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*Project Title: Effects of interest rate volatility on mortgage
lending and housing affordability in the UK.*

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Declaration

I, **Md. Reza** (Student ID: **2421692**) certifies that this dissertation is my own unique work, entitled Effects of interest rate volatility on mortgage lending and housing affordability in the UK. I affirm that I have not registered it, wholly or in segments, in any other degree or award at this or any other institution. I am also affirmative that all the sources employed in this dissertation have been duly referenced and cited in the reference list. Anything that does not belong to me has been marked explicitly.

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Abstract

The dissertation is an investigation of the impact of the level and volatility of the Bank of England policy rate on mortgage lending in the UK and housing affordability between 2016 and 2025. It utilises monthly secondary data, which are published by the Bank of England, FCA and other government sources. An ARDL error-correction model predicts first the pass-through of the Bank Rate to the 2-year 75% LTV mortgage rate. Second, dynamic log regressions refuse the relationship between three months realised rate volatility with house-purchase approvals, as well as other secured approvals and house-purchase approvals as a proxy to refinancing activity. Third, regressions are used to estimate the rate of policy and volatility rates with the measures of affordability, such as price to income, deposit to income, and payment to income. Lastly, an interrupted time-series model is used to assess the Mortgage Charter of 2023. It is found that the results indicate a high long-run pass-through of approximately 0.65 and a quick adjustment, where over 70% of deviations were corrected within a month. A greater volatility in rates has been linked to significantly lower approvals, implying that uncertainty will postpone borrowing decision-making. Weaker affordability on the basis of price is also associated with higher rate levels and volatility. The Mortgage Charter is associated with an early decline in approvals but a subsequent positive reaction to the trend, even though the activities are still burdened with high rates and volatility. The research concludes that policy uncertainty is one of the most vital channels through which the housing-market performance can be screened, and it should be taken into account in informing, stress testing, and supporting borrowers.

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Chapter 1: Introduction

1.1 Background to the Study

The United Kingdom has experienced a prolonged low-interest-rate period ever since the global financial crisis (GFC) (Robertson et al., 2022). The policy rates were famously kept near zero throughout the 2010s. Here, the cost of borrowing was low, and a high number of households were on short-term agreements with fixed-rate mortgages (Bottero et al., 2019). Since the end of 2021, things have taken a different turn. The Bank of England (BoE) embarked on a cycle of quick tightening due to the high inflation (Abolarin, 2025). Within a span of less than two years, the Bank Rate has gone up to over 5% after it was increased to 0.1% (Abolarin, 2025). This has inverted the cost and risk profile of UK mortgage lending.

The BoE Bank Rate has an impact on mortgage markets in a number of ways (Beukers et al., 2022). On the one hand, they determine the price of the mortgage (Beukers et al., 2022). New fixed products (two and five years) are repriced, and Standard Variable Rates (SVR) are changed by lenders. Increased rates of the policy will increase the funding costs and swap rates of lenders (Boutros et al., 2022). These strains contribute to the mortgage rates and spreads on the yields of the government bonds (Boutros et al., 2022). Second, the variation in the Bank Rates modifies the monthly payments of both the borrowers (Beck et al., 2018). Expiring a fixed-rate transaction in a more favourable rate regime leads to a fixed shock in the households as repayment increases monthly (Luu & Sawang, 2024). This is able to tighten disposable income and increase the chances of financial distress. Third, alteration of policies has an impact on the risk and margins of lenders (Western, 2020). Banks need to deal with pipeline risk in applications, have to re-price products

on a regular basis, and have to trade off profitability and credit risk. When they operate in a volatile environment, they can increase spreads, brush up credit requirements, or cancel some products.

Simultaneously, UK households are experiencing a wider cost-of-living squeeze (Aguerreberre, 2024). Food, energy, and other essential prices have been increasing at a greater rate than wages in recent years. Most households are now eating up a significant proportion of their income on housing expenses such as rent and mortgage payments (Coibion et al., 2020). Consequently, the affordability of housing has emerged as one of the issues of concern among the regulators and the populace. Some of these include payment-to-income (PTI), price-to-income, and deposit-to-income, all persistently under the strain, particularly with first-time buyers and males with lower income (Levine-Schnur, 2020).

The majority of the discussion in the mass media is centred on the level of interest rates. Interest-rate volatility is also important, though. The volatility causes a lot of uncertainties for the borrower who is at liberty to determine when to purchase, whether to refinance or not, and the kind of product to engage in (Udohaya, 2025). It also leaves the lenders with insider knowledge on offers because of pipeline risk, margin loss, and difficulties in creating an appropriate product menu (Yu et al., 2021). High volatility may therefore make demand less elastic, supply less elastic, and have an impact on affordability despite not changing the average level of rates (Programme, 2023). The volatility and level of policy rates are important factors that make a complete picture of mortgage lending and housing affordability in the UK.

1.2 Problem Statement

The tightening cycle experienced recently has placed a number of May households in the UK in a position that exposes them to repayment shocks. When the fixed-rate agreements pass their expiry, borrowers frequently shift their extremely low rates to significantly higher rates (Slaymaker et al., 2022). This may increase monthly repayments by hundreds of pounds and put PTI ratios near or even above typical affordability levels (Arena et al., 2020). In other households, this is causing severe financial pressure and increasing the chances of unpaid debts or foreclosure (Orum, 2019).

New challenges are also being encountered by the lenders. Quick and erratic fluctuations in the Bank Rate enhance the risk of prices, hedging expenses, and balance-sheet ambiguity (Hassan & Rashid, 2018). The institutions would have to determine the pace of adjusting the rate of mortgages, the type of products to be provided, and control the risk of refinancing (Ibrahim et al., 2025).

Even though these pragmatic issues exist, the current empirical literature remains weak in various aspects. The volatility is not considered as an independent driver, and the majority of studies concentrate primarily on the average level of the policy rate. Even the evidence on regional affordability in the UK remains incomplete, particularly when there is an integration of income, prices, and mortgage expenses into a consistent framework. Lastly, new policy reactions like the 2023 Mortgage Charter have not been measured fully on mortgage lending and affordability. This study will fill these gaps with current UK data.

1.3 Aim and Objectives

1.3.1 Aim

The aim of this study is to explore the impacts and variations in the interest rates charged by the Bank of England on the patterns of mortgage lending, repayment, and housing affordability in the United Kingdom during 2016–2025. The research employs secondary data based on official sources and econometric procedures to correlate policy-rate dynamics with pricing, volumes of lending, affordability, and arrears.

1.3.2 Objectives

- i. To test historical trends of the Bank Rate, and determine their pass-through to new mortgage pricing and reversion rate.
- ii. To quantify the impact of interest-rate volatility on approvals of mortgages, mortgage product mix, and affordability of borrowers.
- iii. To determine the difference in the affordability of houses in the regions in relation to the changes in policing rate and its volatility.
- iv. To examine the effects that the change in rate and volatility has had on mortgage arrears and refinancing.
- v. To assess the impact of major policy and regulatory interventions, such as the 2023 Mortgage Charter, on whether it alleviates or increases the effects on borrowers.

1.4 Research Questions and Indicative Hypotheses

The dissertation will be steered by five research questions.

RQ1. What is the speed and extent of transmission of change in the Bank Rate to new mortgage rates and reversion rates?

RQ2. Whether increased policy-rate volatility causes a decrease in mortgage approvals and a change in the product mix, e.g., changes in demand to longer fixed-rate products or to products with lower loan-to-value (LTV) ratios?

RQ3. What are the implications of policy-rate level and volatility on important measures of affordability, including PTI, price to income ratios, and deposit to income ratios, as well as by region, which areas are getting worse?

RQ4. What are the responses of mortgage arrears, refinancing levels and volumes to the level and volatility of the policy rate?

RQ5. Was there any material change in the association between policy rates, lending outcomes, affordability, and arrears as a result of the Mortgage Charter of 2023?

Based on these questions, four indicative hypotheses are outlined.

H1: The Bank rate-new mortgage rate pass-through is asymmetric and stronger during tightening than relaxation periods.

H2: An increase in the volatility of interest rates discourages mortgage authorizations and repositions borrowers to longer fixed-rate offerings.

H3: The ratio of payment to income is growing at a faster rate in the lower-income regions, and, therefore, the worst areas will lose their affordability as rates increase.

H4: Mortgage Charter reduces the rate of increase in mortgage arrears, benefiting mortgage shock victims.

The hypotheses give a systematic connection between the theoretical mechanics, the research questions, and the empirical models in succeeding chapters.

1.5 Scope of the Study

The study will focus on a time period of January 2016 up to December 2025, assuming that the data will be available. The late low-rate regime, the COVID-19 period, the post-2021 tightening cycle, and the early impacts of Mortgage Charter fall under this window. The analysis has been done spatially in terms of the UK aggregate, and where data allows, space will have been based on NUTS1 areas to understand variation in affordability across regions. The data will be completely secondary and aggregate. Bank of England (Bank rate, quoted mortgage rates, product mix, and arrears) and FCA/MLAR (product mix and arrears) are core sources. UK Finance (arrears and possessions) and HM Land Registry, ONS (house price indices), HM income and ONS (inflation statistics), and DLUHC (housing supply indicators) are all core sources.

1.6 Significance and Contributions

The research contributes in a number of ways to both theory and practise.

Theoretically, it applies the volatility of interest rates to the study of monetary pass through and housing affordability. Most of the literature tends to measure the extent of the policy rate; in this dissertation both the level and volatility have been modelled, and the impact of these is followed throughout an entire empirical chain of rate to mortgage pricing, approvals, product mix, affordability, and arrears. It also integrates time-series and panel pieces of evidence that connects national dynamics and regional, inferring the affordability pattern where the data permit.

Practically and also on the policy level, the findings can inform more responsible decisions by central banks, regulators, and lenders. In the case of the Bank of

England, the results of the pass-through and volatility effects may be used in the communication strategies and evaluations of the transmission of policy changes into the balance sheets of households. In the case of Financial Conduct Authority and the macroprudential authorities, affordability stress evidence, refinancing behaviour evidence, and arrears evidence can be used to make decisions about stress-test scenarios, affordability, and rules and guidance on forbearance. To the lenders, the findings can be used to improve risk-management practices, product design, and pricing strategy in conditions of volatile rates. Lastly, the determination of whether the country and the regions can afford housing can aid the housing policy, particularly when it comes to decisions of whether or not to assist first time buyers and vulnerable borrowers in high-cost areas.

1.7 Structure of the Dissertation

The rest of the dissertation will be structured in the following way. In Chapter 2, it will review the literature on monetary transmission, volatility, mortgage markets, affordability, and arrears. Chapter 3 will provide the data sources, the variable construction, and the measurement of the volatility and affordability. Chapter 4 will establish the econometric research design, and they are, error-correction and ARDL models, panel fixed-effects regressions, and interrupted time series designs. Chapter 5 will show the empirical findings of pass-through, lending performance, affordability, arrears, and policy interventions. In Chapter 6, the findings will be discussed in terms of the research questions and literature, and policy implications will be drawn. Chapter 7 will end with a conclusion on what has been contributed to, the study limitations, and results based on research suggestions.

Chapter 2: Literature Review

2.1 Overview

The chapter is a review of the principal scholarly and policy literature that applies to interest-rate volatility, mortgage lending and housing affordability in the UK. It has four linked aims. First, it describes the way that the policy decisions of the Bank of England (BoE) travel through to household borrowing and to mortgage pricing. Two, it looks at the studies conducted on interest-rate volatility and the wider uncertainty and their influence on the credit supply and the behaviour of the borrowers. Third, it examines literature concerning the concept of housing affordability and its measurement, with UK and regional evidence taken into account. Fourth, it provides a summary of mortgage arrears, forbearance and policy responses, such as the macroprudential regulation and the 2023 Mortgage Charter.

Throughout these strands, the review identifies how little has been given to volatility as such (as opposed to the intensity of the policy rate) and how little has been done in terms of integrating empirical analysis that connects rate movements with pricing, approvals, product mix, affordability and arrears as one framework. A conceptual model that inspires the empirical approach and elucidates the value added by this research is presented at the end of the chapter.

2.2 Monetary Policy Transmission and UK Mortgage Markets

This study will begin with the monetary policy of the BoE. The Bank rates in the UK are dictated by the Monetary Policy Committee (MPC) with the aim of achieving aggregate economic objectives of delivering inflation at 2% in the medium run and other objectives in the long run. Bank rate impacts the economy in a number of

ways: market interest rates (e.g mortgage rates), asset prices, credit conditions, exchange rates and expectations. The new study of the transmission mechanism by the BoE highlights how variations in the Bank rate and anticipations of its future course influence the cost of household borrowing and housing wealth and consequently consumption, investment and inflation.

In the UK, it is the housing and mortgage channel that is of significant importance. Cloyne, Ferreira and Surico (2016) show that the response of spending by mortgagors to an altered mortgage payment is much greater than that of an outright owner or a renter, highlighting the importance of indebted households in the transmission. BoE research based on heterogeneous-agent models findings points to the possibility that the housing channel is contributing much of the overall effect of monetary policy to household consumption, and that mortgagors will be shouldering most of the adjustment to an increase in interest rates. Similarly, Cumming and Hubert (2019) demonstrate that the strength of monetary policy varies based on the percentage of restricted borrowers within the mortgage stock.

The nature of these transmission effects is determined by the pattern of the UK mortgage market. The majority of new UK mortgage lending is on a short-term fixed-rate contract, usually two or five years, and the borrower goes back to a higher reversion or Standard Variable Rate (SVR) in the absence of switching. SVRs tend to be 2-4 points higher than Bank Rate, and they vary as the policy rate changes. According to a study of switching rates in the mortgage market by FCA, the majority of borrowers can switch to a reversion rate, and a considerable number can save substantial sums, say £1,240 per annum, by re-mortgaging to a new direct deal with the same lender (Jack&Kremer, 2018). This reset mechanism implies that bank rate

passes on to household cash flows are lagging but strong when high ages of borrowing households refinance during a high interest rate period.

The prices of the UK mortgage products are compared to the Bank Rate and the longer-term funding costs, i.e. swap rates and gilt yields. Pass-through. Empirical studies of pass-through commonly conduct a cointegration and error-correction model to estimate dependable relationships between the policy rate and mortgage rates. Becker, Osborn, and Yildirim (2012) use a threshold cointegration model of UK mortgages and conclude that new lending and pass-through of the Bank Rate is incomplete and asymmetric with lags, and with stronger and quicker responses in certain regimes.

But this work is mainly devoted to the level of Bank Rate and to the average association between policy and mortgage rates. The fluctuation in the rate and uncertainty surrounding the future course of the rate are typically captured indirectly, as an expectation encoded within market yields. This creates a gap in studies that explicitly include realised or conditional volatility of policy rates in pass-through models and trace their influence using the mortgage market.

2.3 Interest-Rate Volatility, Uncertainty, and Lending Behaviour

The volatility of interest rates has two related meanings. Realised volatility measures the variability of the observed window changes in rates, say, within a month-to-month standard deviation in Bank Rate. Conditional volatility incorporates uncertainty, which varies over time on future rates, and this is usually through a GARCH-type process or can be based on financial market indicators (Honda et al.,

2022). The two concepts are proxies for the instability of the policy environment and may influence the behaviour of banks and households.

Investment decline, hiring and risk-taking are associated with but not restricted by a large macroeconomic literature that attributes uncertainty shocks. Bloom (2009) indicates that sharp fluctuations in uncertainty cause brief contractions in activity, which are very sharp since companies cease to spend until the period of uncertainty is over and then recover after the shock (Sebastiani, 2016). Research on macroeconomic and monetary policy uncertainty discovers that greater uncertainty decreases the amount of bank lending and raises risk premia in response to the broader dispersion of conceivable risks and larger downside risk.

Regarding banks, unstable policy rates are associated with interest-rate and pipeline risk. When the wholesale or retail funding cost changes at an extremely fast rate, the lenders could increase spreads or restrict access to credit to defend their margins. Theory indicates that with risk-sensitive capital and liquidity regulations, banks experiencing higher earnings volatility can ration credit to riskiest households, reduce fixation periods or increase pricing on large loan-to-value (LTV) loans (Hoffman et al., 2019). The empirical evidence on these margins is less strong but generally indicates that uncertainty corresponds to more restrictive credit policies and lower loan growth, particularly among borrowers that possess less collateral or income information.

The volatility of household impacts the quality and predictability of default-service costs. With a consistent environment of low rates, the risk of refinancing becomes remote, and a more short-term fixed environment may be recommended. In contrast, with fluctuating and volatile rates, the value of waiting might go up: prospective buyers may consider acquisitions later, and current borrowers may

extend the length of fixed-rate obligations to diversify the risk. The real options and housing finance literature indicate such intertemporal choice under uncertainty, and comparatively little quantifies these effects on the basis of UK mortgage data.

The majority of available empirical evidence on UK lending behaviour is in reactions to the degree of interest rates or to macroprudential measures, rather than to explicit volatility metrics. As an illustration, BoE research on borrowing constraints and finances utilises domestic forecasts to indicate that the effectiveness of transmission is contingent upon the proportion of highly indebted households as well as the behaviour of home prices (Cumming&Hubert, 2019). It does not forecast rate volatility. The issue of how the month-to-month changes in the Bank Rate affect approvals, product mix and risk distribution within the mortgage book remains open.

Accordingly, although theoretical channels of interaction between volatility and risk appetite and credit supply are clearly developed, the UK-specific evidence on the mortgage market scale is sparse. Specifically, scant empirical evidence has been conducted combining macro volatility measures, mortgage grants, product features (LTV, maturity of fixation), and borrower performances within one example. The present study contributes to filling this gap.

2.4 Housing Affordability Concepts and Metrics

Housing affordability is a multi-dimensional concept defining the correlation between the cost of housing and household resources. The most significant metrics of the UK policy debate and this study are the metrics that are Payment-to-Income (PTI), Price-to-Income, and the Deposit-to-Income (J. Muellbauer, 2018).

PTI (or debt-service ratio) is the household income spent on debt services (payment of mortgages). It may be stated at the point of formation, the monthly mortgage payment as an amount of gross or net income or the cross-section of current borrowers. It has been indicated in the international evidence that high PTI ratios have a better success in predicting financial stress and arrears as compared to loan balances alone, as they reflect the joint impact of interest rates, debt, and income (Miles&Monro, 2021).

Price-to-income ratios compare the prices of houses with the annual earnings or disposable income. The Office for National Statistics (ONS) issues national and sub-national per capita affordability ratios, which are the median house prices relative to median earnings at the workplace. The median price to earnings ratio in England was estimated at 8.6 in 2023, as compared to 4 in the late 1990s, and even higher in London and the South East (Team, 2024). Deposit-to-Income, in its turn, looks at the initial limitation: the deposit necessary is commonly 520% of the purchase price compared to the annual income. In high-priced areas, first-time purchasers often find it harder to commit to raising a deposit than to maintain a mortgage after the fact.

The long-run rise in price-to-income ratios of housing in the UK and the international literature records regional inequalities. Muellbauer et al. also contend that the UK experienced one of the most substantial increases in house prices relative to incomes among developed economies since the 1970s due to limited housing supply, credit liberalisation and policy failure. According to ONS and other statistical reports, it becomes most apparent in London and some south-eastern areas of England, where average housing is now unaffordable to many

middle-income families, whilst parts of the North and devolved authorities are comparatively cheaper (Team, 2025).

The distributional aspects of affordability are also noted in studies. The burden on lower-income and younger households is doubled: high price-to-income ratios and tougher deposit restrictions imply that they will be unable to enter homeownership; the proportion of income that private renters pay to housing costs is rising. A recent ONS review reveals that tenants in England are paying rents much higher than the standard 30% affordability measure of income-based, with rents in London being very high.

Regardless of this descriptive detail, the number of studies that incorporate affordability metrics in models of monetary transmission explicitly is smaller. Aggregate debt-service ratios or house price-to-income ratios can often serve as indicators of vulnerability in central bank and macroprudential research, but in very few empirical studies have they been linked to regional incomes, mortgage product structures and policy-induced payment shocks. The current study fills this gap by developing national and regional measures of PTI, price to income and deposit to income and correlating them with the path and volatility of Bank Rate. That makes it possible to get a more policy-relevant perspective in which monetary tightening can be converted into affordability stress both in income and spatial distribution.

2.5 Arrears, Forbearance, and Policy Interventions

The final indicators of financial distress in the housing market are mortgage arrears and possessions. There is a rich empirical body of work that researches their macroeconomic factors and policy in crisis mitigation.

A UK-based model-based work by Muellbauer cites three key determinants of arrears and repossession, namely the aggregate debt-service ratio, the share of mortgages in negative equity, and the unemployment rate. These time-series-based studies relying on scenario analysis indicate that stronger interest rates and low income growth increment arrears in terms of payment shock, and declining house prices contribute to more distress after raising negative equity and refinancing the situation (Ryan&Elena, 2024). These models have been applied to stress-testing as well as calculating the effect of the policy measures in determining the future arrears paths.

According to official statistics and parliamentary briefings, UK arrears and repossessions have decreased significantly since the global financial crisis, and appear to represent lower interest rates, greater lender forbearance and more targeted governmental action. Nevertheless, the tightening cycle that began in 2021 has seen the arrears reshardening their rise. According to the Bank of England data, the balance of mortgages in arrears grew to 1.23% in 2023-24, which is the highest figure since 2016, although much lower than 3.6% in the wake of the financial crisis. The UK Finance records a common trend where arrears rates have been on the rise, though they still lie below 1% when it comes to homeowner mortgages by 2025.

The regulation has aimed at creating resilience using the responsible lending standards and the macroprudential tools. In 2014, the FCA established the Mortgage Market Review (MMR) that introduced new, stricter affordability tests and interest-rate stress tests to guarantee that mortgagors were able to afford their mortgage in case the rates increased. FPC also included in its advice that lenders should stress-test the affordability at three percentage points above the reversion rate; this guidance was removed in 2022 after the FPC deemed it adequate because

of the strengths given by other instruments, including loan-to-income (LTI) limits and FCA regulations.

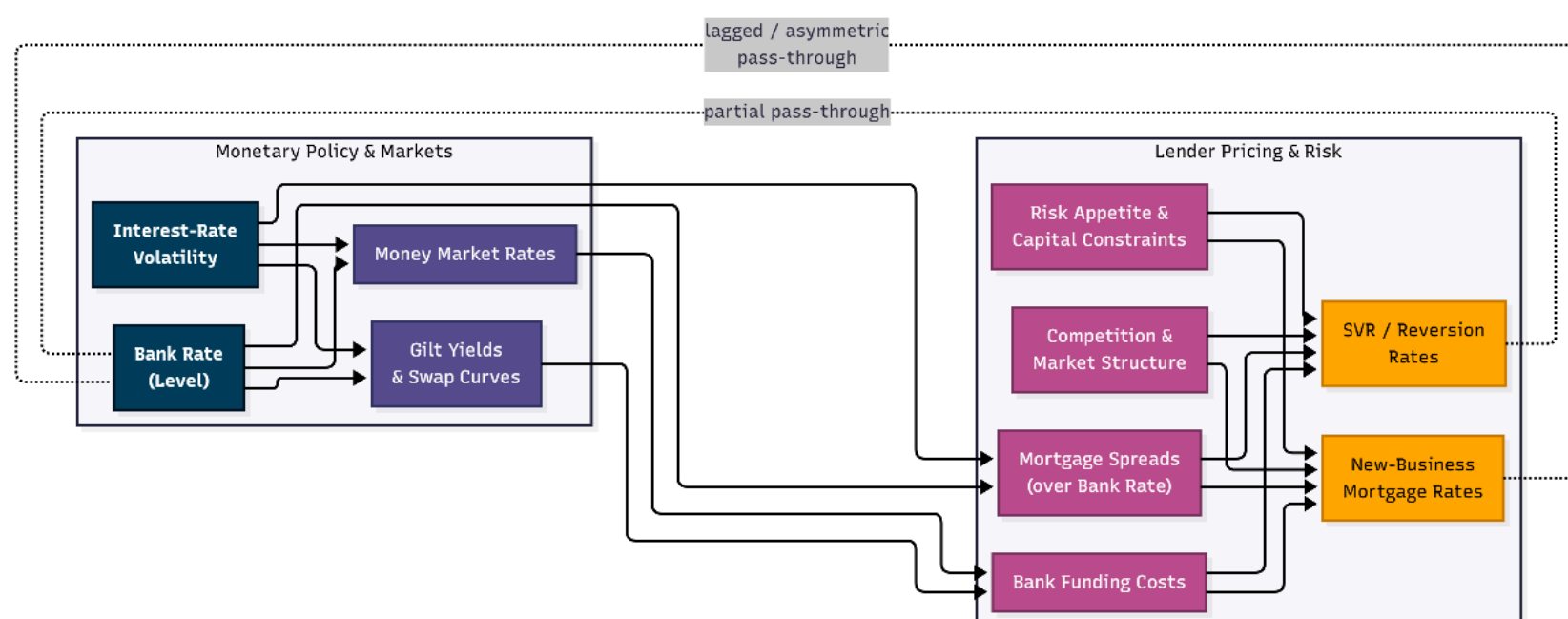
Government and regulators have responded to the rapid tightening and cost-of-living increases in the post-2021 period with the introduction of the Mortgage Charter in 2023. The Charter represents a voluntary commitment between key lenders, the government, the FCA and industry agencies to a set of borrower-support measures by the signatories, comprising approximately 85% of the mortgage market. These also offer a switch of six months to interest-only, extending the mortgage term or fixing a new deal that does not affect the credit scores of the borrowers. The FCA made amendments to its MCOB rules in Policy Statement PS23/8 so that lenders could more flexibly deliver these commitments.

Current reviews of these types of interventions are usually descriptive. Media and parliamentary comment states that forbearance and moratoria were useful in maintaining low repossessions in the Covid-19 period (Pradhan et al., 2020). Nevertheless, little empirical research involves the measurement of the Mortgage Charter on the arrears trends, refinancing or new approvals. Similarly, although quantitative research shows the effect of LTI limits on urban credit growth, as well as on the sharing of credit, it rarely relates those measures to the regional affordability or to how arrears and remortgaging interact in the high-volatility environment.

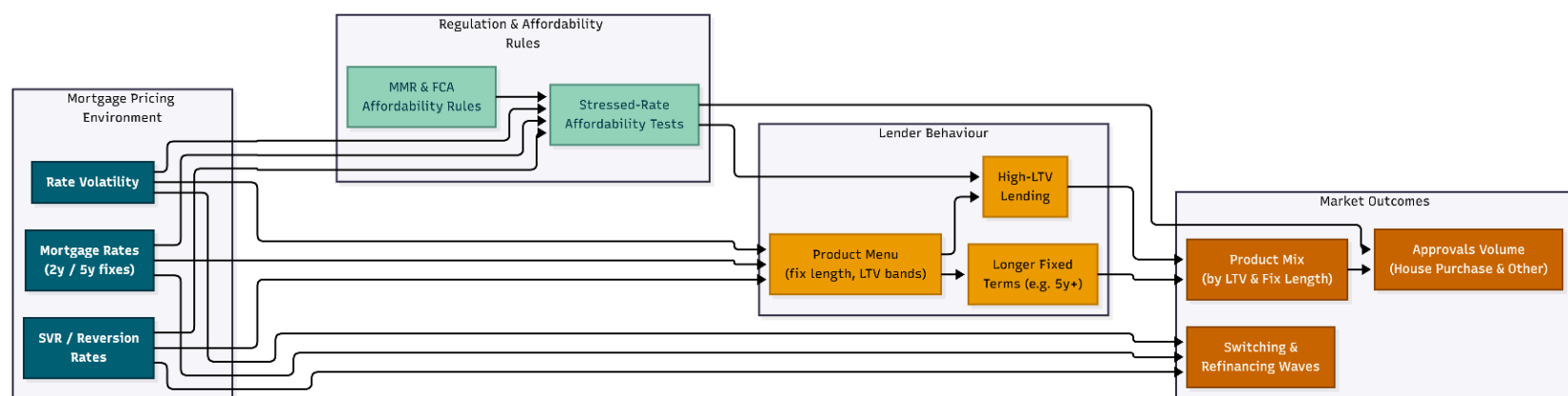
This study fills these gaps by modelling outcomes related to arrears as well as approvals and affordability, and applying interrupted time series and difference-in-differences models to such structural breaks as the introduction of the Mortgage Charter.

2.6 Conceptual Framework

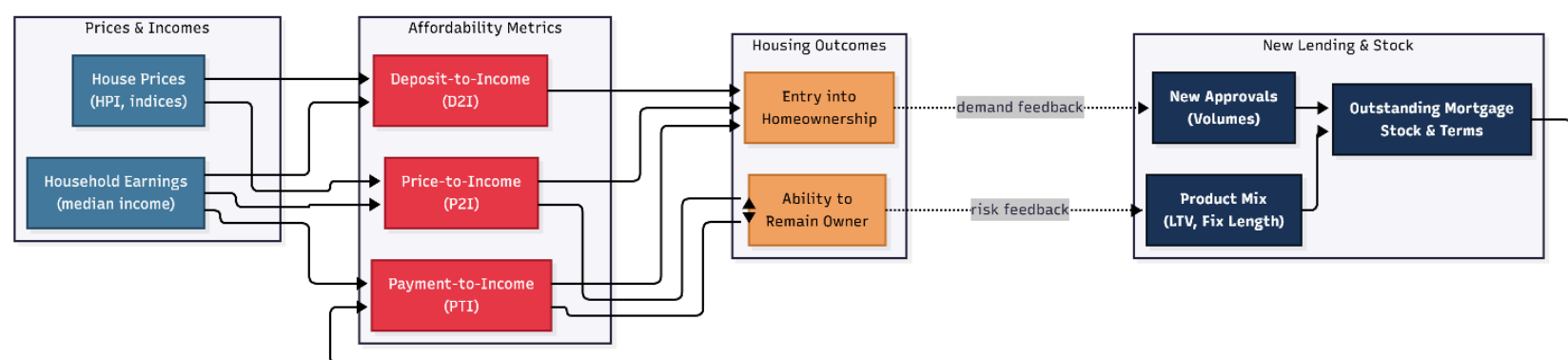
Based on the literature above, in this section, a conceptual framework is provided which connects Bank rate, interest-rate volatility, mortgage lending and borrower outcomes. The framework directs the empirical effort and is summed up in Figure 2.1.

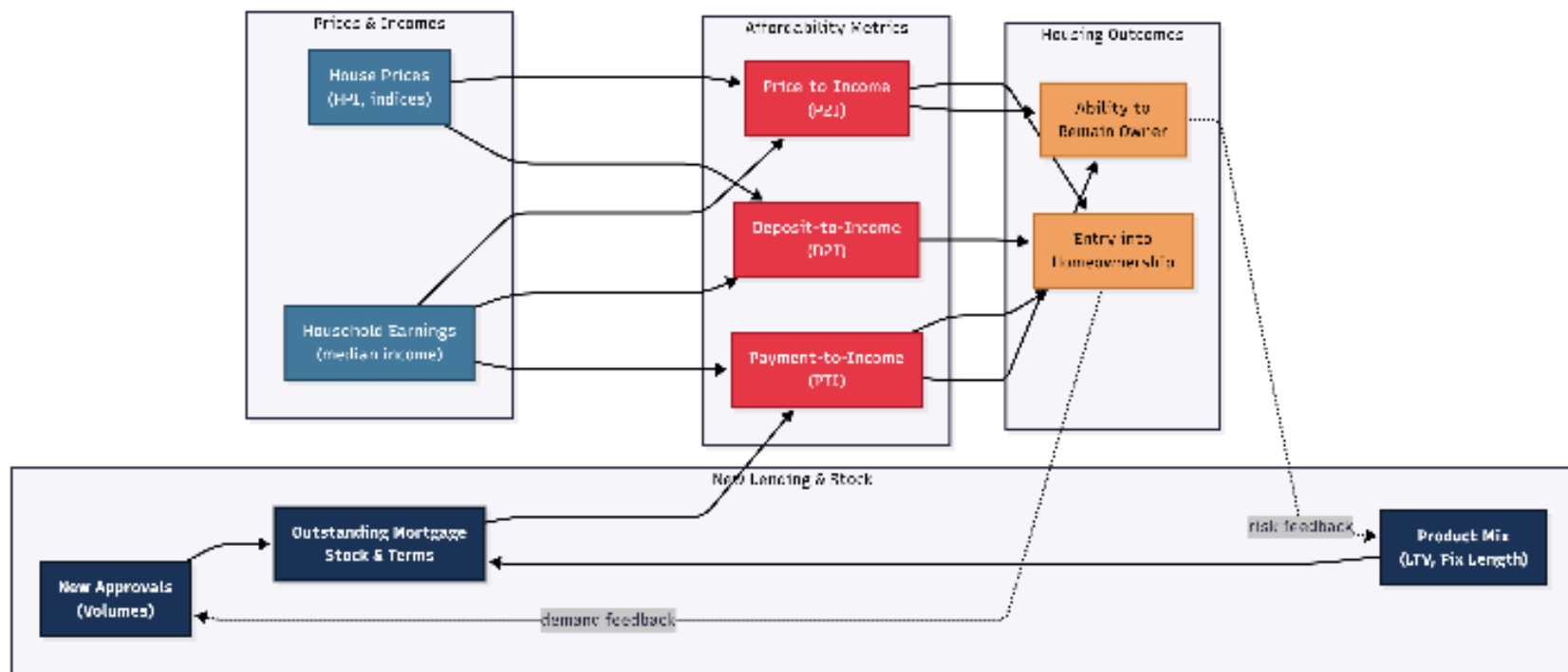


The first connection is between the Bank rate level and volatility, and the pricing of mortgages. Variations in Bank Rate, and the uncertainty of its direction, influence financing costs to banks through the money markets rates, gilt yields and swap curves. These costs lead the lenders to indicate new-business mortgage rates as well as SVRs, depending on competition and risk factors. Empirical pass-through analysis, such as that by Becker et al. (2012) and work by the BoE on the housing channel, demonstrates that mortgage rates change with lags, and probably asymmetrically, in response to changes in the policy rates. Spreads may become wider because lenders require compensation in terms of increased risk and losses, which can occur in the mark-to-market.

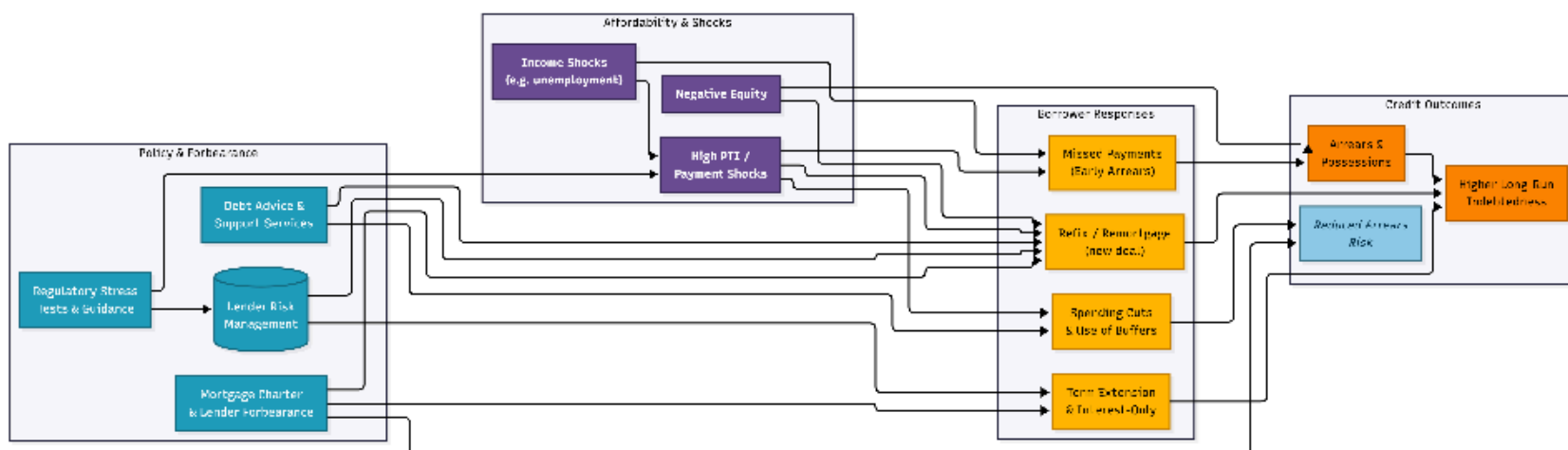


Second interconnection Pricing = approvals and product mix. An increase in mortgage rates increases the qualifying payment burden, and households are less likely to pass the affordability test. According to MMR and similar rules, lenders need to evaluate the capacity of borrowers to repay at stressed rate conditions, which are increasingly binding with an increase in rates. The lenders can also react to an unstable environment by modifying their product menus, such as advertising longer fixed terms or limiting the high-LTV lending. FCA evidence of existing switching reveals that a considerable proportion of borrowers are being subjected to temporary fixed deals, and they would be subjected to steps in being changed back to SVRs, creating space to cause refinancing waves that interact with monetary shocks. The volume of approvals and mix of products, therefore, rely on the rate level and rate volatility.





Third connexion: approvals and product mix have an impact on affordability. The prices, rates and incomes are mixed in the form of affordability metrics– PTI, price-to-income, deposit-to-income. Increase in new lending at increased rates raises PTI at a given income and house price; an increase in prices deteriorates the price to income ratio and deposit to income ratio. Sustained price-to-income ratios in most regions were documented by ONS data, and moderate increases have only been recorded recently as earnings increased more rapidly than prices in certain localities. The relationship between rates, prices and incomes thus defines the degree to which households can enter or stay in homeownership.



Fourth connexion: affordability = arrears and refinancing. Borrowers can also experience difficulties with payments in case of PTI rises sharply, either due to higher

rates or due to income shocks, increasing the arrears risk. The UK empirical models indicate that the debt-service ratio, negative equity and unemployment drive arrears and possessions. Simultaneously, other households would react to the increase in the rates by refinancing the lengthening of terms, or tapping equity to smooth consumption, potentially ameliorating cash-flow constraints in the short run, but potentially raising long-run indebtedness. This relationship is altered by policy interventions like the Mortgage Charter, which widens the forbearance and modification options, which may help to weaken the positive correlation between affordability stress and arrears.

All the connections are determined by macroeconomic and structural factors: real debt burden and inflation are affected by wage growth; income and default risk are affected by unemployment; housing supply is a constraint on price actions; macroprudential and conduct regulation limits risk-taking behaviour.

2.7 Literature Gap and Summary

The review identifies four key gaps that inform this study.

First, the majority of empirical research on UK mortgage markets is concerned with the degree of interest rates and average pass-through, but not with direct measures of policy-rate volatility and uncertainty. Although paradigm arguments and cross-country evidence indicate volatility to be important to credit supply and risk pricing, very limited studies in the UK have applied realised or conditional Bank rate volatility to models of mortgage pricing, approvals or arrears.

Second, the current literature tends to single out each and every area of the transmission chain, such as pass-through to mortgage rates, determinants of

arrears, and then not combine them into a single empirical model that would relate rate changes and volatility to mortgage pricing, approvals, product mix, affordability and arrears.

Third, deep descriptive statistics of the regional affordability, ONS and others as well, offer limited econometric data that combine PTI, price-to-income and deposit-to-income of UK regions and correlate them with the monetary policy conditions. This complicates the measurement of the differential impact of interest-rate shocks on the affordability in lower- and higher-income neighbourhoods.

Fourth, although the Mortgage Charter policy and the previous forbearance schemes emulate prominent policy heights, formal assessments of how both schemes impact arrears, refinance behaviour and approvals behaviour have not been realised through interrupted time-series or difference-in-differences designs. The majority of the evidence is qualitative or descriptive.

To address these gaps, this study builds a monthly data set from 2016 to 2025, incorporating Bank rate, volatility indices, mortgage rates, approvals and house prices, in addition to affording proxies, and estimates time-series and panel models using the conceptual framework.

Chapter 3: Methodology

This chapter shows the design of the study and the execution of the empirical analysis. It connects the research objectives with the particular econometric tools and characterises the major models, diagnostics, and reproducibility options. It is concentrated on the clarification of what is done and why.

3.1 Research Philosophy

The research methodology in this study adheres to the research onion by Saunders (Saunders et al., 2015), which illustrates the various steps that a researcher must pass through to come up with an effective research methodology (See Figure 3.1).

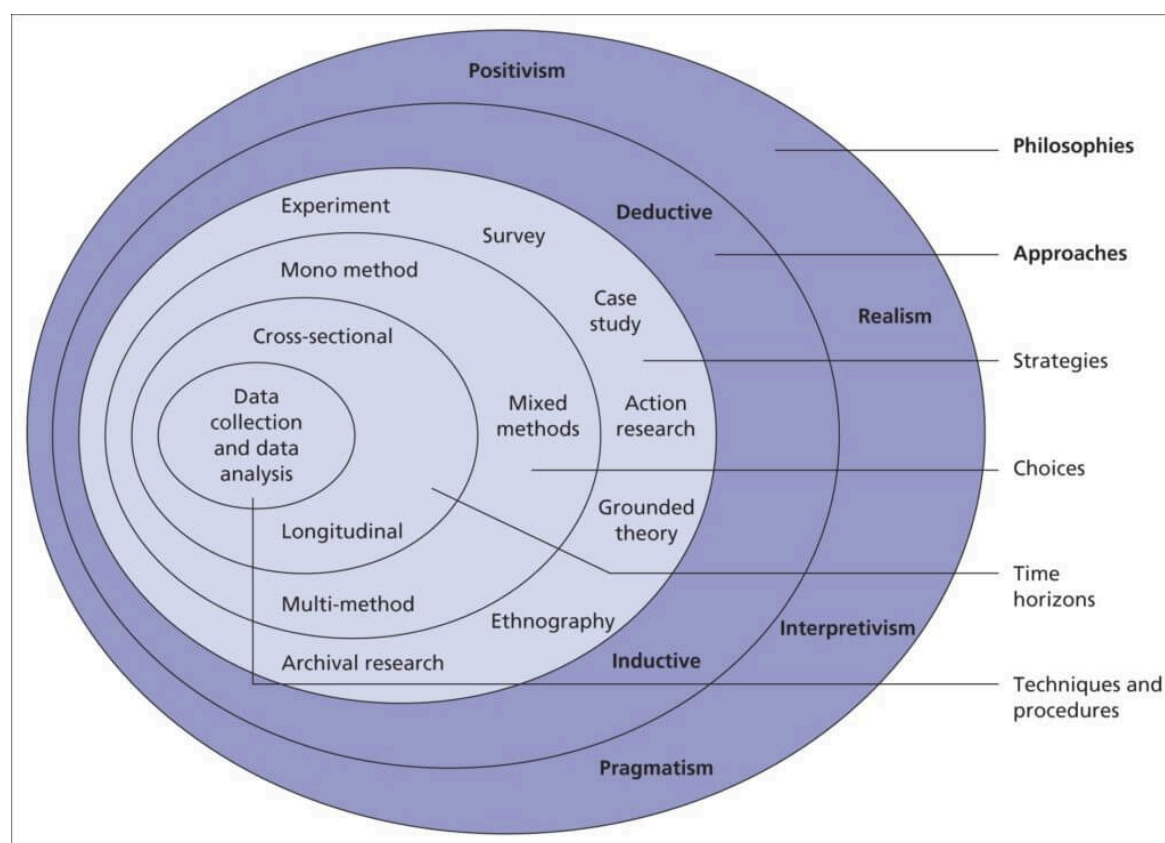


Figure 3. 1 Saunders Research onion (Saunders et al., 2015).

3.2 Research Approach

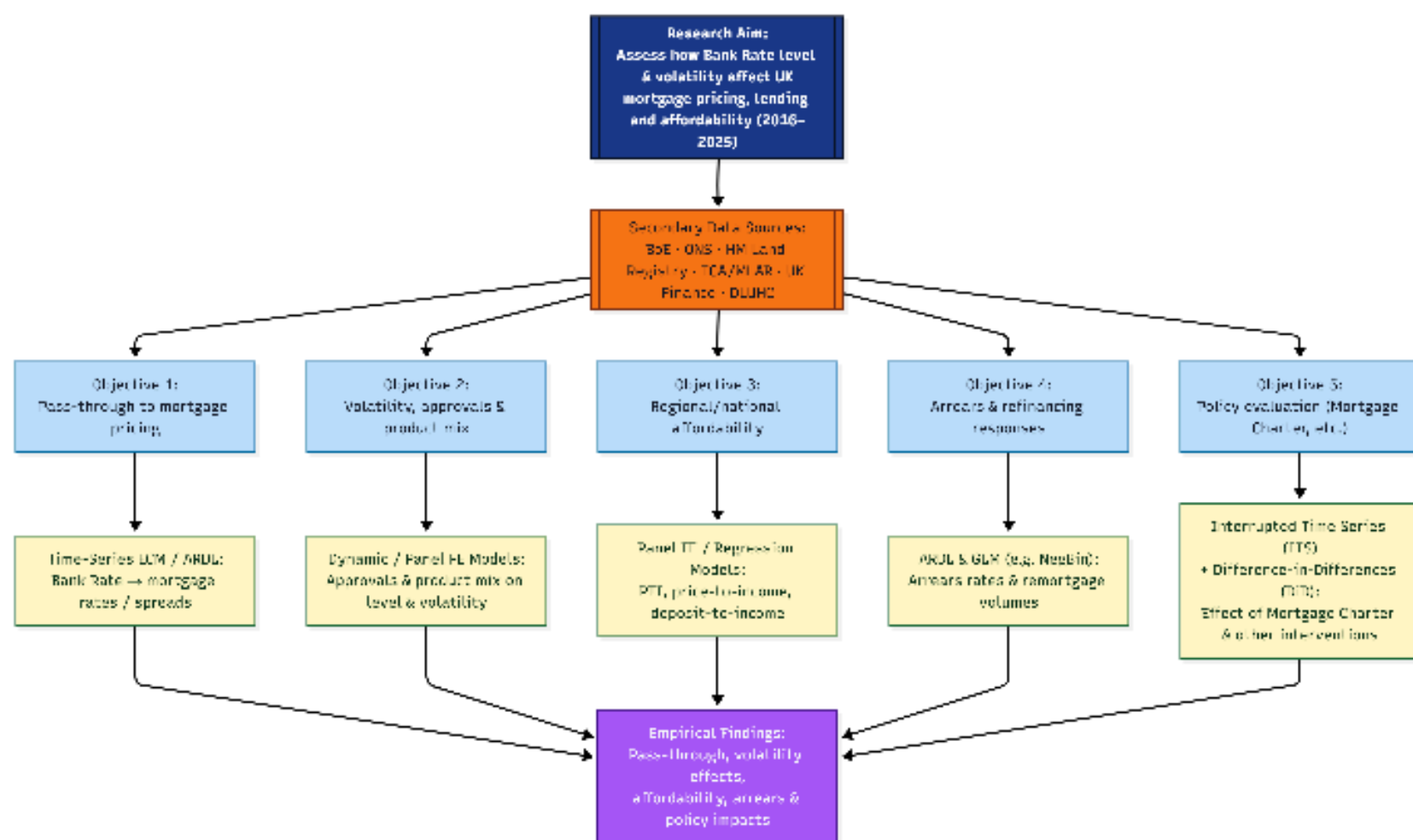


Figure 3. 2 Research Design Process (self-made).

The research design applied in this study is ex-post, quantitative and observational. It compares the impact of past fluctuations in policy rate and the volatility of the policy rate on the Bank of England on the pricing of mortgages, lending behaviour in the money market, and expenditure on housing. The construction is ex-post since everything has already happened.

The research is based on the secondary macro and meso-level data. The primary sources will be the official Bank of England, Office for National Statistics, and HM Land Registry, along with their related agencies' statistical series. These data will give monthly or quarterly rates on policy rates, mortgage rates, approvals, house prices, and incomes. They include the entire UK, and, where they exist, superior-level regional aggregates. There is no individual-level (micro) data being utilised (Warren, 2019).

In this case, it is not possible to use an experimental or field-experimental design (Duflo&Banerjee, 2017). It would neither be ethical nor viable to arbitrarily impose an interest rate condition on households or lenders. The monetary policy is based in a centralised way and influences the entire macro economy. Due to this reason, the most reasonable method is to employ the econometric model implemented on the historical time-series and panel data. These models enable the work to isolate the short-run and long-run effects, to manage the persistence and common shocks, and to determine the influence of the interest-rate level and volatility variations on other factors being constant. The design is thus observational; it employs already developed quantitative tools to provide systematic and clear responses to research questions.

3.3 Research Strategy

The empirical strategy adheres to the five research objectives and employs a sequence of interconnected models. Every goal is overlaid with one or several econometric methods. These mappings are conceptualised in Figure 3.1, where the analysis proceeds to the policy rates as the starting point, flowing to pricing, approvals, affordability, arrears, and policy evaluation as the destination points.

In Objective 1, pass-through between the Bank Rate and mortgage pricing, time-series Error-Correction Models (ECM), and Autoregressive Distributed Lag (ARDL) models are utilised in the study (Urbain, 2012). These models are able to model the long-run relationship between the policy rate and the mortgage rates as well as the short-run dynamics of adjustment.

In Objective 2, which analyses the impact of Bank rate level and volatility on approvals and product mix, a two-way fixed effects panel model across the region

and time is the framework of choice. The implementation necessarily employs, because of data limitations, national-level dynamic regressions which share the same logic as panel fixed-effects models.

In the case of Objective 3, which researches affordability gradients, panel fixed-effects is also preferable with affordability indicators like PTI, price-to-income, and deposit-to-income being the dependent variables (Stevenson, 1999). The affordability in the existing empirical work is measured at the national level, yet the specification of the model can be extended to the regional panels, as data will be available.

In Objective 4, addressing arrears and refinancing behaviour, the planned approach is a combination of ARDL to address arrears rates (percentages) and generalised linear models (GLM) to address the number of remortgages or possessions. Practically, other secured approvals are approximated as a proxy to refinancing because of the arrears data gaps.

The study applies Interrupted Time Series (ITS) models on Objective 5, which compares the Mortgage Charter and other interventions, with Difference-in-Differences (DiD) logic (where feasible) (McDowall et al., 2019). The ITS determines the variation in levels and slope of outcomes around the date of policy introduction.

This combined empirical approach enables the dissertation to pursue a consistent and transparent path of the chain of monetary policy to housing results.

3.4 Method Choice

3.4.1 Pass-Through to Mortgage Pricing (Objective 1)

The first question (objective 1) is, how does the Bank rate change transfer to new mortgage pricing? The primary variable of outcome is the 75% fixed-rate mortgages, two-year, ultimate quote denoted (m_t). Analogues of the analysis can also be done to spreads, e.g., ($s_t = m_t - r_t$), (r_t), the Bank rate.

The initial stage is a long run relationship as:

$$m_t = \alpha_0 + \alpha_1 r_t + u_t$$

Where (u_t) is an equilibrium error, and (0,1) is long-run pass-through. The value of ($\alpha_1 = 1$) would be full pass through. A value of 0 to 1 is a partial pass-through.

This study relies on an Error-Correction Model (ECM) in order to model short-run dynamics (Vialar, 2016). The overall ECM shape may be in the form of:

$$\Delta m_t = \beta_0 + \sum_{i=0}^p \beta_i \Delta r_{t-i} + \sum_{j=1}^q \gamma_j \Delta m_{t-j} + \lambda(m_{t-1} - \alpha_0 - \alpha_1 r_{t-1}) + \varepsilon_t$$

Here, Δ denotes the first difference:

$$\Delta m_t = m_t - m_{t-1}$$

$$\Delta r_t = r_t - r_{t-1}$$

The short-run impact of policy-rate changes on mortgage rates is summarised by the coefficients β_i and the persistence in the changes in mortgage rates is summed up by the γ_i . The error-correction term of the long-run relationship is the bracketed term ($m_{t-1} - \alpha_0 - \alpha_1 r_{t-1}$). The coefficient λ is an indication of how fast it takes to

correct the situation at equilibrium in the long run following some shock. A negative and significant λ indicates that the long-run equilibrium is adjusted in the long term.

After verifying cointegration between the m_t and the r_t ordinary least squares (OLS) is used to estimate the ECM. The information criteria and visual analysis of residual are used to choose the lag lengths p and q . The interpretation is concerned with three:

- a) The short-run elasticity (β_0) that indicates the responsiveness of the mortgage-rate change within a month of a policy-rate alteration.
- b) The pass-through (α_1) in the case of the static model.
- c) The rate of adjustment (λ) which reveals how fast the system will get back to an equilibrium state.

The study also estimates an ECM that will enable the entry of positive and negative changes in policy rates separately in order to accommodate the possibility of asymmetry. This imbalanced ECM can be available as:

$$\Delta m_t = \beta_0 + \beta^+ \Delta r_t^+ + \beta^- \Delta r_t^- + \sum_{j=1}^q \gamma_j \Delta m_{t-j} + \lambda (m_{t-1} - \alpha_0 - \alpha_1 r_{t-1}) + \varepsilon_t$$

Where,

$$\Delta r_t^+ = \max(\Delta r_t, 0)$$

$$\Delta r_t^- = \min(\Delta r_t, 0)$$

A greater β_+ than β_- would imply stronger pass-through during periods of increasing rates as opposed to decreasing rates.

The ECM framework is also desired over a simple differenced regression since it does not lose long-run information when there is non-stationarity in the levels. It also provides a clear definition of speed (how quickly gaps are decreasing, in months) and completeness (the coefficient of pass-through in the long run) of pass-through.

3.4.2 Volatility, Approvals and Product Mix (Objective 2)

The second objective is to study the relationship between the level and volatility of the Bank Rate on the outcomes of mortgage lending, namely, mortgage approvals and, using more detailed data, the product mix. A two-way cross-region time-fixed effects panel model is preferred.

Where y_{it} is a lending performance in region i and month t . Based on the application, y_{it} may be:

- the registry of mortgage approvals on houses,
- the proportion of stringent loan-to-value (LTV) lending (Bian, 2018), or
- the proportion of long fixed-rate mortgage products.

Where r_t refers to the Bank-Rate, and v_t refers to the interest-rate volatility (i.e. the rolling standard deviation of monthly changes in the Bank-Rate).

A two way general fixed-effects specification is:

$$y_{it} = \beta_0 + \beta_1 r_t + \beta_2 v_t + \beta_3' X_{it} + \alpha_i + \delta_t + u_{it}$$

Where,

- X_{it} is a time-varying regional control (e.g. unemployment, growth of income, growth of house-prices) which is a vector.
- α_i are region fixed effects,
- δ_t are time fixed effects, and
- u_{it} is the error term.

The fixed effects of regions (α_i) represent time-unchanging factors that vary across the regions, including long-run income levels, housing supply, and structural preferences for renting or owning. Time fixed effects (δ_t) represent national shocks and national changes that occur to all regions at the same time, which include macroeconomic policy effects and regulatory changes.

The key parameters are β_1 and β_2 ,

- The way that relation of the level of the policy rate and approvals or product shares varies with region and time effects remaining constant is measured by β_1 .
- β_2 is a measure of volatility above the rate level.

A β_2 of negative in an approvals regression would suggest that a larger rate volatility decreases lending, which is in line with the effects of uncertainty. A positive β_2 in a product-mix regression (e.g., the proportions of long fixes) would indicate that volatility redistorts borrowers and lenders to more stable mortgage products.

The work is based on a fixed-effect (FE) as opposed to pooled OLS since it is unlikely that regional features that are not being observed are correlated with interest-rate

sensitivity (Hu&Tang, 2021). FE eliminates this bias by using changes in the region within time. Random effects would not be appropriate since the orthogonality assumptions would hardly be satisfied.

Practically, the existing set of data is largely national (not regional), thus the empirical implementation is a simplified time series implementation of the framework, being dependent on time variations only. Thereupon the model can be estimated dynamically (that is, with lagged dependent variables). Introducing the FE structure, however, helps understand the way in which the framework can be expanded as soon as more comprehensive regional data is obtained.

The study would apply the cluster-robust or Driscoll Kraay standard errors to account for the problem of serial correlation and cross-sectional dependence in the entire panel scenario. To implement the current aggregate, heteroskedasticity-robust standard errors are used.

3.4.3 Regional Affordability (Objective 3)

Objective 3 focuses on the influence of interest-rate level and volatility on space housing affordability. A panel-fixed-effects type of set-up is also desired, and the measures of affordability are the dependent variables.

Where (A_{it}) is a measure of affordability of region (i) at time (t). This may be PTI (payment-to-income), price-to-income or deposit-to-income. The core panel model is:

In which (Y_{it}) is income, (U_{it}) is unemployment rate, and (HPI_{it}) . As in the foregoing case, (α_i) and (δ_t) are region and time bilaterally ordered effects.

The model may contain the interaction between volatility and the relative income position of each region in order to capture distributional effects. Establish income quartile according to the manner in which median incomes are distributed in regions. Let $Q_i^{(low)}$ Be a dummy that takes the value 1 in the areas in the first percentile. To this, an interaction term (v_t times $Q_i^{(low)}$) is added:

$$Q_i^{(low)} = 1\{\text{region } i \text{ is in the lowest income quartile}\}$$

In this case, γ_2 reveals the impact of volatility on affordability in higher-income areas, and γ_6 Reveals the further impact in lower-income areas. A significant (positively) value of γ_6 would reveal that volatility would contribute more to affordability deterioration in low-income areas.

In the existing empirical literature, the aspect of affordability is applied nationally, as there is a lack of data. This structure of regression is the one without the regional index (i). Here, the coefficients γ_1 and γ_2 They are understood to be of average national impact. The panel formulation is provided to demonstrate how the analysis may be generalised when regional series of measures of PTI and other related variables are complete.

Coefficients are easily interpreted. So, γ_1 Would be the change in the ratio of PTI as the Bank rate goes up by one percentage point, with other parameters being the

same, γ_2 Would be the change in PTI with a one unit increase in volatility (ie, 0.1) and other factors held constant. Marginal effects of low-income regions are calculated as $\gamma_2 + \gamma_6$.

3.4.4 Arrears and Refinancing (Objective 4)

Objective 4 will be concerned with the responsiveness of the arrears and refinancing to changes in the policy rate and volatility. Preferably, arrears are calculated in the ratio of mortgage balances in arrears, and refinancing in the number of arrears, with mortgages being remortgaged or the mortgages being completed.

In the case of arrears rates at the national level, the ARDL model is appropriate (Hacioglu, 2019). Let (a_t) refer to the arrears rate. An average ARDL(p,q) equation is:

$$a_t = \delta_0 + \sum_{j=1}^p \delta_j a_{t-j} + \sum_{k=0}^q \theta_k r_{t-k} + \sum_{k=0}^q \phi_k v_{t-k} + \sum_{k=0}^q \psi_k Z_{t-k} + \eta_t$$

where (Z_t) is a control parameter (unemployment, growth of house prices). The lag structure enables the arrears to adapt to the fluctuations in rates and volatility slowly. In appropriate circumstances, the ARDL can be reorganised in the ECM emphasise, where there is an explicit relationship between arrears and the regressors in the long run.

GLM of counts, like the count of remortgages, is more suitable for refinancing counts. Remortgage volumes shall be denoted by (R_t). A Negative Binomial model may be defined as:

$$E[R_t] = \exp(\kappa_0 + \kappa_1 r_t + \kappa_2 v_t + \kappa_3 W_t)$$

where (Wt) represents controls and time dummies. The exponential relationship will guarantee positive mean expected counts and the ability to interpret semi-elastically (i.e. κ_2 will provide the percentage change in the expected number of remortgages means of a one unit increase in volatility).

Direct arrears data are not yet entered into the main data in this dissertation, and the other secured approvals are instead taken as an approximation of refinancing and a corresponding manner of behaviour. The model implemented is thus dynamically linear regression of log other approvals in resemblance to an approvals model as used in Objective 2. The conceptual framework is on the ARDL and GLM formulations that can be utilised in future extensions when complete arrears and remortgage series are recorded.

Local projections can also be added to the methodology in order to determine the dynamic reaction of arrears or remortgages to rate and volatility shocks across multiple horizons. This would be a regression of the future values of result at the prevailing shocks and controls on the horizon.

3.4.5 Policy Evaluation: Mortgage Charter and Other Interventions (Objective 5)

In objective 5, it is assessed how the Mortgage Charter and the policy interventions on the mortgage market perform (Brunner&Meltzer, 1976). The primary instrument is a type of design Interrupted Time Series (ITS).

Under the ITS framework, time, an intervention dummy, and an interaction term are regressed against the outcome (as in the case of the logarithm of house-purchase

approvals). Where (y_t) is the result, (t) is a time index, and (D_t) can be equal to 1 after the date of the Charter start (say, August 2023) and zero before. The model is:

$$y_t = \rho_0 + \rho_1 t + \rho_2 D_t + \rho_3 (t \times D_t) + \rho_4 r_t + \rho_5 v_t + \epsilon_t$$

In this case, the pre-intervention trend is represented by ρ_1 , the level change at the intervention by the intervention is represented by the change in the level ρ_2 , and the importance of the slope (trend) after the intervention is represented by the change in the slope ρ_3 . The coefficients of the effect of policy rate level and volatility are suppressed by the coefficients of ρ_4 , and ρ_5 . With the help of OLS and strong standard errors, the ITS is estimated. The essential question is whether the level and slope coefficients show the improvement or worsening of the outcomes following the Charter compared to the previous trend, considering the rate and volatility effects.

A Difference-in-Differences (DiD) method can be added to the ITS in case the data allow it. As an illustration, one of the treatments could be the borrowers or products most directly affected by the Charter (e.g., high-LTV refinancers), and another could be lower-risk borrowers. The DiD model would be used to compare the pre-intervention and post-intervention changes in outcomes between the Charter group and the Control group in an analysis. The key concern in this dissertation is, however, on the ITS design as the main dataset is not micro, but rather aggregate.

3.4.6 Model Diagnostics and Robustness Checks

The study uses the standard diagnostics and robustness cheques to achieve reliable inference.

In the case of time-series models (ECM, ARDL, ITS), the initial step is to analyse the time-series characteristics of the individual variables. The tests that are employed to test the stationarity are the augmented Dickey Fuller (ADF) and KPSS tests. In non-stationary cases, cointegration of levels relationships is tested in a Johansen or bounds test. An ECM is only estimated in case there is a cointegrating relationship. The residuals are verified to be serially correlated (such as the Breusch-Godfrey test) and heteroskedastic.

In the case of panel-type formulation, where its formulation is applied in national form, the study will take into account the possibility of serial correlation and non-homoskedasticity of the residuals. Wooldridge tests of serial correlation and tests of heteroskedasticity across panels would be undertaken in a genuine panel. The assessment of multicollinearity is conducted based on the Variance Inflation Factors (VIFs) of the leading regressors.

Robustness checks include:

- a) Replacing three-month realised volatility on the volatility windows by alternative volatilities, e.g., one-month and six-month.
- b) The inclusion of a main COVID-19 shock period months or a dummy, to verify whether the findings are influenced by this unique event.
- c) Another way of experimenting with the definition of affordability is to work with alternative house price indices (e.g., UK HPI vs. Halifax or Nationwide) or different assumptions about the loan-to-value or mortgage term of the PTI calculations (Mattei, 2025).
- d) Multiplying the models by including more macro controls, so as to determine whether policy variables coefficients are stable.

These diagnostic and robustness cheques are useful in demonstrating that the key results have not been produced by specific modelling decisions or by flaws in the data.

3.4.7 Software and Reproducibility

Empirical work is performed with all of R. Data cleaning, transformation, and plotting are performed primarily using tidyverse packages dplyr, tidyr, ggplot2, and lubridate. Both time-series models, such as ECM and ARDL-type regressions, are estimated with the help of dynlm and base standard functions. Computations of volatile measures may be calculated with rolling-window functions and in long-term labour with the rugarch package. Packages to implement dynamic regressions, fixed-effects regressions include fixest, plm, and lmtest, along with sandwich to estimate robust variance.

The project should be managed with the Renv package to help aid reproducibility, as it logs the precise versions of all R packages utilised. The path through which raw data are imported, cleaned, and transformed, model estimation, and creating figures and tables can be explained in a target pipeline. This makes it so that one can generate all the results with just one command, and that modifications in either code or data can be monitored. Table and figure outputs are stored in folders of each chapter, into which they can be simply pasted into the dissertation content.

3.5 Ethical Considerations

The dissertation works with secondary, aggregate data, published by official institutions in the UK and involves no human subjects or personal-level data. Manipulation of interest-rate conditions cannot and should not be done

experimentally; thus, the analysis is based on observational econometric designs of historical series. All data are managed in an open and transparent way, and the source is referenced and coded to replicate.

Chapter 4: Results and Analysis

The empirical findings of this chapter are the UK monthly data of 2016–2025. The analysis is conducted according to the sequence of the research objectives. Each of the subsections connects the research questions on pass-through, lending activity, affordability and policy interventions to the econometric estimates.

4.1 Descriptive Statistics and Timeline

variable	n	mean	sd	min	max
approvals_house_purchase_sa	117	64938.19	13195.97	9375	107814
approvals_other_sa	117	12351.6	2665.196	5696	17988
bank_rate	119	1.780252	1.986717	0.1	5.25
bank_rate_change	118	0.029661	0.162544	-0.65	0.75

bank_rate_vol_3m	116	0.082374	0.110154	0	0.381881
deposit_to_income	28	0.846865	0.029541	0.805801	0.889844
mort_2y_75ltv	24	4.65	0.344964	4.13	5.28
mort_spread_2y75	24	-0.13125	0.22994	-0.6	0.22
price_to_income	28	8.468652	0.295413	8.058006	8.898445
pti_2y75	18	0.427494	0.01747	0.400523	0.473571
uk_avg_price	112	229761.9	25585.79	189268	272862
uk_hpi_index	112	88.05446	9.807773	72.5	104.6

Table 4. 1 Descriptive Statistics of Key Variables.

Table 4.1 documents the main variable summary statistics. Mean house-purchase approvals throughout the sample are approximately 64,939 loans per month and the standard deviation amounted to 13,196. The lowest approximation of not quite 9,400 approvals is achieved during the COVID period whereas the highest level of over 107,800 approvals is achieved during a robust expansion period. Other secured lending approvals are approximately 12,400 per month, range being 5,700–18,000, which reveals that refinancing and other secured credit is subject to heavy cyclical changes.

The standard deviation of the Bank Rate is large, 2.0% points, as the near-zero rates of the period around 2020 have given way to the severe hardening of 2021.

The policy rate will drop to the minimum of 0.1% in 2020/2021, and it will increase to the peak of 5.25% towards the end of 2023. The Bank Rate of realised three-month volatility averages 0.08 with the maximum value of at least 0.38 with most of the volatility being much more stable, but has occasional periods of willingness to change rapidly.

The average price of houses throughout the country is approximately one hundred and thirty, and greater than thirty as the standard deviation, and one hundred and eighty-nine as the minimum to two hundred and seventy-three as the maximum. The UK HPI index has an average slightly above 88 with great dispersion across the sample. The price to income ratio stands at 8.47, with a 8.06 to 8.90 whereas the deposit to income ratio (supposing a 10% deposit) is 0.85, 0.81 to 0.89. During the months that have both data on income and mortgage rate, the payment-to-income (PTI) factor on a typical 2-years, 75% LTV mortgage is 0.43 with a relatively low standard deviation of 0.40-0.47.

	bank_rate	bank_rate_vol_3m	mort_2y_75ltv	mort_spread_2y75	approvals_house_purchase_sa	approvals_other_sa	uk_avg_price	price_to_income	deposit_to_income	pti_2y75
bank_rate	1	0.347788648	0.883205109	-0.710605312	-0.387986903	-0.70749	0.773155454	-0.242979078	-0.242979078	0.549018189
bank_rate_vol_3m	0.347788648	1	-0.818099958	0.385695291	-0.579641987	-0.49821	0.456947255	0.625764089	0.625764089	-0.502976665
mort_2y_75ltv	0.883205109	-0.818099958	1	-0.297635331	-0.619528292	-0.85009	-0.643647965	0.201081303	0.201081303	0.792123022
mort_spread_2y75	-0.710605312	0.385695291	-0.297635331	1	0.112916076	0.569682	0.394199072	0.101302502	0.101302502	0.235400068
approvals_house_purchase_sa	-0.387986903	-0.579641987	-0.619528292	0.112916076	1	0.647863	-0.209078869	-0.788381978	-0.788381978	-0.63154637
approvals_other_sa	-0.70748605	-0.498214709	-0.850090941	0.569682269	0.647862933	1	-0.52693	-0.784619732	-0.784619732	-0.801810016
uk_avg_price	0.773155454	0.456947255	-0.643647965	0.394199072	-0.209078869	-0.52693	1	-0.154615161	-0.154615161	-0.359166477
price_to_income	-0.242979078	0.625764089	0.201081303	0.101302502	-0.788381978	-0.78462	-0.154615161	1	1	0.756911625

deposit_to_income	-0.242979078	0.625764089	0.201081303	0.101302502	-0.788381978	-0.78462	-0.154615161	1	1	0.756911625
pti_2y75	0.549018189	-0.502976665	0.792123022	0.235400068	-0.63154637	-0.80181	-0.359166477	0.756911625	0.756911625	1

Table 4. 2 Correlation Matrix of Main Variables.

Table 4.2, the correlation among these series, indicates that these series are strongly correlated. Bank Rate and the quoted 2-year 75% LTV mortgage rate go together ($\rho \approx 0.88$), meaning they move together in the period of data collection of mortgage-rates.

The policy rate has a negative correlation with approvals: approvals of houses-purchases are related to approximations of -0.39 , whereas those of other secured are related to -0.71 . House-purchase approvals also have a negative correlation with the mortgage rate ($\rho \approx 0.62$).

Affordability indicators have a close connexion: price-to-income and PTI have a correlation of approximately 0.76 and neither is strongly correlated with approvals.

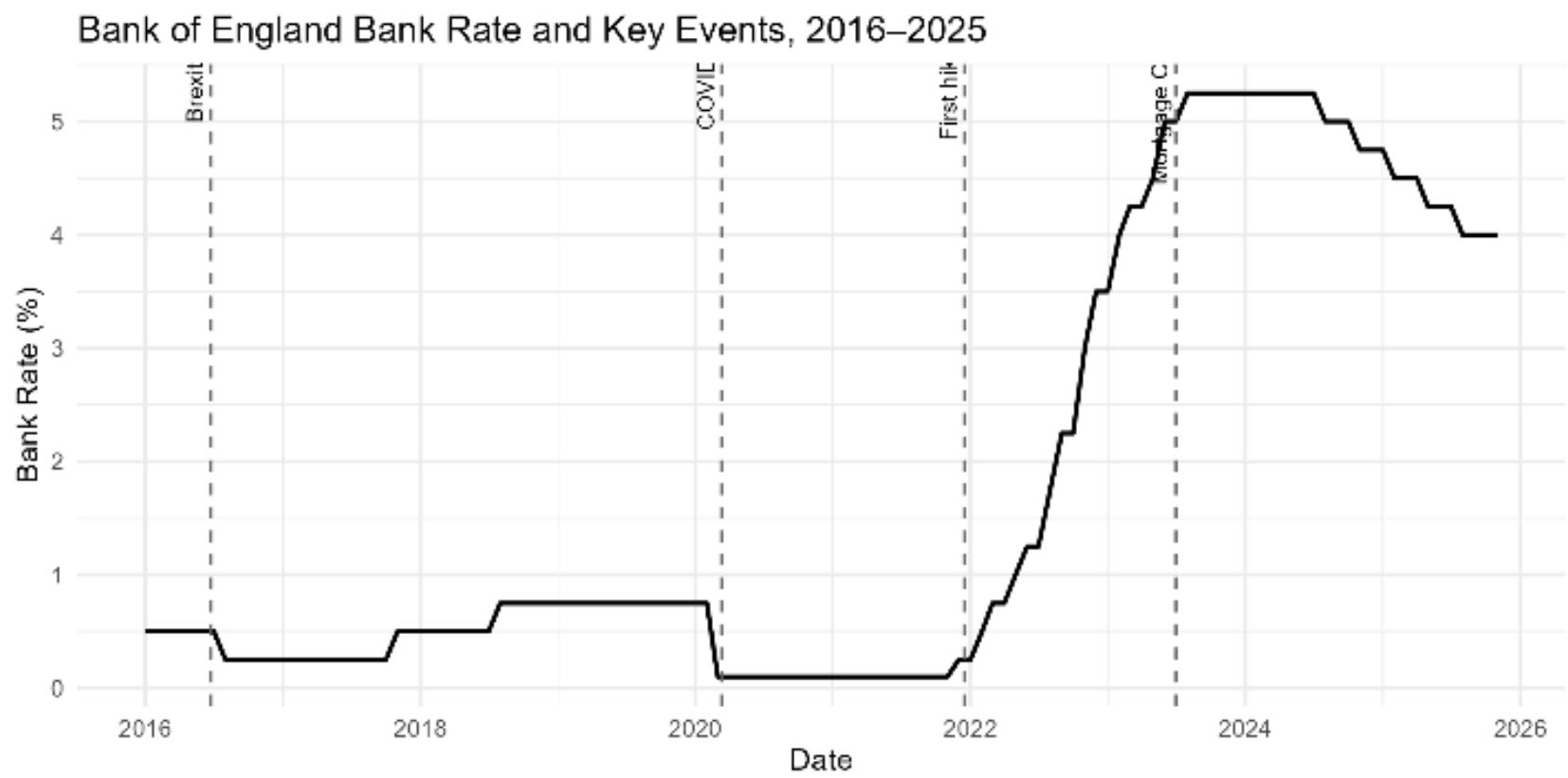


Figure 4. 1 Timeline of Bank Rate and Key Policy Events.

The Bank Rate plot in figure 4.1 includes prominent events indicated in the plot. Its rate is currently maintained at 0.5% up until the beginning of 2016, then reduced to 0.25% after the Brexit referendum. It remains at or below 0.75% until the start of the COVID-19 pandemic, when this figure is drastically lowered to 0.1% in March 2020.

Late 2021 through mid-2022 the Bank of England starts a speedy process of cyclic tightening, increasing the Bank Rate to 1% by mid-2022, 3.5% by the end of 2022 and 5.25% by end of 2023. This rate plateau corresponds to the Mortgage Charter in the middle of 2023. The Bank Rate falls slightly in 2024/2025 and will shift towards 4% at the end of the sample.

Against this background approvals demonstrate a definite cycle: they are rather high in the pre-COVID years, significantly decline during 2020/2021 together with the enormous rate cuts and lockdowns, partially recover in early reopening, and again deteriorate as rates rise at an alarming pace in 2022/2023.

Affordability ratios change toward the contrary, as price-to-income and deposit-to-income are high but stable, whereas PTI is at its maximum in the high-rate phase of end 2023, during which it declines marginally as the rates resume their downward path.

4.2 Pass-Through to Pricing

The first objective is to consider the speed and extent to which the Bank Rate movements are transferred to fresh mortgage pricing. The pass-through analysis will be conducted on a 2-year 75% LTV fixed-rate series, between 2023–2025, due to the unavailability of details on its quoted-rate data before late 2023 onwards.

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	-0.01709	0.032366	-0.52788	0.604402	-0.08537	0.051202
mort_diff_l1	0.59631	0.178522	3.340254	0.003878	0.219661	0.97296
rate_diff	0.223747	0.24701	0.905823	0.37769	-0.2974	0.744892
rate_diff_l1	-0.16874	0.240543	-0.70151	0.492477	-0.67625	0.338759
ect_lag	-0.70553	0.181061	-3.89665	0.00116	-1.08754	-0.32353

Table 4. 3 ECM/ARDL Pass-Through Estimates.

An estimated long-run pass-through coefficient is of 0.65, which is obtained by a static long-run regression of the mortgage rate on the Bank Rate. It implies that in the equilibrium a 1% point shift in policy rate correlates with approximately a 0.65% point shift in the 2-year 75% LTV rate.

There is an intervening zero of approximately 1.5% points that indicates that, even when the Bank Rate is zero, prices suffer a positive pricing margin that indicates funding spreads, credit risk and operating costs.

The value of R-squared is approximately 0.78, which means that most of the changes in this short mortgage rate are explained by the policy rate within the considered sample.

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	-0.00538	0.027343	-0.19691	0.846105	-0.06283	0.052061
mort_diff_l1	0.57614	0.173688	3.317092	0.003834	0.211234	0.941046
rate_diff_pos	NA	NA	NA	NA	NA	NA
rate_diff_neg	0.275746	0.232278	1.187142	0.250603	-0.21225	0.763743
ect_lag	-0.69687	0.178073	-3.91339	0.001019	-1.07099	-0.32275

Table 4. 4 ECM Asymmetric.

In order to achieve dynamic capture, a model of the monthly change in the mortgage rate error-correction model (ECM) is estimated.

The most significant variables in this specification are the first difference of the mortgage rate, the current change and the lagged change in the Bank Rate and the lagged error-correction variable in the long-run relationship.

The coefficient on the lagged mortgage rate change is approximately 0.60, which is statistically significant, and shows that there is a short-run momentum in the adjustment of rates.

The modern change in the Bank Rate is positively co-efficient, approximately 0.22, but not even significant separately at the conventional levels due to the small sample.

The Bank Rate change, which has been lagging, is not significant or high.

What is important is the error-correction coefficient, estimated to be about -0.71, which is very significant ($p = 0.001$).

This negative coefficient indicates that when the mortgage rate moves off the rate that would be logical in the long-run relationship with the Bank Rate, there is more than 70% to close the gap in a month.

That is to say that lenders will rapidly correct the misalignment: when the mortgage rate is low in comparison with the policy rate, the adjustment in the next month will be upwards, and the other way round.

According to this estimate, a larger portion of any shock to the long-run spread is taken up in a matter of two months.

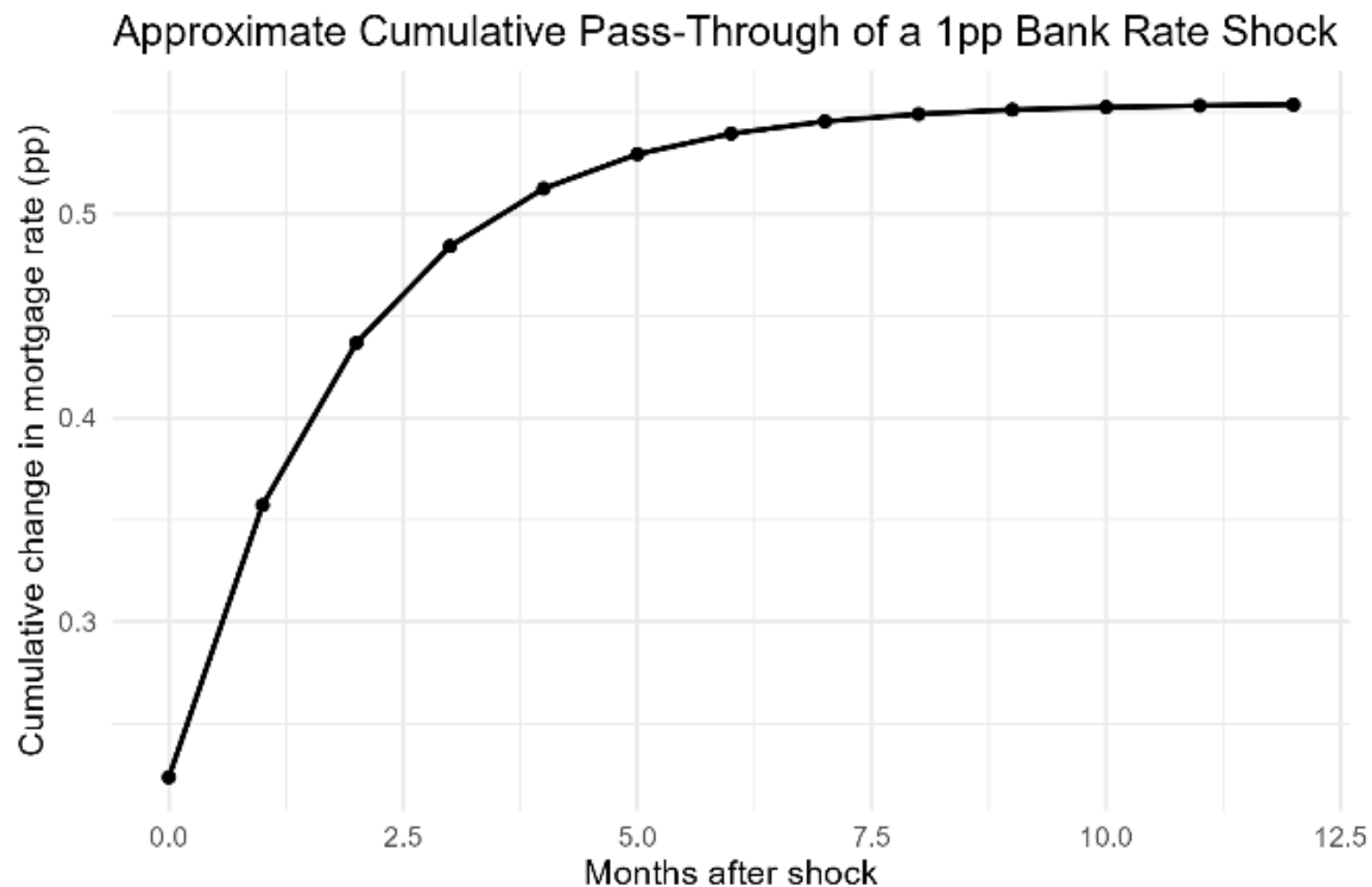


Figure 4. 2 Cumulative Pass-Through Profile.

A basic cumulative pass-through profile is drawn on the basis of ECM coefficients (Figure 4.2).

A one-time one% point boost in the Bank Rate will result in a first-month boost in the mortgage rate by approximately 0.22% points. The cumulative adjustment also amounts to 0.36% points in 2 months and 0.48% points in 3 months.

With a one-year passage of time, the cumulative change will be around 0.55% points, which is approximately 85% of the long-run pass-through of the equilibrium relationship that is normally constant. This profile indicates that pass-through is rapid but incomplete in the short run, and that most of the adjustment is completed within one quarter, and that the pass-through occurs only steadily.

In order to analyse the asymmetry, another ECM is used to separate the positive and negative changes in the policy rate. But otherwise, in the short planning 2023-2025, the Bank Rate remains largely stable or decreasing; the tightening measures are not significantly large when the quoted-rate data begin. The positive-change dummy is therefore not estimated and only the coefficient of the negative rate change is estimated.

The approximate reaction to the negative changes is good yet statistically non-significant, meaning that in these periods of easing, can-not identify any striking asymmetric pattern. The error-correction factor is again almost equal to -0.70 and is very significant, supporting the opinion that mortgage rates are rather firmly anchored to the policy rate in the long run.

The results of objective 1 reveal that the policy rate is closely associated with mortgage pricing with a long-run pass-through of approximately two-thirds and a very powerful error correction process.

Short-run responses to month-to-month policy adjustments are less precisely estimated, though the impulse profile satisfies the fact that most of the response to a Bank Rate shock has taken place within a few months.

4.3 Volatility, Approvals and Product Mix

The second objective examines the impact of interest-rate volatility on the mortgage approval volumes, besides the level of the bank rate. As a result of the data overload, analysis is narrowed to national monthly approvals to purchase a house and other secured lending, not finer shares of product mix by fixation length or LTV range.

The baseline dynamic specification is a logarithmic regression of the house-purchase approvals on the lag of itself, Bank Rate at a given time and three-month realised volatility of the Bank rate.

The coefficient of the lagged dependent variable is approximately 0.62, with a significant value, which means that there is much persistence in approvals. Once the dynamics and volatility are held constant, the coefficient of the Bank Rate level has a small and statistically insignificant value (approximately 0.01). The coefficient on volatility, on the contrary, is big, negative and significant at the 1% level (around -1.01). The model captures approximately 67% of the variation in monthly approvals of log (R-squared $\approx$ 0.67).

There is an economic interpretation of this volatility coefficient. This is due to the fact that the dependent variable is in logs, and thus can be transformed into an approximate% effect.

An increased volatility of three-month rate, say by a quarter (0.05-0.15) more than the standard, i.e. more realistic than the 0.08 determined by the sample. Would result in an estimated fall of about 9-10% in house-purchase approvals.

The increase in the volatility of at least 0.3, which is similar to the extreme levels of volatility witnessed during the COVID shock or the initial tightening cycle, is linked to the decline in approvals of over 25.

These findings indicate that probability confusion over the future direction of the rates is at least as important as the magnitude of the rates to the movement of fresh mortgage commitments.

Another set of secured approvals is estimated by a parallel regression, which is a proxy of a mixture of remortgages and other secured emerging lending. The specification is the same, where the dependent variable is the log of other approvals and the regressors include the lag, the Bank rate and the volatility. The lag coefficient is approximately 0.81, which is also very important, as it implies that these credit flows have a high degree of persistence. The coefficient of the Bank rate is insignificant, and the volatility coefficient is approximately (-0.55) and highly significant. The R-squared is also big at about 0.89, indicating that dynamics and volatility collectively describe a significant proportion of the variance in other secured lending.

The effect of volatility in this model, the effect of an increase in realised Bank-Rate volatility by one unit on other secured approvals, is a fall in the amount approved of by about 56%, and an increase by three units depicts a fall in the amount approved of by about 15%. The scale is slightly less than the house-purchase approvals, but economically significant.

	HP approvals	Other secured approvals
(Intercept)	4.262*** (0.653)	1.847*** (0.430)
ln_approvals_hp_11	0.620*** (0.059)	
bank_rate	0.008 (0.008)	-0.004 (0.006)
bank_rate_vol_3m	-1.010*** (0.154)	-0.550*** (0.080)
ln_approvals_oth_11		0.809*** (0.045)
Num.Obs.	113	113
R2	0.675	0.886
R2 Adj.	0.666	0.883
AIC	-83.3	-225.2
BIC	-69.6	-211.6
Log.Lik.	46.638	117.612
F	75.327	282.568
RMSE	0.16	0.09

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 4. 5 Approvals and Volatility Regression Results.

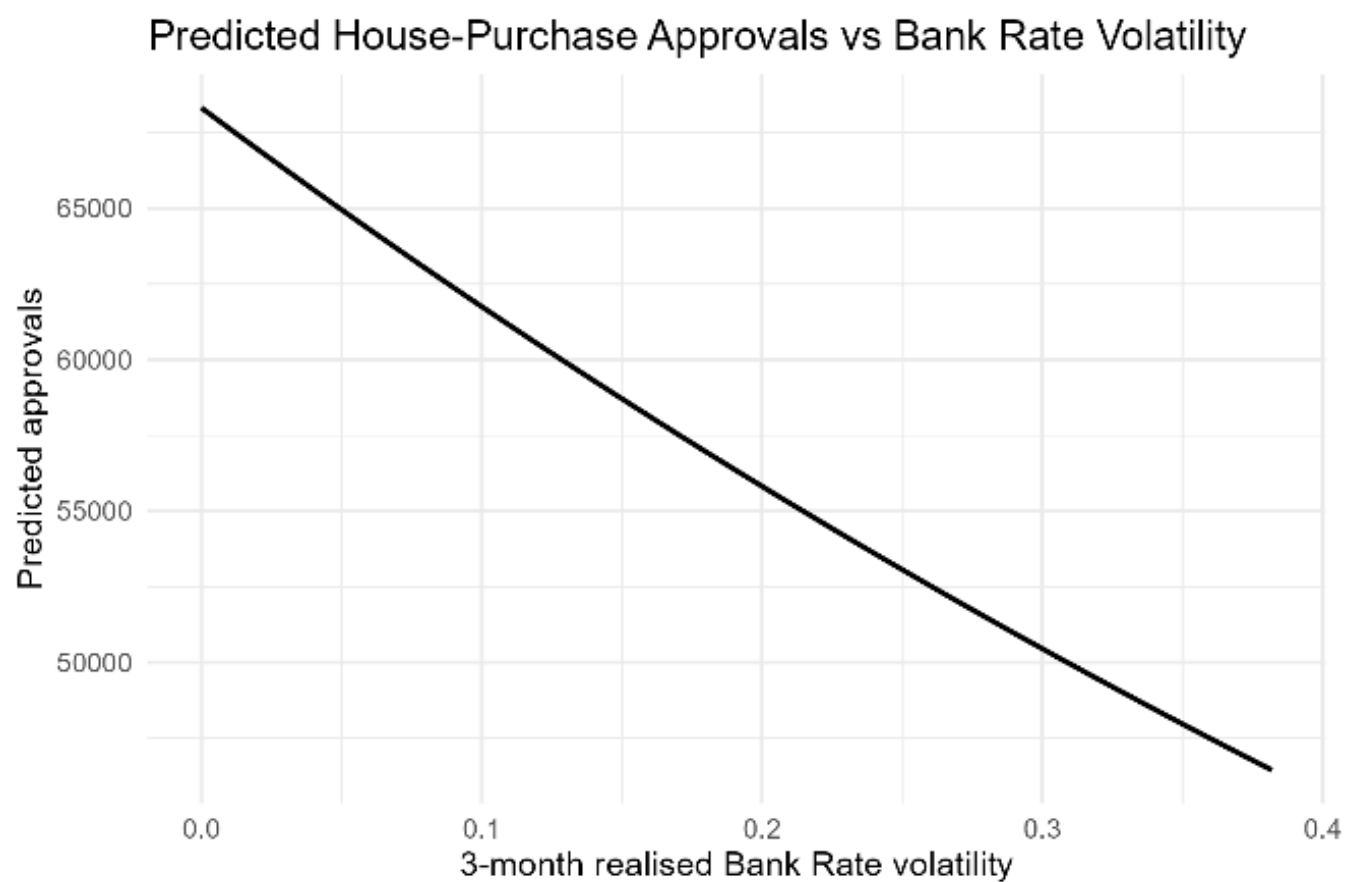


Figure 4. 3 Predicted House-Purchase Approvals vs Volatility.

Figure 4.3 shows the forecasted curve between volatility and approvals of house purchases, keeping the rates of the Bank and the lag approvals at the means of the sample. The form of the curve is downwards, with the approvals decreasing drastically as volatility changes zero and moves to the upper part of the given range of variation. This graphical data is aligned with the regression findings: when the households and the lenders are in a situation that is characterised by a more uncertain rate, fewer new mortgages are initiated.

In the case of Objective 2, it is evidenced that the volatility of rates will prove to discourage loan allocation beyond the impact of the rate level. Households and lenders become tight in a volatile environment by putting off buying or refinancing a home where they are uncertain about future repayments, and lenders may tighten credit conditions. Since the data that are available lack a product-mix breakdown by fixation length or LTV, the analysis can-not explicitly test the hypothesis as to whether volatility also drives borrowers into longer fixed-rate terms or lower leverage. The negative coefficients are, however, strong, and this could suggest that the volatility is a significant medium of transmission between monetary policy and the housing activity, together with secured credit volumes.

4.4 Affordability Gradients

The third objective explores the relationship between policy rate changes and their volatility and broad indices of housing affordability. The research estimates three national-level indices that include price-to-income, deposit-to-income, and payment-to-income (PTI) of a typical 2-year 75% LTV mortgage. Since data are not available before 2023, it means that such affordability measures will only be observed

after that time, and PTI will only be available in more limited months with income and quoted-rate data on which to match.

The average of the price-to-income ratio is 8.47, and the standard deviation is approximately 0.30, indicating that the average UK house price is approximately eight and a half times the median annual income during this time interval.

The deposit-income ratio, holding 10% deposit, has an average of 0.85 and volatility equals about 0.03. Such levels suggest that even the average deposit is nearly one year of median income. In the subset including mortgage-rate data, the PTI ratio has 0.43 as the average, which suggests that an average new 2-year 75% LTV mortgage would consume only a little more than 40% of gross monthly earnings.

The initial regression is between price to income, Bank rate, and volatility. It has an estimated coefficient on the Bank Rate of 0.32, which is significant at the 5% level, and a coefficient on volatility of 2.74, which is very significant. The two variables used in combination decipher a little more than 50% of the change in price-to-income (R-squared 0.51). The enhancements in the price-to-income ratio are tied to the increase in the Bank Rate by 1% point, and the volatility by 0.1 increase are linked to an improvement of about 0.32 and 0.27 points, respectively. Compared to the sample mean, a 0.27 increase is about a 3% increase in the price-to-income ratio.

The second regression is based on deposit-to-income as the dependent variable and the same regressors. Since this ratio is mechanically equal to price to income when given the assumption of 10% deposit, then the coefficients are also divided by one-tenth. This constant approximates 0.65, the coefficient of the Bank rate is 0.032, and the volatility coefficient is 0.27, all following the same trend of significance.

Therefore, when volatility increases by 0.1, the deposit-to-income ratio increases on average by 0.027, which is about 3% difference from its average of 0.85.

The PTI regression results are smaller, primarily due to the fact that the PTI series is shorter (18 observations) and because PTI is not solely a factor of the mortgage rate, but also incomes and closed-end loans. The Bank Rate coefficient is positive, approximately 0.027, though it is not statistically significant, and the volatility coefficient is small and not significant. R-squared is approximately 0.30 and the joint F-test is very insignificant. Those estimates imply that PTI is less sensitive to policy conditions than price-based measures of affordability, using only a small sample.

These regression results can be explained using the correlation matrix. Correlations to PTI include price-to-income and deposit-to-income, which have a high correlation with PTI (0.76) and PTI, which has the most negative correlation with house-purchase and other approvals. The value of approvals against price to income is approximately -0.79, and against PTI, against approvals against house purchase is -0.63 and against approvals against other values is -0.80. These trends are in line with the concept of weakening affordability that is linked to weak mortgage demand and supply.

	PTI (2y 75% LTV)	Price-to-income	Deposit-to-income
(Intercept)	0.296*	6.547***	0.655***
	(0.133)	(0.714)	(0.071)
bank_rate	0.027	0.321*	0.032*
	(0.025)	(0.135)	(0.013)
bank_rate_vol_3m	-0.026	2.741***	0.274***
	(0.101)	(0.578)	(0.058)
Num.Obs.	18	28	28
R2	0.304	0.505	0.505
R2 Adj.	0.212	0.465	0.465
AIC	-94.2	-1.5	-130.5
BIC	-90.6	3.8	-125.1
Log.Lik.	51.092	4.755	69.227
F	3.283	12.732	12.732
RMSE	0.01	0.20	0.02

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 4. 6 Affordability Regressions (PTI, Price-to-Income, Deposit-to-Income).

Since the data are national as opposed to regional, the analysis cannot directly indicate regional gradients of affordability or interactions with the income quartiles. These outcomes can thus be viewed as mean national effects as opposed to distributional influences regionally or among groups of people. Nevertheless, volatility has a strong positive correlation with price- and deposit-to-income ratios, which suggests that time of rate uncertainty is associated with stricter national affordability levels even after earnings are factored in. Figure 5.4, a price-to-income and PTI plot over the years, reveals that the two indicators come to a peak as the rate rises during the late 2023 years and subsequently fall a little as the rates drop, but continue to stay high in terms of historical levels.

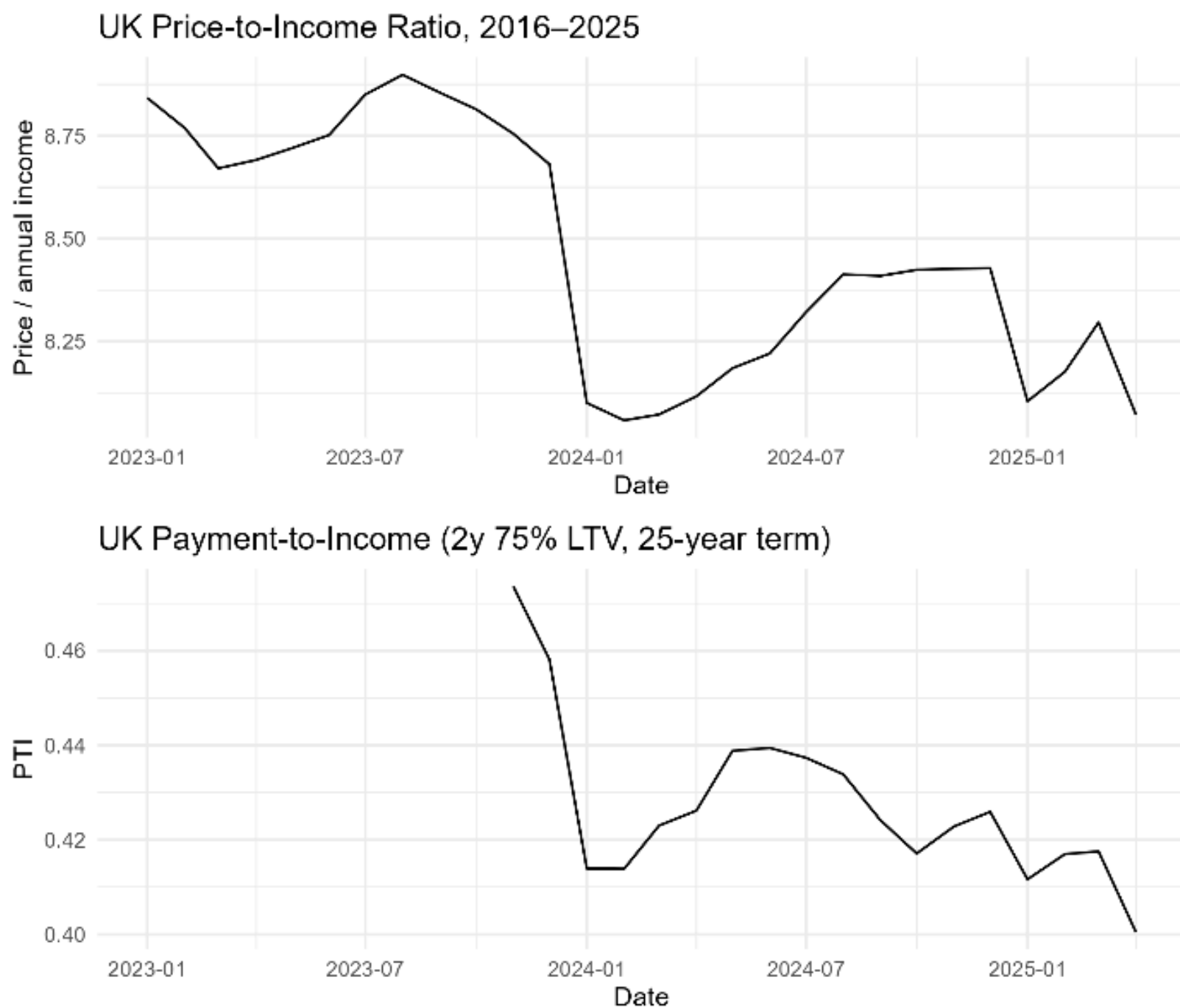


Figure 4. 4 Affordability Over Time (Price-to-Income and PTI).

4.5 Arrears and Refinancing Responses

Objective 4 was formulated to examine how mortgage arrears and the refinancing activity respond to the policy rate and its volatility changes. In the available data, there is no specified series on arrears. Consequently, alternative secured lending approvals are the proxy measures of the refinancing and other associated secured-credit flows in the analysis. The limitation must be remembered during the interpretation of the results.

The dynamic regression of log other approvals, which is already in the discussion under Objective 2, can be interpreted as a reduced-form refinancing equation as well. The coefficient of the lagged dependent variable is about 0.81 and very significant, and it means that the volumes of refinancing at present are strongly anchored on the preceding-month volumes.

The Level of the Bank Rate has a small, negative yet statistically non-significant coefficient (approximately -0.004), indicating that, other things being equal, the position of rates does not predict refinancing volumes on a month-to-month basis in a systematic manner.

term	estimate	std. error	statistic	p.value	conf. low	conf. high
(Intercept)	1.846557	0.430365	4.290676	3.87E-05	0.993588	2.699527
ln_approvals_oth_l1	0.809041	0.045008	17.97532	2.21E-34	0.719836	0.898246
bank_rate	-0.00428	0.005758	-0.74332	0.458889	-0.01569	0.007132
bank_rate_vol_3m	-0.55011	0.079902	-6.88486	3.86E-10	-0.70848	-0.39175

Table 4. 7 Proxy Refinancing Model (Other Secured Approvals).

Comparatively, the coefficient of interest-rate volatility is substantial and very significant (approximately -0.55, $p < 0.001$). In the log scale, a 1 volatility increment in realised is related to about a 5-6% drop in other secured approvals, and a -0.3 increment translates to a 15% drop. This is marginally less in scale than the impact on house-purchase approvals, but nonetheless of economic value. The large value in R-squared, approximating 0.89, implies that these dynamics are able to explain the majority of the variability in the proxy refinancing series.

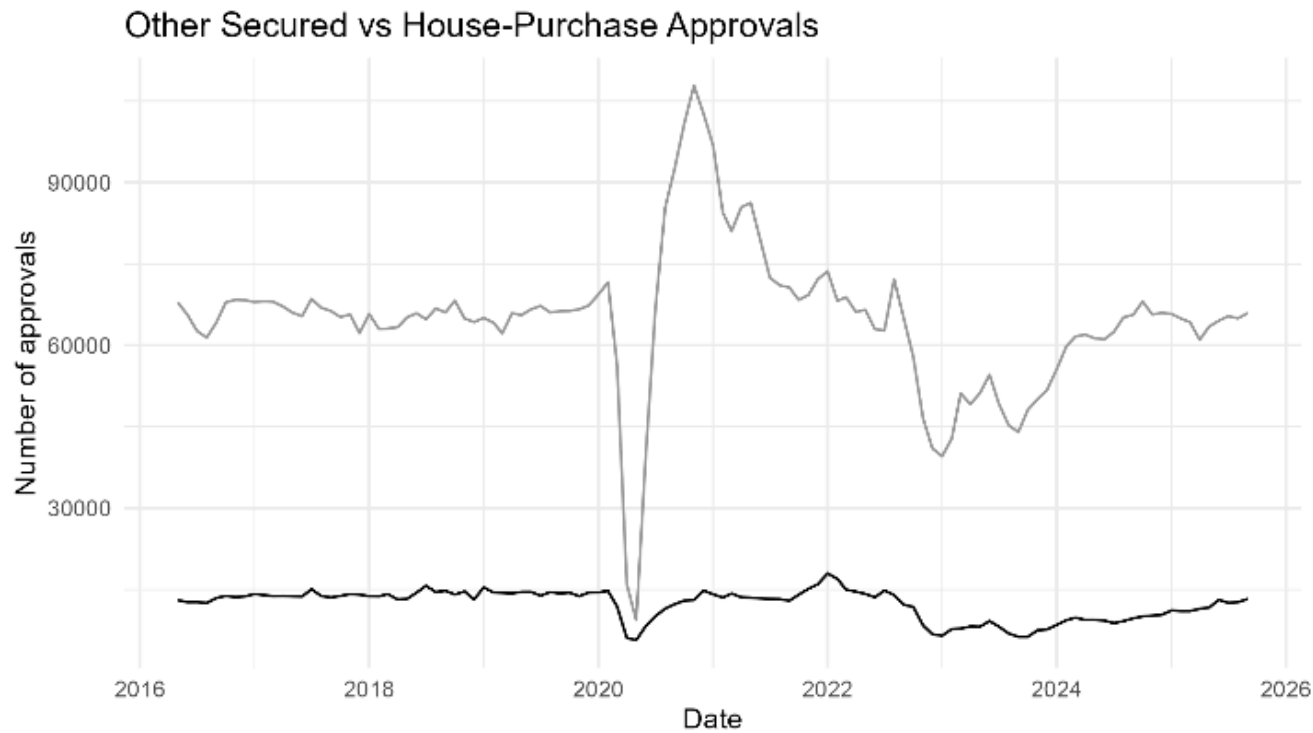


Figure 4.5 Other Secured vs House-Purchase Approvals Over Time.

Figure 4.6 is a graph that shows the levels of house purchase and other approvals across time. Both series decline drastically in the initial COVID shock, which aligns with the significant interference and stricter credit conditions, whereas the Bank Rate is at its minimum. They revert to their original course in the first round of reopening but start to drift apart slightly in the tightening cycle: house-purchase approvals decline more severely with increasing rates, other-secured approvals are less susceptible to declines but still exhibit evident declines during volatility spikes.

According to these estimates, again, volatility is at the centre of refinancing behaviour. In a situation where uncertainty prevails on rates, borrowers would be hesitant when it comes to refinancing, and lenders would hesitate in offering more credit secured by housing.

The non-significance of the direct effect of the rate level is corroborative of the notion that it is not solely the level of how high rates are that affects refinancing, but rather also the instability and uncertainty within them. The analysis is not able to explicitly model the effect of an increase in rates and volatility on repayment stress

and default because no data on arrears are available. The absence of a positive correlation between volatility and other secured approvals, however, is a sign that borrowers are less likely to restructure their debts in uncertain conditions, and this, when such a result would be tied to arrears in a more exhaustive data set, would be correlated.

4.6 Policy Interventions: Mortgage Charter and Other Measures

Objective 5 will measure the impact of the policy intervention and the Mortgage Charter in particular, on the mortgage approvals. The analysis is based on an interrupted time-series (ITS) combined with the date (August 2023) of the intervention as the month when the Charter measures were being introduced.

The house-purchase approvals are the dependent variable in logarithmic form. These regressors are a linear time trend, a post-intervention dummy, a product of interaction between terms that capture change in slope following the intervention, the Bank rate and its volatility.

term	estimate	std. error	statistic	p.value	conf. low	conf. high
(Intercept)	11.07973	0.049851	222.2587	1.51E-145	10.98091	11.17854
time	0.002532	0.001123	2.254507	0.026182	3.06E-04	0.004758
post_charter	-0.41766	0.147685	-2.82802	0.005584	-0.71039	-0.12492
time_post	0.017716	0.006171	2.870906	0.004926	0.005484	0.029947
bank_rate	0.00331	0.025962	0.127507	0.898776	-0.04815	0.054771
bank_rate_vol_3m	-1.80862	0.233217	-7.75508	5.24E-12	-2.27089	-1.34634

Table 4. 8 ITS Estimates for Mortgage Charter (House-Purchase Approvals).

A summary of the ITS outcomes is provided in Table 4.6. The overall time trend coefficient is positive but small (approximately 0.0025), which means that there is a small positive drift in the log approvals across the entire sample when all other

variables are held constant. The level of the shifting coefficient is approximately -0.42, which is significant at the 1% level. This means that the house-purchase approvals in the log scale would immediately decrease by about 34 at the time of the Charter, all other variables held constant. This negative level effect is a portrayal of the circumstances under which the Charter was introduced, when the rates and the volatility were high, and the housing activity was already on a downward trend.

Nevertheless, the interaction term that reflects the alteration in the slope following the intervention is positive and significant (coefficient ≈ 0.018). This is to indicate that the monthly approvals have a more positive trend after the initial level drop, with log approvals increasing about 1.8% per month in a similar direction as indicated by a stronger rate as compared to the preceding. That is, the Charter period is linked to a brief decline, then a slow recovery in approvals in comparison to the pre-intervention trend.

The Bank rate coefficient and volatility coefficient in the ITS model are generally consistent with previous findings. The immediate impacts of the level of the Bank Rate are very small and not statistically relevant, and the volatility is about -1.81 with the B coefficient of great significance. One standard deviation of volatility change shows a decrease in approvals by around 16–17%, despite holding constant the Charter and the time trend. This supports the premise that the Charter was implemented at a time when volatility, per se, was already exerting a potent adverse influence on new lending.

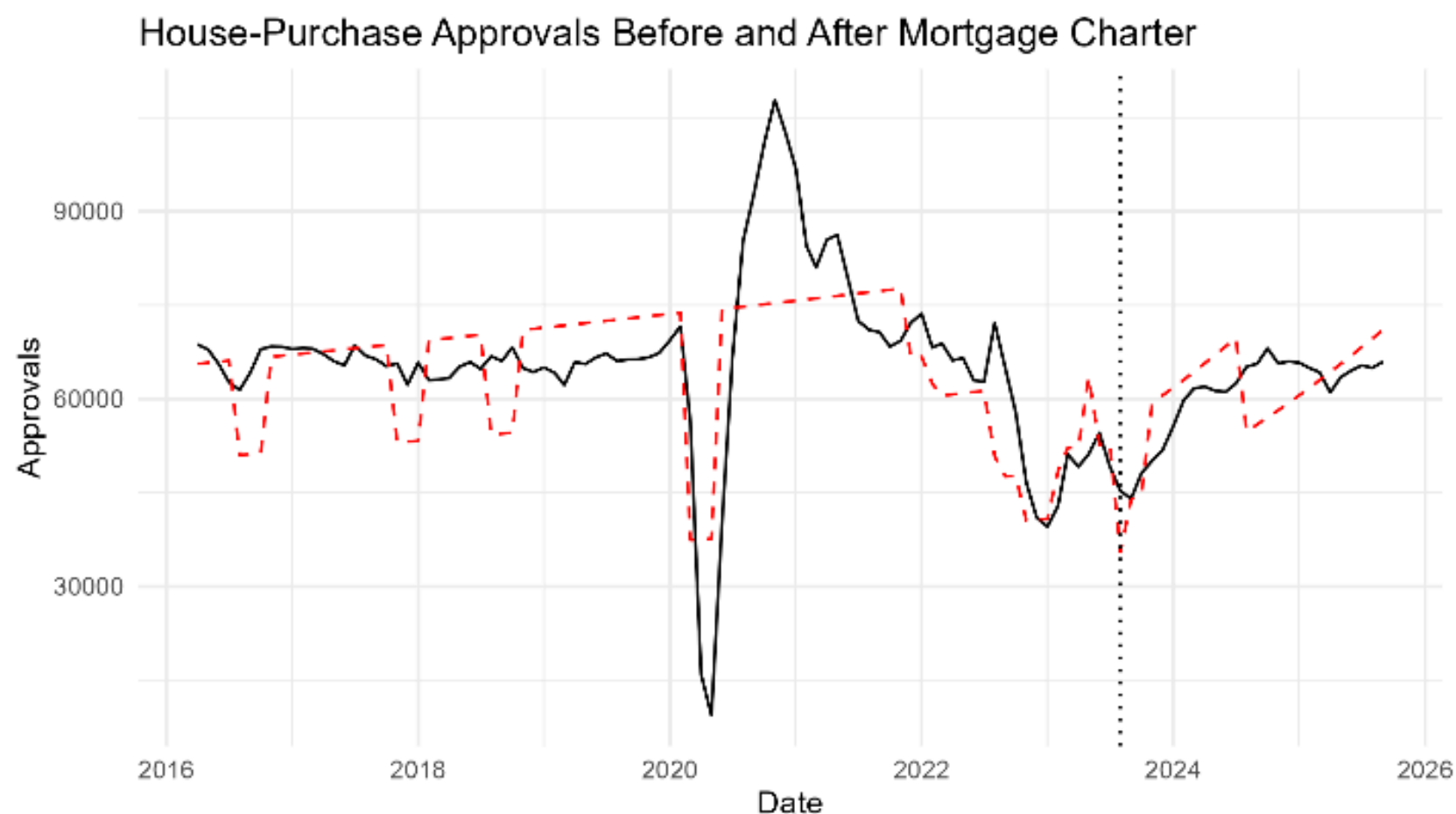


Figure 4. 6 House-Purchase Approvals Before and After the Charter.

The actual approvals are compared to the fitted values of the ITS model in Figure 4.6, and the date of intervention is noted. This figure indicates that there is an apparent downward movement at the point of mid-2023, after which a slight upward movement is observed in the fitted line compared to the dynamics prior to the Charter. Though adjustments in approvals are seemingly apposite with the Charter in the short-term, the slope of positive post-intervention is indicative that it might have played a role in stabilising the expectations and contributing to a progressive recovery, although not completely counteracting the pull of higher rates and volatility.

There is partial support of the hypothesis that the Mortgage Charter contained elements in mitigating the effects of the tightening cycle on new lending, which is provided in the ITS evidence. The response level on the negative end is immediate, and it shows the Team a difficult macro-financial environment, not the actual effects

of Charter. The more favourable post-Charter trend, however, is in line with the interpretation that selective forbearance and flexibility actions can assist borrowers in making adjustments that avoid an even further or more lasting fall in approvals.

4.7 Interim Summary

Empirical findings according to the period 2016–2025 have been presented in the chapter based on UK monthly data of the policy rates, mortgage approvals, house prices and income. The real-time and descriptive data indicate a direct order of shocks: the Brexit referendum, the COVID-19 pandemic with almost zero rates, and an accelerating tightening process leading in 2023, then a slight relaxation.

In Objective 1, the pass-through analysis established a close long-run relationship between the Bank Rate and the 2-year 75% LTV mortgage rate, having an error-correction term and a strong long-run coefficient of 0.65. A majority of the adjustment to a policy-rate shock is made within the first few months. Regressions which are dynamic indicate that an interest-rate volatility, in contrast to the level of the Bank Rate, is most strongly related to mortgage approvals in Objective 2. The increase in volatility is associated with large-scale decreases in house-purchase and other secured approvals. In Objective 3, national affordability indexes suggest that higher rates and stronger volatility are associated with higher price and deposit to income ratios, respectively, but PTI is a less sensitive variable in the brief sample. In the case of Objective 4, other secured approvals, which are a proxy of refinancing, are again negative to volatility; the implication is that uncertainty in refinancing will put off the activity. Finally, Objective 5 demonstrates that the Mortgage Charter period has been characterised by an immediate decline in approvals followed by a

more encouraging subsequent trend, in line with a small stabilising operation once high rates and volatility have been factored in.

Chapter 5: Discussion

5.1 Overview of Key Findings

The purpose of this dissertation was to determine the impact of the policy rate and the volatility of the policy rate on the UK mortgage pricing, lending activity and housing affordability during 2016–2025. The findings demonstrate that there is a definite policy-mortgage outcomes transmission chain, but certain aspects of the analysis are restricted by the information.

To start with, the pass-through models demonstrate a close long-term relationship between the Bank Rate and the new two-year 75% LTV mortgage rate. The Bank Rate coefficient of the static regression is 0.651 ($p < 0.001$, $R^2 \approx 0.78$) and therefore, a one percentage point change in policy will be associated with a change in the mortgage rate given a change of 0.65 percentage points. The model of error-correction has the error-correction coefficient = -0.706 ($p \approx 0.001$), and it means that approximately 70% of the annual deviation of the long-run dispersion is eliminated in a month.

Second, volatility has a primary role in the lending results. The coefficient on three-month realised volatility in the house-purchase approvals model is -1.010 ($p < 0.001$, $R^2 \approx 0.68$). In the remaining secured approvals model, the volatility coefficient equals -0.550 ($p < 0.001$, $R^2 \approx 0.89$). Any increase of volatility by 0.1 is linked with an approximate 10% decline in house-purchase approvals and a 5–6% decline in other secured approvals.

Third, the rate environment is reflected in the profitability ratios. It is also positively associated with Bank Rate ($\beta = 0.321$, $p \approx < 0.025$) and volatility ($\beta = 2.741$, $p < 0.001$, $R^2 \approx 0.50$). The same trend with deposits to income. The regressions of PTI are less significant, and PTI is elevated at the highest point of the tightening cycle.

Fourth, the other secured approvals, which are treated as the proxy of refinancing, also have a strong and negative correlation with volatility. Lastly, it can be indicated that the Mortgage Charter is estimated to have caused an immediate decrease in approvals (level shift -0.418 , $p \approx 0.006$) and then a more affirmative change in the future (slope change 0.0177 , $p \approx 0.005$).

The hypothesis H1 on asymmetric pass-through can only partly be verified: long-run pass-through and adjustment speed are robust, though it is not possible to find asymmetry. The volatility-cutting approvals H2 are evidently backed. With the aggregate data, H3 on larger PTI shocks in lower-income regions cannot be tested. Mortgage Charter slowing arrears growth H4 partially supported: the Charter does seem to level off trends in approvals, but the data is missing on arrears to directly test the mechanism.

5.2 Interpretation in Light of Existing Literature

The pass-through results are located conveniently in the literature describing retail-rate transmission. The coefficient of 0.651 in the long-run shows some though significant pass-through of policy to mortgage rates, as in previous estimates in the UK, which fall between a half and a full. The large error-correction value of -0.706 indicates that, within one or two months, the lenders usually put to rest most of the gaps between the actual and the equilibrium mortgage rates. This is in line with banks that are actively controlling margins and reacting to changes in financing costs.

The asymmetric error-correction model was formulated to evaluate the hypothesis that tightening episodes compared to easing episodes have a stronger pass-through. Short change The coefficient of negative changes in policy rate is 0.276 ($p \approx 0.25$), and the reverse is not found during the short sample when both

mortgage-rate data are available in detail. The fact that there is no large asymmetry indicates, however, that the lack thereof is a data constraint as opposed to a clear indication that UK pass-through is symmetric in every period. H1 would require a more differentiated history of tightening and loosening cycles to be completely tested.

The substantial place of volatility in the lending regressions is a response to the research about the uncertainty, investment, and risk-taking. The volatility coefficient of the house-purchase approvals model is -1.010, and this means that an individual who moves into a very turbulent environment and a much more stable environment may see a reduction in approvals by over a quarter. With the other secured approvals model, the coefficient of -0.550, which is accompanied by an approximated R^2 of 0.89, indicates that the volatility is responsible for a large proportion of the movement in the refinancing-type activity. These results are consistent with the models of real option, where households postpone irreversible choices when the future is uncertain and the models of risk-taking channels, where the supply of credit is constrained when the future gets increasingly volatile.

The affordability regressions provide a touch of enigma to the current research on housing stress. The standard deviation of price-to-income and deposit-to-income ratios is approximately 0.30 and 0.03, respectively, with a sample mean of about 8.47 and 0.85, respectively. The estimated coefficients suggest that price to income increases by approximately 0.32 points with an increase in Bank rate by a 1 percentage point and increases by about 0.27 points with a 0.1 increase in volatility. These have been changes of approximately 4% and 3% in comparison with the sample mean. The value of R^2 at 0.50 indicates that the relationship between rate level and volatility causes half of the variation in the changes in these affordability statistics between 2023 and 2025. The regressions of PTI result in lower explanatory

power ($R^2 \approx 0.30$) and a significant intercept only, which may be the consequence of the small sample (18 observations) and due to the fact that PTI is a factor of incomes, prices, and rates.

Weaker demand and stricter and uncertain conditions also coincide with the correlation matrix. House-purchase approvals have negative relationships with Bank Rate ($\rho = -0.39$), volatility ($\rho \approx -0.58$), mortgage rates ($\rho \approx -0.62$) and affordability ratios ($\rho \approx -0.79$ with price-to-income). The other secured approvals portray even more negative correlations with the Bank rate ($\rho \approx -0.71$) and PTI ($\rho \approx -0.80$). These trends support the regression evidence and are consistent with previous results that indicate an inverse relationship between the costs and the conditions and purchase and refinancing activity.

The interrupted time series results present preliminary quantitative research on the Mortgage Charter. The change in levels according to the estimates is -0.418 , which implies that, after taking into account the trend, the policy rates and the volatility, approvals during the years around the Charter date are actually thirty-four percent lower than the pre-Charter trend. The positive slope change of 0.0177 indicates that, at that point, approvals increase approximately 1.8% faster than they have been. Simultaneously, the coefficient of volatility in this model is large and negative at the same time, with the value of -1.809 ($p < 0.001$). These findings imply that the Charter came into action under a challenging environment, although it might have contributed to stabilising expectations and a slow recovery in activity.

5.3 Mechanisms and Distributional Implications

The trends in the data are in correspondence with various transmission mechanisms. To the lenders, the unstable policy rates increase pipeline risk. Contracts settled today could be unprofitable at the time they are settled in case of a

change in the funding costs or swap rates. The high error-correction term in the pricing model and the high volatility effects in the approvals models may indicate that lenders will adjust product menus, reducing the offer validity and expanding spreads when the conditions are volatile.

In the case of borrowers, the volatility in the rates makes timing and repayment a risk. A household that decides to either purchase or refinance must be uncertain about future payments in case rates keep varying. Ensuring net approvals decrease when volatility is high, as some households will wait to transact, whereas others will hurry up to get a deal.

There are also distributional implications of the results. Low-income households and first-time buyers are generally found to have bigger PTI, reduced savings aid and bigger reliance on high-LTV products. In a volatile rate environment, these groups face an increased risk of being pushed out of the market or facing distress on refix when the price-to-income and PTI ratios increase. The positive-negative relationships between approvals and affordability variables indicate the exclusion of marginal borrowers first. This could, in the long run, increase home-ownership disparities and solidify inequalities.

5.4 Policy and Practice Implications

The results have a number of policy and practise implications. In the case of the Bank of England, the outcomes show that policy rate volatility is important in addition to the level. Clear communication on the probable direction that rates will take and on the circumstances under which they may alter can curb undue volatility and doubt. In evaluating financial stability, stress situations must be evaluated in both high-rate environments and also those when policy change is rapid and frequent.

5.4.1 Financial Conduct Authority

To the Financial Conduct Authority and other regulating bodies, this is an indication that stress-testing and other macroprudential practises must have volatility-sensitive channels. Existing affordability regulations tend to impose set buffers over current rates. The scale of refix shocks may not be represented by them in a fluctuating environment. Supervisory guidance would prompt firms to think about situations involving higher (and more volatile) rates, especially high-LTV lending and borrowers at affordability limits. The partial effectiveness of the Mortgage Charter in normalising approvals suggests the effectiveness of focused and time-limited forbearance instruments.

5.4.2 Lenders

To the lenders, the volatility effects in regard to the purchase and other secured approvals are detrimental and hence the necessity to have an effective risk management. Banks and building societies might have to hedge pipeline exposures more effectively to enable them to offer longer fixed terms without withdrawing products ungraciously in response to markets. Borrowers can learn about changes with clear pricing structures, which describe the relationship associated with policy rates, swap curves and mortgage offers. Customer data also allows lenders to work out custom assistance to borrowers with high refinance shocks.

The findings highlight the need to provide simple, practical consumer advice on horizon fixing and affordability planning to consumer advisory bodies and financial counsellors. Households will require assistance in times of high volatility to develop insights about shorter fixes compared to longer fixes and the risk of excessively stretching PTI.

5.5 Chapter Summary

This chapter has explained the empirical findings of the study and made reference to the literature and policy discussion. It has demonstrated that the movements of the Bank Rate are transmitted purely to mortgage prices, that the interest-rate volatility poses a sizeable and independent drag to lending and affordability and that intervention, like the Mortgage Charter, could be used to stabilise outcomes in stressful times. Plausible processes and groups that are the most vulnerable to the volatility-induced shocks have also been outlined in the chapter. These observations can form the foundation of the ultimate conclusions that can summarise the input of the dissertation and set priorities for future studies.

Chapter 6: Conclusion

The present study has analysed the impact of Bank of England policy-rate level and volatility on the level of UK mortgage lending and affordability of houses between 2016 and 2025. The objective was to follow the entire sequence of policy rates to mortgage prices, approvals, affordability and borrower outcomes and evaluate the Mortgage Charter that was launched in 2023.

The results provide answers to the research questions as follows. In the case of RQ1, the saved changes in the Bank Rate were transferred to new mortgage pricing in a clear manner. The long-run pass-through to the 2-year 75% LTV of mortgage rate was approximately 0.65. The adjustment was also fast. Close to 70% of the long-run relationship gap was bridged in a month. This means that lenders would very quickly reprice in case of a change in policy.

In the case of RQ2, interest-rate volatility was of great importance to mortgage activity. Greater realised volatility in the three months was associated with a big decline in house purchase approvals. It was also attributed to reduced other secured approvals, which, in this case, is replaced by refinancing-related activity. This substantiates the fact that confusion causes households and lenders to postpone. But product-mix information (fixed-term choice or LTV shares) was not in detail, so movements in product composition could not be tested directly.

Price-based measures were the most evident in affordability pressures in RQ3. Increased price-to-income and deposit-to-income ratios were related to increased Bank Rate levels and increased volatility. The tightening phase payment-to-income (PTI) levels were high, yet the statistical outcomes were poor since PTI figures were

recorded over a limited time. There were no limits to test regional affordability differences, and thus the study reports primarily national impacts.

In RQ4, where the direct arrears data were missing, no estimation of the arrears responses was possible. In the proxy refinancing model, the volatility decreased the approvals of refinancing. This implies that volatility could restrict the capacity or the willingness of households to change loans in response to a change in conditions.

With RQ5, the time-series results with interruption indicate that Mortgage Charter was associated with an instant decline in approvals, which was followed by a more encouraging direction. This is an indication of potential stabilisation, and yet volatility was significantly negatively correlated with lending.

This study fills a definite research gap by considering volatility in policy rates to be a driver on its own rather than the level of rates, and by connecting several outcomes of the housing market in a single model. It also brings practical value to the Bank of England, regulators and lenders. Effective communication that will lead to less confusion can assist. Volatility testing should also be applied to stress testing, not just the high-rate testing. Lenders are able to manage their pipeline and pricing risk as well as pursue lenders with refix shocks.

The limitations are mainly short series of pass-through mortgage rates, unavailable arrears information, fewer regional panels, and thick product-mix indicators. The future studies are supposed to incorporate longer time series, loan-level data, better regional affordability data and direct arrears and remortgage data. It must also examine distributional effects in first-time purchasers and low-income subdivisions.

The research indicates that volatility is not secondary. It represents the key avenue through which monetary policy impacts the lending of mortgages and residential affordability in the UK.

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Appendix

```
#####  
## R Script – UK Mortgage, Rates & Affordability ##  
## Data: uk_monthly_macro_mortgage_hpi_income_2016_2025 ##  
#####  
  
## 0. Setup ----  
  
# Load packages  
library(tidyverse)  
library(lubridate)  
library(zoo)  
library(dynlm)  
library(urca)  
library(lmtest)  
library(sandwich)  
library(broom)  
library(modelsummary)  
library(patchwork)  
library(stringr)  
  
# Create output folders if they don't exist  
if (!dir.exists("outputs")) dir.create("outputs")  
if (!dir.exists("outputs/tables")) dir.create("outputs/tables", recursive = TRUE)  
if (!dir.exists("outputs/figures")) dir.create("outputs/figures", recursive = TRUE)
```

```
## 1. Load and prepare data ----
```

```
# 👉 EDIT THIS PATH to where your file is saved:
```

```
data_raw <-  
read_csv("C:/Users/mahaf/Downloads/uk_monthly_macro_mortgage_hpi_income_2  
016_2025.csv",  
         show_col_types = FALSE)
```

```
# Inspect columns (optional)
```

```
# glimpse(data_raw)
```

```
# Robust date handling - your file has "YYYY-MM-DD" so this will work
```

```
data <- data_raw %>%  
  mutate(  
    date = ymd(date),          # ensure proper Date type  
    ym   = as.yearmon(date),    # year-month (zoo)  
    time_index = row_number()   # simple time trend for ITS  
  )
```

```
# Check that date parsed correctly
```

```
stopifnot(!all(is.na(data$date)))
```

```
# Fill earnings within each year so every month has values
```

```
data <- data %>%  
  group_by(year) %>%
```

```

arrange(date) %>%
  tidyr::fill(median_annual_pay_gbp, median_monthly_pay_gbp, .direction =
"downup") %>%
  ungroup()

# Derived variables: spreads, logs, affordability measures
assumed_ltv      <- 0.75    # assumed LTV for loan amount
assumed_deposit  <- 0.10    # assumed deposit share of price
assumed_term_years <- 25    # mortgage term
n_payments       <- assumed_term_years * 12

data <- data %>%
  mutate(
    # Spreads (where mortgage data exists)
    mort_spread_2y75 = mort_2y_75ltv - bank_rate,
    mort_spread_5y75 = mort_5y_75ltv - bank_rate,

    # Basic logs
    ln_approvals_hp = log(approvals_house_purchase_sa),
    ln_approvals_oth = log(approvals_other_sa),
    ln_uk_price     = log(uk_avg_price),

    # Affordability ratios (national)
    price_to_income = uk_avg_price / median_annual_pay_gbp,
    deposit_to_income = (assumed_deposit * uk_avg_price) /
median_annual_pay_gbp,

```

```

# PTI based on 2-year 75% LTV rate (where available)
loan_amount      = assumed_ltv * uk_avg_price,
r_month_2y75     = (mort_2y_75ltv / 100) / 12,
monthly_payment_2y75 = if_else(
  !is.na(r_month_2y75)&r_month_2y75>0,
  loan_amount * r_month_2y75 / (1 - (1 + r_month_2y75)^(-n_payments)),
  NA_real_
),
pti_2y75 = monthly_payment_2y75 / median_monthly_pay_gbp
)

# Core analysis subset (from 2016 onwards – should be all rows)
data_core <- data %>%
  filter(date >= as.Date("2016-01-01"))

#####

## Descriptive Statistics&Timeline    ##

#####

## 5.1.1 Descriptive statistics (Table 5.1) ----

vars_for_stats <- data_core %>%
  select(
    bank_rate,
    bank_rate_change,

```

```

bank_rate_vol_3m,
mort_2y_75ltv,
mort_spread_2y75,
approvals_house_purchase_sa,
approvals_other_sa,
uk_avg_price,
uk_hpi_index,
price_to_income,
deposit_to_income,
pti_2y75
)

tbl_descriptives <- vars_for_stats %>%
  pivot_longer(everything(), names_to = "variable", values_to = "value") %>%
  group_by(variable) %>%
  summarise(
    n    = sum(!is.na(value)),
    mean = mean(value, na.rm = TRUE),
    sd   = sd(value, na.rm = TRUE),
    min  = min(value, na.rm = TRUE),
    max  = max(value, na.rm = TRUE),
    .groups = "drop"
  )

write_csv(tbl_descriptives, "outputs/tables/Table5_1_descriptive_statistics.csv")

```

```
## 5.1.2 Correlation matrix ----
```

```
vars_for_corr <- data_core %>%
```

```
  select(
```

```
    bank_rate,
```

```
    bank_rate_vol_3m,
```

```
    mort_2y_75ltv,
```

```
    mort_spread_2y75,
```

```
    approvals_house_purchase_sa,
```

```
    approvals_other_sa,
```

```
    uk_avg_price,
```

```
    price_to_income,
```

```
    deposit_to_income,
```

```
    pti_2y75
```

```
  )
```

```
corr_matrix <- cor(vars_for_corr, use = "pairwise.complete.obs")
```

```
write.csv(corr_matrix, "outputs/tables/Table5_1b_correlation_matrix.csv", row.names  
= TRUE)
```

```
## 5.1.3 Timeline of Bank Rate&Events (Figure 5.1) ----
```

```
brexit_ref    <- as.Date("2016-06-23")
```

```
covid_shock   <- as.Date("2020-03-11")
```

```
first_hike    <- as.Date("2021-12-16")
```

```
mortgage_charter <- as.Date("2023-07-01")
```

```

max_rate <- max(data_core$bank_rate, na.rm = TRUE)

p_timeline <- ggplot(data_core, aes(x = date, y = bank_rate)) +
  geom_line(linewidth = 0.8) +
  geom_vline(xintercept = brexit_ref, colour = "grey40", linetype = "dashed") +
  geom_vline(xintercept = covid_shock, colour = "grey40", linetype = "dashed") +
  geom_vline(xintercept = first_hike, colour = "grey40", linetype = "dashed") +
  geom_vline(xintercept = mortgage_charter, colour = "grey40", linetype = "dashed")
+
  annotate("text", x = brexit_ref, y = max_rate, label = "Brexit", vjust = -0.5,
angle = 90, size = 3) +
  annotate("text", x = covid_shock, y = max_rate, label = "COVID", vjust =
-0.5, angle = 90, size = 3) +
  annotate("text", x = first_hike, y = max_rate, label = "First hike", vjust = -0.5,
angle = 90, size = 3) +
  annotate("text", x = mortgage_charter, y = max_rate, label = "Mortgage Charter",
vjust = -0.5, angle = 90, size = 3) +
  labs(
    title = "Bank of England Bank Rate and Key Events, 2016–2025",
    x = "Date",
    y = "Bank Rate (%)"
  ) +
  theme_minimal()

ggsave("outputs/figures/Figure5_1_bank_rate_timeline.png", p_timeline,

```

```

width = 8, height = 4, dpi = 300)

#####

## Pass-Through to Pricing (ECM/ARDL)  ##

#####

# Use 2-year 75% LTV mortgage rate as main pricing variable
pt_data <- data_core %>%
  filter(!is.na(mort_2y_75ltv), !is.na(bank_rate)) %>%
  arrange(date)

if (nrow(pt_data) >= 10) {

  mort_ts <- ts(pt_data$mort_2y_75ltv,
    frequency = 12,
    start = c(year(min(pt_data$date)), month(min(pt_data$date))))
  rate_ts <- ts(pt_data$bank_rate,
    frequency = 12,
    start = c(year(min(pt_data$date)), month(min(pt_data$date))))

  ## 5.2.1 Static long-run relation ----
  lr_model <- lm(mort_ts ~ rate_ts)
  beta_lr <- coef(lr_model)["rate_ts"]

  ect <- resid(lr_model)
  pt_data$ect_lag <- dplyr::lag(ect, 1)

```

```
## 5.2.2 ECM variables ----
```

```
pt_data <- pt_data %>%
```

```
  mutate(
```

```
    mort_diff = c(NA, diff(mort_2y_75ltv)),
```

```
    rate_diff = c(NA, diff(bank_rate)),
```

```
    rate_diff_l1 = dplyr::lag(rate_diff, 1),
```

```
    mort_diff_l1 = dplyr::lag(mort_diff, 1)
```

```
  )
```

```
ecm_data <- pt_data %>%
```

```
  drop_na(mort_diff, rate_diff, ect_lag)
```

```
ecm_model <- dynlm(mort_diff ~ mort_diff_l1 + rate_diff + rate_diff_l1 + ect_lag,  
  data = ecm_data)
```

```
ecm_tidy <- broom::tidy(ecm_model, conf.int = TRUE)
```

```
write_csv(ecm_tidy, "outputs/tables/Table5_2a_ECM_pass_through.csv")
```

```
## 5.2.3 Asymmetric ECM ----
```

```
ecm_data <- ecm_data %>%
```

```
  mutate(
```

```
    rate_diff_pos = pmax(rate_diff, 0),
```

```
    rate_diff_neg = pmin(rate_diff, 0)
```

```
  )
```

```

ecm_asym_model <- dynlm(
  mort_diff ~ mort_diff_l1 + rate_diff_pos + rate_diff_neg + ect_lag,
  data = ecm_data
)

ecm_asym_tidy <- broom::tidy(ecm_asym_model, conf.int = TRUE)
write_csv(ecm_asym_tidy, "outputs/tables/Table5_2b_ECM_asymmetric.csv")

## 5.2.4 Cumulative pass-through profile (Figure 5.2) ----
phi <- coef(ecm_model)["mort_diff_l1"]
gamma <- coef(ecm_model)["rate_diff"]

horizons <- 0:12
cum_effect <- gamma * (1 - phi^(horizons + 1)) / (1 - phi)

irf_df <- tibble(
  horizon = horizons,
  cum_d_mort = cum_effect
)

p_irf <- ggplot(irf_df, aes(x = horizon, y = cum_d_mort)) +
  geom_line(linewidth = 0.8) +
  geom_point(size = 1.5) +
  labs(
    title = "Approximate Cumulative Pass-Through of a 1pp Bank Rate Shock",
    x = "Months after shock",

```

```

    y = "Cumulative change in mortgage rate (pp)"
  ) +
  theme_minimal()

ggsave("outputs/figures/Figure5_2_cumulative_pass_through.png", p_irf,
       width = 6, height = 4, dpi = 300)

} else {
  message("Not enough non-missing observations for mort_2y_75ltv and bank_rate
to estimate ECM.")
}

#####
## Volatility, Approvals&Product Mix  ##
#####

vol_data <- data_core %>%
  filter(!is.na(ln_approvals_hp), !is.na(bank_rate_vol_3m)) %>%
  arrange(date) %>%
  mutate(
    ln_approvals_hp_l1 = lag(ln_approvals_hp, 1),
    ln_approvals_oth_l1 = lag(ln_approvals_oth, 1)
  ) %>%
  drop_na(ln_approvals_hp_l1, ln_approvals_oth_l1)

if (nrow(vol_data)>10) {

```

```

mod_hp <- dynlm(
  ln_approvals_hp ~ ln_approvals_hp_l1 + bank_rate + bank_rate_vol_3m,
  data = vol_data
)

mod_oth <- dynlm(
  ln_approvals_oth ~ ln_approvals_oth_l1 + bank_rate + bank_rate_vol_3m,
  data = vol_data
)

modelsummary(
  list("HP approvals" = mod_hp, "Other secured approvals" = mod_oth),
  output = "outputs/tables/Table5_3_approvals_volatility.html",
  statistic = "{std.error}",
  stars = TRUE
)

# Marginal effects plot vs volatility (Figure 5.3)
vol_grid <- tibble(
  bank_rate      = mean(vol_data$bank_rate, na.rm = TRUE),
  bank_rate_vol_3m = seq(
    min(vol_data$bank_rate_vol_3m, na.rm = TRUE),
    max(vol_data$bank_rate_vol_3m, na.rm = TRUE),
    length.out = 50
  ),

```

```

    ln_approvals_hp_l1 = mean(vol_data$ln_approvals_hp, na.rm = TRUE)
  )

  vol_grid$ln_pred_hp <- predict(mod_hp, newdata = vol_grid)
  vol_grid$pred_hp <- exp(vol_grid$ln_pred_hp)

  p_me_vol <- ggplot(vol_grid, aes(x = bank_rate_vol_3m, y = pred_hp)) +
    geom_line(linewidth = 0.8) +
    labs(
      title = "Predicted House-Purchase Approvals vs Bank Rate Volatility",
      x = "3-month realised Bank Rate volatility",
      y = "Predicted approvals"
    ) +
    theme_minimal()

  ggsave("outputs/figures/Figure5_3_predicted_approvals_volatility.png",
    p_me_vol, width = 6, height = 4, dpi = 300)
} else {
  message("Not enough observations with bank_rate_vol_3m and approvals for
volatility models.")
}

#####
## Affordability (National)      ##
#####

```

```

aff_data <- data_core %>%
  filter(!is.na(price_to_income), !is.na(deposit_to_income)) %>%
  arrange(date)

if (nrow(aff_data)>10) {

  mod_pti <- lm(pti_2y75 ~ bank_rate + bank_rate_vol_3m, data = aff_data)
  mod_p2i <- lm(price_to_income ~ bank_rate + bank_rate_vol_3m, data = aff_data)
  mod_d2i <- lm(deposit_to_income ~ bank_rate + bank_rate_vol_3m, data =
aff_data)

  modelsummary(
    list("PTI (2y 75% LTV)" = mod_pti,
        "Price-to-income" = mod_p2i,
        "Deposit-to-income" = mod_d2i),
    output = "outputs/tables/Table5_4_affordability_regressions.html",
    statistic = "{std.error}",
    stars = TRUE
  )

  p_p2i <- ggplot(aff_data, aes(x = date)) +
    geom_line(aes(y = price_to_income), colour = "black") +
    labs(
      title = "UK Price-to-Income Ratio, 2016-2025",
      x = "Date",
      y = "Price / annual income"
    )

```

```

) +
  theme_minimal()

p_pti <- ggplot(aff_data, aes(x = date)) +
  geom_line(aes(y = pti_2y75), colour = "black") +
  labs(
    title = "UK Payment-to-Income (2y 75% LTV, 25-year term)",
    x = "Date",
    y = "PTI"
  ) +
  theme_minimal()

p_aff_combo <- p_p2i / p_pti

ggsave("outputs/figures/Figure5_4_affordability_over_time.png",
       p_aff_combo, width = 7, height = 6, dpi = 300)
} else {
  message("Not enough affordability data (income + prices) for regressions.")
}

#####

## Arrears&Refinancing (Proxy)      ##

#####

# No arrears in this dataset; we treat approvals_other_sa as proxy for other secured
lending

```

```

arf_data <- data_core %>%
  filter(!is.na(ln_approvals_oth), !is.na(bank_rate_vol_3m)) %>%
  arrange(date) %>%
  mutate(
    ln_approvals_oth_l1 = lag(ln_approvals_oth, 1)
  ) %>%
  drop_na(ln_approvals_oth_l1)

if (nrow(arf_data) > 10) {

  mod_arf <- dynlm(
    ln_approvals_oth ~ ln_approvals_oth_l1 + bank_rate + bank_rate_vol_3m,
    data = arf_data
  )

  arf_tidy <- broom::tidy(mod_arf, conf.int = TRUE)
  write_csv(arf_tidy, "outputs/tables/Table5_5_approvals_other_proxy.csv")

  p_arf <- ggplot(arf_data, aes(x = date)) +
    geom_line(aes(y = approvals_other_sa), colour = "black") +
    geom_line(aes(y = approvals_house_purchase_sa), colour = "grey60") +
    labs(
      title = "Other Secured vs House-Purchase Approvals",
      x = "Date",
      y = "Number of approvals"
    )

```

```

) +
  theme_minimal()

ggsave("outputs/figures/Figure5_6_approvals_other_vs_house.png",
       p_arf, width = 7, height = 4, dpi = 300)
} else {
  message("Not enough observations for proxy arrears/remortgage model.")
}

#####

its_data <- data_core %>%
  arrange(date) %>%
  mutate(
    post_charter = if_else(date >= as.Date("2023-08-01"), 1L, 0L),
    time        = time_index,
    time_post    = if_else(post_charter == 1L,
                          time - min(time[post_charter == 1L]) + 1L,
                          0L)
  ) %>%
  filter(!is.na(approvals_house_purchase_sa),
         !is.na(bank_rate),
         !is.na(bank_rate_vol_3m))

if (nrow(its_data) > 10 && any(its_data$post_charter == 1L)) {

```

```

its_data <- its_data %>%
  mutate(ln_approvals_hp = log(approvals_house_purchase_sa))

its_model_hp <- lm(
  ln_approvals_hp ~ time + post_charter + time_post + bank_rate +
bank_rate_vol_3m,
  data = its_data
)

its_tidy_hp <- broom::tidy(its_model_hp, conf.int = TRUE)
write_csv(its_tidy_hp, "outputs/tables/Table5_6_ITS_approvals_hp.csv")

its_data$ln_pred_hp <- predict(its_model_hp, newdata = its_data)
its_data$pred_hp <- exp(its_data$ln_pred_hp)

p_its_hp <- ggplot(its_data, aes(x = date)) +
  geom_line(aes(y = approvals_house_purchase_sa), colour = "black") +
  geom_line(aes(y = pred_hp), colour = "red", linetype = "dashed") +
  geom_vline(xintercept = as.Date("2023-08-01"), linetype = "dotted") +
  labs(
    title = "House-Purchase Approvals Before and After Mortgage Charter",
    x = "Date",
    y = "Approvals"
  ) +
  theme_minimal()

```

```
ggsave("outputs/figures/Figure5_7_ITS_approvals_hp.png",
      p_its_hp, width = 7, height = 4, dpi = 300)
} else {
  message("Not enough data to estimate ITS around Mortgage Charter.")
}

# Zip tables
zip(zipfile = "tables.zip", files = list.files("outputs/tables", full.names = TRUE))

# Zip figures
zip(zipfile = "figures.zip", files = list.files("outputs/figures", full.names = TRUE))

# Zip everything
zip(zipfile = "outputs_all.zip", files = list.files("outputs", recursive = TRUE, full.names = TRUE))
```