

A MICROECONOMETRIC MODEL OF THE CHOICE BETWEEN FIXED AND VARIABLE RATE MORTGAGES IN THE UK

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ABSTRACT

Microdata from the UK Survey of Mortgage Lenders is used to model borrowers' choices between variable and fixed rate mortgages. The ordered probit model is used for estimation. Explanatory variables are divided into four groups: borrower characteristics; borrower tastes; mortgage price variables; and market conditions. A large number of strong effects are found, including: the presence of females borrowers increases the propensity to fix; high-income borrowers are more likely to fix, but if income is "self-certified", fixing is less likely; those with higher loan-to-income ratios are more likely to fix; fixing is more likely when interest rates are high, especially when the market expects further increases. Many of these findings are consistent with the interpretation of the choice of a fixed rate being the choice of a safe alternative in a risky choice problem.

Key words and phrases: Fixed and variable rate mortgages; interest rate expectations; ordinal data; ordered probit.

1. Introduction

Fixed rate mortgages are desirable from the borrower's point of view, for the obvious reason that it eliminates uncertainty over future outgoings, and makes financial planning easier. The take-up of fixed-rate mortgages is also desirable from the point of view of policy-makers, since such a culture is thought to have the potential to bring about stability in the housing market. In 2003, the then Chancellor of the Exchequer Gordon Brown advocated a widening in the use of fixed-rate mortgages as a precondition for British entry into the Euro. In the April 2003 Budget, he commissioned Professor David Miles to investigate why long-term fixed rate mortgages take up such a small share of total business, and to make recommendations for addressing the issue. The final report appeared as Miles (2004). The recommendations included measures designed to raise levels of borrowers' understanding of interest rate risk, and measures making it less risky for lenders to lend at long-term fixed rates. It remains to be seen how effective Miles' recommendations have been.

This paper is concerned almost exclusively with the demand side of this market. That is, we are interested in identifying the determinants of the borrower's choices over whether, and how long, to fix. It is useful to interpret this choice in the context of a risky choice problem: fixing is the safe alternative, while the variable rate is the risky alternative. Clearly, the borrower's decision is influenced by the fear of experiencing future rises in interest payments; however, at the same time they are influenced by the anticipated regret they will feel if interest rates fall following a decision to fix.

Some theoretical work has been done on this decision, including Alm and Follain (1984) and Campbell and Cocco (2003).

Some empirical work has also been done. Dhillon et al. (1987) apply a binary probit model to the choice between fixed and variable for a sample of 78 households in Louisiana, USA. Leece (2000) applies a binary probit model to the choice between fixed and variable for a sample of 762 UK households, extracted from the British Household Panel Survey (BHPS).

Sa-Aadu and Sirmans (1995) go one step further and consider the extent of fixing (variable, fixed for up to one year; fixed for more than one year), using a multinomial logit model, applied to a sample of 345 midwestern (USA) households. We take strong exception to the use of multinomial logit model in this context, for the following reason. The choice problem under consideration is indisputably ordinal, and hence there are strong a-priori reasons for expecting the assumption of independence of irrelevant alternatives (IIA) to be violated. To see this, consider a situation in which the mortgage deal with the longest fix is suddenly withdrawn from the market. It is natural to expect the borrowers who would have chosen this deal instead to choose the deal with the *second* longest fix. Hence the ratio of the probabilities of the remaining deals must surely change as a result of the withdrawal of one deal, and IIA is violated.

The data we use is similar to that of Sa-Aadu and Sirmans (1995), but for the reason explained in the preceding paragraph, we respect the ordinality of the choice variable. There are in principle two ways of doing this. We can consider an underlying latent

variable “propensity to fix”, and investigate the dependence of this propensity on the various explanatory variables. This leads to the ordered probit model (Daykin and Moffatt, 2002). Alternatively, we can consider the underlying variable length of fix in years, treating choices of variable-rate deals as zero-censored observations. This leads to the interval regression model (Stewart, 1983).

Another difference between this paper and previous work is in the size of the sample. We use six consecutive years of data from the UK Survey of Mortgage Lenders. Even reducing the sample to those deals that are free of any sort of discount, we have a sample of 115,379 borrowers. This sample clearly has the potential to yield considerably more precise estimates of the effects that others (cited above) have previously found.

The explanatory variables are divided into four groups: borrower characteristics; borrower tastes; mortgage price variables; and market conditions. Borrower characteristics include age, gender, income, loan-to-income ratio, type of mortgage and term of mortgage. Borrower tastes are modelled using a straightforward time trend. The mortgage price variable for a given fixing level is obtained as the difference between the average rate offered for that fixing level and the Bank of England interest rate. Market conditions include the Bank of England Interest rate and a variable representing the term structure, namely the difference between the 20-year bond yield and the 6-month bond yield, which represents market expectations of future movements in interest rates.

2. Data

We use data from the UK Survey of Mortgage Lenders, which is administered on an annual basis by the Council of Mortgage Lenders (CML). The CML consists of a number of reputable Building Societies, and one in 20 of the mortgages approved by these lenders make up the Survey. We select all mortgages approved between 1996 and 2001, which are *not* subject to any sort of initial discount. This gives a sample size of 115,379.

Figure 1 shows how the proportion choosing fixed rates has evolved over the six years of the sample. It is clear that the trend is non-monotonic, with fixes apparently reaching a peak of popularity in 1998 and losing ground thereafter.

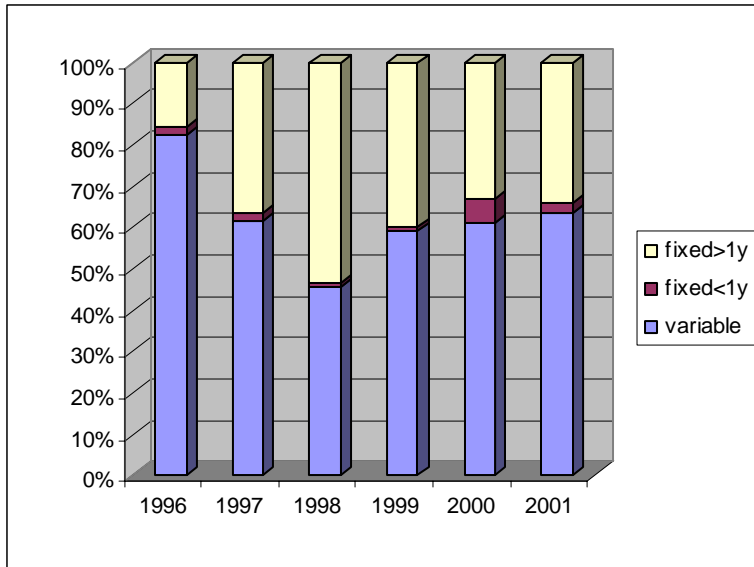


Figure 1: Proportion choosing different levels of fix in different years.

Figure 2 shows the time-paths of the “prices” of each of the three mortgage types, measured as the mean interest rate struck each month for each mortgage type. Also shown is the Bank of England interest rate. It is clear that the rates all seem to follow paths not too different from that of the Bank of England rate. In order to remove the influence of the underlying interest rate, the variables used in the model to represent the prices are the differences between the relevant mean rate, and the Bank of England rate.

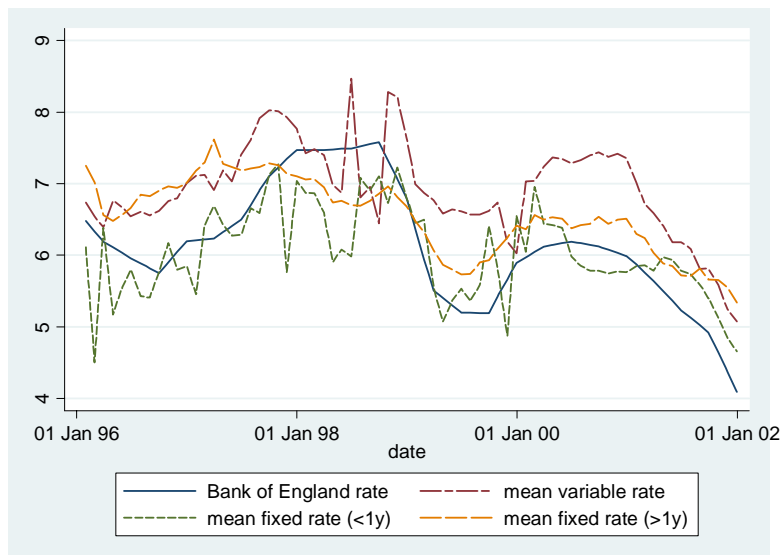


Figure 2: Bank of England interest rate, and mean (over borrowers) monthly rates of each type of mortgage.

A key determinant of the choice between variable and fixed rate is the expectations of future movements in interest rates. As is conventional, we represent such expectations by the slope of the yield curve; that is, the difference between the yield on long-dated bonds (20 years) and short-dated bonds (6 months). The time paths of these two yields are shown in Figure 3. The way to use Figure 3 is simply to consider which line is higher. For example, during 1996 and 1997, the long yield was

considerably higher than the short yield, representing the fact that the market was expecting increases in the interest rate. In Figure 2, we see that this expectation was correct. In the estimation of our model, we shall refer to the yield differential as TS (for “term structure”).

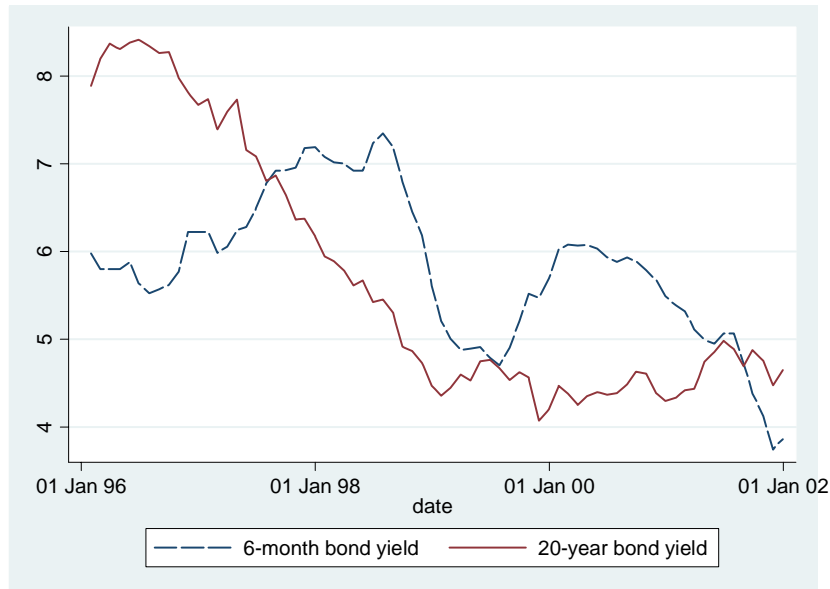


Figure 3: Long term and short term bond yields.

3. Model

Since this paper is concerned with the choice between fixed and variable rate mortgages, and not the overall demand for mortgages, we commence from the assumption that total demand is fixed. To aid understanding, the market can be perceived as consisting of a single borrower who has already made the decision to take out a mortgage, and is in the process of deciding between a fixed rate and a variable rate. In this context, the demand function discussed below may simply be interpreted as that single individual’s propensity to choose a fixed rate over a variable rate.

Total demand (Q^{tot}) is represented by the vertical line in Figure 4. The focus of the analysis is the proportion of this total demand that is fixed-rate. This is represented by the downward sloping curve, which simply conveys the obvious fact that a rise in the interest rate at which the fixed-rate deal is struck (r_f), ceteris paribus, causes a fall in the propensity of a typical borrower to opt for the fixed rate.

Supply of fixed rate mortgages is represented by the horizontal line in Figure 4. This is because we are assuming that the lender chooses a single fixed rate (r_f^*). The resulting quantity demanded of fixed rate deals is then given by Q^* , and the remainder of deals demanded ($Q^{tot}-Q^*$) are variable-rate.

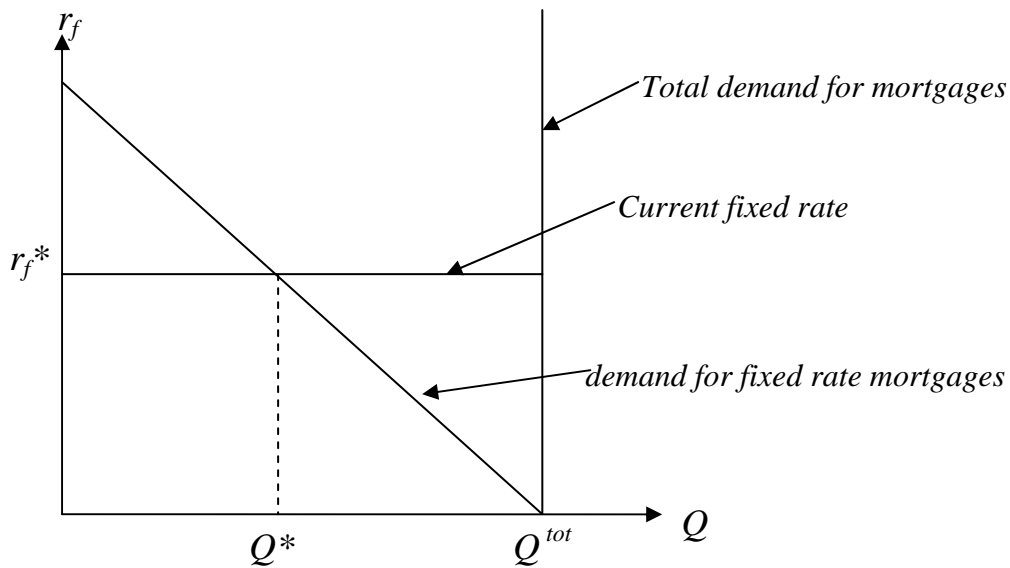


Figure 4: The market for fixed rate (and variable rate) mortgages.

Clearly, if lenders increase the price of the fixed rate, r_f^* , the quantity demanded (Q^*) is expected to fall. Since data is available on this price, its coefficient in the econometric model loosely represents the slope of the downward-sloping demand curve in Figure 4. All of the other factors that affect the demand for fixed rates will be assumed to determine the position of this demand curve. For example, if age of borrower has a negative effect on the propensity to fix, then an increase in age brings about a leftward shift in the entire demand schedule. The extent of any such shift is represented by a parameter estimated within the econometric model.

As mentioned in Section 1, the dependent variable is ordinal with three outcomes (variable; fixed for up to one year; fixed for more than one year), and accordingly we use an ordered probit model. The ordered probit model always assumes that there is an underlying latent variable; in this case it is the “propensity to fix”. As illustrated in Figure 5, the model assumes that the mean propensity to fix ($x'\beta$) depends on the explanatory variables appearing in the vector x , that actual propensity to fix is distributed normally (with variance normalised to 1) around this mean, and that the fixing decision depends on the value of this propensity in relation to the two “cut-points” κ_1 and κ_2 . The two cut-points are estimated along with the parameters contained in the vector β , by maximum likelihood. Note that the vector β does not include an intercept, since it would not be separately identifiable from the two cut-points.

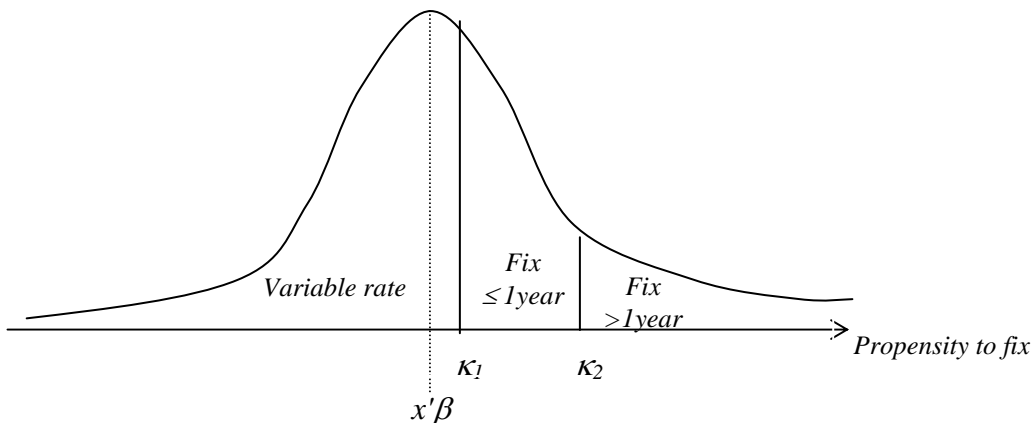


Figure 5: The ordered probit model; density function of “propensity to fix”, and its relationship to the observed fixing decision.

The other approach that was mentioned in Section 1 is the Interval Regression model. Here, the underlying variable is taken to be the desired length of the fix, measured in years. As illustrated in Figure 6, this variable is assumed to vary between $-\infty$ and $+\infty$, but negative values are censored and correspond to choices of a variable rate. If desired length of fix is positive, we observe the interval (either $(0,1]$ or $(1,\infty)$) in which the actual length of fix lies. As with the ordered probit model, the underlying variable is assumed to have mean determined by a set of variables x , and to be normally distributed around this mean. However, there are a number of differences from ordered probit. Firstly, the variance parameter is identified and is therefore a parameter that requires estimation. Secondly, the intercept in this model is also identified. Thirdly, the “cut-points” in this model are known values (0 and 1 in this case) and therefore do not require estimation.

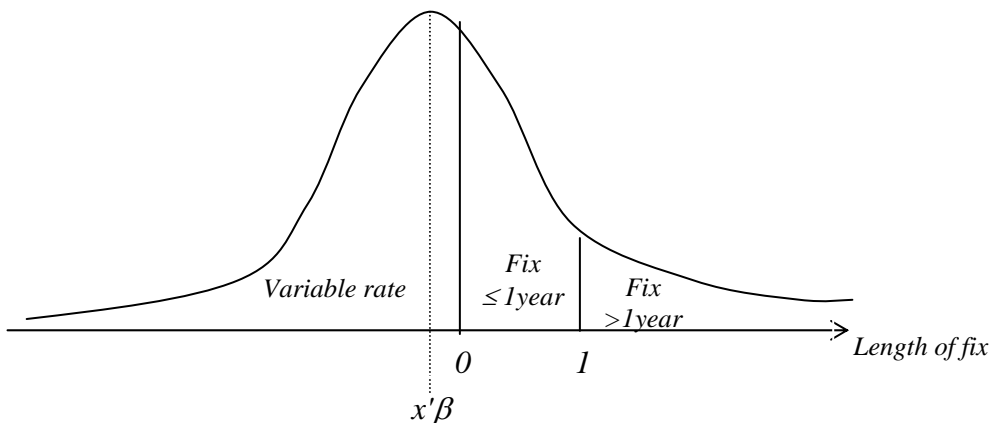


Figure 6: The interval regression model; density function of length of fix, and its relationship to the observed fixing decision.

A question that inevitably arises is which of these two models is preferred. The answer is that, generally, the interval regression model is preferred on the grounds that knowledge of the cut-points allows greater efficiency with respect to the estimation of the model’s other parameters. However, in the special case in which

there are only three outcomes, the two models contain exactly the same number of unknown parameters, and, interestingly, they are identical in terms of the value of their maximised log-likelihoods, and therefore their explanatory power.

Since the variable of interest here has only three outcomes, we may therefore conclude that ordered probit and interval regression are equivalent models in explaining our data. We shall therefore estimate only the ordered probit model, and, accordingly, draw conclusions in terms of the effects of different factors on the borrower's propensity to fix. However, it is still conceptually useful to recognise that an alternative, and effectively equivalent, approach would be to consider the length of the fix as the underlying variable of interest, and to proceed by estimating the interval regression model.

4. Results

	<i>Coeff. (s.e.)</i>
<i>Borrower characteristics:</i>	
# males	0.019 (0.013)
# females	0.235**(0.012)
Age of main borrower	-0.0095**(0.0004)
Log(income)	0.256**(0.007)
Self-certified income	-0.732**(0.009)
Loan-to-income ratio	0.348**(0.005)
Repayment mortgage	-0.125**(0.010)
Endowment mortgage	-0.080**(0.012)
Other mortgage (base)	-
Period of loan	-0.001(0.0008)
First-time buyer	0.234**(0.010)
<i>Borrower tastes:</i>	
Trend	0.066**(0.003)
Trend-squared	-0.0006**(0.00003)
<i>Mortgages prices:</i>	
Mean rate for variable – BoE rate	0.003 (0.011)
Mean rate for short fix – BoE rate	0.011(0.010)
Mean rate for long fix – BoE rate	-0.397**(0.021)
<i>Market conditions:</i>	
Bank of England rate	0.211**(0.020)
Term structure	0.255**(0.018)
Term structure squared	-0.027**(0.003)
<i>Cutpoints:</i>	
κ_1	5.515(0.202)
κ_2	5.589 (0.202)
<i>Sample size</i>	115,379
<i>LogL</i>	-73,311.85

Table 1: Results of ordered probit model of choice between: variable; fixed for up to 1 year; fixed for more than 1 year. Standard errors in parentheses. * indicates significance (p<0.05); ** indicates strong significance (p<0.01).

Results from the estimation of the ordered probit model are presented in Table 1. As always, this set of results represents the end of an extensive specification search.

The majority of explanatory variables are borrower characteristics. Considering these in turn, we first see a strong gender effect, with the number of female borrowers having a strongly positive effect on the propensity to fix, and the number of males having no effect. This may be interpreted in terms of higher risk aversion in females, although previous experimental evidence on such a gender effect on risk attitude is mixed. The negative coefficient associated with age tells us that younger borrowers have a higher propensity to fix, and another coefficient tells us that first-time-buyers are particularly likely to fix. Higher income borrowers are more likely to fix. Those with “self-certified” income are less likely to fix. This may be because self-certifiers tend to be self-employed, and there is evidence elsewhere in the literature (Elkelund et al., 2005) that risk-seeking individuals tend to select into self-employment. The positive coefficient associated with loan-to-income ratio is unsurprising and simply indicates that borrowers are more risk averse when more is at stake. Borrowers who choose repayment mortgages are the least likely to fix, while those who choose “other” mortgages (mainly interest-only) are least likely.

Borrower tastes are simply represented by a quadratic time trend. The coefficients indicate that, over the sample period, fixed rates became (*ceteris paribus*) more popular until July 2000, after which they started to lose popularity. This turning point is later than the one evident from Figure 1 above. This is a consequence of controlling for variables other than taste change.

Of the three mortgage price variables, only one has a significant effect. The price of fixed rate (more than one year) mortgages (measured as the difference between the mean rate for such mortgages, and the Bank of England rate), as expected, has a negative effect on the propensity to fix, and, consequently, a positive effect on the propensity to opt for a variable rate. However, the other two prices have no apparent effect. This is evidence of the rare phenomenon of *asymmetric substitutability* (De Jaegher, 2003): while variable-rate mortgages appear to be a substitute for fixed rates, fixed rates are *not* a substitute for variable rates. The marketing implication of this result is that lenders are less likely to lose business by raising rates on their variable-rate deals than they would by raising rates on fixed-rate deals.

The final group of explanatory variables represent market conditions. The positive coefficient associated with the Bank of England rate simply tells us that borrowers are more risk-averse in times of high interest rates. The positive coefficient associated with the term-structure variable (defined in Section 2 above) implies that, as expected, expectations of future rises in interest rates bring about an increase in the propensity to fix. The negative coefficient on the quadratic term indicates an asymmetry in this effect, with expected falls in interest rates having a greater negative effect on fixing propensity than the positive effect that applies when a rise is expected.

5. Conclusion

There is no doubt that the market for mortgages is a highly topical area at present, not least since it is the suspected source of the volatility that has plagued financial markets around the world in mid-2007. In this paper, we have considered one aspect of this market: borrowers' choices over whether and for how long to fix the interest rate when they take out a mortgage. This is an important aspect of the market, partly for the reasons given at the start of the paper: fixing fosters stability both for the individual borrower and for the economy at large.

Some previous studies have studied the choice as a binary one: between fixing and not fixing. The shortcoming of such an approach is that the length of fix is disregarded. In this paper, both the decision to fix and the length of fix have been modelled using the ordered probit model.

Another difference from previous empirical work is the large sample size, which has enabled us to estimate effects with very high precision. Many of these effects have been interpreted in terms of the role of risk attitude in a risky choice problem, for example, individuals borrowing the highest proportion of their income exhibiting the greatest risk aversion. Most data on choice under risk is experimental (see, for example: Hey and Orme, 1994; Loomes, Moffatt and Sugden, 2002). A further advantage of this study is that it uses field data on a genuine risky choice problem.

A possible criticism of this study is that it focuses on the demand side of the market, and largely neglects the supply side. We have assumed that the "price" set by lenders for fixed rate mortgages is an exogenous variable, while in truth it is endogenous. We need to recognise that while demand for fixed rates depends on future expectations of interest rates, so does supply. The horizontal supply curve in Figure 4 may be expected to rise with expectations in interest rates, at the same time as the demand curve shifts outwards. The equation we have estimated may be interpreted as a reduced form equation, and the positive effect of the term structure variable that is used to represent interest rate expectations, may allow us to infer that borrowers are more sensitive to interest rate expectations than lenders.

To confirm this sort of result, a simultaneous equation model is required that separates out the two sides of the market. Such a model is for future research.

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