), experiencing business as usual (BAU), and being at home but not working (AHNW) respectively during the estimation window. See Table A1 for information on how these groups are classified. *** p<0.01, ** p<0.05, * p<0.1

Table 8:   Parameter Values Used in ADL Model of Optimal Refinancing.

| Parameter | Name | Value | Source |
|---|---|---|---|
| Inflation | $\pi$ | 0.02 | Average IE inflation |
| Real discount rate | $\rho$ | 0.05 | Standard |
| Nominal interest rate volatility | $\sigma$ | 0.002 | CBI monthly interest rate series |
| Marginal tax rate for interest deduction | $\tau$ | 0 | Eliminated in Ireland in 2019 |
| Exogenous Pr(termination) | $\mu$ | 0.11 | Microdata from partner bank |
| Perceived fixed costs of refinancing (€) | $\kappa$ | 100 | Usual cost is zero |

Notes: Table reports parameter values used in the Agarwal et al. (2013) model of optimal refinancing discussed in Section 6 adapted to the Irish mortgage market context.

Table 9: Mixture Model Maximum Likelihood Estimates

| Parameter | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Incentive Sensitivity ($\beta$) | -125.48*** | -1.61*** | -0.23 | -1.58*** | -1.65*** |
| | (1.12) | (0.01) | (0.51) | (0.05) | (0.05) |
| Fixed Cost of Refinancing ($\gamma_0$) | | 13.15*** | 6.43*** | 8.71*** | 8.71*** |
| | | (0.70) | (0.49) | (0.03) | (0.20) |
| Non-Dublin Indicator ($\gamma_1$) | | | | | 0.25 |
| | | | | | (0.18) |
| Age ($\gamma_2$) | | | | | 0.02*** |
| | | | | | (0.01) |
| First-time Homebuyer ($\gamma_3$) | | | | | 0.48*** |
| | | | | | (0.14) |
| COVID-19 Forbearance ($\gamma_4$) | | | | | -0.57** |
| | | | | | (0.25) |
| Inattention Constant ($\delta_0$) | | | 1.28*** | 1.13*** | 1.02*** |
| | | | (0.19) | (0.11) | (0.12) |
| Treatment on Inattention ($\delta_1$) | | | | -0.31** | -0.33** |
| | | | | (0.12) | (0.13) |
| Reminder on Inattention ($\delta_2$) | | | | -0.43*** | -0.44*** |
| | | | | (0.08) | (0.09) |
| | | | | | |
| Observations | 11,200 | 11,200 | 11,200 | 11,200 | 11,200 |

Notes: Table reports maximum likelihood estimates of the mixture model of inattentive refinancing described in the text. Incentive Sensitivity is the coefficient on the ADL refinancing incentive described in Section 6 using the parameters defined by Table 8, with coefficient $\exp(\beta)$. The fixed cost of refinancing constant $\gamma_0$ estimates an average fixed cost term to rationalize observed refinancing variable. The fixed-cost controls ($\gamma_1$-$\gamma_4$) allow for differences across groups in the estimated fixed cost of refinancing. The inattention constant $\delta_0$ allows the inattention index in (2) to have a constant term. The inattention treatment effects allow borrowers who treated with redesigned disclosures ($\delta_1$) and disclosure reminders ($\delta_2$) to have different levels of attention. Age is demeaned. COVID-19 indicates whether the borrower was approved for mortgage-payment forbearance with a COVID hardship. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

# Appendix

## A    Robustness to Alternative Refinancing Parameters

One concern with our use of the ADL model of optimal refinancing is that their model considers only US-style fixed-rate mortgages. Specifically, ADL study the optimal exercise of the option to refinance a US-style fixed-rate mortgage into another fixed-rate mortgage, resetting the term of the new mortgage back to 30 years. In contrast, Irish fixed-rate mortgages do not have fixed interest rates for their entire duration, instead converting to variable-rate mortgages by default after an initial fixation period of usually 1-5 years. Furthermore, when mortgagors in Ireland refinance, they generally keep their remaining term constant instead of restarting at 30 years or switching to an entirely different duration. In this appendix, we consider alternative formulations of the incentive to refinance that account for these differences in mortgage product design. Before proceeding, we note that despite the shorter fixation periods in Ireland relative to the US, Irish mortgagors still behave similarly in terms of duration, with a typical mortgage lasting for around 12 years despite rolling over to a variable rate.

One approach to tweak the ADL model to accommodate differences between mortgage systems is used by Fisher et al. (2021). They set the likelihood of prepayment for exogenous reasons to $\mu = 0.5$, which makes the actual duration of a typical mortgage approximately two years. By making borrowers expect the need to go back to the market for a new market-rate mortgage with With such a high probability, this mimics the effect of having a fixation period end with the mortgage rolling over to a variable rate. Strictly speaking, this is not what happens in the data in Ireland—typical borrowers hold their mortgages much longer. However, we also adopt this approach in a robustness check of setting $\mu = 0.5$ to demonstrate that our core estimates are relatively insensitive to the particulars of the optimal mortgage refinancing model parameterization.

In Appendix Table A2, we report estimates from reestimating the maximum likelihood specification of section 6, formulating $I(x_i, \varphi)$ with $\mu = 0.5$ and the other parameters the same as in Table 8. On the whole, the estimates are similar across the two tables. The fixed cost estimates are generally bigger in Appendix Table A2, with $\exp(\hat{\gamma}_0) \approx €3,133$ in column 3, for example, but also more stable across specifications. The biggest change is a decrease in the baseline estimated rate of inattention $\Lambda(\hat{\delta}_0) \approx 64\%$ in column 3, down from 78% in Table 9. While a majority of borrowers are inattentive to the opportunity to refinance in either parameterization of the refinancing decision, it is intuitive that the model would find fewer households inattentive when borrower horizons are short because exogenous prepayment is high. In this case, which approximates a world where mortgages are not fixed rate for their entire duration, households may optimally fail to refinance because they will likely have to refinance soon anyway, reducing the length of time over which they should expect to have enjoyed the benefits of refinancing. This force in the serves to alleviate some of the pressure for inattention to explain low refinancing levels, reducing the estimated baseline inattention rate. However, even when allowing for this possible force to be stronger in the model than it seems in the data given slow Irish refinancing, inattention is still high. Moreover, even in Appendix Table A2, the combined treatment effect of receiving a redesigned disclosure and

follow-up reminder letter is still large and of a similar magnitude to the original maximum-likelihood results in Table 9.

A final approach, also explored by Fisher et al. (2021) that abstracts away from the ADL model is to remove the optimal threshold term $O(x_i, \varphi)$ from the specification of the incentive to refinance given in equation (1). Doing so remains agnostic about the precise threshold for optimal options exercise and instead lets the incentive to refinance just be proportional to the interest-rate gap, defined as the difference between a borrower's current interest rate $r_i^{old}$ and her potential rate if refinancing $r_i^{new}$. Again, we find that our core results are unchanged, further emphasizing that our conclusions are not driven by the particular form or parameterization of the ADL model.

Figure A1: In the last 5 years have you changed mortgage loan provider?
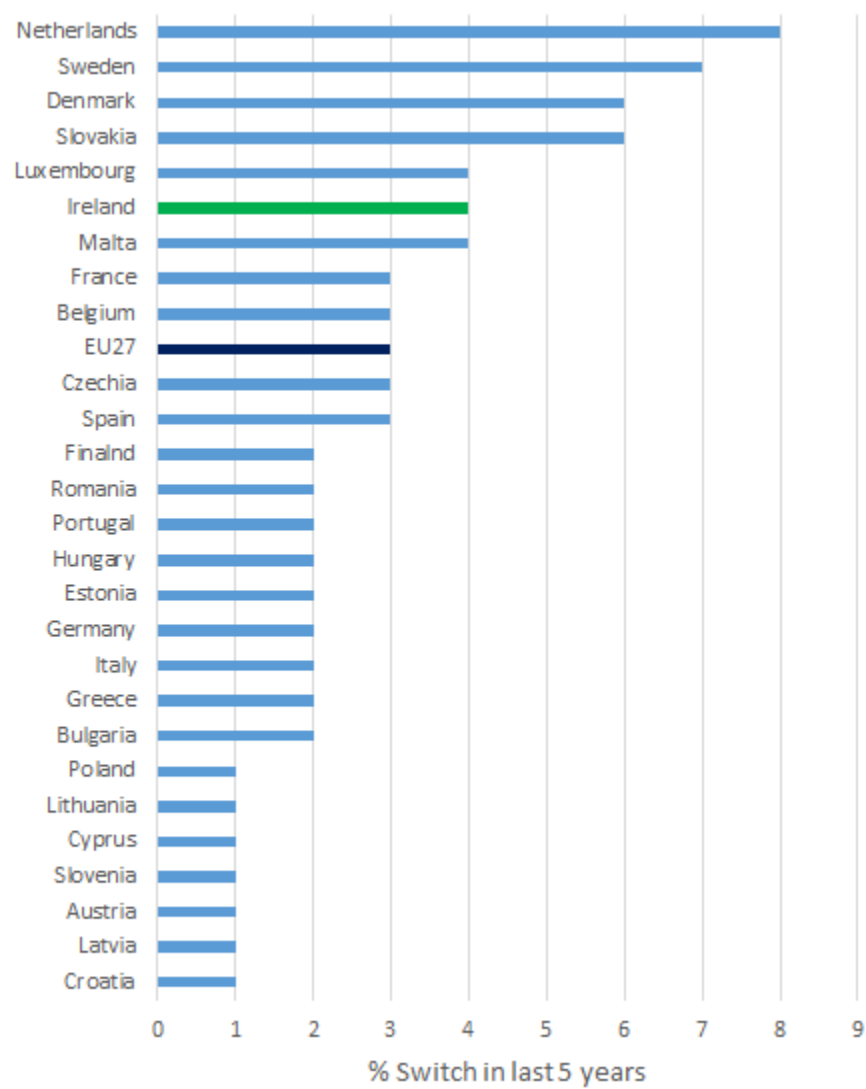


Source: Flash Eurobarometer 509. Fieldwork: 30/5 - 8/6/2022

## Figure A2: Example Control-Group Disclosure Letter

Mortgage Account Number: 1234567

**You may be able to save money on your mortgage**

Dear John,

This letter supplements the information we sent with your annual mortgage loan statement in the leaflet called "Information about your mortgage (You may be able to save money on your mortgage)".

The standard variable interest rate we currently charge you on your mortgage loan is 4.34%. However, we want to make sure you are getting the best deal and we may have a lower interest rate for your mortgage.

**What rates are available?**

The lowest interest rate currently available to you is a one or two-year fixed rate of 2.9%. We also offer fixed rates for periods of three, five and ten years. The ten-year rate varies depending on your Loan to Value (LTV). We explain Loan to Value at the end of this letter.

**Explaining the tables below**

These tables show you the interest rates along with the Annual Percentage Rate of Charge (APRC). We explain APRC at the end of this letter.

**Fixed interest rates**

| Fixed interest rate options | Loan to Value Up to 60% | Loan to Value 61-80% | Loan to Value over 80% |
|---|---|---|---|
| 1-year | 2.9% (3.9% APRC) | 2.9% (4.2% APRC) | 2.9% (4.4% APRC) |
| 2-year | 2.9% (3.8% APRC) | 2.9% (4.0% APRC) | 2.9% (4.3% APRC) |
| 3-year | 3% (3.7% APRC) | 3% (3.9% APRC) | 3% (4.1% APRC) |
| 5-year | 3% (3.6% APRC) | 3% (3.7% APRC) | 3% (3.9% APRC) |
| 10-year | 3.3% (3.5% APRC) | 3.3% (3.6% APRC) | |

## Figure A3: Example Treatment-Group Disclosure Letter

Mortgage Account Number: 1234567

**You may be able to save money on your mortgage**

Dear John,

Your current mortgage interest rate is a standard variable rate of 4.5%. We want to make sure you are getting the best deal and we may have a lower interest rate for your mortgage.

| | | |
|---|---|---|
| Current monthly repayment at 4.25%: | €716 | • We have a range of interest rates that could save you money. |
| Potential monthly repayment at 2.9% fixed: | €590 | • Our lowest rate is a fixed rate of 2.9%, which could result in an immediate monthly saving to you of about €126. Over the course of a full year, that's approximately €1,512 in savings. |
| Estimated difference in monthly repayments | -€126 | • Below, we outline the full range of interest rate options currently available, along with the next steps to take if you wish to choose one of these alternative options. |
| Potential difference over the year: | -€1,512 | |

**Explaining the tables below**

These tables show you the interest rates along with the Annual Percentage Rate of Charge (APRC). We explain APRC at the end of this letter. The rates may vary by Loan to Value (LTV) ratio. We also explain LTV at the end of this letter.

**Fixed interest rates**

| Fixed interest rate options | Loan to Value Up to 60% | Loan to Value 61-80% | Loan to Value over 80% | Difference in monthly repayments | Difference over the year |
|---|---|---|---|---|---|
| 1-year | 2.9% (3.9% APRC) | 2.9% (4.2% APRC) | 2.9% (4.4% APRC) | -€126 | -€1,512 |
| 2-year | 2.9% (3.8% APRC) | 2.9% (4.0% APRC) | 2.9% (4.3% APRC) | -€126 | -€1,512 |
| 3-year | 3% (3.7% APRC) | 3% (3.9% APRC) | 3% (4.1% APRC) | -€118 | -€1,416 |
| 5-year | 3% (3.6% APRC) | 3% (3.7% APRC) | 3% (3.9% APRC) | -€118 | -€1,416 |
| 10-year | 3.3% (3.5% APRC) | 3.3% (3.6% APRC) | | -€95 | -€1,140 |
| 10-year | | | 3.5% (3.8% APRC) | -€80 | -€960 |

Figure A4: Example Reminder Letter

Mortgage Account Number: 1234567

## REMINDER: You may be able to save money on your mortgage

Dear X,

We recently wrote to you about the availability of lower mortgage interest rate options and the potential for savings on your monthly mortgage repayments.

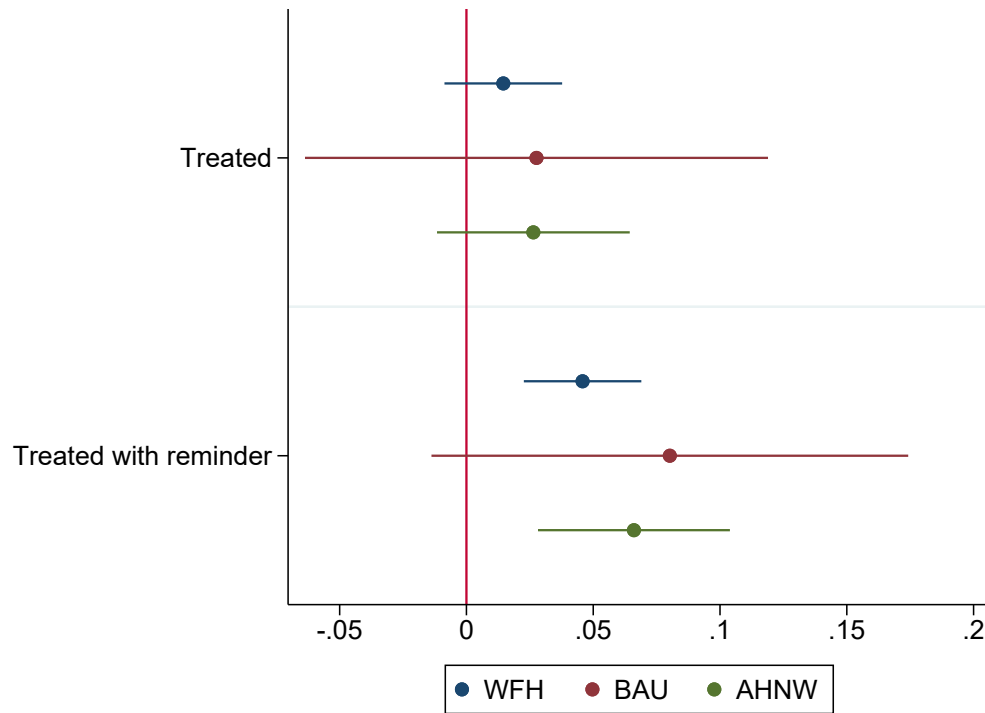This is a reminder to take action to avail of one of these options.

If you wish to take up a lower interest rate for which you are eligible, you can go online at websiteaddress.com/mortgages, call us on 01 XXX XXXX, or visit a branch.

Yours sincerely,

Firstname Secondname
Head of Mortgages

Figure A5: Coefficient plot of treatment effects by employment sector



Note: Figure plots coefficient estimates of main treatment effects across employment sectors, grouped by their likelihood of working from home (WFH), experiencing business as usual (BAU), and being at home not working (AHNW) during the estimation window.

Figure A6: Mortgage Breakdown by Type
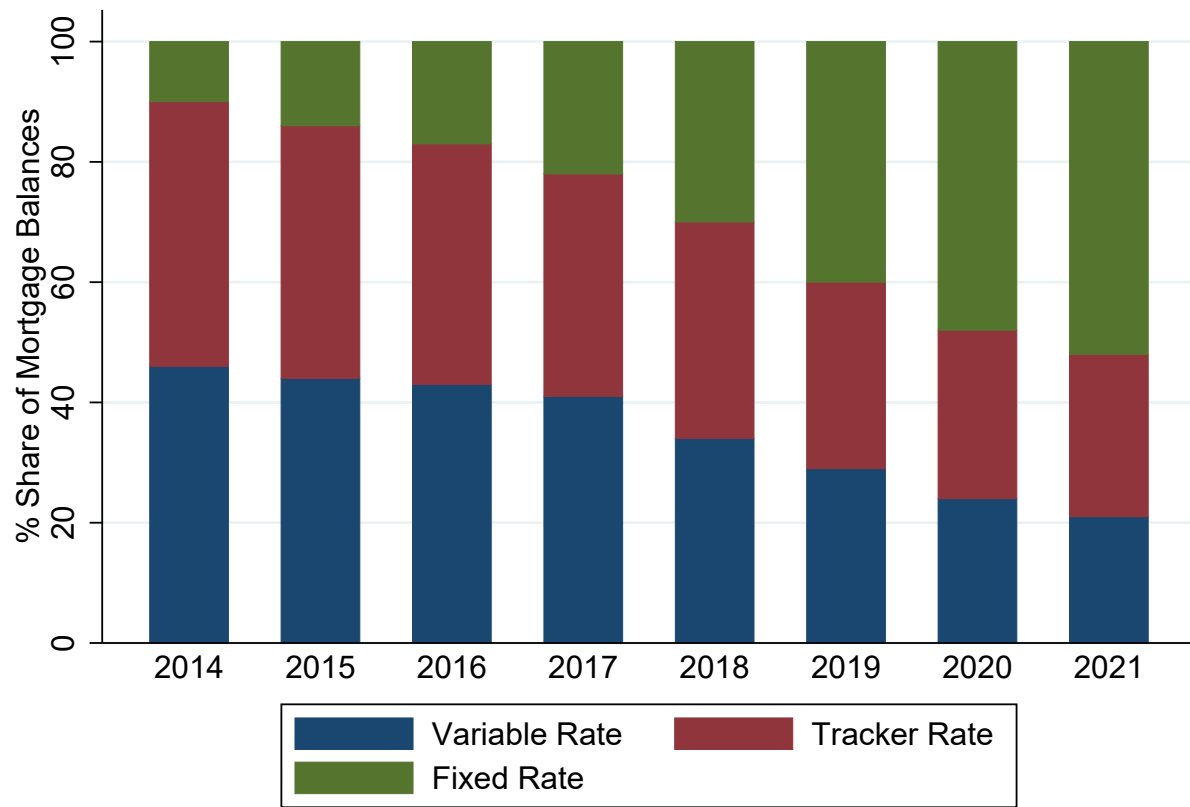


Source: Central Bank of Ireland Retail Interest Rate Statistics
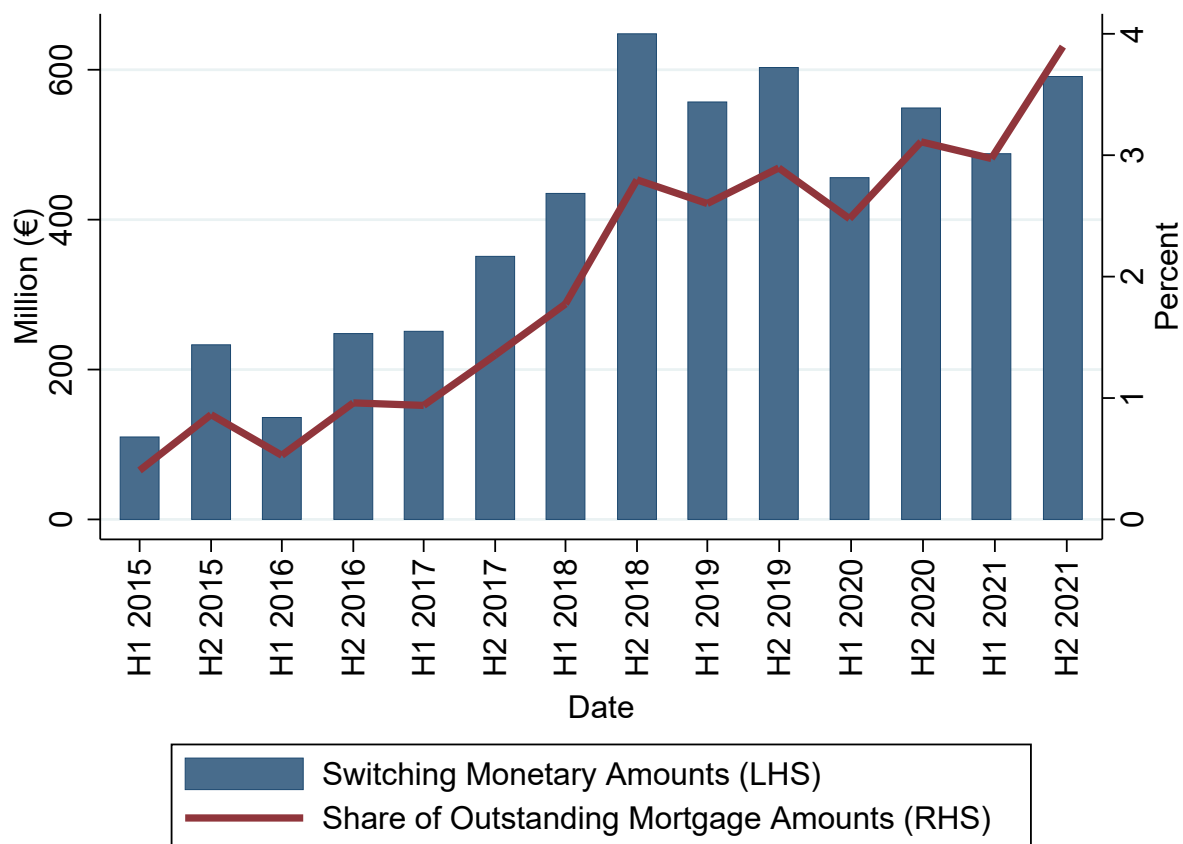
Figure A7: Levels of Switching

Table A1: Classification of employment sectors

| Working from home (WFH) | Business as usual (BAU) | At home not working (AHNW) |
|---|---|---|
| J: Information and communication | A: Agriculture, forestry, fishing | C: Manufacturing |
| K: Financial and insurance | D: Electricity, gas supply | F: Construction |
| M: Professional, scientific, technical | H: Transport and storage | G: Wholesale and retail trade, vehicle repair |
| O: Public administration | | I: Accommodation and food services |
| S: Other service activities | | |

Notes: Table reports the classification of employment sectors into groups more likely to be working from home (WFH), experiencing business as usual (BAU), and at home not working (AHNW). Prefix letters represent Eurostat Statistical Classification of Economic Activities in the European Community, Rev. 2 (2008) available at Eurostat.

Table A2: Mixture ML Estimates: Robustness to Alternative Prepayment Assumptions

| Parameter | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Incentive Sensitivity ($\beta$) | -125.48*** | -1.44*** | -1.63*** | -1.63*** | -1.72*** |
| | (1.56) | (0.02) | (0.05) | (0.05) | (0.05) |
| Fixed Cost of Refinancing ($\gamma_0$) | | 9.66*** | 8.05*** | 8.04*** | 9.01*** |
| | | (0.03) | (0.04) | (0.04) | (0.15) |
| Non-Dublin Indicator ($\gamma_1$) | | | | | -0.26* |
| | | | | | (0.14) |
| Age ($\gamma_2$) | | | | | 0.02*** |
| | | | | | (0.00) |
| First-time Homebuyer ($\gamma_3$) | | | | | 0.03 |
| | | | | | (0.12) |
| COVID-19 Forbearance ($\gamma_4$) | | | | | -0.36* |
| | | | | | (0.19) |
| Inattention Constant ($\delta_0$) | | | 0.57*** | 1.05*** | 0.78*** |
| | | | (0.05) | (0.11) | (0.13) |
| Treatment on Inattention ($\delta_1$) | | | | -0.32** | -0.35** |
| | | | | (0.13) | (0.14) |
| Reminder on Inattention ($\delta_2$) | | | | -0.45*** | -0.51*** |
| | | | | (0.09) | (0.10) |
| Observations | 11,200 | 11,200 | 11,200 | 11,200 | 11,200 |

Notes: Table reports maximum likelihood estimates of the mixture model of inattentive refinancing described in the text, but where we adjust the model parameters to take account of the typically short fixation periods which predominate in Irish (and UK) mortgage markets, as distinct from the long-term fixation periods to which the Agarwal et al. (2013) model is originally attuned. Incentive Sensitivity is the coefficient on the ADL refinancing incentive described in Section 6 using the parameters defined by Table 8, with coefficient $\exp(\beta)$. The fixed cost of refinancing constant $\gamma_0$ estimates an average fixed cost term to rationalize observed refinancing variable. The fixed-cost controls ($\gamma_1$-$\gamma_4$) allow for differences across groups in the estimated fixed cost of refinancing. The inattention constant $\delta_0$ allows the inattention index in (2) to have a constant term. The inattention treatment effects allow borrowers who treated with redesigned disclosures ($\delta_1$) and disclosure reminders ($\delta_2$) to have different levels of attention. Age is demeaned. COVID-19 indicates whether the borrower was approved for mortgage-payment forbearance with a COVID hardship. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1