Cyclical Attention to Saving

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Abstract

I explore the business-cycle implications of household inattention to savings product choices. In a model with heterogeneous banks, savers pay more attention to their bank choice when the marginal utility of income is high. Consistent with this, in data from the UK retail savings market I find savers more reliably choose products closer to the top of the available interest rate distribution during contractions. Countercyclical attention amplifies shocks to consumption: after contractionary shocks, attention rises, so savers experience higher interest rates, which further reduces consumption. In a quantitative New Keynesian model this amplification increases the variance of consumption by 13.6%.

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In the majority of dynamic macroeconomic models the interest rate is crucial in determining how shocks propagate through the economy, in part because it regulates the consumption of intertemporally maximizing households. The interest rate is usually taken as given by households in these models, but regulators have noted that in reality savers face a range of rate-bearing products, and that they could increase the interest rate they earn on their savings by 'shopping around' for the best product (Financial Conduct Authority, 2015).

In this paper I ask if the extent of shopping around, or *attention* to product choice, varies systematically with the business cycle. I find in both theory and data that attention is countercyclical. This substantially amplifies shocks in an estimated business cycle model, because of the effects of attention on the interest rate that households experience.

I first develop a simple model to explore the interaction of rationally inattentive savers and deposit-taking banks. Profit-maximizing banks face heterogeneous costs, and in the face of incomplete attention from savers they offer heterogeneous interest rates. If a household pays more attention, they increase their probability of choosing a bank offering a high interest rate, and so they increase the average interest rate they face. The key drivers of attention in this environment are the marginal utility of future income and the extent of interest rate dispersion.

The marginal utility of income drives the countercyclical behavior of attention, which in turn implies that variable attention amplifies business cycle fluctuations. Consider, for example, a shock that causes consumption to fall. The marginal utility of income rises, and so households pay more attention to their choice of savings product: intuitively, it becomes more important to extract every possible dollar of interest income out of their savings, and so they pay more attention in order to achieve that. That means they face higher interest rates relative to the distribution of offered rates. In addition, with all savers paying more attention the deposit market is more competitive, causing banks to offer higher interest rates. Through two channels, the household therefore faces higher interest rates than they would have done if attention had stayed constant, and higher interest rates cause consumption to fall even further through a standard consumption Euler equation. Countercyclical attention therefore amplifies the consumption fall.

I find evidence of countercyclical attention to savings using a novel combination of data on savings markets in the UK. Detailed product-level data reveals substantial dispersion in the interest rates banks offer on a set of extremely similar products at any point in time. Linking this with data on the average interest rates achieved by savers opening new products in this set, I show that savers on average choose products higher up in the interest rate distribution in contractions, as predicted by the model. For this analysis I focus on fixed interest rate products, as their simplicity gives me the best chance of ruling out that rate dispersion and saver decisions are being driven by unobservable product differentiation. This should be viewed as a useful laboratory in which to study household behavior; none of the mechanisms I explore are specific to this market or to the UK.

The existence of interest rate dispersion is an important prerequisite for attention to affect the interest rate households face. I obtain panel data on the savings products available in the UK by digitizing monthly editions of Moneyfacts, a magazine for UK financial advisers. There is substantial dispersion in offered interest rates even among products which are identical across the wide range of product features reported. Considering institutional details of the UK savings market, I argue that unobserved product heterogeneity is unlikely to explain the majority of this dispersion. Instead, I argue that much of this interest rate dispersion persists in equilibrium because of an information friction: it is costly for households to acquire information about the set of products on offer. The existence of the Moneyfacts data is itself a justification for the information cost interpretation. Financial advisers (and indeed the Bank of England and several other regulators) would not need to pay for such a magazine if the information was easy to obtain elsewhere.[1]

The model predicts that savers should experience higher interest rates relative to this distribution of offered rates in contractions, as they increase attention. This is precisely what I find in the data. Data from the Bank of England gives the average interest rate achieved on new accounts opened each month for specific sets of savings products with particular characteristics. Identifying the set of products with those characteristics in the Moneyfacts data, I find that the position of the rate households achieve within the distribution of offers is indeed countercyclical. When the unemployment rate is high, and the level of average interest rates in the market is low, households on average choose products that are higher up within the distribution of interest rates.

To quantify the importance of countercyclical attention for shock transmission, I build a medium-scale small open economy New Keynesian model of the UK, featuring many of the frictions that have become standard in quantitative macroeconomics. To this I add the interaction from the simple model: heterogeneous banks sell domestic bonds to rationally inattentive households. I estimate the model using standard macroeconomic data and key series from the savings data in the empirical part of the paper.

This quantitative exercise is possible because of the novel theoretical approach developed in the simple model. Existing macroeconomic models with limited shopping around for prices or interest rates (e.g. McKay, 2013; Kaplan and Menzio, 2016) mostly have households engaging in costly search following Burdett and Judd (1983), which outside

[1] The UK financial regulator found that shopping around decisions were indeed driven by an analysis of the costs and benefits, including time spent shopping and likely interest rate gains (Cook et al., 2002).

of simple cases are not usually tractable enough to estimate. I retain many of the qualitative features of the Burdett-Judd model, while keeping the model sufficiently tractable that the interaction of households and banks can be embedded into a quantitative DSGE model, and solved and estimated using standard techniques.

I find that variable attention amplifies the consumption impact of most shocks, as in the simple model. This effect is substantial: the consumption response in the estimated model (cumulated over a year) to risk premium and TFP shocks is 25% and 20% larger respectively than if attention is held at steady state. These two shocks explain approximately two-thirds of consumption volatility. Overall, the variance of consumption is 13.6% larger in the baseline model than if variable attention is shut off in this way.

The presence of this amplification has an important policy implication. The extra volatility due to variable attention can be reduced if the marginal cost of information is reduced. Halving the cost of information reduces the variance of consumption by 11%. Policies aimed at providing households with information and facilitating easy product comparisons in this market could therefore lead to lower business cycle volatility.

An additional implication of countercyclical attention is that it can explain a portion of the risk premium shocks typically found to be important in estimated macroeconomic models. Changes in attention affect the model in the same way as risk premium shocks: they change the interest rate faced by the household relative to the policy rate from the central bank. The difference is that attention is an endogenous choice variable. It is not that risk premium shocks cause recessions, but that other kinds of contractionary shock cause attention to rise. Compared with an estimated full-information version of the model, risk premium shocks in the baseline model account for 23% and 33% less of the variance of output and consumption respectively. The extra volatility is largely attributed to supply shocks, notably TFP and price markup shocks. There is also a greater role given to government spending shocks.

Related Literature. There is a large literature studying how information frictions affect the business cycle. Many of these papers study frictions in the information agents receive about continuously distributed exogenous shocks (e.g. Maćkowiak and Wiederholt, 2015),[2] or about the reaction functions of other agents and the relationships of endogenous variables to shocks (e.g. Eusepi and Preston, 2011). Unlike these papers, the friction I study is over the discrete choice of which bank to use for saving each period.

Similar frictions have been studied in a wide range of papers on the role of information and inattention in portfolio choice. A literature starting with Arrow (1987) finds that information frictions are an important determinant of wealth inequality, as wealthier

[2] In most such models tracking exogenous or endogenous variables are equivalent as agents can perfectly map between them. For a review of several of these models see Hubert and Ricco (2018).

households optimally process more information about saving and investment choices, so make better choices and earn higher rates of return on average.[3] In a companion paper, I study the implications of this for the transmission of fiscal policy (Macaulay, 2021). Rational inattention can also account for several other observed features of portfolio choices, such as home bias and under-diversification (Van Nieuwerburgh and Veldkamp, 2009, 2010), and contagion between markets with unrelated fundamentals (Mondria and Quintana-Domeque, 2013). My focus is on cyclical changes in information processing, which also feature in Kacperczyk et al. (2016) and Rachedi (2018). I extend this literature by showing that cyclical changes in household information processing can feed back into the business cycle, amplifying the effect of shocks to consumption.[4]

Specifically, I model the information friction in deposit markets as a discrete choice rational inattention problem, drawing on Matějka and McKay (2012, 2015). This form of inattention has been used to study import decisions (Dasgupta and Mondria, 2018), hiring (Acharya and Wee, 2020), and capacity utilization (Sun, 2020).[5]

Other papers studying the role of rational inattention in consumption behavior have modeled consumers who are inattentive about their wealth or permanent income (Sims, 2003; Luo, 2008; Tutino, 2013), or about aggregate fundamentals (Maćkowiak and Wiederholt, 2015). In these models, households assume there are true realizations of assets and interest rates that they cannot affect, and must decide how much information to gather about those realizations. As a result, inattention implies consumers make suboptimal consumption decisions given prices and their wealth, as studied more generally in Lian (2023). In contrast, in the model in this paper households observe the interest rate they face before choosing consumption and saving, but increasing attention leads to increases in that rate, as they make fewer mistakes in their choice of savings product. The households are able to choose consumption optimally given this and other prices and state variables. While this paper therefore shares the idea in Maćkowiak and Wiederholt (2015) that households may have little incentive to pay attention to real interest rates, the form of the inattention studied, and the resulting implications, are different.

Another way of modeling the friction in financial product choice would be to use costly search or shopping effort. Coibion et al. (2015) find that households spend more time and effort shopping for groceries when unemployment rises, echoing my findings for attention

[3] Campanale (2007), Kacperczyk et al. (2019), Lei (2019) (among others) find that this is quantitatively important in explaining observed features of the wealth distribution over time.

[4] Flynn and Sastry (2021) and Song and Stern (2021) observe similar countercyclical patterns in firm attention to macroeconomic news, and derive business cycle implications.

[5] See Maćkowiak et al. (2023) for a review of this literature. The model in Sun (2020) is similar to mine, in that buyers are inattentive to their goods choices. However, in equilibrium there is no price dispersion, and so attention is always zero in his model. The variation in attention and the reaction of the equilibrium price distribution in this paper is novel, to the best of my knowledge.

to savings product choices. Similarly, since unemployed households search harder for low goods prices, average search effort rises in recessions (Kaplan and Menzio, 2016). The choice of how much attention to pay to the savings product choice in this paper can be seen as an extension of this literature to financial products, which have particular importance for the business cycle as they influence the intertemporal allocation of consumption.[6]

I also contribute to the literature on the importance of deposit market frictions for the business cycle. Diebold and Sharpe (1990) and Driscoll and Judson (2013) document significant stickiness in the pass-through from wholesale interest rates to retail deposit rates. Drechsler et al. (2017) find that this limited pass-through is critical in the transmission of monetary policy, through the effects of policy on bank balance sheets. The mechanism I explore focuses on the effects of deposit frictions on households through their intertemporal consumption decisions, so is a complement to this channel.

Yankov (2024) finds that search (or information) frictions can explain this limited pass-through in the US market for certificates of deposit, using a model based on Burdett and Judd (1983). While Yankov (2024) uses data similar to the Moneyfacts data used in this paper, I differ from his work in combining that with data on how savers choose between products, and how their attention behavior interacts with the business cycle. Evidence of substantial inattention in retail financial markets can also be found in Martín-Oliver et al. (2009), Branzoli (2016), Deuflhard et al. (2019), and Adams et al. (2021) (among others). I extend this literature by studying how that inattention varies over the business cycle, and showing the macroeconomic consequences of that variation.

Finally, I contribute to the literature on the drivers of the business cycle, by showing that countercyclical attention provides a structural interpretation for a portion of the risk premium shock that is commonly found to be important in estimated macroeconomic models (e.g. Smets and Wouters, 2007; Christiano et al., 2015). Attention, however, is not exogenous, but is a response to other variables.

The rest of the paper is organized as follows: I develop a partial equilibrium model of rationally inattentive households interacting with heterogeneous banks in Section I. In Section II I detail the data sources I use, and some institutional background on UK savings markets. I examine this data, showing the dispersion in interest rates and studying household choices within that distribution in Section III. In Section IV I quantify the impact of variable attention on the business cycle by estimating a medium-scale New Keynesian model of the UK incorporating the interaction modeled in Section I. Section V concludes.

[6] McKay (2013) also studies a model of search for higher interest rates, but he does not consider how this changes over the business cycle. In Appendix C.1 I show that a model of endogenous search effort gives the same qualitative implications as in the main body of the paper.

I Partial Equilibrium Model

I.A Savings Products

There are $N \geq 2$ banks. Each period t, each bank n buys bonds from the government and sells them on to individuals, both at price 1. In the next period, the government pays the bank $1 + i_t^{CB}$ per bond bought, and the bank pays $1 + i_t^n$ to the individuals it sold to. Bank n also pays a transaction cost χ_t^n per bond. In this partial equilibrium exercise the policy rate is exogenous, but it is endogenous in the quantitative model in Section IV.

Bank n chooses the interest rate they offer to individuals i_t^n to maximize profits, taking into account that their market share will depend on how their interest rate compares with the distribution of rates offered by the other banks. All individuals are identical, and will choose one bank each per period, so the market share equals the probability a saver chooses that bank. Denoting the probability a saver chooses bank n for a given interest rate distribution as $\Pr(n|i_t^n, i_t^{-n})$, the bank problem is:

$$i_t^n = \arg\max_{\hat{i}_t^n} \Pr(n|\hat{i}_t^n, i_t^{-n}) \cdot (i_t^{CB} - i_t^n - \chi_t^n) \tag{1}$$

This gives the first order condition:

$$\frac{d}{di_t^n} \Pr(n|i_t^n, i_t^{-n}) \cdot (i_t^{CB} - i_t^n - \chi_t^n) = \Pr(n|i_t^n, i_t^{-n}) \tag{2}$$

The probability function $\Pr(n|i_t^n, i_t^{-n})$ is derived in Section I.C. The resulting function is twice continuously differentiable in i_t^n, and such that equation 2 is sufficient for profit maximization.

Throughout, I will assume that the costs χ_t^n differ across banks. In equilibrium this will create dispersion in interest rates, as a bank with higher costs will choose lower interest rates, accepting a lower market share to prevent a larger fall in their markup. I assume that these costs are random variables, but for the moment do not place any structure on their distribution.

I.B Households

There is a large representative household composed of many individuals. Each period the household decides how much each individual will consume and save, and how much attention they will pay to the choice of savings products, to maximize expected lifetime utility. As in the rational inattention literature, 'attention' in this model refers to information processing, in this case about which banks are offering the highest interest rates that period. I assume the household is a net saver, so prefers to choose banks offering higher rates.

All asset income is redistributed among individuals each period, so there is no inequality within the household. Before choosing a bank (Section I.C), all individuals are therefore identical, so the household makes one saving and attention choice for all. The interest rate the household faces across all of their saving is therefore the expected interest rate achieved across individuals, which I refer to as the 'effective interest rate' i_t^e. The household problem is therefore:

$$\max_{c_t, b_t, \mathbb{E}_s i_t^e} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \big(u(c_t) - \mu \mathcal{I}(\mathbb{E}_s i_t^e)\big) \tag{3}$$

subject to

$$c_t + b_t = b_{t-1}(1 + i_{t-1}^e) + y_t \tag{4}$$

where c_t is consumption, b_t is real bond holdings, and y_t is exogenous income.

The novel element of this problem is the term $\mathcal{I}(\mathbb{E}_s i_t^e)$, the amount of attention required for the household to earn an expected effective interest rate $\mathbb{E}_s i_t^e$ on assets bought in period t (which pay off in $t+1$). This expectation is taken over states of the world s, where a realized state of the world s_t summarizes the interest rates offered by each bank that period, which the household takes as given. For a given state of the world, the assumption of a large household of many individuals ensures that there is no uncertainty in the effective interest rate.

The properties of $\mathcal{I}(\mathbb{E}_s i_t^e)$ are therefore central to household attention choices. We initially suppose that:

$$\mathcal{I}'(\mathbb{E}_s i_t^e) > 0, \quad \mathcal{I}''(\mathbb{E}_s i_t^e) > 0 \tag{5}$$

That is, if the household pays more attention they will earn a higher expected rate of interest, but the interest rate gain from more attention diminishes as attention grows. We will verify that these properties arise from the individual bank choice problem below (Section I.C).

Households choose how much attention to pay by balancing the expected future marginal utility of higher interest income with the costs of attention, which are modeled here as an additively separable utility cost with a constant marginal cost $\mu > 0$ (as in e.g. Woodford, 2009; Kamdar, 2019). This can be thought of as costly cognitive effort.

In Appendix C.1 I show that a monetary cost leads to the same qualitative conclusions.

In the maximization above I allow the household to directly choose the expected effective interest rate they face. This is equivalent to choosing the amount of attention to pay as there is a one-to-one mapping between the two variables (see Appendix A.3). Household behavior is described by an Euler equation and a first order condition on the effective interest rate:

Proposition 1 *The first order conditions for the household problem (equations 3-5) are:*

$$u'(c_t) = \beta \mathbb{E}_t(1 + i_t^e)u'(c_{t+1}) \tag{6}$$

$$\beta b_t \mathbb{E}_t u'(c_{t+1}) = \mu \mathcal{I}'(\mathbb{E}_s i_t^e) \tag{7}$$

These are sufficient for utility maximization if:

$$b_t < \bar{b}_t \tag{8}$$

where the threshold $\bar{b}_t$ is defined in Appendix A.1.

Proof. Appendix A.1. ■

The first order condition on effective interest rates (7) is crucial in understanding this model. It shows that households choose attention to equalize the marginal utility of higher asset returns next period with the marginal cost of the attention required to achieve it. The marginal utility of higher asset returns is simply the marginal utility of income in the next period multiplied by the amount saved. Attention therefore rises when consumption is expected to be low, as then the marginal utility of future income rises. It is marginal utility in $t + 1$ that matters because that is when bonds bought in period t pay out.

Attention also rises when the marginal information needed to increase effective interest rates ($\mathcal{I}'(\mathbb{E}_s i_t^e)$) falls, as this reduces the marginal cost of increasing asset income. In Section I.C I show that this marginal cost falls when interest rate dispersion rises, so attention rises with rate dispersion.

Finally, equation 7 also implies that, all else equal, a wealthy household with large b_t will choose to process more information than a poorer one. This is because, with more assets, those households experience a greater income gain from increasing i_t^e (as in Arrow, 1987). As a household saves more, they therefore increase attention, and so face higher interest rates. This in turn encourages further saving through the Euler equation (6). Condition 8 ensures that the resulting non-concavity is small enough that the first order conditions remain sufficient for utility maximization, and is easily satisfied at plausible parameters.[7] Since households are net savers (government bonds are in positive net supply), $b_t > 0$ and the household always chooses to process some information.

I.C Individuals

Since all asset income is redistributed around the household each period, individuals are risk neutral with respect to interest rates: their payoff depends only on the expected interest rate. There is therefore no incentive for them to diversify beyond a single bank, so I model individuals as facing a discrete choice rational inattention problem (as in Matějka and McKay, 2012, 2015). Risk neutrality also implies that the objective function in the bank choice problem is simply the expected interest rate.

Individuals start the period with a prior belief about the probabilities of different states of the world. They share information on returning to the household at the end of the period, so all individuals have the same priors. Let $\mathcal{P}_{n,t}$ denote the probability that an individual would choose bank n if they were to process no information and rely only on their priors. Following Steiner et al. (2017) I refer to this as the 'predisposition' towards bank n.

Before they choose a bank, however, individuals augment their priors by processing some information about the interest rates offered at each bank. In principle, they have access to an infinite set of such information. If an individual processed enough of that information before making their bank choice - if they paid enough attention - they would therefore be able to precisely identify the best interest rate in the market and choose it with probability 1. However, because attention is costly, the household chooses to limit the amount of information each individual can process before choosing their bank. I further assume that individuals cannot share information within the period.

There are therefore two challenges facing an individual. Using terminology from Matějka and McKay (2015), an individual must decide on an *information strategy* (what kinds of information to process given their limited attention capacity) and an *action strategy* (how to translate that information into a bank choice). Formally, we can write this as the individual choosing the joint distribution of a noisy signal and the true distribution of interest rates among banks, subject to a constraint on the amount of information about the bank distribution the signal can contain. The individual then observes a realization from that noisy signal, updates their beliefs and chooses a bank. The quantity of infor-

[7] The interaction between attention and wealth implies that, with the addition of a no-borrowing constraint, the model has two steady states: one with identical households and another in which some households are wealthy and attentive, while others remain at the borrowing constraint paying no attention. As the data in Section III is only informative about average household choices, I study the model with identical households. See Macaulay (2021) for analysis of the two-agent steady state in a related model.

mation embodied in a particular signal structure is defined (following Sims, 2003) as the expected reduction in entropy between the prior and posterior beliefs about the state of the world from observing a realization of that signal.

Using Lemma 1 from Matějka and McKay (2015), we can leave the belief distributions and signal structures in the background, and rewrite the individual's problem in terms of conditional choice probabilities. The individual's maximization problem becomes:

$$\max_{\Pr(n|s_t)} \mathbb{E}_s \sum_{n=1}^{N} i_t^n(s_t) \Pr(n|s_t) \text{ subject to} \tag{9}$$

$$\mathcal{I}_t = -\sum_{n=1}^{N} \mathcal{P}_{n,t} \log(\mathcal{P}_{n,t}) + \mathbb{E}_s \sum_{n=1}^{N} \Pr(n|s_t) \log(\Pr(n|s_t)) \tag{10}$$

where $\Pr(n|s_t)$ is the probability that the individual chooses bank n in state of the world s_t, and the amount of attention $\mathcal{I}_t$ is fixed in the household problem. The individual therefore chooses a decision rule (a set of conditional choice probabilities for each possible s_t) to maximize their expected interest rate, subject to the constraint that $\Pr(n|s_t)$ cannot deviate too far from the predisposition $\mathcal{P}_{n,t}$. The more attention the household allows individuals to pay, the more their conditional choice probabilities can deviate from these predispositions, towards the unconstrained choice rule in which $\Pr(n|s_t) = 1$ if bank n offers the highest interest rate in state s_t, and $\Pr(n|s_t) = 0$ otherwise.

Solving the individual's rational inattention problem gives the following multinomial logit choice rule:

$$\Pr(n|i_t^n, i_t^{-n}) = \frac{\mathcal{P}_{n,t} \exp(\frac{i_t^n}{\lambda_t})}{\sum_{k=1}^{N} \mathcal{P}_{k,t} \exp(\frac{i_t^k}{\lambda_t})} \tag{11}$$

where λ_t is the Lagrange multiplier on the attention constraint 10 in the individual problem, or the shadow value of information. To ensure this solution is well-defined, we restrict the model to cases in which $\lambda_t > 0$. The implications of this are discussed in Section I.D below.

In what follows, it will be useful to note that $\partial\lambda_t/\partial\mathcal{I}_t < 0$: as the household increases attention, holding all else equal the constraint becomes less binding and the shadow value of information falls (see Appendix A.2). Note that to simplify notation I have replaced s_t with the realized interest rate distribution in time t, made up of the rate offered by bank n and the rates at all of their competitors.

The effective interest rate i_t^e is then given by:

$$
\begin{aligned}
i_t^e &= \sum_{k=1}^{N} i_t^k \Pr(k|i_t^k, i_t^{-k}) \\
&= \frac{\sum_{k=1}^{N} i_t^k \mathcal{P}_{k,t} \exp(\frac{i_t^k}{\lambda_t})}{\sum_{k=1}^{N} \mathcal{P}_{k,t} \exp(\frac{i_t^k}{\lambda_t})}
\end{aligned} \tag{12}
$$

This leads to the two key properties of the household information problem in Condition 5.

Proposition 2 *With the individual bank choice problem in equations 9-10, and the effective interest rate defined as in equation 12, the information required to achieve a given* i_t^e *is such that:*

$$\mathcal{I}'(\mathbb{E}_s i_t^e) = \lambda_t^{-1} > 0 \tag{13}$$

and:

$$\mathcal{I}''(\mathbb{E}_s i_t^e) > 0 \tag{14}$$

Proof. Appendix A.3. ■

Intuitively, as attention increases (λ_t falls), individuals successfully choose higher interest rate banks with a greater probability, and so the effective rate experienced by the household rises. Achieving a higher effective interest rate therefore requires more attention. Diminishing returns to that attention ensure that $\mathcal{I}''(\mathbb{E}_s i_t^e) > 0$.

The predispositions allow for substantial flexibility in this model. If there is some reason, aside from the current interest rate, for individuals to be more likely to choose one bank than another, that can simply be incorporated into $\mathcal{P}_{n,t}$. The model can therefore incorporate some banks having more 'brand recognition' than others, and so attracting inattentive individuals with a higher probability.[8] Cognitive switching costs can be included by specifying greater predispositions to staying with the previous period's choice. Finally, the model can allow for persistence in the ordering of banks within the rate distribution, in which case knowledge of past states of the world is informative about the current state, and so affects the prior probability of choosing particular banks.

I study the case of persistence in bank costs, and so in the positions of banks within the interest rate distribution, in Appendix B.1. For the modeling in the main body of the paper however I assume for simplicity that no bank has more brand power than any

[8]This would take the model away from purely 'rational' inattention, as information choice and choice probabilities would no longer be optimal given priors.

other, and that bank costs have no persistence, which implies that there is no persistence in the ranking of banks within the rate distribution.[9] This means that for any distribution of interest rates, each bank is equally likely to occupy each position within that distribution, meaning that banks are interchangeable in individual priors. The predispositions therefore all equal $1/N$, and the conditional choice probabilities and effective interest rate become:[10]

$$\Pr(n|i_t^n, i_t^{-n}) = \frac{\exp(\frac{i_t^n}{\lambda_t})}{\sum_{k=1}^{N}\exp(\frac{i_t^k}{\lambda_t})} \tag{15}$$

$$i_t^e = \frac{\sum_{k=1}^{N} i_t^k \exp(\frac{i_t^k}{\lambda_t})}{\sum_{k=1}^{N}\exp(\frac{i_t^k}{\lambda_t})} \tag{16}$$

The conditional choice probabilities therefore mirror those in a standard logit oligopoly model (Anderson et al., 1992), with the important addition that λ_t arises endogenously from household choices, and therefore varies over time.

Finally, I assume that the distribution of bank costs χ_t^n is the same each period, with the only variation being in which bank draws which cost. This ensures that the effective interest rate i_t^e is unaffected by the specific draws of bank costs. Intuitively, we can think of this assumption as being that each period, a ranking of banks is drawn from an i.i.d. distribution, and then that bank costs are a deterministic function of these rankings. This simplifies the household problem as the expectations operator within $\mathcal{I}(\mathbb{E}_s i_t^e)$ becomes redundant.

After this simplification, the effect of interest rate dispersion on attention can be seen in a corollary of Proposition 2.

Corollary 1 *A mean-preserving spread of interest rates replaces each i_t^n with:*

$$\tilde{i}_t^n = k(i_t^n - \bar{i}_t) + \bar{i}_t \tag{17}$$

where $k > 1$ is a constant and $\bar{i}_t$ is the unconditional mean interest rate:

$$\bar{i}_t = \frac{1}{N}\sum_{n=1}^{N} i_t^n \tag{18}$$

[9] There is in fact little persistence in bank interest rate rankings for the products studied in Section III (see Appendix B.2), though this may not be true of all assets. The Burdett-Judd models common in this literature also have no persistence, as all price-setters follow identical mixed strategies.

[10] A similar case is studied in Matějka and McKay (2012) Section C. This assumption also removes the possibility that individuals exclude some banks from their consideration set, as in Caplin et al. (2019).

At constant attention, this transformation strictly increases λ_t, and strictly decreases $\mathcal{I}'(i_t^e)$.

Proof. Appendix A.4. ■

When interest rates get more dispersed, small improvements in the probability of choosing higher interest rate banks have a larger effect on the effective interest rate. Achieving a marginal rise in i_t^e therefore requires less additional information. In equation 7, the resulting fall in $\mathcal{I}'(\mathbb{E}_s i_t^e)$ implies an increase in attention.

I.D Equilibrium

Given exogenous draws of y_t, χ_t^n, and i_t^{CB}, an equilibrium consists of values for $\{c_t, b_t, \lambda_t, i_t^e, i_t^n\}$ such that:

1. *Individuals* maximize the effective interest rate i_t^e subject to the household's chosen level of attention, yielding choice probabilities as in equation 15, and i_t^e as in equation 16.
2. *Households* maximize expected utility net of attention costs, choosing c_t and b_t, and setting attention $\mathcal{I}_t$ to achieve their chosen i_t^e, according to equations 4, 6, and 7. The attention choice implicitly defines the shadow value of attention λ_t (equation 13).
3. *Banks* maximize profits, setting i_t^n according to equation 2.

The bank condition was left in Section I.A in terms of the probability of savers choosing each bank. Substituting in the conditional choice probabilities from equation 15 this becomes:

$$\left(1 - \frac{\exp(\frac{i_t^n}{\lambda_t})}{\sum_{k=1}^{N} \exp(\frac{i_t^k}{\lambda_t})}\right) \cdot (i_t^{CB} - i_t^n - \chi_t^n) = \lambda_t \tag{19}$$

This mirrors the pricing rule in a standard logit oligopoly model. For given values of $\lambda_t, i_t^{CB}, \chi_t^n$, equations 15 and 19 therefore define the unique equilibrium for interest rates (Anderson et al., 1992). Proposition 1 then ensures that the household first order conditions are the unique solution to the utility maximization problem, implying a unique λ_t. Equilibrium therefore exists, and is unique.

Since we consider $\mu > 0$ and $b_t > 0$, the first order condition 7 implies $\mathcal{I}'(i_t^e) > 0$. In turn, equation 13 implies $\lambda_t > 0$. That is, the shadow value of information is always positive, because the individuals are at their information constraint. This means we are only considering situations where individuals have less than complete information: they do not identify the highest interest rate bank with certainty. This restriction is necessary here as equations 15 and 16 are not well defined with $\lambda_t = 0$.[11]

Note that if we allowed $\lambda_t = 0$, there would be another equilibrium in which all banks offer identical interest rates, and so households have no incentive to pay attention.[12] Since interest rate dispersion is a robust feature of the data, we abstract from this equilibrium, and focus on the equilibrium with interest rate dispersion and $\lambda_t > 0$.

Finally, as $\lambda_t > 0$, the equilibrium offered interest rates i_t^n are bounded above by $i_t^{CB} - \chi_t^n$, and all banks make positive profits. As this is not a full general equilibrium model (y_t, χ_t^n, and i_t^{CB} are left exogenous) I do not specify who receives the bank profits and in what form. In the quantitative model in Section IV bank profits are returned to households as a lump sum.

I.E Implications

To analyse the role of attention in shock transmission, it is first helpful to establish how equilibrium interest rate offers change with attention.

Lemma 1 *With interest rates set according to equation 19, then:*

$$\frac{\partial i_t^n}{\partial \lambda_t} < 0 \text{ for all } n \tag{20}$$

if:

$$\lambda_t > \underline{\lambda} \tag{21}$$

where the threshold $\underline{\lambda}$ is defined in Appendix A.5.

Proof. Appendix A.5. ■

When attention rises, λ_t falls, and the distribution of interest rates shifts up. Intuitively, higher attention means that the demand facing an individual bank becomes more elastic to changes in that bank's interest rate relative to their competitors, as choice probabilities can depend more on specific realizations of interest rates. With more elastic demand, markups decrease, and so the interest rates offered to households rise relative to the policy rate. Furthermore, each bank wants to increase their interest rates to keep pace with rate rises at their competitors, because interest rates are strategic complements

[11] As $\mu \to 0$, equation 22 implies $\lambda_t \to 0$, and the model approaches Bertrand competition among banks with heterogeneous costs.

[12] Formally, with zero interest rate dispersion we have $\mathcal{I}'(i_t^e) = \infty$, and so $\mathcal{I}''(i_t^e)$ is undefined (Proposition 2 does not apply). Condition 5 fails, and equation 7 therefore ceases to be part of household optimization. In this case banks act as monopolists facing inelastic demand from individuals, so set interest rates to $-\infty$, or to a finite interest rate lower bound if one is imposed.

in this market. This holds as long as λ_t is not too low, though note this condition is not restrictive at plausible parameters.[13]

Next, note we can write the household first order condition on attention as:

$$\beta b_t \mathbb{E}_t u'(c_{t+1}) = \mu \lambda_t^{-1} \tag{22}$$

Holding current saving b_t constant, a shock z_t that reduces future consumption therefore affects attention according to:

$$\frac{\partial \lambda_t}{\partial z_t} = -\mathbb{E}_t \frac{\beta b_t \lambda_t^2 u''(c_{t+1})}{\mu} \frac{\partial c_{t+1}}{\partial z_t} < 0 \tag{23}$$

Households increase attention, because the marginal utility of interest income rises. This affects effective interest rates through two channels.

Proposition 3 *Writing i_t^e as:*

$$i_t^e = \sum_{n=1}^{N} \Pr(n|s_t) i_t^n \tag{24}$$

we have:

$$\begin{aligned} \frac{\partial i_t^e}{\partial z_t} &= \left[\sum_{n=1}^{N} \frac{\partial \Pr(n|s_t)}{\partial \lambda_t} i_t^n + \sum_{n=1}^{N} \Pr(n|s_t) \frac{\partial i_t^n}{\partial \lambda_t} \right] \frac{\partial \lambda_t}{\partial z_t} \\ &= \left[-\frac{1}{\lambda_t^2} Var^e(i_t^n) + \sum_{n=1}^{N} \Pr(n|s_t) \frac{\partial i_t^n}{\partial \lambda_t} \right] \frac{\partial \lambda_t}{\partial z_t} \end{aligned} \tag{25}$$

where $Var^e(i_t^n)$ is defined as:

$$Var^e(i_t^n) = \sum_{n=1}^{N} \Pr(n|s_t) \cdot (i_t^n - i_t^e)^2 > 0 \tag{26}$$

Both terms inside the square brackets in equation 25 are strictly negative.

Proof. Appendix A.6. ■

First, the probability of an individual choosing high interest rate banks rises, increasing the effective interest rate relative to the distribution of rates on offer. Second, the

[13] In Appendix A.5 I also show that interest rate dispersion falls when attention rises with $N = 2$ banks in the market. If we additionally impose an interest rate lower bound (akin to the reservation price in Burdett and Judd (1983)), then at very low levels of attention price dispersion is increasing in attention as rates begin to rise above the bound. Numerically, the same is true for $N > 2$ banks. Qualitatively, a rise in attention therefore has the same effect as a rise in search effort in Burdett and Judd (1983).

increased competition in the deposit market causes banks to increase the interest rates they offer, so the rate distribution shifts up. Both channels therefore imply that the contractionary shock z_t leads to higher effective interest rates.

Through the consumption Euler equation (6), this encourages households to delay consumption, and so current consumption falls by even more than it would have done without an attention change. Variable attention therefore amplifies shocks to consumption, unless the shock also reduces interest rate dispersion through other channels so much that attention actually falls. In Section IV I find that this is rare, so on average variable attention amplifies the consumption effect of shocks.

Note that this mechanism would be further amplified if the fall in consumption generates greater savings b_t, as this implies a further incentive to pay more attention to savings choices.[14] This is the focus of Macaulay (2021). I abstract away from it here because the quantitative model below features a representative agent, so the level of saving in equilibrium is determined by the exogenous supply of bonds from the government, which is unaffected by attention variation.

I.F Extension: Attention to Borrowing

The model so far has focused on attention to the choice between saving products. I now extend this to consider attention to borrowing. As with saving, paying attention to the interest rates offered on different borrowing products can impact the interest rate households face. The difference, however, is that extra processed information helps households to reduce the interest rate they face on borrowing.

To explore how this affects the conclusions above, I extend the model to include debt. In addition to savings, households hold a fixed quantity of debt d every period, and that debt comes with an effective interest rate of i_t^{ed}. As with savings, individuals within the household each choose a bank for their portion of household debt, and they face a rational inattention problem in doing so. In contrast to saving choices, household income is decreasing in i_t^{ed}, so more attention allows individuals to identify and choose banks offering lower interest rates. For simplicity, I assume that information about borrowing rates carries the same marginal cost μ as information about saving, and I keep to the case with uninformative priors and a constant bank cost distribution, as in Section I.E.

As the household and individual problems are very similar to those in sections I.A-I.C, I leave the details of the full extended model to Appendix C.2. The household first order

[14]Note this only amplifies the rise in attention as long as the greater savings in period t are not used to fund a large rise in c_{t+1}, as that would reduce the marginal utility of future income and potentially offset the direct effect of higher b_t in equation 7. The argument here therefore relies on a sufficient degree of consumption smoothing.

conditions consist of the same Euler equation and first order condition on attention to saving as before (equations 6 and 22), along with a first order condition on attention to borrowing:

$$\beta d \mathbb{E}_t u'(c_{t+1}) = \mu(\lambda_t^d)^{-1} \tag{27}$$

where λ_t^d is the shadow value of information about borrowing products. This has exactly the same form as equation 22 for saving products, with the same implications. Attention to borrowing rises when the amount of borrowing d increases, and when the marginal utility of future income is expected to be high. As with saving, we should therefore expect attention to borrowing to rise in contractions.

The key difference is that for borrowing, more attention corresponds to *lower* effective interest rates. Solving the individual's rational inattention problem as for saving products, the probability of choosing bank n for borrowing is given by:

$$\Pr(n|i_t^{nd}, i_t^{-nd}) = \frac{\exp(-\frac{i_t^{nd}}{\lambda_t^d})}{\sum_{k=1}^{N^d} \exp(-\frac{i_t^{kd}}{\lambda_t^d})} \tag{28}$$

where i_t^{nd} is the interest rate offered on borrowing by bank n, and $N^d \geq 2$ is the number of lenders in the market.

Loans are made by separate banks from those that take deposits. This simplifies the analysis, as the existence of debt then has no effect on the savings market, except possibly indirectly through aggregate conditions. Lenders raise funds at a cost of i_t^{CB}, and face a transaction cost per unit of lending of χ_t^{nd}. They choose the interest rate on their loans i_t^{nd} to maximize profits, subject to individual choice probabilities (equation 28). Their structure is therefore similar to those for deposit banks (Section I.A), except that markups increase in $i_t^{nd} - i_t^{CB}$ rather than decrease. Profit maximization for bank n implies:

$$\left(1 - \frac{\exp(-\frac{i_t^{nd}}{\lambda_t^d})}{\sum_{k=1}^{N^d} \exp(-\frac{i_t^{kd}}{\lambda_t^d})}\right) \cdot (i_t^{nd} - i_t^{CB} - \chi_t^{nd}) = \lambda_t^d \tag{29}$$

This has the same form as equation 19 in the saving market.

Overall, equilibrium in the borrowing market is characterized by equations 28 and 29, with λ_t^b determined by equation 27. Following the same steps as Proposition 3, shocks z_t

affect i_t^{ed} according to:

$$\frac{\partial i_t^{ed}}{\partial z_t} = \left[\frac{1}{(\lambda_t^d)^2} Var^e(i_t^{nd}) + \sum_{n=1}^{N^d} \Pr(n|i_t^{nd}, i_t^{-nd}) \frac{\partial i_t^{nd}}{\partial \lambda_t^d}\right] \frac{\partial \lambda_t^d}{\partial z_t} \tag{30}$$

where:

$$Var^e(i_t^{nd}) = \sum_{n=1}^{N^d} \Pr(n|i_t^{nd}, i_t^{-nd}) \cdot (i_t^{nd} - i_t^{ed})^2 > 0 \tag{31}$$

As with saving products, if z_t is a shock that reduces future consumption, attention rises and λ_t^d falls (equation 27). However, here the increase in attention implies lower i_t^{ed}, as the terms inside the square brackets in equation 30 are positive. The channels are as with savings products, but in reverse: with greater attention individuals choose lower-rate borrowing products from the distribution of offered interest rates, and the distribution of those rates shifts down as the borrowing market becomes more competitive. Countercyclical attention therefore increases interest rates on saving in contractions, but decreases interest rates on borrowing.

In this simple extension of the model, such fluctuations in i_t^{ed} have very little effect. Households cannot adjust their debt holdings, so i_t^{ed} does not directly enter the Euler equation. Rather, borrowing interest rates only affect consumption through net income: when attention rises in recessions, i_t^{ed} falls, increasing net asset income and so increasing consumption. With any plausible degree of consumption smoothing this income effect is very small relative to the substitution effects induced by attention to savings.[15]

This is clearly an extreme assumption, made to allow for a tractable extension of the model to borrowing.[16] However, the effects of attention to borrowing are likely to remain quantitatively small even in richer models that match evidence on the large effects of debt interest rates (e.g. Cloyne et al., 2020). The key reason is that, among debt-holders, debt (particularly mortgage debt) is typically large relative to financial assets. Across the 2006-2016 waves of the UK Wealth and Assets Survey (Office for National Statistics, 2019), the median mortgage debt among mortgage holders was £80,000. This is 8.7 times larger than the median holding of interest-bearing assets among those same households (£9,240), and those assets are themselves a sum across several product types.

[15] See e.g. Kaplan et al. (2018) for a discussion of the relative strength of substitution effects over income effects of interest rate changes in representative-agent models.

[16] If the household could also adjust d every period, they would face Euler equations for both saving and borrowing products. Absent other frictions, they could only satisfy both of them, and hold both products, if $i_t^e = i_t^{ed}$, removing the possibility of separate attention fluctuations for each product. Economically, the fixed-d assumption can be seen as reflecting the fact that mortgages are typically less liquid than savings, as remortgaging involves frictions from administrative and legal costs (see e.g. Eichenbaum et al., 2022).

The fact that mortgages are large implies high levels of attention (equation 27), because households face large interest costs if they mistakenly choose high-interest loans. This high average attention implies cyclical attention to borrowing has only small effects on shock transmission, through two channels summarized in Proposition 4.

Proposition 4 *The response of λ_t^d to a shock z_t can be expressed as:*

$$\frac{\partial \lambda_t^d}{\partial z_t} = \frac{b_t}{d}\frac{\partial \lambda_t}{\partial z_t} \tag{32}$$

where $\partial \lambda_t / \partial z_t$ is independent of d. $\partial \lambda_t^d / \partial z_t$ is therefore monotonically decreasing in d.

Furthermore, as d grows large:

$$\lim_{d \to \infty} \frac{1}{(\lambda_t^d)^2} Var^e(i_t^{nd}) = 0 \tag{33}$$

$$\lim_{d \to \infty} \sum_{n=1}^{N^d} \Pr(n | i_t^{nd}, i_t^{-nd}) \frac{\partial i_t^{nd}}{\partial \lambda_t^d} < 0 \tag{34}$$

Proof. Appendix C.2. ■

The first of these results (equation 32) shows that a given shock will have comparatively small effects on attention to borrowing, relative to saving. This is because at high attention the costs of reducing effective interest rates further become more convex, so shocks to the marginal utility of income produce only small changes in optimal attention.

The second and third results (equations 33 and 34) show that a given change in attention will have comparatively small effects on i_t^{ed}, due to d being large. In the special case of $N^d = 2$, it can be shown that $\partial i_t^{ed} / \partial \lambda_t^d$ declines monotonically as d grows.

Corollary 2 *If $N^d = 2$, then for all $d > 0$:*

$$\frac{\partial}{\partial d}\left[\frac{1}{(\lambda_t^d)^2} Var^e(i_t^{nd}) + \sum_{n=1}^{N^d} \Pr(n | i_t^{nd}, i_t^{-nd}) \frac{\partial i_t^{nd}}{\partial \lambda_t^d}\right] < 0 \tag{35}$$

Proof. Appendix C.2. ■

Intuitively, high levels of attention imply that the borrowing market is highly competitive, with low markups and low interest rate dispersion. With this low dispersion, increasing attention cannot substantially alter effective interest rates. Indeed, in the limit as d grows large banks on average increase interest rates when attention rises, flipping the sign of the usual effect to be the same as that for saving. This occurs because at high levels of attention, all except the lowest-cost bank set interest rates very close to their marginal costs. These banks have no ability to lower rates further when attention rises. In contrast, the lowest-cost bank still achieves a positive markup. As attention rises further, individuals are even more able to distinguish this lowest-cost bank from the next best offer. As a result, the lowest-cost bank does not need to set an interest rate as far below the second-best rate to ensure they attract the majority of the market. They therefore respond to higher attention by increasing interest rates.

While countercyclical attention to borrowing could in principle offset the effects of countercyclical attention to saving analysed in Section I.E, these results suggest that the borrowing channel is likely to be quantitatively small.[17]

The data in the remaining parts of this paper concerns saving only, so is not able to test this result formally. However, analysis with related data support the result. First, Table 6 in Appendix C.2 shows that Google searches for mortgage comparisons are substantially more frequent than those for savings in the UK, US, and globally, despite the fact that many fewer households hold mortgages than some form of savings product. This is suggestive of greater attention to mortgages.[18] Consistent with the model mechanism, larger balances within financial products are correlated with a variety of measures of 'shopping around' intensity (Financial Conduct Authority, 2015). Second, interest rate dispersion is substantially lower for mortgages than for saving products: Cook et al. (2002) find that the spread between the highest and lowest interest rates on 5-year fixed rate mortgages available to start in December 2000 was 0.3%, while the equivalent spread was more than three times that for all categories of retail saving products, reaching 4.5% for commonly-held easy access saving accounts. As predicted by the model, attention is therefore substantially higher for mortgages than any saving product, and interest rate dispersion is correspondingly smaller.

Given these results, for the remainder of the paper I keep the main focus on the case without debt. I return to attention to borrowing in Appendix E.3, where I extend the quantitative model of Section IV to include liquidity-constrained borrowers, and confirm that cyclical attention to borrowing has only weak effects on the amplification mechanisms due to savers.

[17]Note that even if we construct weighted average interest rates across saving and borrowing, the first channel entirely offsets the larger weight on borrowing, leaving the other two channels intact.

[18]Relatedly, the Financial Conduct Authority (2019) found "high levels of consumer engagement" with mortgage decisions, while their equivalent study of retail savings (Financial Conduct Authority, 2015) found "Consumers often do not shop around for their [saving] accounts."

II Data

To provide evidence on cyclical attention to savings, I combine data from two sources. To observe the choice set facing households, I digitize 14 years (1996-2009) of monthly editions of Moneyfacts, a magazine for UK financial advisers.[19] To observe household choices within that set, I combine this with data on average interest rates earned on newly opened savings products each month from the Bank of England. In this section I explain the nature of these datasets, and provide some institutional background on the specific savings market I study.

II.A Data Sources

Each month Moneyfacts magazine publishes tables of the interest rates and product characteristics of all saving and credit products on offer from retail financial institutions in the UK (Moneyfacts Group, 2009). A key advantage of this data is that it reports all observable dimensions of product heterogeneity which are relevant for savers, which means that the interest rate dispersion remaining after controlling for these characteristics cannot be explained by observable product differentiation. The magazine reports the full set of relevant characteristics because it is designed for household financial advisers: if savers care about a product characteristic then financial advisers need to know about it.

Of all the products available in the data, I focus on the specific subset of fixed interest rate savings products, for which the product characteristics are simple and easily quantifiable. This enables me to account for product heterogeneity. In contrast, mortgages and other loans, as well as other more complicated savings products, have many more dimensions of product heterogeneity, and many products have their own idiosyncratic features. Such idiosyncrasies preclude accounting for product differentiation in interest rate dispersion. In addition, it is common for these products to come bundled with offers for current accounts and other financial services, so the headline interest rates may not accurately capture the value of each product. Further details on fixed interest rate savings products are given in Section II.B.

Household choices within this market are reported in the Quoted Household Interest Rate published by the Bank of England. This gives the average interest rate earned by households each month on a subset of fixed interest rate savings products which are identical along all the major dimensions of product heterogeneity identified in Moneyfacts: length of term, size of investment, and frequency of interest payments. The Quoted

[19] The editions from January 2008, December 2008, and February 2009 were missing from the library collection at the University of Oxford when this research took place, so data from these months is missing. Where HP-filtered series are used below, I fill in the missing data by linearly interpolating between the months either side, then drop the interpolated observations after the series has been filtered.

Household Interest Rate therefore directly relates to a set of products which are identical except for the interest rate, and which can be easily identified in the Moneyfacts data.[20] Importantly, the average interest rate reported is for accounts opened in that month only, not the stock of all active accounts, which would include accounts opened in previous months when interest rates were different.

There are several Quoted Household Interest Rate series available for fixed rate savings products with different combinations of product characteristics. I focus on the series for products with a term of one year, an investment of £5000, and where interest is paid annually (Bank of England, nda), because the Quoted Household Interest Rate series goes back to 1996 for these products, whereas the series for other combinations of features have only been published since 2009. In addition, this is one of the most common combinations of product features in the market, so my results in Section III are less affected by outliers than would be the case with a more niche combination of product features. There are no switching costs for these products at the end of the term.

A limitation of the Quoted Household Interest Rate data is that the interest rates on qualifying products are weighted imperfectly. The ideal measure of the average rate achieved by households in these products would weight each bank's interest rate by the amount of new deposits that month in that product. However, in the absence of deposit data by product, the Bank of England instead weights each interest rate by deposit inflows per bank and month across the somewhat broader set of all fixed-rate bonds with a term less than or equal to one year. While this implies that the Quoted Household Interest Rate is not a precisely quantity-weighted average, I show in Appendix D.1 that a bank's position in the distribution of interest rates on products qualifying for inclusion in the Quoted Household Interest Rate is very highly correlated with their position in the other market segments used in the weighting scheme. The countercyclical pattern of the Quoted Household Interest Rate relative to the distribution of interest rates in that set of products found in Section III therefore reflects a systematic shift towards banks that are more competitive across these market segments in recessions. Although imperfect, I therefore continue to refer to the Quoted Household Interest Rate as the average interest rate achieved by households. The measurement errors on the savings data in the quantitative model in Section IV are included partly to reflect this limitation.

[20] The only characteristics reported in Moneyfacts that differ among products in the Quoted Household Interest Rate are the penalty for withdrawing deposits before the end of the term, and whether the product is managed through a branch, by post, telephone, or the internet (online-only products are excluded from the Quoted rate before 2009). The Financial Conduct Authority (2015) found that holders of fixed-rate bonds did not place much importance on these product characteristics, mostly valuing products based on their interest rate and term.

II.B Institutional Background

Retail savings products are provided in the UK by conventional banks and building societies, which offer deposit products to fund mortgage lending.[21] Deposits at all of the institutions in the data were covered by deposit insurance up to £35,000 throughout the period studied, substantially above the £5,000 investment size of the products considered (I return to the issue of deposit insurance and bank risk in Section III.A). The largest four institutions had 74% of the market for current accounts in 2000, and the largest branch networks (Vickers, 2011). The market for savings accounts is less concentrated, with a Herfindahl-Hirschman Index between 20% and 30% lower than the current account market between 2000 and 2008 (Vickers, 2011).

In 2013, 12% of households held fixed interest rate savings products, and they accounted for 20% of all cash savings balances in the UK (Financial Conduct Authority, 2015). In the Moneyfacts data there are an average of 309 such products available each month in the sample. The median number of products satisfying the criteria for inclusion in the Quoted Household Interest Rate is 34.

There are two other factors which aid analysis of choices in this particular market. First, product bundling is uncommon. In the median month, just 3.5% of products qualifying for inclusion in the Quoted Household Interest Rate are explicitly bundled with other products at the offering bank. I do not remove the few products for which this is the case before analysing the data because they are not removed in the Quoted Household Interest Rate data. Savers also do not appear to value having these accounts with the same institution as their other financial products, which might give rise to an implicit bundling of products. The Financial Conduct Authority (2015) found that 76% of savers using fixed rate bonds use an institution which is not their 'main provider of financial services'. In addition, if implicit bundling of this type was powerful, it would create switching costs that would allow banks with larger customer bases to persistently exploit customers by offering lower interest rates than smaller competitors (see Klemperer, 1995, for a review of such models). We should therefore expect substantial persistence in bank interest rate rankings, which is not present in the data (see Appendix B.2).

Second, the interest rate is the most important product feature for the large majority of savers in this market (Financial Conduct Authority, 2015). Savers hold fixed rate savings bonds as assets, not for transactions or any other purposes. This is important for my analysis, as customer service and the convenience of a large branch network are

[21] The main differences between building societies and banks are that building societies are owned by their customers, and are more limited than banks in how much of their funding can come from wholesale money markets. I will not distinguish between the two types of provider as industry experts suggest it is not important for consumer choices (e.g. Hannah Maundrell, quoted in Hannah, 2017). As the degree of wholesale funding could be related to bank risk, I discuss this in Section III.A.

unobservable product features that I cannot easily control for. That these do not matter much to savers means that this is unlikely to explain much of the interest rate dispersion I find in Section III.A. The presence of a local branch is less important for these products than others because they are of a fixed maturity, so the saver does not need to interact with the bank on as regular a basis, as is the case for products with the potential for continual adjustment (Financial Conduct Authority, 2015).

III Empirical Results

In this section I explore household choice using the datasets described in Section II. First, I show that there is substantial heterogeneity in interest rates offered by retail banks which cannot be explained by product heterogeneity. I then construct a summary statistic for the 'success' of household choice, which is closely related to attention in the model in Section I. Consistent with the model, this statistic is countercyclical.

III.A Interest Rate Dispersion

The products used to compute the Quoted Household Interest Rate series are close substitutes for one another: they have the same term, investment size, and interest rate payment frequency. Table 1 presents summary statistics on the distribution of interest rates available on these products each month.

Table 1: Summary statistics for the within-month distribution of annualized interest rates available on products qualifying for inclusion in the Quoted Household Interest Rate.

Statistic	Median	Lower Quartile	Upper Quartile
Mean	518	447	610
Median	525	450	611
Standard Deviation	45	38	50
90^{th} Percentile - 10^{th} Percentile	100	80	117

Note: Statistics are computed for each month using the distribution of interest rates offered on products listed in Moneyfacts magazine that qualify for inclusion in the Quoted Household Interest Rate (defined in Section II.A). All values are in basis points. Sample period: 1996-2009. Source: Moneyfacts Group (2009).

These products are identical across the major dimensions of product heterogeneity in this market (see Section II.A). If the market was perfectly competitive, these products should all have similar interest rates. This is not what is observed: interest rates are substantially dispersed even among similar products. The median within-month standard deviation of annualized interest rates on these products is 45 basis points, and going from the 10^{th} to the 90^{th} percentile of the interest rate distribution would gain a saver 100 basis points in the median month.

Missing out on 100 basis points on the £5000 investments in these products implies an annual loss of £50. However, it is not the magnitude of asset income that matters for intertemporal consumption decisions in standard macroeconomic models, or in the models in Sections I and IV of this paper. Rather it is the interest *rate*, and 100 basis points is large in terms of typical interest rate changes, for example stemming from monetary policy decisions. In fact, the small monetary loss helps explain why savers do not pay much attention to their product choice from this set, even with low costs of attention.[22]

This exercise, however, only controls for observable product heterogeneity. While I can discount many possible dimensions of unobserved heterogeneity (see Section II.B), there could still be attributes known and valued by households that differentiate the products on offer.

Bank risk. In principle risk could explain interest rate dispersion, if riskier banks offer higher interest rates to compensate savers for their risk. This is unlikely, however, to be a significant driver of rate dispersion in this market. Throughout the sample deposits in the UK are insured up to £35,000 (£50,000 after October 2008) per depositor per provider, which is far above the £5,000 investments I study. This removes the majority of risk to savers of bank failure. As long as deposit insurance is credible, risk should therefore not affect pricing, as Ben-David et al. (2017) find for the US. Indeed, Chavaz and Slutzky (2024) find that deposit rates in the UK are on average uncorrelated with a variety of measures of bank risk, suggesting that risk is not the main driver of the dispersion found here.[23] This is supported by the fact that regressing the panel of interest rates on bank and month fixed effects still leaves the mean and median unexplained within-month standard deviation of interest rates at 31 and 29 basis points respectively. Note however that this approach ignores changes in bank risk over time, and removes all persistent variation in bank interest rates, whether driven by risk or other factors. Appendix B.1 contains an example where rate persistence arises due to information costs.

There could, of course, still be other sources of unobserved product differentiation which explain the dispersion of interest rates that I have not considered here. I therefore proceed by arguing from the other side, giving evidence that there are substantial costs of information/search in this market, which could explain why interest rate dispersion persists in equilibrium (e.g. Baye et al., 2006).

[22]See Carroll et al. (2020) for another example in which household inattention to variables with small monetary impacts on their individual problems has substantial aggregate effects.

[23]While Chavaz and Slutzky (2024) do find that riskier banks offer higher interest rates when they face spikes in household attention (measured by Google searches), primarily during the 2008 financial crisis, this is only significant for variable-rate products.

Limited Attention. First, a series of reports by the regulator (Financial Services Authority, 2000; Cook et al., 2002; Financial Conduct Authority, 2015), using a variety of methods, have concluded that households could benefit if they engaged in more product search and comparison in this market. They find that such search is costly, particularly in terms of time and effort. Prior literature has similarly concluded that inattention plays an important role in retail financial product markets, using data from Spain (Martín-Oliver et al., 2009), Italy (Branzoli, 2016), and the UK (Adams et al., 2021).

In addition, the founding of Moneyfacts magazine is itself evidence that information costs are substantial in retail financial markets. Moneyfacts was created to help "quickly and easily compare financial products" (Moneyfacts Group, 2021). This suggests that it is costly (in time, effort, or money) for households to obtain this information from elsewhere: the magazine would not have been founded, and would not keep selling subscriptions, if data on the full set of available savings products was easy to find. Since less than 8% of UK households employ financial advisers (Financial Conduct Authority, 2023) the existence of the magazine has not itself removed the information friction behind saver inattention. Moreover, the use of financial advisers is concentrated among the wealthiest households (Financial Services Authority, 2000; Lei, 2019), not those using the lower-value accounts studied here.

The rapid spread of comparison websites covering savings products in the early 2000s supports this evidence (Connon, 2007). Savers would not need to visit a comparison website if they were already fully informed about the products on offer. However, as with the founding of Moneyfacts, these websites did not reduce the cost of information to zero. It still takes time and effort to use the websites, to process the information and translate it to choices. Indeed, in 2013 only 35% of savers in fixed-term products consulted a comparison website before choosing their product (Financial Conduct Authority, 2015).

Finally, I will discuss below how the endogenous attention decisions studied in the model in Section I can explain the time series variation in how households choose from among the set of offered rates.

III.B Constructing φ_t: a Summary Statistic for Household Choice

I now combine the Moneyfacts and Bank of England data to study how successful households are at choosing the highest interest rate product in the market each month. To do this I compute a monthly statistic φ_t, defined as follows:

$$\varphi_t = \frac{\mathbb{E}_h i_t - i_t^b}{\sigma(i_t)} \tag{36}$$

The numerator of this statistic is the spread between the average interest rate earned by households opening new accounts that month $\mathbb{E}_h i_t$ and a benchmark rate i_t^b. This benchmark is designed to capture the average interest rate earned by a household paying no attention to their choice. This spread is then normalized by the standard deviation of interest rates on offer that month, $\sigma(i_t)$. Normalizing in this way ensures that the measure is not mechanically affected by changes in the dispersion of interest rates, and gives a statistic which is closely related to attention in the model.

In Section I.C I showed that when a household pays more attention, the effective interest rate they experience rises relative to what they would have achieved if they processed no information and simply followed their predispositions (equation 12). This corresponds to a rise in the average rate achieved by households relative to the benchmark rate, and so a rise in φ_t. I also showed that attention is only a function of conditional choice probabilities, so if interest rates all move further apart but choice probabilities stay the same attention has not changed (equation 10). Normalizing the spread between the average achieved rate and the benchmark rate by the standard deviation of interest rates ensures that changes in rate dispersion do not mechanically alter φ_t. In Appendix A.7 I show that there is an exact correspondence between φ_t and attention in the model with two banks and uninformative priors, and that they remain closely related with more banks in the market.

Note that φ_t is homogeneous of degree zero in interest rates, so it is unaffected by market-wide trends in the level of nominal interest rates. If household decisions are driven by real interest rates rather than nominal rates, φ_t is unaffected by changes in inflation expectations for the same reason.

Choice of Benchmark Interest Rate. I construct the no-attention benchmark interest rate i_t^b by taking the average interest rate on offer from the 'big four' banks, which in 1993 had 48% of the bank branches in the UK.[24] This reflects a probable predisposition towards larger market players: small 'challenger' banks are likely to be discovered only if the saver does some careful research, as they do not have large numbers of physical branches or large advertising budgets (see Honka et al., 2017, for evidence that these both have large effects on consumer banking choices in the US).

Throughout the sample period these four banks hold most of the market share in many retail banking markets, and have many more branches than other banks (Office of Fair Trading, 2008). They are particularly dominant in current accounts, which are the key product from which banks cross-sell other services, such as savings accounts (Cruickshank, 2000). Using this as the benchmark interest rate assumes that households

[24] These are Barclays, HSBC, Lloyds, and Royal Bank of Scotland. NatWest also has a large number of branches, but for the majority of my sample period they do not offer a product qualifying for the Quoted Household Interest Rate, so I leave them out of the calculation of the benchmark rate.

paying no attention to their choice of savings product are likely to go to their closest bank branch, or the bank where they hold a current account. Alternative benchmarks, such as weighting banks by their number of branches or the size of their balance sheets, would be strongly correlated with this simple benchmark because the big four consistently dominate others on these metrics.

There is a concern, however, that changes in φ_t could be driven purely by shifts in the position of the big four within the interest rate distribution, rather than by household behavior. To combat this, the analysis in Section III.C and Appendix D uses the residual of φ_t after regressing on a constant and a measure of the position of the big four within the rate distribution, defined as follows:

$$pos_t := \frac{\bar{i}_t - i_t^b}{\sigma(i_t)} \tag{37}$$

where $\bar{i}_t$ is the unweighted mean interest rate offered in month t. This measure is therefore larger when the interest rate at the big four (i_t^b) is low relative to other rates in the market. Details of the regression are in Appendix D.2.

To further check that the results in Section III.C below are not driven by this choice of benchmark interest rate, in Appendix D.3 I repeat the analysis with several alternative specifications of φ_t, including the raw statistic defined in equation 36 before regressing on pos_t. The key results below are robust across all measures.

Summary Statistics. Table 2 shows summary statistics for φ_t (both raw data and after residualizing), and for the spread and standard deviation components that go into defining it. It also contains statistics for pos_t, and an alternative spread, between the highest interest rate on offer in the market and the average rate achieved $\mathbb{E}_h i_t$.

Table 2: Summary statistics for the household choice statistic φ_t and its components.

Statistic	Median	Standard Deviation	Lower Quartile	Upper Quartile
φ_t (raw)	0.86	0.58	0.54	1.21
φ_t (residualized)	0.03	0.51	-0.22	0.25
$\mathbb{E}_h i_t - i_t^b$	37	28	24	50
$\sigma(i_t)$	45	13	38	50
pos_t	0.94	0.59	0.56	1.31
$i_t^{max} - \mathbb{E}_h i_t$	69	85	53	95

Note: Statistics are computed for each month using the Quoted Household Rate, and the distribution of interest rates offered on products listed in Moneyfacts magazine that qualify for inclusion in that Quoted Household Interest Rate (defined in Section II.A). φ_t is defined in equation 36, and φ_t (residualized) is computed by regressing this on a constant and pos_t (details in Appendix D.2). $\mathbb{E}_h i_t$ denotes the Quoted Household Interest Rate, i_t^b is the unweighted mean interest rate offered by the big four UK banks (Barclays, HSBC, Lloyds, RBS), pos_t is as defined in equation 37, and i_t^{max} is the highest interest rate available among the qualifying set in month t. Values for spreads are in basis points, while values for φ_t (raw and residualized) and pos_t are indices. Sample period: 1996-2009. Source: Moneyfacts Group (2009), Bank of England (nda).

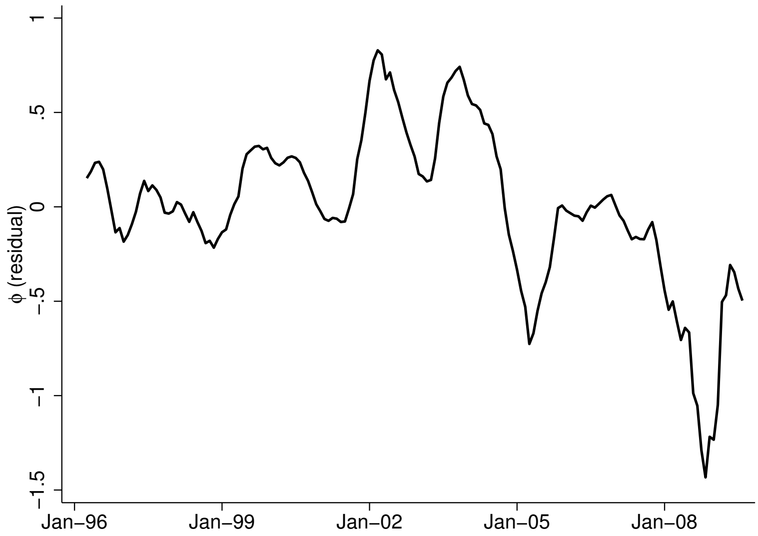
In the median month, savers earn a 37 basis point higher interest rate on average than they would have if they each chose a big four bank at random. They do not, however, all choose the highest-rate product in the market: the average rate earned is 69 basis points below the best rate in the market. The median raw φ_t is such that savers earn an interest rate 0.86 standard deviations above the benchmark rate.

The spread that forms the numerator of φ_t is just over twice as volatile as the standard deviation that forms the denominator. Despite the fact that the position of the benchmark rate varies a lot within the interest rate distribution, with a standard deviation higher that that of φ_t, residualizing φ_t only reduces its volatility by a small amount. This is because the position of the benchmark rate is not strongly correlated with φ_t (see Appendix D.2), consistent with φ_t capturing average saver attention, and not being mechanically driven by the position of i_t^b. From here, for simplicity, I refer to the residualized φ_t as simply φ_t.

III.C Cyclicality of φ_t

Since φ_t is measured monthly, we observe it at a high enough frequency to study co-movements with aggregate variables over the business cycle. Figure 1 plots the time series of φ_t. The largest falls in φ_t occur during the growth periods of 2004-2005 and

Figure 1: Time series of φ_t



Note: Plot shows the residualized φ_t index (defined in Section III.B), 6 month moving average. Source: Moneyfacts Group (2009), Bank of England (nda).

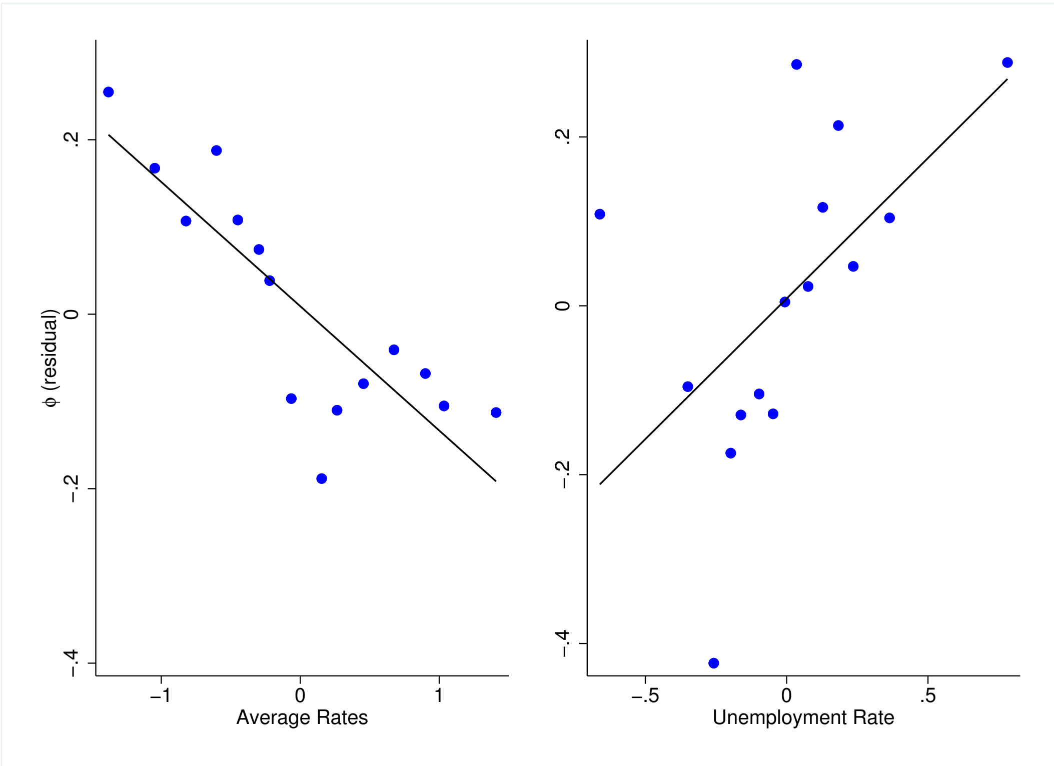
2006-mid 2008. There are substantial rises in φ_t during July 2001 - April 2002, when growth was slowing,[25] and from shortly after the beginning of the Great Recession in the

[25] Although, unlike the US, the UK avoided recession during this period, GDP growth fell and the unemployment rate rose relative to trend.

UK in mid-2008.

These observations are formalized in Figure 2, which shows binned scatter plots of the (HP-filtered) cyclical component of φ_t against the cyclical components of the average interest rate and in unemployment. Lower interest rates and higher unemployment are associated with higher φ_t. That is, when interest rates are high and unemployment is low, savers choose products with low interest rates, close to those offered by the big four banks. As rates fall and unemployment rises, households move up through the distribution of offered rates, more reliably choosing the higher interest rate products in the market, and so achieving higher interest rates relative to the distribution of offers. These relationships are strongly statistically significant.

Figure 2: φ_t against average interest rates and unemployment



Note: Panels show binned scatter plots of φ_t against (unweighted) average interest rates among products considered in the Quoted Household Interest Rate data, and the unemployment rate (ONS series MGSX). All series are cyclical components after HP filtering. Black solid lines are from linear regressions, which give $\hat{\varphi} = -0.142\hat{\bar{i}}$ (t-statistic on slope coefficient -3.24) and $\hat{\varphi} = 0.333\hat{u}$ (t-statistic on slope coefficient 4.33). Blue circles are means of φ_t and the regressor of interest within groups of observations, grouped by their position within the distribution of the regressor. Source: Moneyfacts Group (2009), Bank of England (nda), Office for National Statistics (2020).

To check that these correlations are not an artifact of the specific formulation of φ_t in equation 36, in Appendix D.3 I repeat this exercise with two alternative versions of φ_t. The first considers the (normalized) distance of the Quoted Household Interest Rate from the highest interest rate on offer that month, corresponding to the choice that would be made by a fully-informed saver. The second does not use a specific benchmark, but rather measures the percentile of the interest rate distribution that corresponds to the Quoted Household Interest Rate that month. The countercyclicality documented here is robust to both alternatives: in contractions the average interest rate achieved by households moves closer to the highest interest rate on offer in the market, and sits at a higher percentile of the interest rate distribution. For the remaining analysis I keep to the measure defined in equation 36, because of its close correspondence to attention in the model, which enables it to discipline the role of attention in the model.

Given its otherwise strongly countercyclical nature, it is notable that φ_t does not start rising earlier in the Great Recession. This is possibly because late 2008 was a tumultuous period in the UK retail banking market. There were several large mergers and bailouts as the financial crisis hit the market. At this time the big four banks increased their interest rates relative to the rest of the market. The initial lack of increase in φ_t could therefore be explained by temporarily heightened awareness of bank risk causing savers to stay away from the larger banks who were more exposed to international financial markets (as in Chavaz and Slutzky, 2024).

Attention. These cyclical patterns are consistent with the household attention decisions studied in Section I. In recessions, consumption tends to be low, so the marginal utility of interest income is high, increasing the incentives to pay attention (equation 23). Although not present in the model, this would be compounded if attention costs were specified in terms of time, as labor supply, and so the marginal disutility of time spent processing information, falls in downturns.

In addition, when average rates are low in this market the dispersion of interest rates tends to be high: the correlation between the (HP-filtered) mean and standard deviation of interest rates is -0.27, significantly different from 0 at the 0.1% level.[26] This further increases the benefits of attention in contractions (Corollary 1). Finally, if there is a 'search for yield' motive, i.e. if there is something about low levels of interest rates that make households want to work harder to increase their returns, this would also encourage greater attention, and so higher φ_t, when average rates are low. In the model in Sections I and IV I allow for the first two channels to operate, leaving examination of the search for yield mechanism for future work.

Alternative Explanations. In principle, the counter-cyclicality of φ_t could be driven by other mechanisms unrelated to attention. The first possibility is that there is selection into this particular market which varies over the cycle, as in (Drechsler et al., 2017). In

[26]Note this correlation is partly driven by the substantial increase in interest rate dispersion during the Great Recession, which may be partly due to heightened awareness of bank risk (see Section III.A). However, the correlation remains negative and significant even excluding these crisis periods.

that case the shifting φ_t may be driven by changes in the composition of savers in the market. I explore this in Appendix D.4, and find little evidence of compositional changes in the market for fixed-term retail savings bonds over the Great Recession. It should be noted that this exercise covers a broader group of savings products than the specific market segment studied here.

Other alternatives include bank risk, and marketing activities. Risk does not, however, play a large role in this market (see Section III.A). Bank marketing on average leads to depositors selecting higher-rate products (Honka et al., 2017), so marketing could only explain countercyclical φ_t if it was itself strongly countercyclical. However, Hall (2014) finds that aggregate marketing spending is generally procyclical, so this cannot explain the empirical patterns in φ_t unless retail banks display the opposite time-series patterns to the rest of the economy.

IV Quantitative Assessment

In this section I study the quantitative significance of cyclical attention to saving in an estimated DSGE model of the UK economy.

IV.A Model

I embed the interaction between inattention to saving and bank interest rate setting into an otherwise-standard medium-scale DSGE model, based on Smets and Wouters (2007), and taken to an open economy context as in Adolfson et al. (2007). In this I particularly follow Harrison and Oomen (2010), who find that such a model is able to provide a good fit to UK data. Since much of the model is standard, I report only the most important equilibrium conditions here, and leave a full derivation of the model to the online appendix. The model is solved to first-order, and the log-linearized model equations are in Appendix E.1.

IV.A.1 Households

As in Section I, households composed of many individuals choose how much to consume out of their income, and how much attention to pay to increasing the effective interest rate they face on domestic bonds. Utility maximization implies a standard consumption Euler equation, and a novel first order condition on effective interest rates that regulates attention decisions:

$$u_{c,t} = \beta e^{\zeta_t^c} \mathbb{E}_t \frac{(1 + i_t^e)}{\pi_{t+1}} u_{c,t+1} \tag{38}$$

(39) $$\beta b_t \mathbb{E}_t \frac{u_{c,t+1}}{\pi_{t+1}} = \mu e^{\zeta_t^\mu} \lambda_t^{-1}$$

where $u_{c,t}$ is the marginal utility of consumption in period t, π_t is consumer price inflation, and ζ_t^c, ζ_t^μ are mean-zero risk premium and attention shocks. As in Section I, c_t is consumption in period t, i_t^e is the effective interest rate, b_t is the quantity of real bonds purchased in period t, and λ_t is the shadow value of information. The marginal utility of consumption is given by:

(40) $$u_{c,t} = \frac{1}{\bar{c}_{t-1}^{\psi^{hab}}} \left(\frac{c_t}{\bar{c}_{t-1}^{\psi^{hab}}} \right)^{-\frac{1}{\sigma^c}}$$

where $\bar{c}_t$ is aggregate consumption. $\psi^{hab} > 0$ therefore determines the strength of external habit formation.

Relative to the simple model of Section I, I have specified a parametric form for the marginal utility of consumption, which now depends also on past aggregate consumption through external habits. Both optimality conditions depend on expected future inflation, which transforms the returns from nominal bond investment into real terms. Finally, I introduce two shocks: a risk premium shock ζ_t^c and an i.i.d. attention shock ζ_t^μ. This second shock is introduced to allow for disturbances to attention not otherwise captured in the first order condition.[27] However, it is estimated below to have a very small variance, so it plays a negligible role in the behavior of endogenous variables. The risk premium shock, in contrast, is estimated to account for a substantial fraction of business cycle variation, as in Smets and Wouters (2007) and many other similar models.

To keep the estimation simple I set the number of banks to 2, and set up the banking market such that priors are uninformative (see Section IV.A.2). Otherwise the individual problem is as in Section I.C: each individual faces a discrete choice rational inattention problem over the two banks. Since priors are uninformative, solving the rational inattention problem yields:

(41) $$p_t^g = \frac{\exp(\frac{i_t^g}{\lambda_t})}{\exp(\frac{i_t^g}{\lambda_t}) + \exp(\frac{i_t^b}{\lambda_t})}$$

where p_t^g is the probability of choosing the bank with the higher interest rate (the 'good' bank) in period t. The interest rate at that bank is i_t^g, and the interest rate at the 'bad' bank is i_t^b.

The effective interest rate faced by the household is the average over the rates achieved

[27]For example, profit announcements may put the banking sector in the media, making bank choices temporarily more salient.

by the many individuals:

$$i_t^e = p_t^g i_t^g + (1 - p_t^g) i_t^b \tag{42}$$

Alongside these choices, in this quantitative model households also choose how much to invest in capital, and how strongly to utilize current installed capital, subject to standard capital adjustment costs, and the fact that greater utilization causes faster capital depreciation. There is no information friction in capital investment, so the attention problem only applies to a subset of household portfolios. Households also decide how to divide their consumption basket c_t across domestically-produced goods and imports, which are combined into c_t with a CES aggregator. Finally, households supply labor to unions, who set wages in a continuum of differentiated labor markets subject to quadratic adjustment costs, giving rise to a standard wage Phillips curve.[28] The adjustment costs include partial indexation to past wage inflation.

IV.A.2 Banks

The two banks are as described in Section I.A, with further assumptions on the bank costs χ_t^n. Each period, a ranking of banks is drawn. One bank, which I will refer to as the 'good' bank and index by the superscript g, draws a low cost $\chi_t^g = \chi_0^g + \zeta_t^\chi$, where χ_0^g is a constant parameter, and ζ_t^χ is a mean-zero AR(1) shock. The other bank draws a high cost, and so I will refer to them as the 'bad' bank (superscript b). They face a cost of χ_t^b, for which I specify the following process:

$$\chi_t^b = \chi_0^b + \chi_1(i_t^{CB} - \bar{i}^{CB}) + \zeta_t^\chi + \zeta_t^{\chi b} \tag{43}$$

where $\chi_0^b > \chi_0^g$ and χ_1 are parameters, $\bar{i}^{CB}$ is the steady state policy rate, and $\zeta_t^{\chi b}$ is a further mean-zero AR(1) shock.

The restriction that $\chi_0^b > \chi_0^g$ ensures that in the absence of shocks, the bad bank faces higher costs than the good bank. If $\chi_1 \neq 0$, then the bad bank's costs also fluctuate endogenously with the policy rate. This possibility is included as a reduced-form way for the model to capture the observed correlation of interest rate dispersion with the level of policy rates (see Section III.C).[29] Finally, the mean-zero AR(1) shocks ζ_t^χ and $\zeta_t^{\chi b}$ cause

[28]This setup with union wage-setting is as in Schmitt-Grohé and Uribe (2005), who use Calvo-style staggered wage setting rather than quadratic adjustment costs. The quadratic adjustment cost version follows e.g. Auclert et al. (2018).

[29]Without this term, the estimation would be forced to match the correlation of rate dispersion with i_t^{CB} using the $\zeta_t^{\chi b}$ shock only, which would require that shock to be strongly correlated with the other model shocks driving i_t^{CB}. I discuss the role of endogenous fluctuations in bank costs for the attention mechanism in Section IV.D below.

exogenous fluctuations in the level and dispersion of bank interest rates. Since each bank draws either χ_t^g or χ_t^b with probability 0.5 each period, the persistence in these cost shocks does not imply persistence in bank cost rankings. Since there is no persistence in the positions of each bank in the interest rate distribution, individuals have uninformative priors, as used in the derivation of equation 41.

Each bank chooses interest rates to maximize profits. Their first order condition is the same as equation 19 derived in Section I, which for the good and bad bank respectively reduces to:

$$(1 - p_t^g) \cdot (i_t^{CB} - i_t^g - \chi_0^g - \zeta_t^\chi) = \lambda_t \tag{44}$$

$$p_t^g \cdot (i_t^{CB}(1 - \chi_1) - i_t^b - (\chi_0^b - \chi_1 \bar{i}^{CB}) - \zeta_t^\chi - \zeta_t^{\chi b}) = \lambda_t \tag{45}$$

Bank profits and transaction costs are redistributed back to the representative household as a lump sum.

IV.A.3 Firms, Policy, and Market Clearing

The rest of the model is standard, so I leave the equations to the online appendix, and give a brief description here.

Domestic firms hire utilization-adjusted capital services and labor to monopolistically produce intermediate goods, which are aggregated by perfectly competitive final goods firms who supply home and export markets. Intermediate goods firms face price adjustment costs with partial indexation to past prices, with different adjustment costs for the home and export markets. This firm block therefore includes a production function, and generates equations for factor demands, along with separate Phillips curves for domestic and export goods.

A monetary authority sets the interest rate on domestic government bonds following a Taylor rule with interest rate persistence. The fiscal authority issues a positive amount of bonds, engages in wasteful government spending, and collects lump sum taxes. Since taxes are lump sum, if there were no information problem ($\mu = 0$) the model would feature Ricardian equivalence. With rational inattention to saving choices ($\mu > 0$), an increase in bond supply only affects consumption because it increases the incentives to pay attention to savings. Changes in bond supply are therefore isomorphic to changes in the cost of attention μ (see equation 39), and so without loss of generality I fix the supply of real bonds at $b_t = 1$, and allow for shocks to μ (ζ_t^μ in equation 39). I refer to these as 'attention shocks' above, but they could equally therefore be interpreted as shocks to government debt.

Four foreign variables (inflation, export demand, relative export prices, interest rates) follow a VAR process estimated outside of the model, as in Adolfson et al. (2007). Details of this are in Appendix E.2. Given these, the real exchange rate is then determined by UIP. Foreign exchange market participants can buy bonds directly from governments, so the domestic interest rate that matters for UIP is the policy rate i_t^{CB}, not the effective interest rate faced by households i_t^e. Import prices are set by foreign exporters, who like domestic firms are monopolistically competitive, and subject to a quadratic cost of adjusting prices with partial indexation to past import prices. We therefore obtain a Phillips curve in imports, to add to those in domestic goods, exports, and wages.

Finally, the model is closed with market clearing conditions in all goods, factor, and asset markets. Overall, there are 14 shocks: to TFP, government spending, the disutility of labor, the capital adjustment cost, the consumption Euler equation (risk premium shock), the price markup on domestic goods, the nominal policy interest rate (monetary policy shock), the cost of information, the level of bank costs, the dispersion of bank costs, and to each of the four international variables. Aside from the attention problem and bank market, the model is very similar to that in Harrison and Oomen (2010), which was designed specifically for the UK context. They show the model obtains a good fit to UK data along a number of dimensions.

IV.B Steady State

Before solving, all equilibrium conditions are log-linearized about the non-stochastic steady state with zero inflation. All impulse responses below are expressed in percentage deviations from this steady state. As is standard, this steady state is the equilibrium of the non-linear model in the absence of exogenous shocks.

To ensure the household attention problem remains well-defined, I make one exception to this, and assume that each bank still has a 50% chance of drawing high or low costs each period. Specifically, in the absence of cost shocks the steady state low cost is $\bar{\chi}^g = \chi_0^g$, and the high cost is $\bar{\chi}^b = \chi_0^b$. However, each bank n still alternates between these two cost levels, as in Section I.A.

From the household point of view, in this steady state they therefore face a constant non-degenerate distribution of interest rates, but they are still unable to observe which bank is offering the higher interest rate. Attention is therefore positive in steady state, and equations 39 - 45 describe the attention and bank-choice components of equilibrium.

In particular, equations 44 and 45 in steady state become:

$$(1-\bar{p}^g)(\bar{i}^{CB}-\bar{i}^g-\chi_0^g)=\bar{\lambda} \tag{46}$$

$$\bar{p}^g(\bar{i}^{CB}-\bar{i}^b-\chi_0^b)=\bar{\lambda} \tag{47}$$

where I use $\bar{x}$ to denote the steady state of each variable x_t.

In any given period in this steady state, whichever bank draws the low cost sets $\bar{i}^g$ to satisfy equation 46, and the other bank sets $\bar{i}^b$ to satisfy equation 47. The distance $\chi_0^b-\chi_0^g$ therefore regulates the dispersion of offered interest rates in steady state. Maintaining bank cost switching in this way is crucial, as without it the interest rate at each bank would be constant over time, meaning households could learn which bank offers higher interest rates after observing one period of realized returns, and the information friction would disappear.

In log-linearizing the model about this steady state, I therefore directly log-linearize equations 44 and 45 to give the approximations to the first order conditions for whichever bank is good, and whichever is bad, in period t:

$$\hat{\lambda}_t=\frac{1}{\bar{i}^{CB}-\bar{i}^g-\chi_0^g}(\bar{i}^{CB}\hat{i}_t^{CB}-\bar{i}^g\hat{i}_t^g-\hat{\zeta}_t^{\chi})-\frac{\bar{p}^g}{1-\bar{p}^g}\hat{p}_t^g \tag{48}$$

$$\hat{\lambda}_t=\frac{1}{\bar{i}^{CB}-\bar{i}^b-\chi_0^b}(\bar{i}^{CB}(1-\chi_1)\hat{i}_t^{CB}-\bar{i}^b\hat{i}_t^b-\hat{\zeta}_t^{\chi}-\hat{\zeta}_t^{\chi b})+\hat{p}_t^g \tag{49}$$

where $\hat{x}_t$ for denotes log-deviations of each variable x_t from steady state. Log-linearizing equations 39, 41, and 42 then completes the attention block of the model:

$$\mathbb{E}_t\hat{u}_{c,t+1}-\mathbb{E}_t\hat{\pi}_{t+1}=-\hat{\lambda}_t+\hat{\zeta}_t^{\mu} \tag{50}$$

$$\hat{p}_t^g=\frac{1-\bar{p}^g}{\bar{\lambda}}(\bar{i}^g\hat{i}_t^g-\bar{i}^b\hat{i}_t^b-(\bar{i}^g-\bar{i}^b)\hat{\lambda}_t) \tag{51}$$

$$\bar{i}^e\hat{i}_t^e=\bar{p}^g(\bar{i}^g-\bar{i}^b)\hat{p}_t^g+\bar{p}^g\bar{i}^g\hat{i}_t^g+(1-\bar{p}^g)\bar{i}^b\hat{i}_t^b \tag{52}$$

All other log-linearized equations are standard, and are reported in Appendix E.1.

IV.C Estimation

I conduct a Bayesian Maximum Likelihood estimation of the model log-linearized around the zero-inflation steady state described above. There are 11 standard observable variables: GDP, consumption, inflation, the 3-month treasury bill rate, investment, real wages, hours worked, foreign inflation, foreign industrial production, foreign interest rates, and foreign relative export prices. The foreign variables are trade-weighted averages from the G7 countries excluding the UK. On top of these I add 3 observables from the Moneyfacts data: the mean and standard deviation of deposit rates, and the choice statistic φ_t. I use data from 1993-2009. The start point coincides with the beginning of the final UK monetary regime identified by Benati (2006).

The key assumption made here is that the 3 observables from the Moneyfacts data relate to each other, and to other aggregate variables, in a way that is not specific to the fixed interest rate products used in their calculation. That product market is treated as a laboratory which is useful for identifying patterns that apply to all domestic bonds in the model. Since this is likely an approximation, I allow for i.i.d. measurement error on each of the newly introduced observables.

In addition, note that using these new observables implies that the interest rate on domestic bonds in the model is disciplined only by data on newly opened savings accounts each quarter, not on the average rate experienced by households. As is standard in quantitative DSGE models, I therefore abstract from the effects of households who continue to face out-dated interest rates for multiple periods due to a lack of switching. These effects are beyond the scope of this paper (see e.g. Berger et al. (2021) for a discussion).

I begin by setting some parameters to match standard values or long-run features of UK data. This in particular includes χ_0^g and χ_0^b, the constants in the bank cost functions. I set these to target the average dispersion of interest rates in the Moneyfacts data, and the spread between mean interest rates in that data and the policy rate.

For the remaining parameters to be estimated, I take priors where possible from Harrison and Oomen (2010). The only parameters to estimate not present in their model are the cost of attention μ, the cyclicality of bank costs χ_1, and the persistence and volatility of the new shocks. μ must be greater than 0, but there are no such restrictions on χ_1. I choose relatively weak priors for both in the absence of strong evidence for the values they should take, and choose priors for the new shock processes to match those of other shocks. For full details of the data, calibration, and priors see Appendix E.2.

IV.D Results: Amplification from Attention

The posterior parameter estimates are reported in Appendix E.2.3. The key novel parameters in the estimation are the cost of information μ and the cyclicality of bank cost dispersion χ_1, which have estimated posterior means of 0.037 and -0.280. These imply a steady state $\bar{p}^g$ of 0.565. To interpret these estimates I compare the estimated model to an alternative with the same equations and parameters, but where attention is held at its steady state each period.

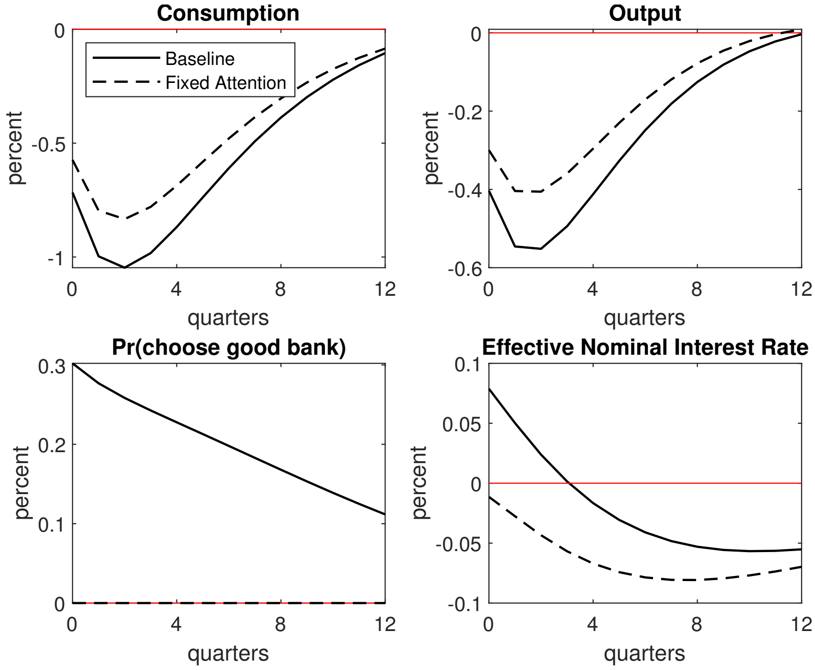
Specifically, in this alternative model, I replace the first order condition on attention (equation 39) with the restriction that $p_t^g = \bar{p}^g = 0.565$ in every period. By holding the choice probabilities fixed at their steady state values, attention $\mathcal{I}_t$ is also held constant (equation 10). All cyclical fluctuations in attention, and the resulting effects on bank and household decisions, are therefore assumed away, while the steady state of this alternative model remains the same as in the baseline specification with variable attention.

In the estimated model, risk premium shocks account for the largest share of the variance of consumption. Figure 3 displays the impulse responses of several key variables to a contractionary risk premium shock, in both the baseline model and the alternative with fixed attention. The upper panels show that consumption and output fall more on impact in the baseline case, and this extra contraction persists for several quarters. The lower panels reveal why this is: as in the simple model (Section I.E), the fall in consumption prompts savers in the baseline model to pay more attention to their choice of bank, so the probability that they choose the good bank rises. This in turn causes an increase in the distribution of offered interest rates, so that between these two effects the effective interest rate faced by the household i_t^e actually rises on impact. The fall in i_t^{CB} in response to the contraction only brings i_t^e below its steady state level four quarters after the shock. Without the rise in attention, households in the alternative model see i_t^e fall immediately, and it remains below the levels of the baseline case for many quarters. This is despite the fact that, due to the larger contraction in output (and inflation), the policy rate i_t^{CB} falls more in the baseline model.

These patterns are not confined to risk premium shocks. Each row of Table 3 reports the magnitude of the cumulative response of consumption to a given shock over a year in the static attention alternative, relative to the baseline estimated model. A value below 1 implies that consumption responds by less to that shock in the fixed attention model than with variable attention. I list this for all shocks that explain more than 1.5% of the variance of consumption, ordered according to the share of consumption volatility they explain. The corresponding consumption impulse response functions for each shock are reported in Appendix E.2.3.[30]

[30]While consumption responds more strongly than output in response to a risk premium shock (Figure

Figure 3: Impulse Response Functions of c_t, y_t, p_t^g, and i_t^e in response to a 1 standard deviation contractionary risk premium shock.



Note: Solid lines are simulations of a 1 standard deviation risk premium shock in the estimated model described in Section IV.A. Estimation details and estimated parameters are listed in Appendix E.2. Dashed lines are simulations from the same model, with the same parameters, but where p_t^g has been held at steady state in all periods, so households are no longer on their first order condition for attention (equation 39) in each period.

For most of the shocks, consumption is substantially less responsive when attention is held at its steady state. For risk premium and TFP shocks, which together explain 66% of consumption volatility in the baseline estimated model, attention variation amplifies the consumption response by 25% and 20% respectively. Overall, the variance of consumption is 13.6% larger with variable attention than if attention is held at steady state.

This amplification from variable attention is substantial even though the information problem only applies to a subset of the household portfolio. This is due to a no-arbitrage condition: for households to hold both bonds and capital the expected benefits of holding them must be equal. If the household pays more attention to bonds and so increases their interest rate there, the return on other assets must adjust to match. Restricting the information problem to one asset does not therefore remove the effects analysed in Section I. In fact, capital provides an extra channel through which attention amplifies fluctuations: when attention rises the interest rate on domestic bonds exceeds the expected return on capital, so investment drops until the returns are equalized, adding to the contraction.

The amplification from variable attention is also strengthened by another general equilibrium effect not seen in Section I. After a contractionary shock, variable attention

3), this is not true of all shocks. Overall, the unconditional variance of consumption growth in the estimated model is therefore smaller than the variance of output growth.

Table 3: Cumulative consumption response to shocks relative to variable attention baseline.

Shock	Fixed Attention
Risk premium	0.797
TFP	0.833
Govt. spending	0.730
Monetary policy	1.159
Bank costs (level)	0.728
Markup	1.168
Foreign inflation	1.023

Note: For each shock, the reported statistic is calculated by taking the 12-month cumulative response of consumption to the shock in the estimated quantitative model, assuming that attention is held fixed at its steady state value, then dividing that by the equivalent cumulative consumption response in the full baseline model with variable attention.

reduces output and inflation relative to where they would be with fixed attention. The monetary authority therefore sets a lower policy rate than with fixed attention. Since χ_1 is estimated to be negative, this lower policy rate leads to greater interest rate dispersion, encouraging even more attention and a greater fall in consumption.

For a minority of shocks, however, variable attention leads to smaller consumption responses (ratios in Table 3 greater than 1). The most important is the monetary policy shock, which accounts for 4% of consumption variance in the baseline model. Variable attention dampens these shocks because interest rate dispersion falls when policy rates rise. If there is a shock that causes a small consumption fall but a large rise in the policy rate, then this dispersion effect will dominate and attention will fall. In this case the interest rates households experience will fall relative to the fixed attention case, mitigating the initial fall in consumption. This dispersion effect is small enough that for most shocks that cause consumption and interest rates to move in opposite directions, such as TFP, the marginal utility of income effect dominates and attention amplifies the shock. However, for monetary policy, markup, and foreign inflation shocks there is a large change in policy rates. Attention therefore co-moves positively with consumption, dampening the shock.

Variable attention therefore amplifies the response of consumption to most shocks. For shocks that cause consumption and output to co-move, such as TFP shocks, then this also amplifies the output response. For other shocks, however, output and consumption move in opposite directions (e.g. government spending shocks), and in those cases the amplification of the consumption effect mitigates the output response to the shock.

These results all come from a model in which there is a representative household engaged in saving. In Appendix E.3, I extend this model to a two-agent setting as in Iacoviello (2005), in which I add impatient households, who borrow up to a binding credit constraint and process information to reduce the interest rate on their borrowing, as in

Section I.F. Consistent with the analytic results from Section I.F, variation in attention to borrowing has little impact on aggregate dynamics, even though the impatient borrower households have a high marginal propensity to consume, and so react strongly to changes in their effective interest rate. The results from the representative-agent model are therefore robust to the inclusion of borrowers.

In fact, cyclical attention to saving is estimated to have a slightly greater amplification effect in the two-agent model than in the representative-agent model studied in this section, even though not all households are savers. This is because cyclical attention causes the unconstrained savers to react more strongly to shocks, which in turn generates larger fluctuations in labor demand, and thus in wages. While constrained households are not directly affected by saver attention, their income (and so consumption) still becomes more volatile through this indirect channel. To examine this, in Appendix E.3 I decompose the transmission of risk premium shocks along similar lines to the decomposition of monetary policy transmission in Kaplan et al. (2018). Direct effects through savers' Euler equations are amplified by cyclical attention to saving, but indirect effects through the incomes of both households are amplified even more, so the share of the shock impact due to direct effects is smaller when attention to saving varies over the business cycle.

IV.E Risk Premium Shocks and Policy Implications

Risk premium shocks are commonly found to be important drivers of aggregate demand in estimated business cycle models (e.g. Smets and Wouters, 2007; Christiano et al., 2015). They are often interpreted as a disturbance to a wedge between the interest rate experienced by households and the policy rate. Similarly, changes in attention also cause the effective interest rate to shift relative to the policy rate (Proposition 3). Changes in attention and risk premium shocks therefore affect consumption Euler equations in exactly the same way. The key difference between attention and risk premium shocks, however, is that attention is an endogenous household choice, so is influenced by policy.

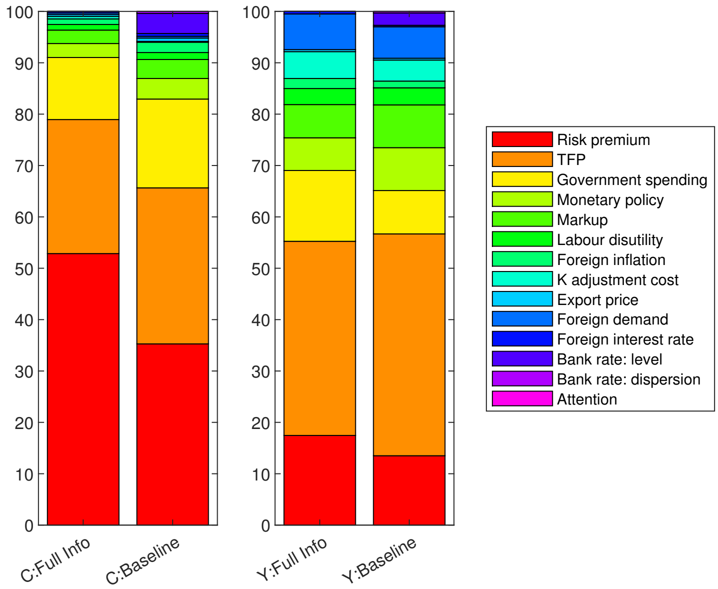
The correspondence between attention and risk premium shocks means that variable attention can provide a structural explanation of risk premium shocks, which is often absent in DSGE models (see Fisher, 2015, for an alternative interpretation). To see the quantitative ability of variable attention to explain risk premium shocks, I compare the baseline estimated model with an otherwise identical model without information frictions.

Specifically, I take the baseline model and set $\mu = 0$. As this implies $\lambda_t = 0$ (individuals are not information constrained), equation 41 is no longer well-defined. Rather, with no information constraint individuals always identify the good bank, so $p_t^g = 1$. Banks therefore compete à la Bertrand: the bad bank sets i_t^b equal to their cost of funding $(i_t^{CB} - \chi_t^b)$, and the good bank sets i_t^g negligibly below that to capture the whole market.

I then re-estimate this full-information model in the same way as the baseline. I use the same data except for the variables associated with the attention problem, which are not used. The calibration and priors for all parameters except those in the attention problem are also the same as in the baseline model. Full details of this estimation, including priors and posteriors of estimated parameters, are reported in Appendix E.2.3.

Figure 4 shows the variance decomposition of consumption and output in this full-information model, alongside the same decomposition for the baseline inattention model.

Figure 4: Variance decomposition of consumption and output in the full information and variable attention models.



Note: Size of each bar segment is a percentage of variance explained. The percentages are computed from a variance decomposition of consumption and output in the estimated quantitative model with Full Information and Rational Inattention respectively. The model is re-estimated under each assumption.

The risk premium shock is the bottom segment of each bar (displayed in red). With no information friction, the risk premium shock explains 52.8% of the variance of consumption, and 17.5% of the variance of output. Only TFP shocks explain a larger share of output variance. Moving to the baseline model with time-varying attention, the risk premium shock becomes less important, explaining 35.3% and 13.5% of consumption and output variance respectively.

Cyclical attention can therefore plausibly explain 23%-33% of the business cycle volatility otherwise attributed to risk premium shocks in the UK. Very little of the fall in the importance of risk premium shocks is made up for by shocks to attention, which explain negligible fractions of consumption and output variance in the baseline model. This portion of the risk premium shock is therefore mostly explained by an endogenous response of attention to other shocks. In particular, the share of consumption and output variance explained by TFP and price markup shocks increases when adding the information friction. Government spending also explains a greater share of consumption variation. Shocks to the level of bank interest rates (ζ_t^{χ}) are the only newly-introduced shocks to play a non-negligible role in the baseline model, explaining 2.4% of output variance and 3.9% of consumption variance.

Importantly, endogenous attention choices can be affected by policy, where exogenous risk premium shocks cannot. One policy that has an intuitive effect on attention is to reduce the cost of information, for example through financial education programmes or regulation to ensure clearer disclosure and presentation of bank pricing policies.

After a permanent fall in the cost of information μ, households pay more attention to savings in steady state. This reduces the amplification from variable attention through two channels. First, attention becomes more sharply convex in effective interest rates at higher levels of attention ($\mathcal{I}''(i_t^e)$ increases), and so fluctuations in the marginal utility of income produce smaller fluctuations in attention. Second, greater attention reduces the equilibrium dispersion of interest rates, which reduces the impact of attention fluctuations on effective interest rates. For these reasons, reducing μ by 50% (and keeping all other parameters as in the estimated model) reduces the variance of consumption by 11%.

V Conclusion

I have presented a novel channel through which aggregate shocks affect consumption. In theory and in data, households are more successful at choosing higher interest rate savings products in contractions, because they pay more attention to their choice when the marginal utility of income is high. An improvement in these savings choices increases the interest rate households face, and so causes current consumption to fall as households postpone more consumption to the future. Countercyclical variation in attention therefore amplifies the consumption response to the shocks that drive the business cycle.

In an estimated model of the UK economy, variable attention amplifies the effect of aggregate shocks on consumption: the variance of consumption is 13.6% higher than it would be if attention remained constant, and the effect of cyclical attention on some specific shocks is substantially larger than that. Variable attention also explains approximately a quarter of the business cycle fluctuations attributed to risk premium shocks in a full information version of the model.

Since attention, unlike the risk premium shock, is an endogenous choice made by households, it can be affected by policy. In particular, policies aimed at making it easier for households to 'shop around' for financial products could reduce business cycle volatility, providing another argument in favor of policies such as financial education and clear disclosure of bank pricing policies.

These results stem from variable attention to savings choices. In extensions to include variable attention to borrowing, I showed that the resulting effects on aggregate dynamics are small relative to those from saving. However, these extensions make the notable simplification that information about borrowing products is assumed to be independent of information about saving products. Future research may investigate the extent of possible complementarities in learning about different financial product types, and explore how this affects the channels analyzed here.

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A Proofs

A.1 Proposition 1

Here I show that for b_t below a certain threshold, the household first order conditions are sufficient for utility maximization in the simple model (Section I), and in the quantitative model (Section IV).

First, write the household problem as an unconstrained maximization by substituting out for consumption using the budget constraint:

$$\max_{b_t, i_t^e, X_t} U = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(u\left(\frac{b_{t-1}}{\Pi_t}(1 + i_{t-1}^e) + y_t(X_t) - b_t \right) - \mu \mathcal{I}(\mathbb{E}_s i_t^e) + v(X_t) \right) \tag{A.1}$$

Here I have summarized all choice variables other than saving b_t and the effective interest rate i_t^e in the vector X_t. In the simple model there are no other choice variables, so X_t is empty and non-asset income y_t is exogenous. In the quantitative model X_t includes wage setting, investment, and capital utilization. Inflation erodes real bond holdings as in the quantitative model. Note that this proof corresponds to the simple model case if Π_t is set to 1 for all t.

I begin by defining H_s as the Hessian matrix of second-order partial derivatives of this utility function with respect to each choice variable that would result if there was no information friction, and so i_t^e was not a choice variable. The Hessian matrix for the full problem is then:

$$H = \begin{bmatrix} & & & 0 \\ & H_s & & \vdots \\ & & & 0 \\ & & & \frac{\partial^2 U}{\partial b_t \partial i_t^e} \\ 0 & \dots & 0 \quad \frac{\partial^2 U}{\partial b_t \partial i_t^e} & \frac{\partial^2 U}{\partial i_t^{e2}} \end{bmatrix} \tag{A.2}$$

Here I have used the fact that the only choice variable that i_t^e interacts with in the utility function is b_t. For all other choice variables X_t, $\frac{\partial^2 U}{\partial X_t \partial i_t^e} = 0$. The first order conditions are sufficient for utility maximization if U is weakly concave, which is true if for any vector x:

$$xHx' = x_s H_s x_s' + 2yz \frac{\partial^2 U}{\partial b_t \partial i_t^e} + z^2 \frac{\partial^2 U}{\partial i_t^{e2}} \leq 0 \tag{A.3}$$

Where $x_s = [x_1, ..., y]$ and $x = [x_s, z]$. If households cannot influence effective interest rates the utility function is concave, as then this is a standard household maximization problem (identical to that in Harrison and Oomen (2010) in the quantitative model). This implies that $x_s H_s x_s' < 0$.

Assuming a diminishing marginal utility of consumption we have that:

$$\text{(A.4)} \qquad \frac{\partial^2 U}{\partial b_t^2} = u''(c_t) + \beta \mathbb{E}_t \frac{u''(c_{t+1})(1+i_t^e)^2}{\Pi_{t+1}^2} < 0$$

It is therefore sufficient for the concavity of U to show that for any y, z:

$$\text{(A.5)} \qquad y^2 \frac{\partial^2 U}{\partial b_t^2} + 2yz \frac{\partial^2 U}{\partial b_t \partial i_t^e} + z^2 \frac{\partial^2 U}{\partial i_t^{e^2}} \leq 0$$

Using the definition of U this condition becomes:

$$\begin{aligned}\text{(A.6)} \quad y^2 u''(c_t) + y^2 \beta \mathbb{E}_t u''(c_{t+1}) \frac{(1+i_t^e)^2}{\Pi_{t+1}^2} + 2yz\beta \mathbb{E}_t u''(c_{t+1}) \frac{(1+i_t^e) b_t}{\Pi_{t+1}^2} \\ + 2yz\beta \mathbb{E}_t u'(c_{t+1}) \frac{1}{\Pi_{t+1}} - z^2 \mu \mathcal{I}''(\mathbb{E}_s i_t^e) + z^2 \beta \mathbb{E}_t u''(c_{t+1}) \frac{b_t^2}{\Pi_{t+1}^2} \leq 0\end{aligned}$$

The two terms that don't depend on c_{t+1} are both negative. The remaining terms can be written as:

$$\begin{aligned}\text{(A.7)} \quad & \beta \mathbb{E}_t \frac{u''(c_{t+1}) b_t^2}{\Pi_{t+1}^2} \left(\frac{y^2 (1+i_t^e)^2}{b_t^2} + z^2 + 2yz \left(\frac{1+i_t^e}{b_t} + \frac{\Pi_{t+1} u'(c_{t+1})}{u''(c_{t+1})} \right) \right) \\ & = -\beta y^2 \mathbb{E}_t \frac{u''(c_{t+1}) b_t^2}{\Pi_{t+1}^2} \left(\frac{2(1+i_t^e)\Pi_{t+1} u'(c_{t+1})}{b_t u''(c_{t+1})} + \frac{\Pi_{t+1}^2 (u'(c_{t+1}))^2}{(u''(c_{t+1}))^2} \right) \\ & \qquad + \beta \mathbb{E}_t \frac{u''(c_{t+1}) b_t^2}{\Pi_{t+1}^2} \left(z + y \left(\frac{1+i_t^e}{b_t} + \frac{\Pi_{t+1} u'(c_{t+1})}{u''(c_{t+1})} \right) \right)^2\end{aligned}$$

Since $u''(c_{t+1}) < 0$, the second term in this expression is negative. A sufficient condition for U to be concave is therefore:

$$\text{(A.8)} \qquad \mathbb{E}_t \frac{u''(c_{t+1})}{\Pi_{t+1}^2} \left(\frac{2(1+i_t^e)\Pi_{t+1}}{b_t \Gamma_{t+1}} - \frac{\Pi_{t+1}^2}{\Gamma_{t+1}^2} \right) \leq 0$$

where:

$$\text{(A.9)} \qquad \Gamma_{t+1} = -\frac{u''(c_{t+1})}{u'(c_{t+1})} > 0$$

is the coefficient of absolute risk aversion.

Rearranging, a sufficient condition for U to be concave is:

$$b_t \leq 2 \cdot \frac{\mathbb{E}_t \frac{u''(c_{t+1})(1+i_t^e)}{\Gamma_{t+1}\Pi_{t+1}}}{\mathbb{E}_t \frac{u''(c_{t+1})}{\Gamma_{t+1}^2}} \equiv \bar{b}_t \tag{A.10}$$

Therefore the first order conditions are sufficient for utility maximization as long as the amount saved is sufficiently low relative to the coefficient of absolute risk aversion.

The qualitative results in Section I hold as long as this condition is satisfied. In the quantitative model this is easily the case for plausible parameters. There $b_t = 1$, and with CRRA utility we have:

$$c_{t+1}\Gamma_{t+1} = \frac{1}{\sigma^c} \tag{A.11}$$

where σ^c is the intertemporal elasticity of substitution, estimated to be substantially below 1.

Condition A.10 can therefore be written as:

$$\mathbb{E}_t u''(c_{t+1})c_{t+1}\left[\frac{\sigma^c}{2}c_{t+1} - \frac{(1+i_t^e)}{\Pi_{t+1}}\right] \geq 0 \tag{A.12}$$

In steady state, $\frac{(1+i_t^e)}{\Pi_{t+1}} = \beta^{-1} > 1$. Since steady state consumption is 0.662, in the region of the steady state the term inside the square brackets is negative, which along with $u''(c_{t+1}) < 0$ means that this condition is comfortably satisfied.

A.2 Inverse Relationship between $\mathcal{I}_t$ and λ_t

The only way λ_t and $\mathcal{I}_t$ can be related in equation 10 is through choice probabilities, which holding i_t^n constant are entirely summarized by the effective interest rate. Using the chain rule we therefore have:

$$\frac{\partial \lambda_t}{\partial \mathcal{I}_t} = \frac{\partial \lambda_t}{\partial \mathbb{E}_s i_t^e}\frac{\partial \mathbb{E}_s i_t^e}{\partial \mathcal{I}_t} \tag{A.13}$$

In Appendix A.3 I show that $\frac{\partial \lambda_t}{\partial \mathbb{E}_s i_t^e} < 0$ and $\frac{\partial \mathcal{I}_t}{\partial \mathbb{E}_s i_t^e} = \lambda_t^{-1} > 0$, implying that:

$$\frac{\partial \lambda_t}{\partial \mathcal{I}_t} < 0 \tag{A.14}$$

A.3 Proposition 2

Substituting the optimal choice probabilities into the information constraint 10 gives (dropping time subscripts to simplify notation, as everything here is defined within the same period):

$$\mathcal{I} = \frac{\mathbb{E}_s i^e}{\lambda} - \sum_{s=1}^{S} \Pr(s) \log d_s \tag{A.15}$$

Where:

$$d_s = \sum_{k=1}^{N} \mathcal{P}_k \exp\left(\frac{i^k(s)}{\lambda}\right) \tag{A.16}$$

and $\{1, 2, ..., S\}$ is the set of all possible states of the world.

Differentiate this with respect to $\mathbb{E}_s i^e$, holding the offered interest rates $i^n(s)$ constant as individuals take them as given:

$$\frac{\partial \mathcal{I}}{\partial \mathbb{E}_s i^e} = \frac{1}{\lambda} - \frac{\mathbb{E}_s i^e}{\lambda^2} \frac{\partial \lambda}{\partial \mathbb{E}_s i^e} - \sum_{s=1}^{S} \frac{\Pr(s)}{d_s} \frac{\partial d_s}{\partial \mathbb{E}_s i^e} \tag{A.17}$$

Each term inside the sum is:

(A.18)

$$\begin{aligned} \frac{\Pr(s)}{d_s} \frac{\partial d_s}{\partial \mathbb{E}_s i^e} &= \frac{\Pr(s)}{d_s} \frac{\partial \lambda}{\partial \mathbb{E}_s i^e} \left[\left(\sum_{k=1}^{N} \exp(\frac{i^k(s)}{\lambda}) \frac{\partial \mathcal{P}_k}{\partial \lambda} \right) - \frac{1}{\lambda^2} \left(\sum_{k=1}^{N} i^k(s) \mathcal{P}_k \exp(\frac{i^k(s)}{\lambda}) \right) \right] \\ &= \frac{\partial \lambda}{\partial \mathbb{E}_s i^e} \Pr(s) \left(\sum_{k=1}^{N} \frac{\Pr(k|s)}{\mathcal{P}_k} \frac{\partial \mathcal{P}_k}{\partial \lambda} \right) - \frac{\mathbb{E}_s i^e}{\lambda^2} \end{aligned}$$

Substituting this back into equation A.17 gives:

$$\frac{\partial \mathcal{I}}{\partial \mathbb{E}_s i^e} = \frac{1}{\lambda} - \frac{\partial \lambda}{\partial \mathbb{E}_s i^e} \sum_{s=1}^{S} \sum_{k=1}^{N} \frac{\Pr(s) \Pr(k|s)}{\mathcal{P}_k} \frac{\partial \mathcal{P}_k}{\partial \lambda} \tag{A.19}$$

Recall that $\mathcal{P}_k$ is defined as the unconditional probability of choosing bank k, so it can be written as $\sum_{s=1}^{S} \Pr(k|s) \Pr(s)$. Using this, equation A.19 becomes:

$$\frac{\partial \mathcal{I}}{\partial \mathbb{E}_s i^e} = \frac{1}{\lambda} - \frac{\partial \lambda}{\partial \mathbb{E}_s i^e} \sum_{k=1}^{N} \frac{\partial \mathcal{P}_k}{\partial \lambda} \tag{A.20}$$

Since the sum of $\mathcal{P}_k$ over banks is always equal to 1, the sum of the derivatives of $\mathcal{P}_k$

must equal zero. We therefore have that:

$$\frac{\partial \mathcal{I}}{\partial \mathbb{E}_s i^e} = \frac{1}{\lambda} \tag{A.21}$$

Since λ is the Lagrange multiplier on the information constraint in the individual's problem, it is always strictly positive and $\mathcal{I}'(\mathbb{E}_s i^e) = \frac{\partial \mathcal{I}}{\partial \mathbb{E}_s i^e} > 0$.

Differentiating again with respect to $\mathbb{E}_s i^e$ we have:

$$\frac{\partial^2 \mathcal{I}}{\partial (\mathbb{E}_s i^e)^2} = -\frac{1}{\lambda^2}\frac{\partial \lambda}{\partial \mathbb{E}_s i^e} \tag{A.22}$$

$\mathcal{I}''(\mathbb{E}_s i^e)$ is therefore positive if $\frac{\partial \lambda}{\partial \mathbb{E}_s i^e} < 0$.

Differentiating the definition of i^e (12) with respect to i^e we have:

$$\frac{d\lambda}{di^e} = \frac{\lambda^2\big(\sum_n \mathcal{P}_n \exp(\frac{i^n}{\lambda})\big)^2}{\big(\sum_n i^n \mathcal{P}_n \exp(\frac{i^n}{\lambda})\big)^2 - \big(\sum_n i^{n^2} \mathcal{P}_n \exp(\frac{i^n}{\lambda})\big)\big(\sum_m \mathcal{P}_m \exp(\frac{i^m}{\lambda})\big)} \tag{A.23}$$

The numerator is always positive, so $\frac{d\lambda}{di^e}$ has the same sign as the denominator. After expanding the terms in brackets the denominator is:

(A.24)

$$\sum_n i^{n^2}\mathcal{P}_n^2 \exp(\frac{2i^n}{\lambda}) + \sum_{m\neq n} i^n i^m \mathcal{P}_n \mathcal{P}_m \exp(\frac{i^n + i^m}{\lambda}) - \sum_n i^{n^2}\mathcal{P}_n^2 \exp(\frac{2i^n}{\lambda}) - \sum_{m\neq n} i^{n^2} \mathcal{P}_n \mathcal{P}_m \exp(\frac{i^n + i^m}{\lambda})$$
$$= -\sum_{m\neq n}(i^{n^2} - i^n i^m)\mathcal{P}_n \mathcal{P}_m \exp(\frac{i^n + i^m}{\lambda})$$

Inside the sum, each pair of banks $\{j,k\}$ appear twice: when $m = k, n = j$ and when $m = j, n = k$. For each distinct pair of banks $\{j,k\}$, the terms inside the sum are equal to:

$$\mathcal{P}_j \mathcal{P}_k \exp(\frac{i^j + i^k}{\lambda})(i^{j^2} - i^j i^k + i^{k^2} - i^k i^j) = \mathcal{P}_j \mathcal{P}_k \exp(\frac{i^j + i^k}{\lambda})(i^j - i^k)^2 > 0 \tag{A.25}$$

Each pair of terms inside the sum in equation A.24 is therefore positive, and so $\frac{d\lambda}{di^e}$ is negative in each state of the world. That therefore implies that $\mathcal{I}''(\mathbb{E}_s i^e) > 0$.

A.4 Corollary 1

With uninformative priors we can write the probability of choosing bank n in state s as:

$$\Pr(n|s) = \frac{1}{1 + \sum_{j\neq n}^{N} \exp(\frac{i^j - i^n}{\lambda})} \tag{A.26}$$

Now consider a mean-preserving spread of interest rates, so replace each i^n with $\tilde{i}^n = ki^n - \bar{i}(k-1)$, where $\bar{i}$ is the unconditional mean of the pre-spread interest rates.

If choice probabilities are unchanged, and so attention $\mathcal{I}$ is unchanged, then it must be that for all n:

$$\sum_{j\neq n}^{N} \exp(\frac{i^j - i^n}{\lambda}) = \sum_{j\neq n}^{N} \exp(\frac{\tilde{i}^j - \tilde{i}^n}{\tilde{\lambda}}) = \sum_{j\neq n}^{N} \exp(\frac{k(i^j - i^n)}{\tilde{\lambda}}) \tag{A.27}$$

This is satisfied when $\tilde{\lambda} = k\lambda$. If $k > 1$ the mean-preserving spread increases the dispersion of interest rates, and correspondingly λ rises. Since $\mathcal{I}'(i^e) = \lambda^{-1}$, this reduces $\mathcal{I}'(i^e)$.

A.5 Lemma 1

First, partially differentiate the first order condition for bank n (19) with respect to λ_t, denoting $\mathcal{S}_n = \frac{\exp(i_t^n/\lambda_t)}{\sum_{k=1^N} \exp(i_t^k/\lambda_t)}$ as the market share of bank n in period t, and $d_n = i_t^{CB} - i_t^n - \chi_t^n$ as the profit bank n makes per bond sold. Time subscripts are dropped for these variables to save notation, as all relevant variables occur within the same period.

$$-d_n \frac{\partial \mathcal{S}_n}{\partial \lambda_t} - (1 - \mathcal{S}_n)\frac{\partial i_t^n}{\partial \lambda_t} = 1 \tag{A.28}$$

Using the definition of $\mathcal{S}_n$ (equation 15):

$$\frac{\partial \mathcal{S}_n}{\partial \lambda_t} = \frac{\mathcal{S}_n(1-\mathcal{S}_n)}{\lambda_t}\frac{\partial i_t^n}{\partial \lambda_t} - \frac{\mathcal{S}_n(1-\mathcal{S}_n)i_t^n}{\lambda_t^2} + \mathcal{S}_n\left(\sum_{j\neq n}\frac{\mathcal{S}_j}{\lambda_t^2}(i_t^j - \lambda_t\frac{\partial i_t^j}{\partial \lambda_t})\right) \tag{A.29}$$

Substituting this in to equation A.28 and rearranging we obtain:

$$\frac{\partial i_t^n}{\partial \lambda_t} = \frac{1}{\lambda_t(1-\mathcal{S}_n)(\lambda_t + d_n\mathcal{S}_n)}\left[i_t^n d_n \mathcal{S}_n(1-\mathcal{S}_n) - \lambda_t^2 - d_n\mathcal{S}_n\Big(\sum_{j\neq n}\mathcal{S}_j(i_t^j - \lambda_t\frac{\partial i_t^j}{\partial \lambda_t})\Big)\right] \tag{A.30}$$

From equation 19 we have $d_n = \lambda_t(1-\mathcal{S}_n)^{-1}$. Separately, we can write $\sum_{j\neq n}\mathcal{S}_j i_t^j = i_t^e - \mathcal{S}_n i_t^n$. Using these we obtain:

$$\frac{\partial i_t^n}{\partial \lambda_t} = \frac{\mathcal{S}_n}{\lambda_t(1-\mathcal{S}_n)}(i_t^n - i_t^e + \lambda_t\sum_{j\neq n}\mathcal{S}_j\frac{\partial i_t^j}{\partial \lambda_t}) - 1 \tag{A.31}$$

We now proceed with a guess-and-verify approach. Suppose that $\frac{\partial i_t^n}{\partial \lambda_t} < 0$ for all banks n, so every bank increases their interest rate when attention rises (λ falls). In that case we have that:

$$\frac{\partial i_t^n}{\partial \lambda_t} < \frac{\mathcal{S}_n}{\lambda_t(1-\mathcal{S}_n)}(i_t^n - i_t^e) - 1 \tag{A.32}$$

A sufficient condition for $\frac{\partial i_t^n}{\partial \lambda_t} < 0$ is therefore:

$$i_t^n < i_t^e + \frac{\lambda_t(1-\mathcal{S}_n)}{\mathcal{S}_n} \tag{A.33}$$

This is clearly true for all banks whose interest rate is below the effective interest rate. I now show that it is true for all banks provided λ_t is above a threshold $\underline{\lambda}$.

Recall that with uninformative priors the effective interest rate rises monotonically with attention and falls monotonically with λ (see Appendix A.3), so $i_t^e \geq \bar{i}_t$, where $\bar{i}_t$ is the unweighted mean interest rate on offer in period t. Condition A.33 is therefore satisfied if:

$$i_t^n < \bar{i}_t + \frac{\lambda_t(1-\mathcal{S}_n)}{\mathcal{S}_n} \tag{A.34}$$

Substituting out for i_t^n and $\bar{i}_t$ using the bank first order conditions, this becomes:

$$\lambda_t\left(\frac{1-\mathcal{S}_n+\mathcal{S}_n^2}{\mathcal{S}_n(1-\mathcal{S}_n)} - \frac{1}{N}\sum_{j=1}^{N}\frac{1}{1-\mathcal{S}_j}\right) > \bar{\chi} - \chi_t^n \tag{A.35}$$

where $\bar{\chi}$ is the unweighted mean transaction cost, which is time-independent. Consider the two fractions inside the brackets. The first is minimized at $\mathcal{S}_n = \frac{1}{2}$, at which point:

$$\min_{\mathcal{S}_n} \frac{1-\mathcal{S}_n+\mathcal{S}_n^2}{\mathcal{S}_n(1-\mathcal{S}_n)} = 3 \tag{A.36}$$

The second is minimized when $\mathcal{S}_j = N^{-1}$ for all j, at which point:

$$\min_{\mathcal{S}_j}\left(-\frac{1}{N}\sum_{j=1}^{N}\frac{1}{1-\mathcal{S}_j}\right) = -\frac{N}{N-1} \tag{A.37}$$

We therefore have:

$$\lambda_t\left(\frac{1-\mathcal{S}_n+\mathcal{S}_n^2}{\mathcal{S}_n(1-\mathcal{S}_n)} - \frac{1}{N}\sum_{j=1}^{N}\frac{1}{1-\mathcal{S}_j}\right) > \lambda_t\left(\frac{2N-3}{N-1}\right) \tag{A.38}$$

A sufficient condition for all banks to increase interest rates when λ_t falls is therefore:

$$\lambda_t > \frac{N-1}{2N-3}(\bar{\chi} - \chi^{min}) = \underline{\lambda} \tag{A.39}$$

Where χ^{min} is the lowest cost experienced by any bank, which again is time-independent as the χ_t^n distribution is assumed to be constant.

Condition A.39 is sufficient rather than necessary, and may in fact be substantially more restrictive than necessary. In particular, it ignores the fact that interest rates are strategic complements ($\frac{\partial i_t^j}{\partial \lambda_t}$ enters equation A.31 with a positive coefficient), so low-rate banks increasing their interest rates when λ falls will incentivize higher-rate banks to do the same. We can see this difference when $N = 2$, in which case the system of equations given by A.31 has a straightforward analytic solution:

$$\frac{\partial i_t^n}{\partial \lambda_t} = \frac{1}{1 - \mathcal{S}_n + \mathcal{S}_n^2}\left[\frac{\mathcal{S}_n^2}{\lambda_t}(i_t^n - i_t^{-n}) - 1 - \mathcal{S}_n\right] \tag{A.40}$$

This is negative as long as (substituting out for i_t^n and i_t^{-n} using the bank first order condition):

$$\lambda_t > \frac{2\mathcal{S}_n^2(1-\mathcal{S}_n)}{1 - 2\mathcal{S}_n + 2\mathcal{S}_n^2 + \mathcal{S}_n^3 - \mathcal{S}_n^4}(\bar{\chi} - \chi^{min}) \tag{A.41}$$

This is substantially less restrictive than condition A.39. The right hand side of condition A.41 is maximized at $\mathcal{S}_n = 0.589$, at which point the condition becomes $\lambda_t > 0.475(\bar{\chi} - \chi^{min})$, while condition A.39 in the two-bank case is $\lambda_t > (\bar{\chi} - \chi^{min})$. In the estimated quantitative model condition A.39 is easily satisfied in the region of steady state, so all interest rates rise with attention in the region of the steady state.

In this case with two banks, we can also show that interest rate dispersion always falls when attention rises (λ_t falls). Using equation A.40, we have that $\frac{\partial i_t^1}{\partial \lambda_t} > \frac{\partial i_t^2}{\partial \lambda_t}$ if:

$$i_t^1 - i_t^2 > \frac{\lambda_t(2\mathcal{S}_1 - 1)}{2\mathcal{S}_1^2 - 2\mathcal{S}_1 + 1} \tag{A.42}$$

Substituting out for i_t^1 and i_t^2 using the two bank first order conditions we obtain:

$$\chi_t^2 - \chi_t^1 > \lambda_t\left[\frac{2\mathcal{S}_1 - 1}{2\mathcal{S}_1^2 - 2\mathcal{S}_1 + 1} - \frac{1}{\mathcal{S}_1(1-\mathcal{S}_1)}\right] = -\lambda_t\frac{(2\mathcal{S}_1^3 - \mathcal{S}_1^2 - \mathcal{S}_1 + 1)}{\mathcal{S}_1(1-\mathcal{S}_1)(2\mathcal{S}_1^2 - 2\mathcal{S}_1 + 1)} \tag{A.43}$$

The fraction on the right hand side is positive for all $\mathcal{S}^1 \in (0, 1)$. We therefore have that in response to an attention rise, bank 1 raises interest rates by less than bank 2 ($\frac{\partial i_t^1}{\partial \lambda_t} > \frac{\partial i_t^2}{\partial \lambda_t}$) whenever bank 2 has higher costs - so whenever bank 2 offers lower rates.

That gives us that dispersion falls when attention rises.

In general, search models based on Burdett and Judd (1983) have price dispersion initially rising in search effort, and then falling with search effort once effort is above some threshold. The reason for the difference with the inattention model is that Burdett-Judd models feature a reservation price, above which consumers do not buy. If we impose that interest rates cannot fall below some lower bound, then as attention approaches zero interest rates again converge on this lower bound, just as prices converge on the reservation price in Burdett and Judd (1983). In that case interest rate dispersion initially rises with attention as banks move away from the lower bound, then falls as found above, just as in Burdett-Judd models. Since there are two banks and no interest rate lower bound in the quantitative model in Section IV, this model behaves in a qualitatively similar way to a Burdett-Judd model in the region where more search effort reduces price dispersion.

A.6 Proposition 3

The first line of equation 25 follows directly from differentiating equation 24, and applying the chain rule and the product rule. The second term inside the square brackets is negative as a consequence of Lemma 1. It only remains therefore to show that:

$$\sum_{n=1}^{N} \frac{\partial \Pr(n|s_t)}{\partial \lambda_t} i_t^n = -\frac{1}{\lambda_t^2} Var^e(i_t^n) < 0 \tag{A.44}$$

First, from equation 15, holding all i_t^n constant, we obtain:

$$\begin{aligned} \frac{\partial \Pr(n|s_t)}{\partial \lambda_t} &= -\frac{\Pr(n|s_t)(1-\Pr(n|s_t))i_t^n}{\lambda_t^2} + \frac{\Pr(n|s_t)}{\lambda_t^2}\sum_{j\neq n}\Pr(j|s_t)i_t^j \\ &= -\frac{\Pr(n|s_t)(1-\Pr(n|s_t))i_t^n}{\lambda_t^2} + \frac{\Pr(n|s_t)}{\lambda_t^2}(i_t^e - \Pr(n|s_t)i_t^n) \\ &= \frac{\Pr(n|s_t)}{\lambda_t^2}(i_t^e - i_t^n) \end{aligned} \tag{A.45}$$

Substituting this into the left hand side of equation A.44:

$$\begin{aligned} \sum_{n=1}^{N} \frac{\partial \Pr(n|s_t)}{\partial \lambda_t} i_t^n &= \frac{1}{\lambda_t^2}\sum_{n=1}^{N}\Pr(n|s_t)i_t^n(i_t^e - i_t^n) \\ &= \frac{1}{\lambda_t^2}\left((i_t^e)^2 - \sum_{n=1}^{N}\Pr(n|s_t)(i_t^n)^2\right) \\ &= -\frac{1}{\lambda_t^2}Var^e(i_t^n) \end{aligned} \tag{A.46}$$

Since variances are positive by definition, this term is strictly negative.

A.7 Relationship between Attention and φ_t

A.7.1 N=2 Banks, Uninformative Priors

As in Section IV, define p_t^g as the probability an individual chooses the high interest rate bank in period t:

$$p_t^g = \frac{\exp(\frac{i_t^g}{\lambda_t})}{\exp(\frac{i_t^g}{\lambda_t}) + \exp(\frac{i_t^b}{\lambda_t})} \tag{A.47}$$

Individuals paying no attention to bank choice choose bank n with probability $\mathcal{P}_n = 0.5$, so the benchmark no-attention rate in the model is the unweighted mean of the available interest rates:

$$i_t^b = \mathcal{P}_1 i_t^1 + (1 - \mathcal{P}_1) i_t^2 = 0.5(i_t^1 + i_t^2) \tag{A.48}$$

With two banks and uninformative priors, the attention constraint 10 becomes:

$$\mathcal{I}_t = \log(2) + p_t^g \log p_t^g + (1 - p_t^g) \log(1 - p_t^g) \tag{A.49}$$

Attention is therefore a monotonically increasing function of p_t^g (as $p_t^g \geq 0.5$).

The empirical statistic φ_t is:

$$\varphi_t = \frac{p_t^g i_t^g + (1 - p_t^g) i_t^b - \frac{1}{2}(i_t^g + i_t^b)}{\frac{1}{2}(i_t^g - i_t^b)} \tag{A.50}$$

This simplifies to:

$$\varphi_t = \frac{p_t^g (i_t^g - i_t^b) - \frac{1}{2}(i_t^g - i_t^b)}{\frac{1}{2}(i_t^g - i_t^b)} = 2p_t^g - 1 \tag{A.51}$$

In this case φ_t is therefore a linear function of the probability an individual successfully chooses the higher interest rate bank, which itself is an increasing concave function of attention. This case also highlights the importance of normalizing the spread $i_t^e - i_t^b$ by the standard deviation of interest rates to obtain φ_t: without that, φ_t would be increasing in $i_t^g - i_t^b$, even if p_t^g and so attention are held constant. The normalization therefore prevents changes in rate dispersion from mechanically affecting φ_t.

The normalization only exactly removes all dependence on the shape of the rate distribution in this case of $N = 2$ and uninformative priors, but still helps mitigate the dependence of $i_t^e - i_t^b$ on the spread of interest rates more generally. In particular, it ensures that φ_t is homogeneous of degree 0 in interest rates, so a mean-preserving spread of the interest rate distribution (as studied in Appendix A.4) leaves φ_t unchanged unless attention, and so choice probabilities, change.

A.7.2 N>2 Banks

Since all variables here are defined within the same period I drop all time subscripts to simplify notation. Denoting the unweighted mean interest rate (which is again the model's no-attention rate) as $\bar{i}$, and the standard deviation of interest rates as $\sigma(i)$, the model-implied φ is:

$$\varphi = \frac{\sum_n i^n \Pr(\text{choose } n) - \bar{i}}{\sigma(i)} = \frac{\frac{\sum_n i^n \exp(\frac{i^n}{\lambda})}{\sum_m \exp(\frac{i^m}{\lambda})} - \bar{i}}{\sigma(i)} \tag{A.52}$$

First, note that as $\mathcal{I}$ approaches 0, λ approaches infinity, and so $\varphi = 0$ when attention is 0:

$$\lim_{\lambda \to \infty} \varphi = \frac{\frac{1}{N}\sum_n i^n - \bar{i}}{\sigma(i)} = 0 \tag{A.53}$$

If attention $\mathcal{I}$ reaches $\log(N)$, then each individual can perfectly identify the highest interest rate bank with probability 1, so denoting this as bank 1 (without loss of generality) we have $\varphi > 0$:

$$\varphi(\mathcal{I} = \log(N)) = \frac{i^1 - \bar{i}}{\sigma(i)} = \frac{\frac{1}{N}\sum_n (i^1 - i^n)}{\sigma(i)} > 0 \tag{A.54}$$

Since φ is continuous in attention for $\mathcal{I} \in (0, \log(N))$, the statements above guarantee that $\mathcal{I}$ and φ are positively related at least in some portions of this range.

To make further progress, I now consider how φ changes in the model assuming that interest rates are held fixed. We use the chain rule to write:

$$\frac{\partial \varphi}{\partial \mathcal{I}} = \frac{\partial \varphi}{\partial \lambda}\frac{\partial \lambda}{\partial \mathcal{I}} \tag{A.55}$$

From Appendix A.2, we have that $\partial\lambda/\partial\mathcal{I} < 0$.

Now consider $\frac{\partial \varphi}{\partial \lambda}$. Since $\frac{\partial \lambda}{\partial i^e} < 0$ we have:

$$\frac{\partial \varphi}{\partial \lambda} = \frac{1}{\sigma(i)}\frac{\partial i^e}{\partial \lambda} < 0 \tag{A.56}$$

This implies that $\frac{\partial \varphi}{\partial \mathcal{I}} > 0$. Holding the distribution of interest rates constant, φ monotonically increases with attention.

This, however, is only the direct effect of a change in attention on φ. As shown in Appendix A.5, a change in attention also implies a change in the interest rate distribution, which when $N > 2$ will have an indirect effect on φ. Numerically, these indirect effects are small, such that attention and φ are positively related as long as attention is not extremely high.

If attention is very high, then φ can fall as attention increases, because an increase in attention causes the highest rate bank to lower their rates, or only raise them a small amount (see Appendix A.4). Since attention is very high, individuals choose this bank with a very high probability, and so their effective interest rate only increases a small amount with attention. The increase in attention does, however, cause lower-rate banks to increase their interest rates, and so the benchmark rate increases more strongly than i^e. With $N = 2$ this is counteracted in φ by the normalization by $\sigma(i)$, but with a larger number of banks this adjustment is incomplete because the $N - 1$ lowest rate banks do not converge on each other at the same rate as they converge on the best bank. This breakdown of the link between φ and $\mathcal{I}$, however, only occurs at extreme levels of attention outside of plausible parameter ranges.

If χ^n are spaced equally on $[0, \chi_0^b]$, where χ_0^b is the highest bank cost in the steady state of the quantitative model, and i^{CB} is at the steady state value from that model, then with $N = 3$ the peak of φ occurs when attention is such that individuals choose the highest rate bank with probability 0.87. As N rises the $\Pr(1|1)$ associated with the threshold level of attention does fall, but only gradually. With $N = 20$, φ is increasing in $\mathcal{I}$ as long as $\Pr(1|1) < 0.85$.

B Persistent Bank Costs

B.1 Modeling Persistent Bank Costs

Here I show how persistent bank costs affect equilibrium attention, interest rates, and individual choice probabilities. For simplicity, I keep to the case of $N = 2$ banks.

Suppose that, as in Section IV, each period one bank is 'good' (cost χ^g) and the other is 'bad' (cost $\chi^b > \chi^g$). There are two possible states of the world: in state 1 bank 1 is good and bank 2 is bad, and in state 2 the ordering is reversed. Unlike in Section IV, assume that there is persistence in the state. Specifically, the state of the world , denoted s_t, follows a two-state Markov process, in which $\Pr(s_{t+1} = s | s_t = s) = g$, where $g \geq 0.5$.

B.1.1 Savers

Assume that savers know the previous state of the world: they observe whether they chose correctly or not when the interest rate payouts occur.[31] Their choice problem in period t therefore remains a static problem. The persistence in s_t shows up as a prior belief biased towards the previous period's realized state, which I assume without loss of generality to be state 1. Savers know the bank policy functions, and so they know what interest rate each bank will set in each state of the world. They therefore face the payoff matrix, where again I have dropped time subscripts since the saver problem is static (the same will also be true of the bank problem):

Table 4: Payoff matrix, observed previous state

	s_1	s_2
a_1	$i^{1,1}$	$i^{1,2}$
a_2	$i^{2,1}$	$i^{2,2}$
Prior prob.	g	$1-g$

Here a_n indicates choosing bank n, and $i^{n,s}$ is the interest rate offered by bank n if state s is realized. This matrix is not, in general, symmetric, because bank policy functions depend on both their costs (i.e. the state of the world) and saver predispositions, so bank 1 will set different interest rates in state 1 than bank 2 would in state 2 if $g \neq 0.5$.

With a marginal cost of information of λ, the probability a saver chooses bank n in state s is as in equation 11:

$$P(n|i^{n,s}, i^{-n,s}, s) = \frac{\mathcal{P}_n \exp(\frac{i^{n,s}}{\lambda})}{\mathcal{P}_n \exp(\frac{i^{n,s}}{\lambda}) + (1-\mathcal{P}_n)\exp(\frac{i^{-n,s}}{\lambda})} \tag{B.1}$$

The unconditional choice probabilities (predispositions) are found as the solution to two normalization conditions (following Matějka and McKay, 2015):

$$\frac{\exp(\frac{i^{1,1}}{\lambda})g}{\mathcal{P}_1 \exp(\frac{i^{1,1}}{\lambda}) + (1-\mathcal{P}_1)\exp(\frac{i^{2,1}}{\lambda})} + \frac{\exp(\frac{i^{1,2}}{\lambda})(1-g)}{\mathcal{P}_1 \exp(\frac{i^{1,2}}{\lambda}) + (1-\mathcal{P}_1)\exp(\frac{i^{2,2}}{\lambda})} = 1 \tag{B.2}$$

$$\frac{\exp(\frac{i^{2,1}}{\lambda})g}{\mathcal{P}_1 \exp(\frac{i^{1,1}}{\lambda}) + (1-\mathcal{P}_1)\exp(\frac{i^{2,1}}{\lambda})} + \frac{\exp(\frac{i^{2,2}}{\lambda})(1-g)}{\mathcal{P}_1 \exp(\frac{i^{1,2}}{\lambda}) + (1-\mathcal{P}_1)\exp(\frac{i^{2,2}}{\lambda})} = 1 \tag{B.3}$$

[31] An exploration of this kind of problem without the assumption that individuals know the history of states (but with exogenous payoffs) can be found in Steiner et al. (2017).

The $\mathcal{P}_1$ that satisfies these conditions is:

$$\mathcal{P}_1 = \frac{e^{\frac{i^{21}}{\lambda}}e^{\frac{i^{22}}{\lambda}} - (1-g)e^{\frac{i^{21}}{\lambda}}e^{\frac{i^{12}}{\lambda}} - ge^{\frac{i^{11}}{\lambda}}e^{\frac{i^{22}}{\lambda}}}{e^{\frac{i^{11}}{\lambda}}e^{\frac{i^{12}}{\lambda}} - e^{\frac{i^{21}}{\lambda}}e^{\frac{i^{12}}{\lambda}} - e^{\frac{i^{11}}{\lambda}}e^{\frac{i^{22}}{\lambda}} + e^{\frac{i^{21}}{\lambda}}e^{\frac{i^{22}}{\lambda}}} \tag{B.4}$$

B.1.2 Banks

Since savers observe past states of the world, their priors are entirely determined by the true previous state and the transition probabilities, neither of which the banks can influence. The bank problem therefore remains static: banks choose interest rates to maximize their instantaneous expected profit, giving the same first order condition as in Section I.A (again dropping time subscripts):

$$\frac{d}{di^n}P(n|s) \cdot (i^{CB} - i^n - \chi^n) = P(n|s) \tag{B.5}$$

I assume that banks take saver predispositions as given when deciding their interest rates. Intuitively, predispositions reflect household knowledge of the exogenous law of motion for the state of the world, and of bank policy functions. If households learn about how banks respond to different costs over time, then a bank changing its policy will not have any effect on predispositions until households learn about the change over many periods. The assumption can therefore be seen as assuming that banks are myopic, and don't take into account the future benefits of manipulating predispositions. While predispositions must be consistent with interest rate policies in the long run, banks do not take this into account in their decisions. This is similar to the assumptions in the deep habits model of Ravn et al. (2006), in which consumption habits evolve very slowly over time, so firms have limited ability to influence them in the short run. This assumption avoids counter-intuitive equilibria in which a fall in attention implies fierce competition for predispositions as households lean more heavily on these in their decisions.

The bank first order condition is then as in Section I:

$$\big(1 - P(n|s)\big) \cdot (i^{CB} - i^n - \chi^n) = \lambda \tag{B.6}$$

The only difference is that $\Pr(n|s)$ here includes the predisposition, which comes from the prior beliefs, which are in turn driven by the persistence of bank costs.

B.1.3 Equilibrium

Given exogenous values for g, λ, χ^n, and i^{CB}, an equilibrium consists of values for $\{P(n|s), \mathcal{P}_1, i^n\}$ such that:

1. *Individuals* maximize their expected interest rate subject to the marginal cost of information λ, yielding a predisposition to bank 1 as in equation B.4, and choice probabilities for each bank n in each state s as in equation B.1.
2. *Banks* maximize profits, setting i^n according to equation B.6.

Since this equilibrium allows $\mathcal{P}_1$ to vary in response to interest rate strategies (equation B.4), this equilibrium can be taken as the steady state of the system after predispositions have had time to adjust.

B.1.4 Simulation Results

I solve this system numerically for an example calibration, and study how the resulting equilibrium varies with λ and g. The qualitative results are robust to a wide variety of calibrations.

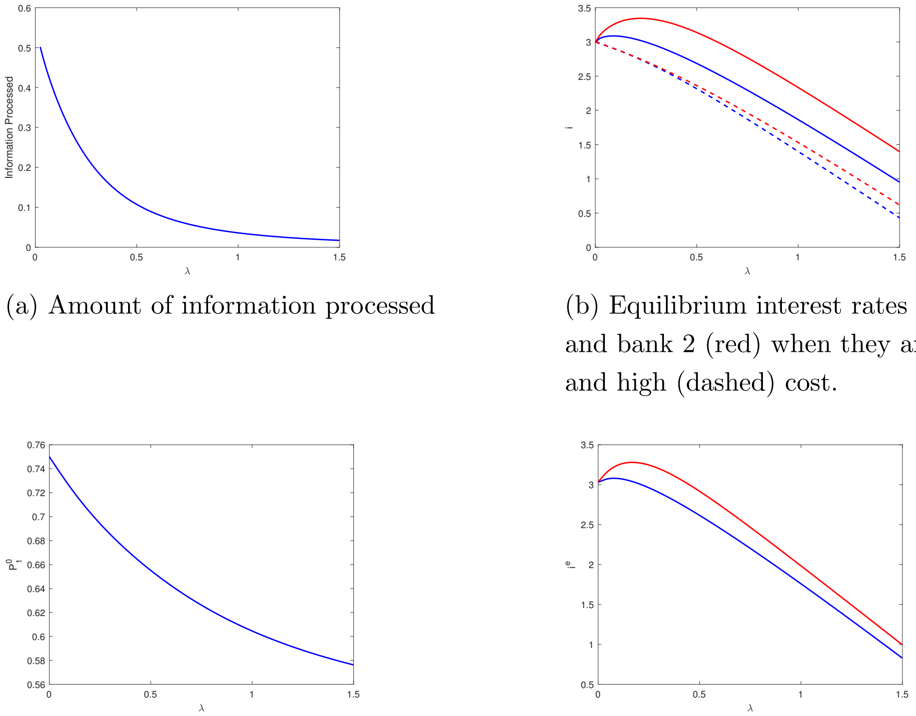
All of the results from the static cost model still hold: as attention rises interest rate dispersion falls and average rates rise. The highest rate in the market rises as λ falls as long as λ is above some threshold level. Figure 5 shows this result for an example calibration.

In addition, we have two new results. First, increasing the persistence of bank costs reduces saver attention, as priors become more informative. This causes bank 1 (which is increasingly likely to be low cost) to offer lower interest rates, as savers will come to them with a high probability anyway. Conversely, bank 2 offers higher rates to try and maintain their market share.

Second, the effective interest rate averaged over individuals depends on the state of the world. Bank 1 is more likely to be the low cost bank, so savers are predisposed to choose them. Bank 1 responds to this predisposition by offering lower interest rates. This only partially offsets the prior belief effect, so savers have $\mathcal{P}_1 > 0.5$ in equilibrium. This means that if the state stays at s_1 (bank 1 is low cost), savers are more likely to correctly identify the low cost bank than they are if the state changes to s_2. This increases the effective interest rate in s_1. At the same time, interest rates at the low cost bank are lower if that low cost bank is bank 1, as they are reacting to savers predispositions. Average interest rates are therefore higher in s_2, which increases the effective interest rate in s_2 relative to s_1. Which effect dominates depends on the calibration, but in either case there are two possible effective interest rates each period, and whenever there is a transition from one state to the other the effective interest rate will change even if all other variables are at steady state.

State transitions therefore produce shocks to the household effective interest rate, with $i^{e,1}$ realized with probability g and $i^{e,2}$ realized with probability $1 - g$. These shocks are the key qualitative difference between this model and the static cost model in Sections I and IV.

Figure 5: Long run equilibrium varies with λ in the model with persistent bank costs.



(a) Amount of information processed

(b) Equilibrium interest rates for bank 1 (blue) and bank 2 (red) when they are low (solid) and high (dashed) cost.

(c) Predisposition to choosing bank 1

(d) Effective interest rate if the low cost bank is bank 1 (blue) and bank 2 (red).

Note: Panels show results from simulations of the persistent bank cost model detailed in Appendix B.1, using the calibration: $g = 0.75, \chi^g = 0, \chi^b = 2, i^{CB} = 5, \lambda \in [0.024, 1.5]$. Quantity of information processed in panel (a) is defined as in equation 10. The effective interest rate in panel (d) is defined as $i^e(s) = \Pr(1|s)i^{1,s} + \Pr(2|s)i^{2,s}$.

B.2 Empirical Persistence of Interest Rate Rankings

In Sections I and IV I assume that the ranking of a bank in the interest rate distribution has no persistence. Table 5 shows the bank transition probabilities between quintiles of the interest rate distribution of the products studied in Section III over a month and a year. The annual transition probabilities are relevant because these products have a term of one year, so individual savers buying these products have to revisit their decision a year later (or exit the market).

Without persistence, every transition probability would equal 0.2. The values on the diagonal of the transition matrices are all greater than this, so there is some persistence in the data. However, the persistence is limited, even in the top and bottom quintiles where it is strongest. If a saver chose a bank in the top quintile of the interest rate distribution in a given period, then a year later when their product matures there is only a 36% probability of that bank still being in the top quintile. This explains why adding bank fixed effects do not account for much of the dispersion of interest rates, as discussed in Section III.A.

Table 5: Bank quintile transition matrices.

	1	2	3	4	5
1	0.59	0.16	0.10	0.07	0.07
2	0.19	0.51	0.19	0.07	0.04
3	0.03	0.28	0.43	0.20	0.07
4	0.01	0.08	0.30	0.41	0.20
5	0.01	0.03	0.08	0.22	0.65

(a) Monthly

	1	2	3	4	5
1	0.36	0.23	0.15	0.13	0.13
2	0.25	0.30	0.22	0.13	0.09
3	0.15	0.25	0.25	0.21	0.14
4	0.09	0.19	0.21	0.28	0.23
5	0.06	0.15	0.19	0.25	0.36

(b) Annual

Note: In each table the cell (n, m) indicates the probability of transitioning from the nth quintile to the mth quintile in the following period. Sample period: 1996-2009. Source: Moneyfacts Group (2009).

I test if these transition matrices are significantly different from a matrix where every element is 0.2 (the no-persistence case) with a likelihood ratio test:

$$-2\ln\left(\frac{\prod_{n=1}^{5}\prod_{m=1}^{5}p_{n,m}}{\prod_{n=1}^{5}\prod_{m=1}^{5}0.2}\right)\sim\chi^2_{19} \tag{B.7}$$

The critical value of the test statistic for 5% significance is 30.1. The monthly and annual transition matrices give test statistics of 25.9 and 4.3 respectively. We therefore cannot reject the hypothesis of no persistence at either an annual or a monthly frequency.

C Simple Model Extensions

C.1 Alternative Models

Here I show that the main mechanism of the inattention model of Section I is also present in a broad class of models in which households can pay a cost to increase the interest rate they face. This includes a model with frictional search for savings products, as in McKay (2013). To maintain simplicity here, I assume an exogenously fixed distribution of interest rates. I show in Appendix A.5 that attention affects the equilibrium interest rate distribution in the model of Section I in qualitatively the same way as search effort affects the equilibrium price distribution in Burdett and Judd (1983).

Consider an infinitely lived household who chooses consumption and saving each period to maximize expected lifetime utility subject to a standard budget constraint, where income comes from an endowment y_t and asset income. Households can choose in period t to pay a cost to increase the interest rate they face i_t^e. That is, to achieve i_t^e they must pay a cost $C(i_t^e)$, where C is an increasing convex function. I will consider two specifications for this cost, one in which the cost is an additively separable cost in the utility function, and another in which it is a monetary cost entering the budget constraint. The utility cost specification could be thought of as time or effort spent searching for products, while the monetary cost would be paying an advisor or intermediary to search on their behalf. The specification in use is determined by the binary variable ϕ: when $\phi = 0$ the cost is a utility cost, when $\phi = 1$ we are studying the monetary cost specification.

$$\max_{c_t, b_t, i_t^e} \mathbb{E} \sum_{t=0}^{\infty} \beta^t \left[u(c_t) - (1-\phi) C(i_t^e) \right] \tag{C.1}$$

subject to

$$c_t + b_t + \phi C(i_t^e) = y_t + b_{t-1}(1 + i_{t-1}^e) \tag{C.2}$$

We obtain a familiar consumption Euler equation, and a first order condition on i_t^e:

$$u'(c_t) = \beta(1 + i_t^e)\mathbb{E}_t u'(c_{t+1}) \tag{C.3}$$

$$\beta b_t \mathbb{E}_t u'(c_{t+1}) = (1-\phi)C'(i_t^e) + \phi u'(c_t) C'(i_t^e) \tag{C.4}$$

The household problem in Section I is a special case of this problem. The household equates the marginal utility of higher asset income with the marginal cost of achieving such a rise in interest rates. With a diminishing marginal utility of consumption, when expected future consumption falls the marginal utility of higher interest rates rises. If $\phi = 0$ households will respond by paying to increase their interest rate, since C is convex. If $\phi = 1$, households will only pay to increase i_t^e (and so $C'(i_t^e)$) if expected future consumption has fallen *relative to* current consumption, as increasing future asset income is achieved by sacrificing current consumption.

After a persistent contractionary shock, expected future consumption will fall, so households will pay to increase their interest rate, which will cause current consumption to fall further through the consumption Euler equation, amplifying the shock. This is true in both the utility cost and monetary cost specifications, as long as future consumption is expected to fall by more than current consumption, as is the case in most quantitative models (including that in Section IV) that feature hump-shaped impulse responses. This amplification is the mechanism explored in Section I: the rational inattention problem is a tractable way to motivate and model the cost $C(i_t^e)$ as a utility cost (in which case hump-shaped IRFs are not required), and allows for the distribution of available interest rates to be endogenized as a bank pricing equilibrium. It is not, however, the only way to do this. I now show that a model with frictional search for banks also fits into this class of models.

Suppose that the household is made up of many individuals. Many banks offer savings products, with interest rates that are distributed according to some CDF $F(i)$. Individuals can only choose a bank for their saving if they have observed its interest rate. All individuals observe one bank drawn at random from F, then with probability ψ they observe a second bank (again drawn at random) before choosing where to place their savings. The meeting rate ψ is an increasing function of the search effort of the individual, denoted e, which is decided by the household.

If an individual observes the interest rates of two banks, they choose the bank offering the higher interest rate, so the interest rate chosen has distribution $(F(i))^2$. The expected interest rate for an individual before we know how many banks they will observe, that is the effective interest rate faced by the household overall, is therefore:

$$i_t^e = (1-\psi(e_t))\int if(i)di + 2\psi(e_t)\int if(i)F(i)di \tag{C.5}$$

This is increasing in the probability of seeing a second bank $\psi(e_t)$, as the expected maximum of two draws from a distribution must be (weakly) greater than the expectation of a single draw. We can rearrange this to express search effort in terms of the interest rate the household ends up facing:

$$e_t = \psi^{-1}\left(\frac{i_t^e - \int if(i)di}{2\int if(i)F(i)di - \int if(i)di}\right) \tag{C.6}$$

The fraction inside the inverse ψ function increases linearly in i_t^e. If there are diminishing returns to effort (ψ is concave) then effort will be a convex function of the desired interest rate. If effort is costly, then the costs of increasing i_t^e will be a direct cost in the household utility function. As long as there are weakly diminishing returns to effort, and the cost of effort is weakly convex in effort, and at least one of those two curvatures is strict, then we obtain the first specification discussed above: there is a direct cost in utility which is convex in the desired (chosen) level of the interest rate. Formally, if the cost of effort in the utility function is $C_e(e)$, then we have:

$$C(i_t^e) = C_e\left(\psi^{-1}\left(\frac{i_t^e - \int if(i)di}{2\int if(i)F(i)di - \int if(i)di}\right)\right) \tag{C.7}$$

$$C''(i_t^e) > 0 \text{ if } C_e''(i_t^e) \geq 0 \text{ and } \psi''(e_t) \leq 0, \text{ one inequality strict} \tag{C.8}$$

C.2 Attention to Borrowing: Details

C.2.1 Model

A finite number $N^d \geq 2$ of lending banks choose their interest rate i_t^{nd} to maximize:

$$i_t^n = \arg\max_{\hat{i}_t^{nd}} \Pr(n|\hat{i}_t^{nd}, i_t^{-nd}) \cdot (i_t^{nd} - i_t^{CB} - \chi_t^{nd}) \tag{C.9}$$

where $\Pr(n|i_t^{nd}, i_t^{-nd})$ is the probability an individual chooses bank n for their borrowing with a given interest rate distribution, and χ_t^{nd} is the transaction cost per unit lending of bank n. This implies the first order condition:

$$\frac{d}{di_t^{nd}} \Pr(n|i_t^{nd}, i_t^{-nd}) \cdot (i_t^{nd} - i_t^{CB} - \chi_t^{nd}) = -\Pr(n|i_t^{nd}, i_t^{-nd}) \tag{C.10}$$

As in Section I.E, I assume for simplicity that the distribution of χ_t^{nd} is constant over time, so the household's effective interest rate on debt is not affected by the realizations of χ_t^{nd}. Each bank is also equally likely to draw each χ_t^{nd}, so individuals will have uninformative priors.

The household problem with debt is:

$$\max_{c_t, b_t, i_t^e, i_t^{eb}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \big(u(c_t) - \mu\mathcal{I}(i_t^e) - \mu\mathcal{I}^d(i_t^{ed})\big) \tag{C.11}$$

subject to

$$c_t + b_t - d = b_{t-1}(1 + i_{t-1}^e) - d(1 + i_{t-1}^{ed}) + y_t \tag{C.12}$$

$$\mathcal{I}'(i_t^e) > 0,\ \mathcal{I}''(i_t^e) > 0,\ \mathcal{I}^{d\prime}(i_t^{ed}) < 0,\ \mathcal{I}^{d\prime\prime}(i_t^{ed}) > 0 \tag{C.13}$$

where $\mathcal{I}^d(i_t^{ed})$ is the information processing required to achieve an effective debt interest rate of i_t^{ed}. The signs of $\mathcal{I}^{d\prime}(i_t^{ed}), \mathcal{I}^{d\prime\prime}(i_t^{ed})$ are assumed here, and are verified below. The household first order conditions are:

$$u'(c_t) = \beta\mathbb{E}_t(1 + i_t^e)u'(c_{t+1}) \tag{C.14}$$

$$\beta b_t \mathbb{E}_t u'(c_{t+1}) = \mu\mathcal{I}'(i_t^e) \tag{C.15}$$

$$\beta d \mathbb{E}_t u'(c_{t+1}) = -\mu \mathcal{I}'(i_t^{ed}) \tag{C.16}$$

As with savings, each individual chooses which bank to use for their portion of the household's borrowing by solving a discrete-choice rational inattention problem. The only difference to the problem in Section I.C is that for borrowing products, household indirect utility is decreasing in i_t^{ed}. Individuals therefore aim to choose the bank with the lowest interest rate on borrowing. The quantity of information processed is therefore defined as in equation 10, with uninformative priors:

$$\mathcal{I}^d(i_t^{ed}) = \log(N^d) + \sum_{n=1}^{N^d} \Pr(n|s_t^d) \log(\Pr(n|s_t^d)) \tag{C.17}$$

where to reduce notation s_t^d summarizes the state of the world in the lending market: that is, the interest rate at each lending bank.

Minimizing i_t^{ed} subject to this information constraint gives the probability of an individual choosing bank n, and the corresponding effective interest rate:

$$\Pr(n|s_t^d) = \frac{\exp(-\frac{i_t^{nd}}{\lambda_t^d})}{\sum_{k=1}^{N^d} \exp(-\frac{i_t^{kd}}{\lambda_t^d})} \tag{C.18}$$

$$i_t^{ed} = \sum_{n=1}^{N^d} \Pr(n|s_t^d) i_t^{nd} = \frac{\sum_{n=1}^{N^d} i_t^{nd} \exp(-\frac{i_t^{nd}}{\lambda_t^d})}{\sum_{n=1}^{N^d} \exp(-\frac{i_t^{nd}}{\lambda_t^d})} \tag{C.19}$$

Equation C.18 is the same as equation 28 in the main text.

Substituting equation C.18 into equation C.17, we obtain:

$$\mathcal{I}^d(i_t^{ed}) = -\frac{i_t^{ed}}{\lambda_t^d} - \log\left(\sum_{n=1}^{N^d} \frac{1}{N^d} \exp\left(-\frac{i_t^{nd}}{\lambda_t^d}\right)\right) \tag{C.20}$$

Comparing this with equation A.15 in the case with uninformative priors and no variation across cost states S, we have that information processed about debt can be expressed using the same function defining information processing about saving:

$$\mathcal{I}^d(i_t^{ed}, \{i_t^{nd}\}_{n=1}^{N^d}, \lambda_t^d) = \mathcal{I}(-i_t^{ed}, \{-i_t^{nd}\}_{n=1}^{N^d}, \lambda_t) \tag{C.21}$$

As a result, we can employ Proposition 2 to obtain:

$$\mathcal{I}^{d\prime}(i_t^{ed}) = -(\lambda_t^d)^{-1} < 0,\ \mathcal{I}^{d\prime\prime}(i_t^{ed}) > 0 \tag{C.22}$$

which when combined with Proposition 2 verifies condition C.13.

Combining equations C.16 and C.22 yields equation 27. Differentiating equation C.18 with respect to i_t^{nd} and substituting into equation C.10 yields equation 29.

Differentiating equation C.19 with respect to an arbitrary shock z_t, we obtain:

$$\text{(C.23)} \qquad \frac{\partial i_t^{ed}}{\partial z_t} = \left[\sum_{n=1}^{N^d} \frac{\partial \Pr(n|s_t^d)}{\partial \lambda_t^d} i_t^{nd} + \sum_{n=1}^{N^d} \Pr(n|s_t^d) \frac{\partial i_t^{nd}}{\partial \lambda_t^d} \right] \frac{\partial \lambda_t^d}{\partial z_t}$$

Holding all i_t^{nd} constant, we have that:

$$\text{(C.24)} \qquad \begin{aligned} \frac{\partial \Pr(n|s_t^d)}{\partial \lambda_t^d} &= \frac{\Pr(n|s_t^d)(1 - \Pr(n|s_t^d)) i_t^{nd}}{(\lambda_t^d)^2} - \frac{\Pr(n|s_t^d)}{(\lambda_t^d)^2} \sum_{k \neq n} \Pr(k|s_t^d) i_t^{kd} \\ &= -\frac{\Pr(n|s_t^d)}{(\lambda_t^d)^2} (i_t^{ed} - i_t^{nd}) \end{aligned}$$

This in turn implies that:

$$\text{(C.25)} \qquad \begin{aligned} \sum_{n=1}^{N^d} \frac{\partial \Pr(n|s_t^d)}{\partial \lambda_t^d} i_t^{nd} &= -\frac{1}{(\lambda_t^d)^2} \sum_{n=1}^{N^d} \Pr(n|s_t^d) i_t^{nd} (i_t^{ed} - i_t^{nd}) \\ &= \frac{1}{(\lambda_t^d)^2} Var^e(i_t^{nd}) \end{aligned}$$

where $Var^e(i_t^{nd})$ is defined as in equation 31. Substituting this into equation C.23, we obtain equation 30.

C.2.2 Proof of Proposition 4

First, combine equations 22 and 27 to obtain:

$$\text{(C.26)} \qquad \lambda_t^d = \frac{b_t}{d} \lambda_t$$

where λ_t is determined as in equation 22, and is therefore independent of d. Differentiating both sides with respect to z_t implies equation 32.

Second, without loss of generality, denote i_t^{1d} as the lowest interest rate on offer in the borrowing market: $i_t^{1d} < i_t^{nd}$ for all $n > 1$. As a consequence, $i_t^{ed} \geq i_t^{1d}$, from which we have:

$$\text{(C.27)} \qquad \frac{1}{(\lambda_t^d)^2} Var^e(i_t^{nd}) = \sum_{n=1}^{N^d} \Pr(n|s_t^d) \cdot \left(\frac{i_t^{nd} - i_t^{ed}}{\lambda_t^d} \right)^2$$

$$\text{(C.28)} \qquad \leq \sum_{n=1}^{N^d} \Pr(n|s_t^d) \cdot \left(\frac{i_t^{nd} - i_t^{1d}}{\lambda_t^d} \right)^2$$

To make further progress, it is useful to derive an expression linking interest rates and choice probabilities. Manipulating equation 28, we can rewrite the probability of an individual choosing bank n as:

$$\text{(C.29)} \qquad \Pr(n|s_t^d) = \frac{\exp(\frac{i_t^{md} - i_t^{nd}}{\lambda_t^d})}{\sum_{k=1}^{N^d} \exp(\frac{i_t^{md} - i_t^{kd}}{\lambda_t^d})}$$

for any $m \in \{1, ..., N^d\}$. Setting $n = m$, this becomes

$$\text{(C.30)} \qquad \Pr(m|s_t^d) = \frac{1}{\sum_{k=1}^{N^d} \exp(\frac{i_t^{md} - i_t^{kd}}{\lambda_t^d})}$$

Combining these:

$$\text{(C.31)} \qquad \Pr(n|s_t^d) = \exp(\frac{i_t^{md} - i_t^{nd}}{\lambda_t^d}) \Pr(m|s_t^d)$$

$$\text{(C.32)} \qquad \implies \frac{i_t^{md} - i_t^{nd}}{\lambda_t^d} = \log \left(\frac{\Pr(n|s_t^d)}{\Pr(m|s_t^d)} \right)$$

Substituting this in to equation C.28 with $m = 1$, we have:

$$\text{(C.33)} \qquad \frac{1}{(\lambda_t^d)^2} Var^e(i_t^{nd}) \leq \sum_{n=1}^{N^d} \Pr(n|s_t^d) \cdot \left(\log \left(\frac{\Pr(n|s_t^d)}{\Pr(1|s_t^d)} \right) \right)^2$$

We now proceed by taking the limit of the right hand side as $d \to \infty$. From equation 27, this is equivalent to $\lambda_t^d \to 0$. From equation 28, this implies $\Pr(1|s_t^d) \to 1$, $\Pr(n \neq 1|s_t^d) \to 0$. That is, as d becomes large, individuals pay large amounts of attention, and in the limit they identify the lowest interest rate in the market with certainty. It is convenient to work directly with the limits as $\Pr(1|s_t^d) \to 1$, and by extension as $\Pr(n \neq 1|s_t^d) \to 0$, noting that in this partial-equilibrium setting this is equivalent to

$d \to \infty$, as the stock of debt has no effect on $u'(c_{t+1})$ or i_t^{CB}.

(C.34)

$$\lim_{\Pr(1|s_t^d)\to 1} \sum_{n=1}^{N^d} \Pr(n|s_t^d) \cdot \left(\log\left(\frac{\Pr(n|s_t^d)}{\Pr(1|s_t^d)}\right)\right)^2 = \sum_{n=1}^{N^d} \lim_{\Pr(1|s_t^d)\to 1} \Pr(n|s_t^d) \cdot \left(\log\left(\frac{\Pr(n|s_t^d)}{\Pr(1|s_t^d)}\right)\right)^2$$

Expanding the limit inside the summation gives:

$$\text{(C.35)} \quad \lim_{\Pr(1|s_t^d)\to 1} \Pr(n|s_t^d) \cdot \left(\log\left(\frac{\Pr(n|s_t^d)}{\Pr(1|s_t^d)}\right)\right)^2 = \lim_{\Pr(1|s_t^d)\to 1} \Pr(n|s_t^d) \left(\log(\Pr(1|s_t^d))\right)^2$$
$$+ \lim_{\Pr(1|s_t^d)\to 1} \Pr(n|s_t^d) \left(\log \Pr(n|s_t^d)\right)^2 - 2 \lim_{\Pr(1|s_t^d)\to 1} \Pr(n|s_t^d) \log(\Pr(n|s_t^d)) \log(\Pr(1|s_t^d))$$

The first limit in this expanded expression is trivially equal to 0. Applying l'Hôpital's rule, we further find that:

$$\text{(C.36)} \quad \lim_{\Pr(1|s_t^d)\to 1} \Pr(n|s_t^d) \left(\log \Pr(n|s_t^d)\right)^2 = 0$$

$$\text{(C.37)} \quad \lim_{\Pr(1|s_t^d)\to 1} \Pr(n|s_t^d) \log(\Pr(n|s_t^d)) \log(\Pr(1|s_t^d)) = 0$$

Combining these results, we therefore have:

$$\text{(C.38)} \quad \lim_{\Pr(1|s_t^d)\to 1} \sum_{n=1}^{N^d} \Pr(n|s_t^d) \cdot \left(\log\left(\frac{\Pr(n|s_t^d)}{\Pr(1|s_t^d)}\right)\right)^2 = 0$$

The definition of $Var^e(i_t^{ed})$ (equation 31) implies $Var^e(i_t^{ed}) \geq 0$. Combining this and equation C.33, by the squeeze theorem we therefore have:

$$\text{(C.39)} \quad \lim_{d\to\infty} \frac{1}{(\lambda_t^d)^2} Var^e(i_t^{nd}) = \lim_{\Pr(1|s_t^d)\to 1} \frac{1}{(\lambda_t^d)^2} Var^e(i_t^{nd}) = 0$$

This completes the proof of equation 33.

Finally, we turn to equation 34. Differentiate bank n's first order condition (29) to obtain:

$$\text{(C.40)} \quad \frac{\partial i^{nd}}{\partial \lambda_t^d} = \frac{1}{1 - \Pr(n|s_t^d)} + \frac{(i_t^{nd} - i_t^{CB} - \chi_t^{nd})}{1 - \Pr(n|s_t^d)} \frac{\partial \Pr(n|s_t^d)}{\partial \lambda_t^d}$$

$$\text{(C.41)} \quad = \frac{1}{1 - \Pr(n|s_t^d)} + \frac{\lambda_t^d}{(1 - \Pr(n|s_t^d))^2} \frac{\partial \Pr(n|s_t^d)}{\partial \lambda_t^d}$$

where the second equality follows from substituting $i_t^{nd} - i_t^{CB} - \chi_t^{nd}$ using equation 29.

Differentiating equation 28 with respect to λ_t^d, we obtain:

$$\frac{\partial \Pr(n|s_t^d)}{\partial \lambda_t^d} = -\frac{\Pr(n|s_t^d)}{\lambda_t^d}\left[\frac{\partial i_t^{nd}}{\partial \lambda_t^d} - \sum_{k=1}^{N^d} \Pr(k|s_t^d)\frac{\partial i_t^{kd}}{\partial \lambda_t^d} - \frac{i_t^{nd} - i_t^{ed}}{\lambda_t^d}\right] \tag{C.42}$$

Combining equations C.41 and C.42 and rearranging we obtain:

$$\begin{aligned} \frac{\partial i_t^{nd}}{\partial \lambda_t^d} = {} & \frac{1-\Pr(n|s_t^d)}{1-\Pr(n|s_t^d)+(\Pr(n|s_t^d))^2} \\ & + \frac{\Pr(n|s_t^d)}{1-\Pr(n|s_t^d)+(\Pr(n|s_t^d))^2}\left(\frac{i_t^{nd}-i_t^{ed}}{\lambda_t^d} + \sum_{k=1}^{N^d} \Pr(k|s_t^d)\frac{\partial i_t^{kd}}{\partial \lambda_t^d}\right) \end{aligned} \tag{C.43}$$

It will be useful now to note that, from the definition of i_t^{ed} (C.19):

$$\frac{i_t^{nd}-i_t^{ed}}{\lambda_t^d} = \frac{i_t^{nd} - \sum_{k=1}^{N^d} \Pr(k|s_t^d) i_t^{kd}}{\lambda_t^d} = \sum_{k=1}^{N^d} \Pr(k|s_t^d)\frac{i_t^{nd}-i_t^{kd}}{\lambda_t^d} \tag{C.44}$$

Using equation C.32, this can further be rewritten as:

$$\frac{i_t^{nd}-i_t^{ed}}{\lambda_t^d} = \sum_{k=1}^{N^d} \Pr(k|s_t^d)\log\left(\frac{\Pr(k|s_t^d)}{\Pr(n|s_t^d)}\right) \tag{C.45}$$

Substituting this into equation C.43, we have:

$$\begin{aligned} \frac{\partial i_t^{nd}}{\partial \lambda_t^d} = {} & \frac{1-\Pr(n|s_t^d)}{1-\Pr(n|s_t^d)+(\Pr(n|s_t^d))^2} \\ & + \frac{\Pr(n|s_t^d)}{1-\Pr(n|s_t^d)+(\Pr(n|s_t^d))^2}\left(\sum_{k=1}^{N^d} \Pr(k|s_t^d)\log\left(\frac{\Pr(k|s_t^d)}{\Pr(n|s_t^d)}\right) + \sum_{k=1}^{N^d} \Pr(k|s_t^d)\frac{\partial i_t^{kd}}{\partial \lambda_t^d}\right) \end{aligned} \tag{C.46}$$

We now proceed with a guess-and-verify approach. Suppose at sufficiently high d, $\sum_{k=1}^{N} \Pr(k|s_t^d)\frac{\partial i_t^{kd}}{\partial \lambda_t^d} < 0$. In that case we have that:

$$\begin{aligned} \Pr(n|s_t^d)\frac{\partial i_t^{nd}}{\partial \lambda_t^d} < {} & \frac{1-\Pr(n|s_t^d)}{1-\Pr(n|s_t^d)+(\Pr(n|s_t^d))^2} \\ & + \frac{\Pr(n|s_t^d)}{1-\Pr(n|s_t^d)+(\Pr(n|s_t^d))^2}\left(\sum_{k=1}^{N^d} \Pr(k|s_t^d)\log\left(\frac{\Pr(k|s_t^d)}{\Pr(n|s_t^d)}\right)\right) \end{aligned} \tag{C.47}$$

Taking limits:

$$\lim_{\Pr(1|s_t^d)\to 1}\left(\Pr(n|s_t^d)\frac{\partial i_t^{nd}}{\partial \lambda_t^d}\right) < \lim_{\Pr(1|s_t^d)\to 1}\left(\frac{\Pr(n|s_t^d)(1-\Pr(n|s_t^d))}{1-\Pr(n|s_t^d)+(\Pr(n|s_t^d))^2}\right)$$
$$+\lim_{\Pr(1|s_t^d)\to 1}\left(\frac{(\Pr(n|s_t^d))^2}{1-\Pr(n|s_t^d)+(\Pr(n|s_t^d))^2}\sum_{k=1}^{N^d}\Pr(k|s_t^d)\log\left(\Pr(k|s_t^d)\right)\right)$$
$$-\lim_{\Pr(1|s_t^d)\to 1}\left(\frac{(\Pr(n|s_t^d))^2}{1-\Pr(n|s_t^d)+(\Pr(n|s_t^d))^2}\log(\Pr(n|s_t^d))\right) \tag{C.48}$$

For all banks, whether they have $\Pr(n|s_t^d) \to 1$ (i.e. if $n = 1$) or $\Pr(n|s_t^d) \to 0$ ($n \neq 1$), all three of the limits on the right hand side are 0. Summing up across banks n we therefore have:

$$\lim_{\Pr(1|s_t^d)\to 1}\left(\sum_{n=1}^{N^d}\Pr(n|s_t^d)\frac{\partial i_t^{nd}}{\partial \lambda_t^d}\right) = \sum_{n=1}^{N^d}\lim_{\Pr(1|s_t^d)\to 1}\left(\Pr(n|s_t^d)\frac{\partial i_t^{nd}}{\partial \lambda_t^d}\right) < 0 \tag{C.49}$$

By the same argument used in deriving equation 33, the limit as $\Pr(1|s_t^d) \to 1$ is equivalent to the limit as $d \to \infty$. This verifies our guess, and completes the proof.

C.2.3 Proof of Corollary 2

With $N^d = 2$, there are several results that will prove helpful in simplifying $\partial i_t^{ed}/\partial \lambda_t^d$. First, using the fact that $\Pr(2|s_t^d) = 1 - \Pr(1|s_t^d)$:

$$1-\Pr(1|s_t^d)+(\Pr(1|s_t^d))^2 = 1-\Pr(2|s_t^d)+(\Pr(2|s_t^d))^2 \tag{C.50}$$

Next, from equation C.45:

$$\frac{i_t^{1d}-i_t^{ed}}{\lambda_t^d} = (1-\Pr(1|s_t^d))\log\left(\frac{1-\Pr(1|s_t^d)}{\Pr(1|s_t^d)}\right) \tag{C.51}$$

$$\frac{i_t^{2d}-i_t^{ed}}{\lambda_t^d} = -\Pr(1|s_t^d)\log\left(\frac{1-\Pr(1|s_t^d)}{\Pr(1|s_t^d)}\right) \tag{C.52}$$

Substituting these into equation C.23, we can write $\partial i_t^{ed}/\partial \lambda_t^d$ in terms of $\Pr(1|s_t^d)$ only:

$$\text{(C.53)}\quad \frac{\partial i_t^{ed}}{\partial \lambda_t^d} = 1 + (2\Pr(1|s_t^d) - 1)\log\left(\frac{1-\Pr(1|s_t^d)}{\Pr(1|s_t^d)}\right) + \Pr(1|s_t^d)(1-\Pr(1|s_t^d))\left(\log\left(\frac{1-\Pr(1|s_t^d)}{\Pr(1|s_t^d)}\right)\right)^2$$

Differentiating with respect to $\Pr(1|s_t^d)$, we find:

$$\text{(C.54)}\quad \frac{d}{d\Pr(1|s_t^d)}\left(\frac{\partial i_t^{ed}}{\partial \lambda_t^d}\right) = \frac{1-2\Pr(1|s_t^d)}{\Pr(1|s_t^d)(1-\Pr(1|s_t^d))} \cdot \left[1 + \Pr(1|s_t^d)(1-\Pr(1|s_t^d))\left(\log\left(\frac{1-\Pr(1|s_t^d)}{\Pr(1|s_t^d)}\right)\right)^2\right]$$

The term inside the square brackets is strictly positive, so the expression takes on the sign of $1 - 2\Pr(1|s_t^d)$ (i.e. it is positive for $\Pr(1|s_t^d) < 0.5$, 0 for $\Pr(1|s_t^d) = 0.5$, and negative for $\Pr(1|s_t^d) > 0.5$).

Next, I turn to how $\Pr(1|s_t^d)$ changes with λ_t^d. Applying the same substitutions (C.50-C.52) to equation C.42 and simplifying, we obtain:

$$\text{(C.55)}\quad \frac{\partial \Pr(1|s_t^d)}{\partial \lambda_t^d} = \frac{\Pr(1|s_t^d)(1-\Pr(1|s_t^d))}{\lambda_t^d}\left[\log\left(\frac{1-\Pr(1|s_t^d)}{\Pr(1|s_t^d)}\right) - \left(\frac{\partial i_t^{1d}}{\partial \lambda_t^d} - \frac{\partial i_t^{2d}}{\partial \lambda_t^d}\right)\right]$$

To evaluate this, we therefore need to evaluate $\partial i_t^{nd}/\partial \lambda_t^d$. Solving the system of equations implied by equation C.41 for $n = \{1, 2\}$, we obtain:

$$\text{(C.56)}\quad \frac{\partial i_t^{1d}}{\partial \lambda_t^d} = \frac{1+\Pr(1|s_t^d)}{1-\Pr(1|s_t^d)+(\Pr(1|s_t^d))^2} + \frac{(\Pr(1|s_t^d))^2}{1-\Pr(1|s_t^d)+(\Pr(1|s_t^d))^2}\log\left(\frac{1-\Pr(1|s_t^d)}{\Pr(1|s_t^d)}\right)$$

$$\text{(C.57)}\quad \frac{\partial i_t^{2d}}{\partial \lambda_t^d} = \frac{2-\Pr(1|s_t^d)}{1-\Pr(1|s_t^d)+(\Pr(1|s_t^d))^2} - \frac{(1-\Pr(1|s_t^d))^2}{1-\Pr(1|s_t^d)+(\Pr(1|s_t^d))^2}\log\left(\frac{1-\Pr(1|s_t^d)}{\Pr(1|s_t^d)}\right)$$

Substituting these in to equation C.55 and simplifying, we obtain:

$$\text{(C.58)}\quad \frac{\partial \Pr(1|s_t^d)}{\partial \lambda_t^d} = \frac{\Pr(1|s_t^d)(1-\Pr(1|s_t^d))(1-2\Pr(1|s_t^d))}{\lambda_t^d(1-\Pr(1|s_t^d)+(\Pr(1|s_t^d))^2)} + \frac{(\Pr(1|s_t^d))^2(1-\Pr(1|s_t^d))^2}{\lambda_t^d(1-\Pr(1|s_t^d)+(\Pr(1|s_t^d))^2)}\log\left(\frac{1-\Pr(1|s_t^d)}{\Pr(1|s_t^d)}\right)$$

Both terms are positive for $\Pr(1|s_t^d) < 0.5$, 0 for $\Pr(1|s_t^d) = 0.5$, and negative for

$\Pr(1|s_t^d) > 0.5$. From this and the sign of equation C.54 we obtain that:

$$\frac{d}{d\lambda_t^d}\left(\frac{di_t^{ed}}{d\lambda_t^d}\right) = \frac{\partial \Pr(1|s_t^d)}{\partial \lambda_t^d} \cdot \frac{d}{d\Pr(1|s_t^d)}\left(\frac{di_t^{ed}}{d\lambda_t^d}\right) > 0 \text{ if } \Pr(1|s_t^d) \neq 0.5 \tag{C.59}$$

Finally, we show that the restriction $\Pr(1|s_t^d) \neq 0.5$ is never binding. From equation C.32 with $n = 1, m = 2$, we have that $\Pr(1|s_t^d) = 0.5$ if $i_t^{1d} = i_t^{2d}$ (as $\lambda_t^d > 0$). Using the bank first order conditions (29) we have:

$$i_t^{1d} - i_t^{2d} = \lambda_t^d \frac{2\Pr(1|s_t^d) - 1}{\Pr(1|s_t^d)(1 - \Pr(1|s_t^d))} + \chi_t^{1d} - \chi_t^{2d} \tag{C.60}$$

Since $\chi_t^{1d} < \chi_t^{2d}$, this implies $\Pr(1|s_t^d) = 0.5, i_t^{1d} = i_t^{2d}$ can never be an equilibrium. With non-zero attention ($\lambda_t^d > 0$), individuals always improve on their priors.

From C.26 we have that λ_t^d is strictly decreasing in d. This, combined with equation C.59, implies equation 35.

C.2.4 Google trends data

Section I.F discusses evidence that mortgages are on average large relative to interest-bearing assets among those who hold them, and that interest rate dispersion is indeed lower in mortgage markets as predicted by the model. Attention is, however, difficult to measure directly, as the method in Section III is not appropriate for mortgages (see discussion in Section II.A). Here I provide supplementary evidence using data from Google trends (Google, 2023). Note that this is not a perfect measure of attention, as some people searching for mortgage-related terms could be exploring (for example) whether they want to buy a house or not. They may not be actively engaged in choosing between different mortgages. Similarly, those searching for saving-related terms may not actually be choosing between saving products at that time.

In Table 6 I report summary statistics for the comparison between search intensity for savings accounts and mortgages. Specifically, for each panel, I construct monthly series of relative search intensity, where for each month I divide the intensity of searches related to saving products by the intensity of searches related to mortgages. This is done from January 2004 to June 2023, for the UK, US, and for global searches. Numbers below 1 indicate there are more searches for information on mortgages than saving products.

For the left panel, I use search intensity on Google-generated search topics, which cover a variety of search terms. I take the ratio of searches on the topic "saving accounts" to those on the topic "mortgages". As this may include searches not related to product comparisons, in the left panel I instead use search intensity on the specific searches "saving comparison" and "mortgage comparison". With both measures, the relative search intensity is below 1 in every month, with the majority of months seeing more than 4 times the search intensity for mortgages than saving products.

Table 6: Summary statistics for relative search intensity of savings to mortgage products.

	Panel A: search type topic				*Panel B: search type comparisons*			
Region	mean	p25	p50	p75	mean	p25	p50	p75
UK	0.22	0.17	0.21	0.25	0.17	0.11	0.14	0.20
US	0.12	0.08	0.11	0.14	0.14	0.07	0.13	0.20
World	0.15	0.11	0.14	0.19	0.18	0.13	0.17	0.21

Note: Each panel presents summary statistics of the time series of $s_t(\text{saving})/s_t(\text{mortgage})$, where $s_t(\cdot)$ is the Google search intensity for that product for that region in month t. In panel A $s(\cdot)$ is the search intensity for the topics "saving accounts" and "mortgages" respectively, in panel B $s_t(\cdot)$ is the search intensity for the terms "saving comparison" and "mortgage comparison". In each case, $s_t(\cdot)$ is normalized so that the greatest search intensity across the two topics or terms is given a value of 100. The columns p25, p50, p75 give the 25th, 50th, and 75th percentiles of each series. The sample runs from January 2004 to June 2023. Source: Google (2023).

D Further Results for Section III

D.1 Relationship between Bank Positions in Different Market Segments

To calculate the Quoted Household Interest Rate used to construct φ_t in Section III, the Bank of England computes a weighted average of the interest rates in the set of products detailed in Section II.A. The weights are the quantities of new deposits per bank across a broader set of products than those from which the interest rates are taken. Here I show that a bank's position in the distribution of interest rates qualifying for inclusion in the Quoted Household Interest Rate is closely related to their position in the other market segments included when the weights are calculated. As argued in Section II.A, this implies that the cyclical patterns in φ_t found in Section III.C reflect a systematic shift towards banks at the top of all of these market segments when unemployment is high and interest rates are low. φ_t is therefore informative about the position of household choices within the distribution of available rates despite this data limitation.

The weights for the Quoted Household Interest Rate are constructed using new deposits in all fixed interest rate bonds with terms up to one year. The products qualifying for inclusion in the Quoted Household Interest Rate make up 30% of the products in this broader set. Taking all products in the broader set from the Moneyfacts data, I divide them into market segments based on their term, investment size, and interest payment frequencies. The set of such characteristics is given in Table 7.

Taking all combinations of these characteristics yields 72 market segments. Many products are included in multiple segments because an investment of £10000, for example,

Table 7: Bank product characteristics used for subdividing the fixed rate bond market

Characteristic	Division
Term length (months)	{1-3, 4-6, 7-9, 10-12}
Investment size (£000s)	$\{1, 2.5, 5, 10, 25, 50\}$
Interest payment frequency	{Monthly, Quarterly, On maturity}

is often eligible for products with lower minimum investments.

For each segment each month, I rank the banks that compete in that segment-month by their interest rate in that segment-month. If a bank has multiple products that qualify for the Quoted Household Interest Rate, I follow the construction of the Quoted Household Interest Rate series and only consider the one with the highest interest rate. I similarly rank the set of products included in the Quoted Household Interest Rate (the Q segment). I then compute the correlation between these ranks each month, then finally for each market segment I take the mean of these rank correlations over the months, weighting by the number of banks competing in both that segment and the Q segment that month (i.e. weighting by the number of observations used to construct that month's correlation). This gives an average interest rate rank correlation between the Q segment and every other market segment used in constructing the Quoted Household Interest Rate weights.

For 30 of the market segments, there are either no products with that set of characteristics, or there are no occasions where more than one bank simultaneously competes in that segment and the Q segment. This leaves 42 segments for which the rank correlation with the Q segment can be computed.

In these remaining market segments, bank rankings are highly correlated with the rankings in the Q segment. The mean rank correlation across the segments is 0.70, and this is distorted by a small number of market segments which very few banks ever compete in. Of the six segments with rank correlations with the Q segment below 0.5, four are 7-9 month bonds with a monthly payment frequency, which contain less than 1 product per month on average. The other two are also very small segments, with an average of 1.02 and 1.17 banks competing simultaneously in them and the Q segment each month. These correlations are therefore based off very few observations, and the small number of banks competing there each month suggests that they are not large market segments, making them unlikely to play a big role in the weights used to calculate the Quoted Household Interest Rate.

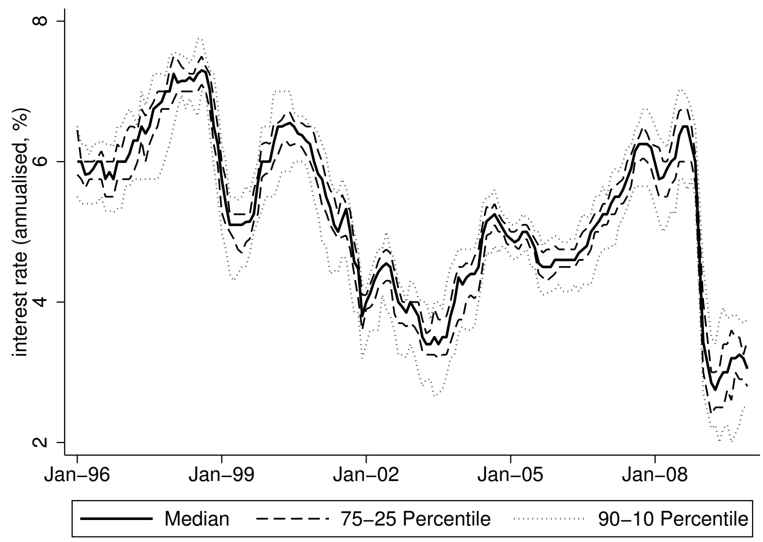
Other market segments are larger. In the ten largest market segments, the average number of banks competing in those segments and the Q segment each month is greater than 11. For the largest five segments, it exceeds 25.

The mean rank correlation across the segments rises to 0.84 when segments are weighted by this mean number of banks competing there and in the Q segment each month. If we take the number of banks competing in a segment as indicative of the size of that market segment, this shows that bank positions within the interest rate distribution analyzed in Section III (in the Q segment), are strongly correlated with bank positions in the other substantial market segments that are included in the weights behind the Quoted Household Interest Rate data.

D.2 Time Series Behavior of Interest Rates and φ_t

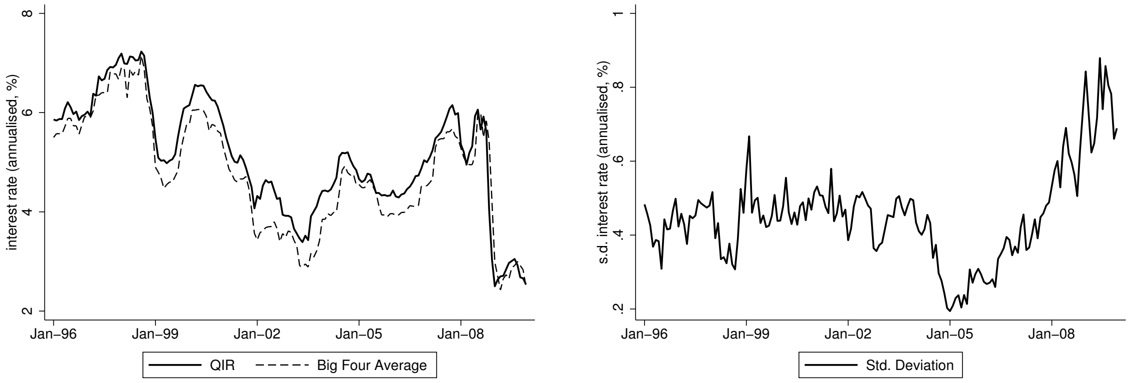
Figure 6 plots the median interest rate each month, alongside the 10th, 25th, 75th, and 90th percentiles of the interest rate distribution. Figure 7 then plots the time series of the three components used to construct φ_t in equation 36, whose summary statistics are reported in Table 2. Although, as discussed above, the spread $\mathbb{E}_h i_t - i_t^b$ is substantially more volatile than $\sigma(i_t)$, the standard deviation of interest rates is still important in determining φ_t. As an example, during 2004 interest rates became substantially less dispersed. If choice probabilities remained constant, we would therefore observe a large fall in $\mathbb{E}_h i_t - i_t^b$. However, no such convergence is observed, suggesting savers became less successful in selecting the highest-rate products in this period. This highlights the importance of normalizing by $\sigma(i_t)$ in the construction of φ_t.

Figure 6: Time series of the 10th, 25th, 50th, 75th, and 90th percentiles of the within-month interest rate distribution.



Note: Percentiles are computed using the products listed in Moneyfacts magazine that qualify for inclusion in the Quoted Household Interest Rate (defined in Section II.A). Source: Moneyfacts Group (2009).

Figure 7: Time series of Quoted Household Interest Rate ($\mathbb{E}_h i_t$), average interest rate at the 'big four' banks (i_t^b), and the standard deviation of interest rates ($\sigma(i_t)$).



Note: The big four banks are Barclays, HSBC, Lloyds, and RBS. The within-month standard deviation is computed using the products listed in Moneyfacts magazine that qualify for inclusion in the Quoted Household Interest Rate (defined in Section II.A). Source: Moneyfacts Group (2009), Bank of England (nda).

The raw series for φ_t constructed from these components may in principle be driven by movements in the position of the big four banks in the distribution, as this is an imperfect proxy for the benchmark interest rate obtained with no information processing. To combat this concern, I estimate the following regression equation using OLS:

$$\varphi_t = \alpha_0 + \alpha_1 pos_t + v_t \tag{D.1}$$

where pos_t is measure of the position of the big four banks within the rate distribution each month, constructed similarly to φ_t and defined in equation 37. The results of this regression are shown in Table 8.

The coefficient on pos_t is positive and significant, indicating that raw φ_t is indeed higher when the big four are lower down in the interest rate distribution. However, this mechanical effect is small, as the R^2 of the regression is low.

Table 8: Regression of φ_t on the position of the big four in the interest rate distribution.

	φ_t
pos_t	0.466
	(0.0466)
Constant	0.396
	(0.0614)
R-squared	0.227
Observations	165

Note: Table shows estimated coefficients α_0, α_1 from OLS estimation of the regression $\varphi_t = \alpha_0 + \alpha_1 pos_t + v_t$. φ_t is defined in equation 36, and pos_t is defined in equation 37. Robust standard errors in parentheses. Sample period: 1996-2009. Source: Moneyfacts Group (2009), Bank of England (nda).

D.3 Alternative Measures of φ_t

Here I present two alternatives to the household choice statistic φ_t, which corroborate the evidence in Section III.C that households move up through the distribution of interest rates when unemployment is high and the level of average rates is low.

First, I define a new variable $\varphi_{best,t}$ in a similar way to φ_t, but rather than comparing the average rate achieved by households each month with the rate at the big four banks, I compare it with the highest interest rate available in the market. Intuitively, rather than comparing choices to a 'no attention' benchmark, this compares choices to a full information benchmark.

$$\varphi_{best,t} = \frac{\mathbb{E}_h i_t - i_t^{best}}{\sigma(i_t)} \tag{D.2}$$

Second, I define $\varphi_{pct,t}$ to be the percentile of the interest rate distribution at which the average interest rate achieved by the household sits. This takes no stance on the appropriate benchmark for choices. As with the previous two statistics, it is homogeneous of degree 0. The downside is that it does not consider the shape of the interest rate distribution either side of the average rate achieved by households.

$$\varphi_{pct,t} = \Pr(i_t^n < \mathbb{E}_h i_t) \tag{D.3}$$

When households are more successful at choosing the higher interest rate products in the market, $\varphi_{best,t}$ is low and $\varphi_{pct,t}$ is high. The pairwise correlations between the baseline (residualized) φ_t measure, the raw (unresidualized) version, these two alternative statistics ($\varphi_{best,t}$, $\varphi_{pct,t}$), unemployment, and mean interest rates are shown in Table 9. As in Section III, all correlations are between the cyclical components of each variable, extracted with a HP filter.

When unemployment is high and interest rates are low, $\varphi_{pct,t}$ and φ_t (raw and residualized) are high, while $\varphi_{best,t}$ is low. All correlations are strongly significant. The alternative measures of household choice success therefore deliver the same qualitative implications as those found in Section III: in contractions households move up within the distribution of interest rates, away from the low rate offered by the big four banks and towards the highest rate in the market.

D.4 Market Composition and Selection

In this appendix I show that the composition of households holding fixed term savings bonds does not vary significantly through the Great Recession.

Table 9: Pairwise contemporaneous correlations of attention proxies, the unemployment rate, and within-month mean interest rates.

	φ_t (residual)	φ_t (raw)	$\varphi_{best,t}$	$\varphi_{pct,t}$	U_t	$\bar{i}_t$
φ_t (residual)	1					
φ_t (raw)	0.895	1				
	(0.000)					
$\varphi_{best,t}$	−0.627	−0.430	1			
	(0.000)	(0.000)				
$\varphi_{pct,t}$	0.712	0.416	−0.548	1		
	(0.000)	(0.000)	(0.000)			
U_t	0.273	0.157	−0.548	0.340	1	
	(0.000)	(0.045)	(0.000)	(0.000)		
$\bar{i}_t$	−0.277	−0.156	0.458	−0.367	−0.792	1
	(0.000)	(0.045)	(0.000)	(0.000)	(0.000)	

Note: All alternative φ_t statistics are computed as detailed in Appendix D.3. U refers to the unemployment rate (ONS series MGSX), and $\bar{i}$ refers to the unweighted mean interest rate on products listed that month in Moneyfacts qualifying for inclusion in the Quoted Household Interest Rate (details in Appendix II.A). All variables are HP-filtered before computing pairwise correlations. P-values in parentheses. Sample period: 1996-2009. Source: Moneyfacts Group (2009), Bank of England (nda), Office for National Statistics (2020).

Drechsler et al. (2017) show that when the Federal Funds Rate rises in the US, retail banks increase their deposit spreads, and deposits flow out of the retail market. In principle, this kind of switching could drive the countercyclicality in Figure 2. If households differ in their propensity to pay attention to savings, then it could be that when the level of interest rates rises the high-attention households switch out of the retail deposit market. The savers that remain buying fixed-rate savings bonds from banks are the low-attention households, and so the average attention of households in the market falls without any individual household changing their attention.

To explore if this compositional change is occurring, I study waves 1-3 (2006, 2008, 2010) of the Wealth and Assets Survey (WAS) (Office for National Statistics, 2019). This survey asks a large number of households about their assets, including whether they hold fixed term savings bonds (note that this is a broader set of products that those used to construct Figure 2). As the three waves span the Great Recession, if a composition effect is driving the cyclicality of φ_t we should find that characteristics associated with being more attentive to financial decisions become relatively more common over the recession, among the people who hold fixed-term bonds.

Iscenko (2018) and Bhutta et al. (2020) find that households are more likely to be attentive to mortgage decisions if they have high incomes and high levels of education. Iscenko (2018) also finds a non-linear association with age. I therefore explore compositional changes among fixed-term bond-holders along these lines. Specifically, I consider household income by decile of the overall income distribution, indicators for any educational qualifications and for degree-level qualifications, and an indicator for whether the household is aged 45-54, the age identified by Finke et al. (2017) as corresponding to peak financial knowledge. Income deciles are computed from self-reported labor income plus self-employed income within each survey wave. Table 10 reports the results of regressing each of these variables on indicators for the wave in which the person was surveyed, using the subset of households who hold a fixed-term bond.

Table 10: Regressions on variables related to financial literacy.

	(1) Income decile	(2) Some qualification	(3) Degree qualification	(4) Aged 45-54
wave=2	-0.126	0.00423	0.0169	-0.0138
	(0.106)	(0.0133)	(0.0167)	(0.0124)
wave=3	-0.396	-0.0228	0.00258	-0.00820
	(0.105)	(0.0136)	(0.0164)	(0.0127)
Constant	4.991	0.836	0.304	0.137
	(0.0730)	(0.00945)	(0.0116)	(0.00877)
Observations	6138	6138	6138	6138

Note: Table shows estimated coefficients $\alpha_0, \alpha_2, \alpha_3$ from OLS estimation of the regression $X_{it} = \alpha_0 + \alpha_2 \mathbb{1}(t=2) + \alpha_3 \mathbb{1}(t=3) + v_{it}$, for a range of dependent variables X_{it} defined in the text. The baseline is wave $t = 1$ (2006). Waves $t = 2$ and $t = 3$ took place in 2008 and 2010. All regressions are weighted using the survey weights in the Wealth and Assets Survey. Robust standard errors in parentheses. Source: Wealth and Assets Survey, waves 1-3 (Office for National Statistics, 2019).

The only composition change that is significantly different from zero is that the income of fixed term bond-holders declined slightly relative to the overall income distribution between waves 1 and 3. This is the opposite direction to the compositional change that would be required to explain the cyclical patterns of φ_t. All other compositional changes are not significantly different from zero. It is therefore unlikely that compositional changes explain the cyclicality of φ_t.

E Quantitative Model: Further Details

E.1 Quantitative Model Equations

Table 11 lists the (endogenous and exogenous) variables of the quantitative model, and Table 12 lists the log-linearized model equations. For a complete derivation see the online appendix. In the tables below, $\overline{X}$ denotes the steady state of the variable X_t, and e_{Xt} is an i.i.d.-normal innovation. To reduce notation, it is convenient below to work with gross interest rates. For any interest rate i_t^x, I use $r_t^x \equiv 1 + i_t^x$ in the tables below. To further reduce notation, I do not use $\hat{X}_t$ to denote the log-deviation of X_t from $\bar{X}$: rather, in

Table 12 any reference to X_t denotes that variable's log-deviation.

Notice that along with the monetary policy and labor disutility shocks, the attention shock ζ^{μ} is assumed to be i.i.d. This is because the estimation finds the shock has a negligible effect on all of the observables, so cannot identify the shock's persistence. As the shock is so small, calibrating the persistence to any other value $[0, 1)$ makes no difference to the results.

Table 11: Description of variables in the quantitative model

Variable	Description	Variable	Description
nfa	Net foreign assets	π^m	Inflation: imports
c	Consumption: total	π^w	Inflation: wage
c^h	Consumption: domestic goods	π^{xvf}	Inflation: producer price of exports
c^m	Consumption: imports	q	Real exchange rate
h	Hours	r	Rental rate on capital
inv	Investment	r^b	Gross bad bank interest rate
k	Capital	r^{CB}	Gross policy interest rate
λ	Shadow value of information	r^e	Gross effective interest rate
p^g	Probability of choosing the good bank	r^g	Gross good bank interest rate
p^h	Relative price of domestic final goods	u_c	Marginal utility of c
p^{hv}	Relative price of domestic intermediate goods	w	Real wage
p^m	Relative price of imported goods	x	Exports
p^x	Relative price of exported goods	y^h	Output: used domestically
p^{xv}	Relative producer price of exported final goods	y^v	Output: total
π	Inflation: total	z	Capital utilization
π^{hv}	Inflation: domestic intermediates		
c^f	Foreign demand	$\hat{\zeta}^{\chi}$	Bank interest rate level shock
g	Government spending	$\hat{\zeta}^{\chi b}$	Bank interest rate dispersion shock
π^f	Foreign inflation	ζ^{hb}	Markup shock
p^{xf}	Foreign relative export prices	ζ^k	Capital adjustment cost shock
r^f	Foreign interest rate	$\zeta^{\kappa h}$	Labor disutility shock
tfp	TFP	ζ^{rcb}	Monetary policy shock
ζ^c	Risk premium shock	ζ^{μ}	Attention shock

Table 12: Log-linearized quantitative model equations

Name	**Equation**
Wage inflation definition	$\pi_t^w = w_t - w_{t-1} + \pi_t$
Wage Phillips Curve	$(1+\beta\epsilon^w)\pi_t^w - \epsilon^w \pi_{t-1}^w$
	$= \beta \mathbb{E}_t \pi_{t+1}^w + \frac{\psi^w(1-\beta(1-\psi^w))}{1-\psi^w}\big(\frac{\sigma^h}{\sigma^h+\sigma^w}\big)\big(\frac{1}{\sigma^h}h_t - u_{ct} - w_t + \zeta_t^{\kappa h}\big)$
Marginal Utility of c	$u_{ct} = -\frac{1}{\sigma^c}c_t + \psi^{hab}\big(\frac{1}{\sigma^c} - 1\big)c_{t-1}$
Consumption Euler equation	$u_{ct} = \mathbb{E}_t(u_{ct+1} + r_t^e - \pi_{t+1}) + \zeta_t^c$
k first order condition	$p_t^h + \chi^k(k_t - k_{t-1} - \epsilon^k(k_{t-1} - k_{t-2})) + \hat{\zeta}_t^k + r_t^e - \mathbb{E}_t\pi_{t+1}$
	$= \beta\mathbb{E}_t(\chi^k(k_{t+1} - k_t - \epsilon^k(k_t - k_{t-1})) + \chi^z r_{t+1} + (1-\delta)p_{t+1}^h + \hat{\zeta}_{t+1}^k)$
z first order condition	$r_t = \sigma^z z_t + p_t^h$
Relative import demand	$c_t^m = -\sigma^m p_t^m + c_t$
Relative home good demand	$c_t^h = -\sigma^m p_t^h + c_t$
Consumption basket	$c_t = \frac{\overline{c}^h}{\overline{c}}(p_t^h + c_t^h) + \frac{\overline{c}^m}{\overline{c}}(p_t^m + c_t^m)$
Attention first order condition	$\mathbb{E}_t u_{ct+1} - \mathbb{E}_t\pi_{t+1} = -\lambda_t + \zeta_{\mu t}$
Optimal bank choice probability	$p_t^g = \frac{1-\overline{p}^g}{\overline{\lambda}}(\overline{r}^g r_t^g - \overline{r}^b r_t^b - (\overline{r}^g - \overline{r}^b)\lambda_t)$
Effective rate definition	$\frac{1}{\beta}r_t^e = \overline{p}^g(\overline{r}^g - \overline{r}^b)p_t^g + \overline{p}^g\overline{r}^g r_t^g + (1-\overline{p}^g)\overline{r}^b r_t^b$
Production function	$y_t^v = tfp_t + \frac{(1-\alpha)\overline{h}^{\frac{\sigma^y-1}{\sigma^y}}}{(1-\alpha)\overline{h}^{\frac{\sigma^y-1}{\sigma^y}} + \alpha\overline{k}^{\frac{\sigma^y-1}{\sigma^y}}}h_t + \frac{\alpha\overline{k}^{\frac{\sigma^y-1}{\sigma^y}}}{(1-\alpha)\overline{h}^{\frac{\sigma^y-1}{\sigma^y}} + \alpha\overline{k}^{\frac{\sigma^y-1}{\sigma^y}}}(k_{t-1} + z_t)$
Domestically consumed inflation definition	$\pi_t^{hv} = p_t^{hv} - p_{t-1}^{hv} + \pi_t$
Export inflation definition	$\pi_t^{xvf} = p_t^{xv} - p_{t-1}^{xv} + \pi_t^f + q_t - q_{t-1}$
Domestic good Phillips Curve	$(1+\beta\epsilon^{hv})\pi_t^{hv} - \epsilon^{hv}\pi_{t-1}^{hv}$
	$= \beta\mathbb{E}_t\pi_{t+1}^{hv} - \frac{\sigma^{hb}-1}{\chi^{hv}}(p_t^{hv} + \frac{1}{\sigma^y}(y_t^v - h_t) - w_t + \frac{\sigma^y-1}{\sigma^y}tfp_t) + \zeta_t^{hb}$
Export good Phillips Curve	$(1+\beta\epsilon^{xv})\pi_t^{xvf} - \epsilon^{xv}\pi_{t-1}^{xvf}$
	$= \beta\mathbb{E}_t\pi_{t+1}^{xvf} - \frac{\sigma^{xb}-1}{\chi^{xv}}(p_t^{xv} + \frac{1}{\sigma^y}(y_t^v - h_t) - w_t + \frac{\sigma^y-1}{\sigma^y}tfp_t) + \zeta_t^{hb}$
Optimal k-h ratio	$z_t + k_{t-1} - h_t = \sigma^y(w_t - r_t)$
Good bank profit maximization	$\lambda_t = \frac{1}{\overline{r}^{CB} - \overline{r}^g - \chi_0^g}(\overline{r}^{CB} r_t^{CB} - \overline{r}^g r_t^g - \hat{\zeta}_t^{\chi}) - \frac{\overline{p}^g}{1-\overline{p}^g}p_t^g$
Bad bank profit maximization	$\lambda_t = \frac{1}{\overline{r}^{CB} - \overline{r}^b - \chi_0^b}(\overline{r}^{CB}(1-\chi_1)r_t^{CB} - \overline{r}^b r_t^b - \hat{\zeta}_t^{\chi} - \hat{\zeta}_t^{\chi b}) + p_t^g$
Taylor rule	$r_t^{CB} = \zeta_t^{rcb} + \theta^{rcb}r_{t-1}^{CB} + (1-\theta^{rcb})(\theta^p\pi_t + \theta^y(y_t^v - tfp_t))$
Export demand	$x_t = c_t^f - \sigma^x(q_t + p_t^x - p_t^{xf})$
Import inflation definition	$\pi_t^m = p_t^m - p_{t-1}^m + \pi_t$
Import Phillips Curve	$(1+\beta\epsilon^m)\pi_t^m - \epsilon^m\pi_{t-1}^m$
	$= \beta\mathbb{E}_t\pi_{t+1}^m + \frac{\psi^m(1-\beta(1-\psi^m))}{1-\psi^m}(p_t^{xf} - q_t - p_t^m)$
Price of domestic consumption basket	$p_t^h = \kappa^{hv}p_t^{hv} + (1-\kappa^{hv})p_t^m$
Price of export consumption basket	$p_t^x = \kappa^{xv}p_t^{xv} + (1-\kappa^{xv})p_t^m$
k law of motion	$\delta inv_t = k_t - (1-\delta)k_{t-1} + \chi^z z_t$
Goods market clearing	$y_t^v = \kappa^{hv}(\overline{c}^h c_t^h + \overline{inv}inv_t + \overline{g}g_t) + \kappa^{xv}\overline{x}x_t$
Domestic goods market clearing	$y_t^h = \frac{\overline{c}^h}{\overline{y}^h}c_t^h + \frac{\overline{inv}}{\overline{y}^h}inv_t + \frac{\overline{g}}{\overline{y}^h}g_t$
nfa law of motion	$nfa_t = (1+\overline{i}^{CB})(nfa_{t-1} + \overline{nfa}(r_{t-1}^f - \pi_t^f - q_t + q_{t-1})) + \overline{x}(p_t^x + x_t) - \overline{c}^m c_t^m$
	$-(1-\kappa^{hv})\overline{y}^h y_t^h - (1-\kappa^{xv})\overline{x}x_t - (\overline{c}^m + (1-\kappa^{hv})\overline{y}^h + (1-\kappa^{xv})\overline{x})p_t^m$
Real UIP	$\mathbb{E}_t q_{t+1} - q_t + \chi^{nfa}nfa_t = r_t^f - r_t^{CB} - \mathbb{E}_t(\pi_{t+1}^f - \pi_{t+1})$
TFP	$tfp_t = \rho_{tfp}tfp_{t-1} + e_{tfpt}$
Government spending	$g_t = \rho_g g_{t-1} + e_{gt}$
Risk premium shock	$\zeta_t^c = \rho_{\zeta^c}\zeta_{t-1}^c + (1-\rho_{\zeta^c}^2)^{\frac{1}{2}}e_{\zeta^c t}$
Markup shock	$\zeta_t^{hb} = \rho_{\zeta^{hb}}\zeta_{t-1}^{hb} + (1-\rho_{\zeta^{hb}}^2)^{\frac{1}{2}}e_{\zeta^{hb} t}$
Capital adjustment cost shock	$\hat{\zeta}_t^k = \rho_{\zeta^k}\hat{\zeta}_{t-1}^k + (1-\rho_{\zeta^k}^2)^{\frac{1}{2}}e_{\zeta^k t}$
Labor disutility shock	$\zeta_t^{\kappa h} = e_{\zeta^{\kappa h} t}$
Monetary policy shock	$\zeta_t^{rcb} = e_{\zeta^{cb} t}$
Bank rate level shock	$\hat{\zeta}_t^{\chi} = \rho_{\zeta\chi}\hat{\zeta}_{t-1}^{\chi} + (1-\rho_{\zeta\chi}^2)^{\frac{1}{2}}e_{\zeta\chi t}$
Bank rate dispersion shock	$\hat{\zeta}_t^{\chi b} = \rho_{\zeta\chi^b}\hat{\zeta}_{t-1}^{\chi b} + (1-\rho_{\zeta\chi^b}^2)^{\frac{1}{2}}e_{\zeta\chi^b t}$
Attention shock	$\zeta_t^{\mu} = e_{\zeta^{\mu} t}$
Foreign variables	VAR(4) in Appendix E.2.2

E.2 Estimation Details

E.2.1 Data Sources and Treatment

There are 11 standard observable variables: domestic (UK) GDP, consumption, inflation, the 3-month treasury bill rate, investment, real wages, hours worked, and foreign inflation, industrial production, interest rates, and relative export prices. The foreign variables are trade-weighted averages of the other G7 countries. On top of these I add 3 observables from the Moneyfacts data: the mean and standard deviation of deposit rates, and φ_t. I use data from 1993-2009.

I follow Harrison and Oomen (2010) to source the standard observables. See their paper and the replication package associated with this paper for details of the data series. The only exception to the Harrison-Oomen method is that I use industrial production for all foreign countries, where they use a mix of industrial production and GDP.

I take log first differences of all domestic real variables, and transform inflation and interest rates into quarterly gross rates before taking logs and de-meaning. For the foreign real variables, I take logs and then extract the cyclical components using a one-sided HP filter. For the average and standard deviation of interest rates in Moneyfacts I follow the same procedure used for the treasury bill rate, averaging across months within each quarter before taking logs, and leaving a quarter as missing when a month of data is missing. I include φ_t in levels to avoid losing more observations after the quarters with missing months through first-differencing. I therefore use a one-sided HP filter to extract the cyclical component of φ_t. I do not take logs of φ_t as on several occasions it is close to zero. This is therefore a measure of linearized, not log-linearized, φ_t. The observation equation is adjusted accordingly. I choose χ_0^g and χ_0^b to match two moments: the average gap between the highest and the (unweighted) mean interest rate available in the Moneyfacts data, and the average gap between the unweighted mean interest rate in Moneyfacts and the policy rate.

Using $N = 2$ banks in the quantitative model keeps the equations simple, but it also means that the model-implied φ_t is always in the range $[0, 1]$. The observed data has larger numbers of banks, so to map that into suitable data for the model I measure the maximum possible φ_t in the data each period, that would be achieved if the Quoted Household Interest Rate was equal to the highest rate available that month. I divide the observed φ_t by the mean of these values (2.993) before HP-filtering to give an approximate mapping into the $\varphi_t \in [0, 1]$ range seen in the model.

E.2.2 Foreign VAR

Foreign variables are assumed to follow a VAR(4) process estimated outside of the model, as in Adolfson et al. (2007). Denoting the vector of foreign variables as Y_t, the structural VAR process is:

$$F_0 Y_t = F_1 Y_{t-1} + F_2 Y_{t-2} + F_3 Y_{t-3} + F_4 Y_{t-4} + u_t \tag{E.1}$$

To identify the parameters, I start with the Adolfson et al. (2007) restrictions: output and inflation are assumed to be unaffected by contemporaneous shocks to anything other than themselves, but interest rates respond to both. As I have an extra variable not in Adolfson et al. (2007) (relative export prices), I add that inflation and output also do not respond contemporaneously to shocks to relative export prices. Furthermore, I assume that the foreign interest rate does not respond contemporaneously to shocks to relative export prices, but that relative export prices can respond contemporaneously to all variables. Intuitively, this reflects the notion that the exchange rate can vary rapidly in response to shocks, and that this will affect the relative export price. This gives:

$$F_0 = \begin{bmatrix} 1, & 0, & 0, & 0 \\ 0, & 1, & 0, & 0 \\ -\gamma_\pi, & -\gamma_y, & 1, & 0 \\ -\gamma_\pi^p, & -\gamma_y^p, & \gamma_r^p, & 1 \end{bmatrix} \tag{E.2}$$

Where the order of variables in Y_t is inflation, output, interest rates, relative export prices. The model is over-identified. We cannot reject the over-identifying restrictions (p-value 0.87).

E.2.3 Calibration, Priors, and Estimation Results

Table 13 gives descriptions of each calibrated parameter and its calibrated value. Table 14 gives descriptions of each estimated parameter and its prior. See Harrison and Oomen (2010) for the sources of each calibrated value and prior except those specific to the attention block, which are discussed in Section IV.C.

Tables 15 and 16 show the estimation results for the baseline model and the full information model in Section IV.E respectively. Impulse response functions of consumption to all shocks listed in Table 3, in both the baseline model and the fixed-attention alternative, are shown in Figure 8.

Table 13: Calibrated parameters

Parameter	Description	Value
α	Capital income share	0.3
β	Discount factor	0.99
δ	Depreciation rate	0.025
χ^{nfa}	Net foreign asset adjustment cost	0.01
χ^{z}	Capital utilization cost	$\beta^{-1} - 1 + \delta$
κ^{hv}	Share of domestic value added in home goods	0.935
κ^{xv}	Share of domestic value added in export goods	0.748
ψ^{m}	Expenditure weight of imports in consumption	0.248
ψ^{pm}	Imports Calvo parameter	0.4
σ^{hb}	Elasticity of substitution: goods varieties	9.668
σ^{m}	Elasticity of substitution: home vs. foreign goods	1.77
σ^{w}	Elasticity of substitution: labor varieties	8.3
σ^{x}	Elasticity of substitution: exports	1.5
σ^{xb}	Elasticity of substitution: export varieties	9.668
σ^{y}	Elasticity of substitution: labor vs. capital in production	0.5
$\bar{g}$	Steady state government spending share of output	0.19
$\overline{inv}$	Steady state investment share of output	0.138
$\bar{\sigma}(i^n)$	Steady state standard deviation of interest rates	0.002*
$\bar{i}^n - \bar{i}^{CB}$	Steady state saving interest rate - policy rate spread	0.001*

*The steady state bank costs χ_0^g, χ_0^b are the parameters that adjust to ensure these targets are met.

Table 14: Description and priors of estimated parameters

Parameter	Description	Prior Distribution
σ^{c}	Intertemporal elasticity of substitution	$N(0.66, 0.198)$
ψ^{hab}	Consumption habit parameter	$\text{Beta}(0.69, 0.05)$
σ^{h}	Labor supply elasticity	$N(0.43, 0.108)$
χ^{k}	Capital adjustment cost constant	$N(201, 60.3)$
ϵ^{k}	Indexation to past capital adjustment in capital adjustment cost	$\text{Beta}(0.5, 0.25)$
σ^{z}	Capital utilization cost elasticity	$N(0.56, 0.168)$
χ^{hv}	Domestic goods price adjustment cost	$N(326, 97.8)$
ϵ^{hv}	Domestic goods inflation indexation	$\text{Beta}(0.26, 0.1)$
χ^{xv}	Export goods price adjustment cost	$N(43, 12.5)$
ϵ^{xv}	Export goods inflation indexation	$\text{Beta}(0.14, 0.05)$
ψ^{pm}	Imported goods Calvo parameter	$\text{Beta}(0.40, 0.15)$
ϵ^{m}	Imported goods inflation indexation	$\text{Beta}(0.17, 0.05)$
ψ^{w}	Wage Calvo parameter	$\text{Beta}(0.21, 0.05)$
ϵ^{w}	Wage inflation indexation	$\text{Beta}(0.58, 0.145)$
θ^{p}	Taylor Rule inflation weight	$N(1.87, 0.131)$
θ^{y}	Taylor Rule output weight	$N(0.11, 0.028)$
θ^{rcb}	Taylor Rule persistence	$\text{Beta}(0.87, 0.05)$
μ	Marginal cost of information	$\text{InvGamma}(0.005, 0.5)$
χ_1	Elasticity of inefficient bank costs to the policy rate	$N(0, 0.25)$
ρ_{tfp}	Persistence of TFP shock	$\text{Beta}(0.89, 0.05)$
σ_{tfp}	s.d. TFP shock	$\text{InvGamma}(0.006, 2)$
ρ_{g}	Persistence of government spending shock	$\text{Beta}(0.96, 0.025)$
σ_{g}	s.d. government spending shock	$\text{InvGamma}(0.009, 2)$
ρ_{x}	Persistence of shock x	$U(0.5, 0.289)$
$\sigma_{\zeta^{\kappa h}}$	s.d. labor disutility shock	$\text{InvGamma}(0.01, 2)$
$\sigma_{\zeta^{c}}$	s.d. monetary policy shock	$\text{InvGamma}(0.025, 2)$
$\sigma_{\zeta^{hb}}$	s.d. price markup shock	$\text{InvGamma}(0.006, 2)$
$\sigma_{\zeta^{k}}$	s.d. capital adjustment cost shock	$\text{InvGamma}(0.06, 2)$
σ_{y}	s.d. shock y	$\text{InvGamma}(0.001, 2)$
$\sigma_{\nu z}$	s.d. measurement error on z	$\text{InvGamma}(0.01, 2)$

$x = \zeta^{c}, \zeta^{hb}, \zeta^{k}, \zeta^{\mu}, \zeta^{\chi}, \zeta^{\chi b}$ refers to the shock to the risk premium, price markups, capital adjustment costs, information costs, interest rate level and dispersion. All other shocks are assumed i.i.d.
$y = \zeta^{rg}, \zeta^{\mu}, \zeta^{\chi}, \zeta^{\chi b}$. z contains the mean and standard deviation of bank deposit rates, and φ_t.

Table 15: Estimated posteriors in baseline model

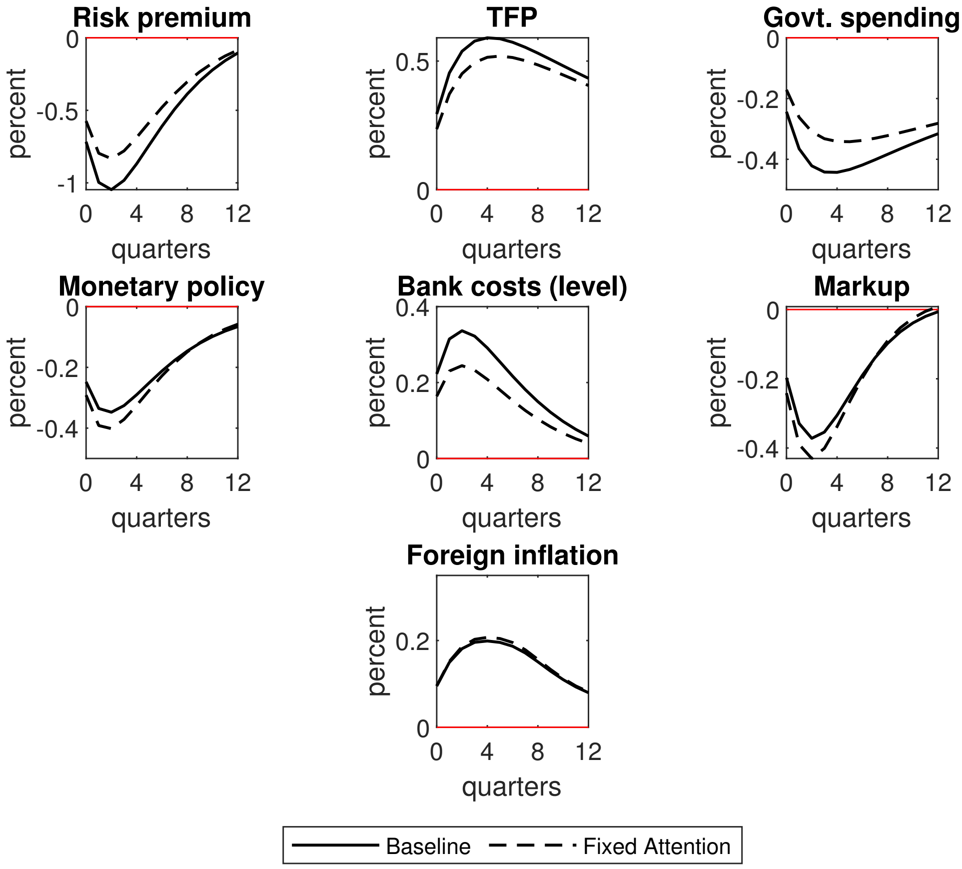
Parameter	Mean	5%	95%	Parameter	Mean	5%	95%
σ^c	0.237	0.172	0.308	$\rho_{\zeta^{hb}}$	0.248	0.003	0.443
ψ^{hab}	0.740	0.675	0.820	ρ_{ζ^k}	0.376	0.000	0.832
σ^h	0.464	0.271	0.631	ρ_{ζ^χ}	0.924	0.860	0.983
χ^k	152.448	58.233	241.595	$\rho_{\zeta^{\chi b}}$	0.785	0.690	0.875
ϵ^k	0.475	0.010	0.822	μ	0.037	0.026	0.047
σ^z	0.564	0.315	0.841	χ_1	-0.280	-0.494	-0.063
χ^{hv}	422.303	274.872	554.110	σ_g	0.033	0.028	0.038
ϵ^{hv}	0.223	0.078	0.363	$\sigma_{\zeta^{\kappa h}}$	1.550	0.676	2.386
χ^{xv}	37.092	13.306	60.056	$\sigma_{\zeta^{rcb}}$	0.001	0.001	0.002
ϵ^{xv}	0.135	0.058	0.217	σ_{tfp}	0.007	0.006	0.008
ψ^{pm}	0.632	0.371	0.894	σ_{ζ^c}	0.009	0.006	0.012
ϵ^m	0.165	0.079	0.244	$\sigma_{\zeta^{hb}}$	0.007	0.005	0.008
ψ^w	0.267	0.202	0.328	σ_{ζ^k}	0.140	0.051	0.221
ϵ^w	0.335	0.184	0.474	σ_{ζ^μ}	0.000	0.000	0.001
θ^p	1.813	1.598	2.024	σ_{ζ^χ}	0.003	0.002	0.004
θ^y	0.144	0.102	0.187	$\sigma_{\zeta^{\chi b}}$	0.003	0.002	0.004
θ^{rcb}	0.912	0.891	0.933	σ_{ν^φ}	0.093	0.078	0.108
ρ_{tfp}	0.957	0.934	0.981	σ_{ν^s}	0.009	0.002	0.019
ρ_g	0.954	0.921	0.983	σ_{ν^m}	0.002	0.001	0.002
ρ_{ζ^c}	0.892	0.831	0.947				

Table 16: Estimated posteriors in full information model

Parameter	Mean	5%	95%	Parameter	Mean	5%	95%
σ^c	0.187	0.108	0.265	$\rho_{\zeta^{hb}}$	0.266	0.044	0.474
ψ^{hab}	0.723	0.652	0.796	ρ_{ζ^k}	0.753	0.578	0.952
σ^h	0.443	0.280	0.582	ρ_{ζ^χ}	NA	NA	NA
χ^k	162.775	66.424	252.815	$\rho_{\zeta^{\chi b}}$	NA	NA	NA
ϵ^k	0.143	0.001	0.295	μ	NA	NA	NA
σ^z	0.534	0.267	0.826	χ_1	NA	NA	NA
χ^{hv}	412.895	270.223	548.295	σ_g	0.033	0.028	0.038
ϵ^{hv}	0.215	0.073	0.365	$\sigma_{\zeta^{\kappa h}}$	2.074	0.852	3.303
χ^{xv}	33.019	4.005	54.746	$\sigma_{\zeta^{rcb}}$	0.001	0.001	0.002
ϵ^{xv}	0.138	0.057	0.216	σ_{tfp}	0.007	0.006	0.008
ψ^{pm}	0.652	0.401	0.893	σ_{ζ^c}	0.012	0.007	0.018
ϵ^m	0.165	0.087	0.241	$\sigma_{\zeta^{hb}}$	0.007	0.005	0.008
ψ^w	0.239	0.173	0.298	σ_{ζ^k}	0.213	0.070	0.364
ϵ^w	0.320	0.172	0.473	σ_{ζ^μ}	NA	NA	NA
θ^p	1.851	1.646	2.058	σ_{ζ^χ}	NA	NA	NA
θ^y	0.146	0.103	0.186	$\sigma_{\zeta^{\chi b}}$	NA	NA	NA
θ^{rcb}	0.912	0.893	0.935	σ_{ν^φ}	NA	NA	NA
ρ_{tfp}	0.962	0.939	0.987	σ_{ν^s}	NA	NA	NA
ρ_g	0.953	0.919	0.990	σ_{ν^m}	NA	NA	NA
ρ_{ζ^c}	0.895	0.837	0.950				

Note: full information implies zero interest rate dispersion, so this can no longer discipline parameters of bank cost functions as in the baseline model. I therefore set $\chi_0^b = \chi_1 = 0$. This implies $r_t^g = r_t^b = r_t^{CB} - \xi_t^\chi - \xi_t^{\chi b}$. In the log-linearized model, bank cost shocks are then isomorphic to risk premium shocks, so are excluded without loss of generality.

Figure 8: Impulse Response Functions of c_t in response to various 1 standard deviation shocks.



Note: Solid lines are simulations of a 1 standard deviation shock in the estimated model described in Section IV.A. Estimation details and estimated parameters are listed in Appendix E.2. Dashed lines are simulations from the same model, with the same parameters, but where p_t^g has been held at steady state in all periods, so households are no longer on their first order condition for attention (equation 39) in each period.

E.3 Attention to Borrowing in the Quantitative Model

E.3.1 Model

I introduce borrowing to the model by assuming that a fraction q_d of households are less patient than others, as in Iacoviello (2005), Eggertsson and Krugman (2012), and many others. These households accumulate debt up to an exogenous constraint, so I refer to them as debtors, and index their idiosyncratic variables and parameters by d.

Lending banks. The banks engaged in lending are set up as in Section I.F and Appendix C.2. There are $N^d = 2$ lending banks, who borrow from the government at the policy rate i_t^{CB} and lend this money out to individuals in debtor households. As with the deposit-taking banks in Section IV.A.2, each period one lender draws a low cost, χ_t^{gd}. The other draws a high cost χ_t^{bd}. There is no persistence in these cost rankings. The first order conditions for the good (low cost) and bad (high cost) lending bank are (following equation 29):

$$(1 - p_t^{gd})(i_t^{gd} - i_t^{CB} - \chi_t^{gd}) = \lambda_t^d \tag{E.3}$$

$$p_t^{gd}(i_t^{bd} - i_t^{CB} - \chi_t^{bd}) = \lambda_t^d \tag{E.4}$$

where p_t^{gd} is the probability a borrower chooses the good lender in period t.

Log-linearizing around steady state as described in Section IV.B, these become:

$$\frac{1}{\bar{i}^{gd} - \bar{i}^{CB} - \bar{\chi}^{gd}}(\bar{i}^{gd}\hat{i}_t^{gd} - \bar{i}^{CB}\hat{i}_t^{CB} - \bar{\chi}^{gd}\hat{\chi}_t^{gd}) - \frac{\bar{p}^{gd}}{1 - \bar{p}^{gd}}\hat{p}_t^{gd} = \hat{\lambda}_t^d \tag{E.5}$$

$$\frac{1}{\bar{i}^{bd} - \bar{i}^{CB} - \bar{\chi}^{bd}}(\bar{i}^{bd}\hat{i}_t^{bd} - \bar{i}^{CB}\hat{i}_t^{CB} - \bar{\chi}^{bd}\hat{\chi}_t^{bd}) + \hat{p}_t^{gd} = \hat{\lambda}_t^d \tag{E.6}$$

where $\bar{x}$ indicates the steady state of x_t, and $\hat{x}_t$ indicates the log-deviation of x_t from $\bar{x}$.

Households. A fraction q_d of households are debtors, while the remaining $1 - q_d$ are savers. The savers are identical to the households in the model presented in Section IV, except for a detail in the budget constraint discussed below. The debtors have the same preferences, except that their discount factor is $\beta^d < \beta$. Denote the consumption of debtors as c_t^d.

The debtor household budget constraint is:[32]

$$PC_t c_t^d - D_t + (1 + i_{t-1}^{ed})D_{t-1} = W_t h_t - PC_t\tau_t + PC_t\tau_0 \tag{E.7}$$

where D_t is nominal debt taken out in period t, i_t^{ed} is the effective interest rate on that debt, and τ_0 is a steady state transfer. Since debtors have lower discount factors than savers, they reduce their asset holdings in all assets until they hit the relevant constraints. This is why there is no capital income or firm profit in equation E.7: debtor households reduce their capital and equity holdings to zero. It is also the reason that these households choose to hold debt D_t rather than savings.

The constraint on debt takes the simple form $D_t/PC_t \leq d$. That is, real debt holdings cannot exceed the constant level d. β^d will be set sufficiently low that this constraint

[32]Note I assume here that debtor households supply labor to the same union as the savers, and that the labor of the two types of households are perfect substitutes, so wages and hours worked are the same for all households. The wage Phillips curve is modified accordingly. See the online appendix for details.

always binds for debtors, so in real terms the debtor budget constraint is:

$$c_t^d - d + \frac{1 + i_{t-1}^{ed}}{\pi_t} d = w_t h_t - \tau_t + \tau_0 \tag{E.8}$$

As in Section I.F, the first order condition on attention takes a very similar form to that of savers:

$$\beta^d d \mathbb{E}_t \frac{u_{ct+1}^d}{\pi_{t+1}} = \mu e^{\zeta_t^\mu} (\lambda_t^d)^{-1} \tag{E.9}$$

where

$$u_{ct+1}^d = \frac{1}{(\tilde{c}_t)^{\psi^{hab}}} \left(\frac{c_{t+1}^d}{(\tilde{c}_t)^{\psi^{hab}}} \right)^{-\frac{1}{\sigma_c}} \tag{E.10}$$

where habits are dependent on aggregate consumption across both household types $\tilde{c}_t \equiv (1 - q_d) c_t + q_d c_t^d$. The same is true for savers. Note that the marginal cost of information $\mu e^{\zeta_t^\mu}$ is part of preferences, and so is assumed to be common to savers and debtors.

Within debtor households, individuals choose banks as in Appendix C.2, and this implies a bank choice probability given by

$$p_t^{gd} = \frac{\exp(-\frac{i_t^{gd}}{\lambda_t^d})}{\exp(-\frac{i_t^{gd}}{\lambda_t^d}) + \exp(-\frac{i_t^{bd}}{\lambda_t^d})} \tag{E.11}$$

Finally, the effective interest rate on debt is defined as:

$$i_t^{ed} = p_t^{gd} i_t^{gd} + (1 - p_t^{gd}) i_t^{bd} \tag{E.12}$$

Log-linearizing in the fashion described in Section IV.B, these become:

$$\bar{c}^d \hat{c}_t^d = \bar{w} \bar{h} (\hat{w}_t + \hat{h}_t) - \bar{\tau} \hat{\tau}_t - d \bar{i}^{ed} \hat{i}_{t-1}^{ed} + d(1 + \bar{i}^{ed}) \hat{\pi}_t \tag{E.13}$$

$$-\frac{1}{\sigma_c} \mathbb{E}_t \hat{c}_{t+1}^d + \psi^{hab} \left(\frac{1}{\sigma_c} - 1 \right) \hat{c}_t^d - \mathbb{E}_t \hat{\pi}_{t+1} = -\hat{\lambda}_t^d + \zeta_t^\mu \tag{E.14}$$

$$\hat{p}_t^{g,d} = \left(\frac{1 - \bar{p}^{g,d}}{\bar{\lambda}^d} \right) [\bar{i}^{bd} \hat{i}_t^{bd} - \bar{i}^{gd} \hat{i}_t^{gd} + (\bar{i}^{gd} - \bar{i}^{bd}) \hat{\lambda}_t^d] \tag{E.15}$$

$$\bar{i}^{ed}\hat{i}_t^{ed} = \bar{p}^{g,d}(\bar{i}^{gd} - \bar{i}^{bd})\hat{p}_t^{g,d} + \bar{p}^{g,d}\bar{i}^{g,d}\hat{i}_t^{g,d} + (1 - \bar{p}^{g,d})\bar{i}^{b,d}\hat{i}_t^{b,d} \tag{E.16}$$

The transfer τ_0 in the debtor household budget constraint (equation E.7) is funded by a lump sum tax on savers, equal to $\tau_0 \cdot q_d/(1 - q_d)$. This has no effect on the log-linearized first order conditions for the savers, but allows me to control the steady state level of consumption inequality, which is important for aggregate dynamics in two-agent New Keynesian models such as this (Debortoli and Galí, 2018). Since the majority of the equilibrium conditions are unchanged from the representative-agent model, I leave the full derivation of this extended model to the online appendix.

E.3.2 Quantification

The calibrations and priors of all parameters present in the representative-agent model are kept the same for this extended model. There are 4 new parameters for this model: β^d, d, q_d, τ_0. In addition, there are two new shock processes: χ_t^{gd}, χ_t^{bd}.

First, I calibrate β^d to 0.98. This is sufficiently low that the debt constraint binds in steady state.[33] Since the stock of saving among saver households has been normalized to 1, I set d to match the ratio of median mortgage debt among mortgage-holders to median gross financial assets among non-mortgage-holders with positive savings in the UK in the first wave of the Wealth and Assets Survey (Office for National Statistics, 2019), conducted towards the end of the sample period used for estimating the baseline model (2006-2008). This implies a calibration of $d = 10$. I focus on mortgage-holders since the data on interest rate dispersion used to specify lender bank costs concerns mortgages. Furthermore, Cloyne et al. (2020) find that mortgagors account for a large majority of the liquidity-constrained households in the UK.

I set the proportion of debtors to $q_d = 0.21$, following Debortoli and Galí (2018) who note this is in the middle of the range of calibrations common in the two-agent New Keynesian literature. This is also close to the proportion of UK households estimated to be liquidity constrained and hold a mortgage by Cloyne et al. (2020). Finally, I follow Galí et al. (2007) and set τ_0 such that steady state consumption is equal across savers and debtors. This does not, however, imply that consumption is equal in all periods, as shocks will affect the two household types in different ways.

Next, I turn to the cost processes χ_t^{gd} and χ_t^{bd}. As with the deposit-taking banks, I assume that the costs of each lending bank consist of a constant component and a

[33] Note that $\beta^d < \beta$ is necessary but not sufficient for this, as debtors face different effective interest rates from savers.

time-varying component:

$$\chi_t^{gd} = \chi_0^{gd} + \tilde{\chi}_t^{gd} \tag{E.17}$$

$$\chi_t^{bd} = \chi_0^{bd} + \tilde{\chi}_t^{bd} \tag{E.18}$$

where $\tilde{\chi}_t^{gd}, \tilde{\chi}_t^{bd}$ are mean-zero stationary processes.

For the constants χ_0^{gd} and χ_0^{bd}, I follow the procedure for the deposit-taking banks and calibrate them to target two empirical moments, once concerning the average spread between mortgage interest rates and the policy rate, and another concerning the dispersion of mortgage interest rates. For the first of these, I compute the average spread between the Quoted Household Interest Rate series for 5-year fixed-rate mortgages (Bank of England, ndb) and the 3-month T-bill rate over the period 1996-2009.[34] This is the data counterpart of $\bar{i}^{ed} - \bar{i}^{CB}$ in the model. Targeting this pins down the average of the constant components of lending bank costs.

To calibrate the dispersion of the constant components of lending bank costs, I first use the data from Moneyfacts described in Section II to compute the spread between the highest and lowest-yield saving products offered in December 2000 in the sample used to construct φ_t. This spread is 250 basis points. This is useful, because Cook et al. (2002) measure the equivalent spread for comparable 5-year fixed-rate mortgages available in the same month. They measure this spread as 33 basis points. I set the constant cost dispersion $\chi_0^{bd} - \chi_0^{gd}$ to match this ratio, i.e. so that in steady state the spread between maximum and minimum debt interest rates is 33/250 times the equivalent spread for saving.

Finally, I set the dynamic components of lending bank costs to be equal to the equivalent processes for deposit-taking banks. That is, the total costs at each lending bank are given by:

$$\chi_t^{gd} = \chi_0^{gd} + \zeta_t^{\chi} \tag{E.19}$$

$$\chi_t^{bd} = \chi_0^{bd} + \chi_1(i_t^{CB} - \bar{i}^{CB}) + \zeta_t^{\chi} + \zeta_t^{\chi b} \tag{E.20}$$

This means that the dynamics of bank costs are the same in borrowing as they are for saving. Economically, this is consistent with a banking environment in which cost shocks are common across the retail finance sector, and are not specific to product types. This assumption is particularly helpful here because identification of lending-bank cost dynamics that are separate from those in saving banks would be very weak in the absence of time-series data on mortgage rate dispersion (see discussion in Section II.A).

[34] Quoted Household Interest Rate is constructed in the same way as the equivalent for saving products, described in Section II.

I estimate this model in the same way as the representative agent model, as detailed in Appendix E.2.

E.3.3 Results

Posterior distributions for all estimated parameters are given in Table 17.

Table 17: Estimated posteriors in two-agent model

Parameter	Mean	5%	95%	Parameter	Mean	5%	95%
σ^c	0.790	0.570	1.015	$\rho_{\zeta^{hb}}$	0.232	0.005	0.426
ψ^{hab}	0.694	0.617	0.772	ρ_{ζ^k}	0.279	0.000	0.747
σ^h	0.496	0.340	0.658	$\rho_{\zeta\chi}$	0.942	0.898	0.990
χ^k	135.946	45.724	225.798	$\rho_{\zeta\chi^b}$	0.782	0.692	0.877
ϵ^k	0.503	0.035	0.793	μ	0.026	0.019	0.035
σ^z	0.489	0.186	0.761	χ_1	-0.322	-0.545	-0.115
χ^{hv}	419.759	279.800	558.862	σ_g	0.033	0.028	0.037
ϵ^{hv}	0.215	0.085	0.358	$\sigma_{\zeta^{\kappa h}}$	1.221	0.582	1.791
χ^{xv}	33.269	4.597	55.553	$\sigma_{\zeta^{rcb}}$	0.001	0.001	0.002
ϵ^{xv}	0.135	0.063	0.212	σ_{tfp}	0.007	0.006	0.008
ψ^{pm}	0.686	0.478	0.899	σ_{ζ^c}	0.016	0.009	0.024
ϵ^m	0.168	0.089	0.249	$\sigma_{\zeta^{hb}}$	0.007	0.005	0.008
ψ^w	0.287	0.224	0.349	σ_{ζ^k}	0.111	0.038	0.182
ϵ^w	0.379	0.221	0.529	σ_{ζ^μ}	0.001	0.000	0.002
θ^p	1.848	1.631	2.048	$\sigma_{\zeta\chi}$	0.003	0.002	0.004
θ^y	0.153	0.112	0.192	$\sigma_{\zeta\chi^b}$	0.003	0.002	0.004
θ^{rcb}	0.914	0.893	0.935	$\sigma_{\nu\varphi}$	0.093	0.079	0.110
ρ_{tfp}	0.954	0.925	0.983	$\sigma_{\nu s}$	0.009	0.003	0.015
ρ_g	0.938	0.896	0.981	$\sigma_{\nu m}$	0.002	0.001	0.002
ρ_{ζ^c}	0.738	0.606	0.875				

To see the effects of cyclical attention to saving and borrowing, Table 18 repeats the exercise of Table 3 for the estimated two-agent model. Specifically, I compute the cumulative 4-quarter response of aggregate consumption to a range of shocks in the baseline estimated model, and then in two alternatives. In the first alternative ('fixed attention') all parameters are as in the baseline, but attention of both savers and borrowers are held at their respective steady states. In the second ('saver attention'), saver attention is allowed to vary optimally, but borrower attention is held at its steady state.

In the first column of Table 18, I compute the aggregate consumption response to each shock in the fixed attention model relative to the response in the saver attention model. This therefore shows the extent of consumption amplification due to variable attention to saving. As in Table 3, for the most important shocks, the ratio is less than 1, implying that cyclical attention to saving amplifies aggregate consumption. In the second column, I compute the aggregate consumption responses in the fixed attention model relative to the full estimated model. This shows the effect of cyclical attention to saving and borrowing combined. The amplification is slightly smaller for the main shocks (i.e. risk premium, TFP, and government spending): cyclical attention to borrowing dampens fluctuations, but the effect is small.

Table 18: Cumulative aggregate consumption response to shocks relative to variable attention baseline.

Shock	Saver vs Fixed	Full vs Fixed
Risk premium	0.879	0.884
TFP	0.905	0.917
Govt. spending	0.861	0.863
Monetary policy	1.137	1.018
Bank costs (level)	0.594	0.553
Markup[a]	0.881	0.857
Foreign inflation	1.085	1.115

[a] Markup shock ratios are calculated the same as all other shocks, except I use the impact response of aggregate consumption rather than the cumulative response over a year, because aggregate consumption rises on impact then falls below zero, so the cumulative response over 4 quarters is very close to zero in all models.
Note: For each shock, the reported statistics are calculated by taking the 12-month cumulative response of consumption to the shock in the estimated quantitative model, assuming that attention is held fixed at its steady state value, then dividing that by the equivalent cumulative consumption responses in the saver attention model (column 1) and the full model with variable attention of both savers and borrowers (column 2).

Overall, cyclical attention to saving alone amplifies the variance of aggregate consumption (relative to the fixed attention model) by 15.7%. Allowing attention to borrowing to vary as well, the variance of consumption is still 12.3% larger than in the fixed attention model. Cyclical attention to saving therefore remains the dominant way in which attention affects aggregate consumption, consistent with the findings in Section I.F.

Interestingly, cyclical attention to saving actually has a greater amplification effect on aggregate consumption in this model than it does in the representative agent model. This is why the overall amplification from cyclical attention of all households is comparable to that in the representative agent model. This occurs even though cyclical attention to saving directly affects only a subset of the population of households.

The reason, as outlined in Section IV.D, is that amplification of saver consumption has second-round effects on debtors, through labor income. To show this, I compute a decomposition similar to that in Kaplan et al. (2018), in which I split the response of risk premium shocks and monetary policy shocks into Euler-equation effects and indirect (general-equilibrium) effects.

Specifically, collect all income from labor, capital, and profits, minus investment and taxes, into a single variable m_t, so that the flow budget constraint of saver households is

$$c_t + b_t = \frac{1 + i^e_{t-1}}{\pi_t} b_{t-1} + m_t \tag{E.21}$$

and the corresponding present-value budget constraint is

$$\sum_{t=0}^{\infty} \frac{1}{\prod_{k=0}^{t-1} \frac{1+i^e_k}{\pi_{k+1}}} c_t = \sum_{t=0}^{\infty} \frac{1}{\prod_{k=0}^{t-1} \frac{1+i^e_k}{\pi_{k+1}}} m_t + \frac{1 + i^e_{t-1}}{\pi_t} b_{t-1} \tag{E.22}$$

Log-linearizing, and imposing that all variables are at steady state in period -1, this becomes

$$\sum_{t=0}^{\infty}\beta^t(\hat{c}_t-\sum_{k=0}^{t-1}\hat{r}^e_k)=\frac{\bar{m}}{\bar{c}}\sum_{t=0}^{\infty}\beta^t(\hat{m}_t-\sum_{k=0}^{t-1}\hat{r}^e_k) \tag{E.23}$$

where $\bar{c},\bar{m}$ are the steady states of c_t and m_t respectively. Hatted variables are log-deviations from steady state, and $\hat{r}^e_t$ denotes the log-deviation of the real effective interest rate $(1+i^e_t)/\pi_{t+1}$ from its steady state.

Next, log-linearize the Euler equation (as in the representative-agent model, this is given by equation 38)

$$\hat{u}_{ct}=\zeta^c_t+\hat{r}^e_t+\hat{u}_{ct+1} \tag{E.24}$$

Substituting forwards T times, and using the definition of marginal utility, this becomes

$$\begin{aligned}-\frac{1}{\sigma^c}\hat{c}_t+\psi^{hab}(\frac{1}{\sigma^c}-1)((1-q_d)\hat{c}_{t-1}+q_d\hat{c}^d_{t-1})&\\=\sum_{k=t}^{T-1}(\zeta^c_k+\hat{r}^e_k)-\frac{1}{\sigma^c}\hat{c}_T+\psi^{hab}(\frac{1}{\sigma^c}-1)((1-q_d)\hat{c}_{T-1}+q_d\hat{c}^d_{T-1})&\end{aligned} \tag{E.25}$$

With repeated substitutions of this into equation E.23, saver consumption in period 0 can be written as

$$\begin{aligned}\hat{c}_0=(1-\beta)(1-\beta\Omega)\sum_{t=1}^{\infty}\beta^t\left[\frac{b}{\beta\bar{c}}-\frac{\sigma^c}{1-\beta}\Omega^{t-1}\right]\sum_{k=0}^{t-1}\hat{r}^e_k&\\-\frac{\sigma^c\beta}{1-\beta\rho_{\zeta^c}}\zeta^c_0+(1-\beta)(1-\beta\Omega)\left(1-\frac{b}{\beta\bar{c}}\right)\sum_{t=0}^{\infty}\hat{m}_t&\end{aligned} \tag{E.26}$$

where

$$\Omega\equiv\psi^{hab}(1-\sigma^c)(1-q_d) \tag{E.27}$$

As in Kaplan et al. (2018), I use this to compute the effects of shocks that operate specifically through intertemporal substitution in the Euler equation of savers. To do this, I assume that a one standard-deviation shock hits the economy in period 0. I then feed into equation E.26 the paths of $\hat{r}^e_t$ and ζ^c_t from the relevant impulse responses computed from the estimated model, but I hold $\hat{m}_t$ constant at 0 (steady state). The share of that shock's transmission on impact through Euler equation effects is given by dividing the

Euler equation effect by the true impact of the shock on aggregate consumption, which incorporates all changes in $\hat{m}_t$.

$$\hat{c}_0^{\text{euler}} \equiv \frac{(1-q_d)\hat{c}_0|\hat{m}_t = 0}{(1-q_d)\hat{c}_0 + q_d\hat{c}_0^d} \tag{E.28}$$

Note that here I am including the response of attention and interest rates to the shock in the Euler-equation effects, so this is not the same as a partial vs. general equilibrium effect decomposition. It rather gives the share of transmission that occurs through intertemporal substitution in the Euler equation of savers. Table 19 shows the results of this decomposition for both risk premium shocks and monetary policy shocks, both of which have no direct effect on borrowers, but can only affect them through indirect income effects. For both shocks, I compute the decomposition for the fixed attention model, and for the saver attention model.

Table 19: Share of shock transmission due to direct Euler-equation effects on savers.

Shock	Fixed Attention	Saver Attention
Risk premium	1.110	0.999
Monetary policy	0.050	0.042

Note: The share of shock transmission due to direct Euler-equation effects is calculated as defined in Equation E.28. The 'Fixed Attention' and 'Saver Attention' models are as defined in the note accompanying Table 18.

In the fixed attention model, more than 100% of the impact of risk premium shocks is through the Euler equation of savers. Indirect effects actually dampen the shock a little, principally because profits rise after a contractionary risk premium shock, and this prevents saver consumption falling too far. In the saver attention model, recall that variable attention amplifies the effects of the shock on saver consumption. Mechanically, this would increase the share of transmission through Euler-equation effects. However, this is more than outweighed by the second-round effects on borrower incomes, such that the Euler-equation share actually falls. Therefore although cyclical attention to saving only directly influences the consumption of savers, debtor consumption is also affected, because labor income is affected and their consumption is very sensitive to income.

With monetary policy shocks, the first thing to note is that this model confirms the results in Kaplan et al. (2018), Bilbiie (2019) and others that the majority of monetary transmission occurs through indirect effects. Variable attention to saving further increases the share due to indirect effects, because this is one of the rare shocks in which attention choices dampen the direct saver response to the shock.