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The relative influence of price and choice factors on retail deposit quantities

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Abstract

This study explores how price and non-price factors influence the quantity of retail deposits held by depository institutions. Price factors examined include the policy or base rate and retail deposit interest rates set by individual banks, and non-price factors include the branch network and the number of deposit accounts offered by individual banks. The analysis is undertaken for a sample of UK building societies over twenty three years using a disaggregated data set of instant access retail deposit accounts. The methodology uses a two stage econometric procedure involving system estimators in a panel framework using SUR and GMM to control for contemporaneous correlation and endogeneity concerns. Both price and non-price factors are significant influences of retail deposit quantities. We conclude risk assessment of retail deposit quantity and monetary policy transmission would benefit from considering price and non-price factors, rather than only price factors.

The relative influence of price and choice factors on retail deposit quantities?

1. Introduction

This study examines the effect of price and non-price factors on the quantity of retail deposits held by depository institutions. Specifically we test the relative influence of price factors, such as depository institution specific deposit interest rates, relative to non-price factors including the scale of the branch network and the number of retail deposit accounts offered to depositors', over changes to retail deposit quantity. The study employs a disaggregated dataset of deposit quantities, instant access deposit accounts and interest rates offered by UK building societies between 1989 and 2011 to test for the relative influence of these factors. To overcome contemporaneous correlated and jointly determined factors and endogenity concerns both Seemingly Unrelated Regression (SUR) and a Generalised Method of Moments (GMM) panel models are employed. It is reported depository institution specific interest rates and the number of deposits accounts marketed are both significant influences on deposit quantities. It is concluded methods used to estimate changes in deposit quantity or assess the impact of policy or base rate changes would benefit from considering both price and non-price factors.

Determining what factors influence the quantity of retail deposits held by depository institutions has a considerable economic importance. 'Core' deposits are a stable form of financing depository institutions (e.g. Cornett, McNutt, Strahan and Tehranian, 2011; Huang and Ratnovski, 2009; Shin 2009; Sheehan, 2013) and higher deposit levels as a proportion of all funding are significantly associated with increased lending (Cornett et al. 2011). In this role deposits confer relative benefits over wholesale finance, as depositors have fewer incentives to monitor banks and withdraw funds based on negative public signals. Retail deposits are therefore a relatively robust and less febrile source of depository institution financing relative to wholesale funding[1] and since the 2007 financial crisis an increasingly cost effective form of funding. These benefits have received institutional recognition within prudential regulation through the definition of stable and less stable deposits by the Basel III agreement (Basel Committee on Banking Supervision 2010 [hereafter Basel]).

Despite the importance of retail deposits it is not always clear what depository institution actions influence their quantity. When addressing this question, conventional wisdom suggests price factors such as wholesale costs, base or policy rates, and bank specific interest rates are highly significant influences. It is widely assumed (see Hutchingson and Pennacchi, 1996) the wholesale or market rate will negatively influence

[1] Low levels of deposit finance has been directly associated with actual banking failures, such as the Northern Rock in the UK in 2007, where the bank held only 23% of its liabilities in the form of deposits (Shin 2009) funding most of its growth through interbank lending and securitisations until mid-September 2007 (National Audit Office 2009).

deposit quantities. If the risk free rate on wholesale investments increases, deposits appear less attractive and depositors shift funds from retail deposits to other investments. Alternatively, subject to the accessibility and viability of banks, depositors observing a higher rate of retail deposit interest, switch funds from other investments into retail deposits. The depository institution will also adjust retail deposit interest rates to accommodate changes in the wholesale cost of funds and also to attract deposit funding when required for bank specific reasons. Emphasising price as the key influence of deposit quantity is therefore widely adopted in banking regulation such as within the Basle regulations on bank interest and liquidity rate risk (see Entrop, Wilkens and Zeisler 2009; Basel, 2010; Sheehan, 2013).

The assumption that price is the key determinant of deposit quantity is also common in an allied and associated literature examining the transmission of monetary policy decisions. This research has extensively examined how base or policy rate changes are transmitted to retail interest rates, where such interest rates are the key influence ultimately affecting deposit quantities. This literature reports retail interest rate setting is 'sluggish', 'sticky', or lagged (e.g. Hannan and Berger 1991; Rosen 2002; De Graeve, De Jonge and Vander Vennet 2007; Fuertes and Heffernan 2009) in many financial services and particularly deposit markets. Therefore factors other than price may be influencing this process. This is a plausible perspective in light of the rising deposit funding requirements of many banks and historically low base or policy rates seen internationally since the 2007-2009 financial crisis. Indeed within such a low interest rate period, the ability for banks to compete for deposits in terms of interest rates alone is constrained and it is not implausible to suggest other non-price factors are influential in these markets.

In light of the foregoing this study provides an academic contribution through assessing liquidity and risk management and monetary policy transmission. This is undertaken by assessing whether non-price as well as price factors are influential determinants of deposit change. To achieve these aims the study is divided into five sections. After this introduction a review of how depository institutions can influence the quantity of retail deposits is provided. In section three the empirical procedures adopted in the paper are outlined, including the hypotheses to be tested, the data sets employed and the testing procedures. In section four, the empirical results are discussed and in section five, conclusions are drawn and suggestions for future work indicated.

2. Literature review

Literatures examining the link between depository institutions' actions and retail deposit quantities have developed around a number of themes. Within this review two such areas are explored. First, the implications of different levels of retail deposits for the viability of depository institutions and the assessment of their liability and liquidity risks. This literature suggests that factors other than wholesale cost of funds and the prevailing interest rate paid on individual deposit accounts are important. Second, this work has implications for the transmission of changes in policy interest rates from central banks to depository institutions' balance sheets. Assessing the speed of this process is an essential step in quantifying the effectiveness of monetary policy actions in influencing the real economy. Academic attention in this literature has focused on the relationship between official rates of interest or the wholesale cost of funds, and the interest rates set by individual depository institutions for banking services. These two literatures are examined in turn[2].

Assessing the determinants of deposit quantities and how deposit markets operate competitively has long been associated with the modelling of liability risks posed by demand deposits and the appropriate methods for hedging such positions (see Cornett et al. 2011; Huang and Ratnovski 2009). These academic literatures have considered the market cost of funds and further factors influencing retail deposit quantities. For example Penacchi and Hutchinson (1998) considered the importance of market power in influencing interest rates and interest rate risk. Jarrow and van Deventer (1998) developed the plausibility of how demand deposits are employed by depository institutions and depositors, through using an arbitrage free procedure acknowledging depository institutions can't buy deposits, and depositors contribute to yet do not issue deposits. Kalkbrener and Willing (2004) considered the term structure of liquidity to enable the forecasting of future deposit quantities. Further Nyström (2008) acknowledges deposit account volumes are closely related to other financial services. It is assumed deposits are often drawn from transactional or current accounts and deposit accounts are then subsequently used to amass money before further investments or spending is undertaken.

[2] This examination of the determinants of deposit supply from depository institution or market actions on the cost of funds in how deposit services are priced or are presented to customers is distinct from literatures examining influences on the deposit supply more widely. Literatures examining determinants of savings rates internationally is extensive and has proposed a variety of factors associated with increased savings rates linked with customer actions and behaviours and wider social and economic institutions. Key developments in this literature have included, normative theories of what savings should be undertaken (Hall 1978), the composition of individual portfolios (e.g. Huberman and Jiang 2006), survey work as to which types of consumers actually make poor financial decisions and quantifying the magnitude of current low levels of saving (Banks and Tanner 1999). Indeed a wide range of factors are associated with different level of saving including for example the availability of credit, retirement age and possible intergenerational transfers (Kirsanova and Sefton 2007), different attitudinal factors (e.g. Canova, Rattazzi, and Webley 2005), the level of economic development (Deaton and Paxson 2000) and the consumption life cycle (Browning and Crossley 2001). While this research has done much to extend our current comprehension of why individuals and families choose to save more or less, the literatures examining what strategies banks may undertake to influence the supply of deposits is far less extensive, at least in quantity and for the purposes of this discussion is a distinct area of investigation.

To summarise, two main findings emerge from this literature. First, it is generally acknowledged that comparative assessment of distinct influences on deposit quantities is absent. Second, it is considered that regulatory authorities such as the Basel Committee on Banking Supervision have not acknowledged the influence of factors other than the wholesale cost of funds in influencing the supply of retail deposits.

An extensive literature has also examined how market or official rates of interest are transmitted to the interest rates of retail deposits and other financial services. This literature assesses how bank interest rate setting is influenced by changes in the policy or base rate or the wholesale cost of funds, indicating how such monetary policy actions can eventually influence the supply of deposits. This approach assumes, not implausibly, that depository institutions specific interest rates are a key determinant of deposit quantities. Evidence of this and other factors is presented in many studies which have identified the competitiveness of retail financial services markets (Calem and Mester 1995; Heffernan 1997); interest rate asymmetry (De Haan and Sterken 2004), the structure of the banking industry, both in the US and Europe (Corvoisier and Groop 2001; De Graeve et al. 2004; Hannan and Berger 1991), lending channel effects (De Graeve et al. 2004), bank efficiency (Fuertes and Heffernan 2009), macroeconomic changes (Gambacorta 2008), regulation (Chong 2010) and the scale of official or base rate changes (Fuertes, Heffernan and Kalotychou 2010) as influential factors influencing the relationship between official or market rates and retail interest rates.

In summary, it is clear that the link between policy rates or the wholesale cost of funds and interest rate setting by individual depository institutions is lagged, at least in the short-run. Despite the many insights offered by this literature the reasons for these rigidities are still not fully explained. These rigidities are at least implicitly acknowledged in the Basel III agreement where retail deposits are subdivided into 'stable' deposits, where depositors have long standing relationships with depository institutions, and 'less stable' retail deposits, more sensitive to deposit interest rates, offered over alternative, non-branch distribution channels and used by more 'sophisticated' or high net worth individuals (Basel, 2010). While this literature has mainly focused on the transmission process from base rate changes to retail interest rates, the link between both policy rate changes, retail interest rates, and changes in retail deposit quantities remains relatively under researched.

3. Hypothesises, Data and Analytical Framework

This section summarises the empirical assessment. Initially, the hypotheses drawn from the preceding literature review are outlined. Next, the data is described, and finally the empirical design is elaborated.

3.1 Hypothesises

Within the preceding review it was articulated that while many depository institution actions could influence deposit quantities, price or interest rates are widely considered to be a key determinant. Therefore depository institutions' specific deposit account interest rates observed in each year (*t*) for each depository institution (*i*) are considered in combination with base rates. It is expected that depository institution specific interest rates will have a positive relationship with deposit quantity change, subject to the influence of base rates i.e. higher deposit returns will attract higher deposit quantities. Models are estimated using either, the average or maximum interest rates offered in any year by each depository institution, reflecting different ways in which competition could operate in deposit markets. If the interest rate on all deposit accounts offered by a particular depository institution informs depositor decisions then an average level of interest is appropriate to consider. Alternatively, a depository institution could compete by offering accounts with higher interest rates to attract new depositors, where new depositors choose the deposit account with the highest available interest rate. This competitive process (see Klemperer 1995 and Carbo-Valverde, Rodriguez-Fernandez and Hannan 2011) suggests the maximum interest rate is a more appropriate measure to determine the influence of interest rates on deposit quantities. We therefore examine:

> *Hypothesis 1. Deposit quantity change is positively associated with depository institutions' specific, deposit account interest rates, be these average or maximum interest rates.*

The second hypothesis is that non-price factors also influence deposit quantities. Both the scale of the branch network and the level of deposit account choice are employed as non-price factors. The scale of the branch network has been previously observed to be a significant attraction to depositors (see Kiser 2002) and through a wider branch network a depository institution can become more convenient for a depositor to access. The number of deposit accounts offered by a depository institution has also been viewed to be a significant influence on purchase decisions, although the expected relationship between the degree of choice and deposit quantities is not clear cut, as Kamenica (2008) reports. While customers' benefiting from more rather than less choice is one of the simplest choice theoretic principles, there have been many reported cases where this principle is violated in financial services and other markets (see Iyengar and Lepper 2000; Boatwright and Nunes 2001; Huberman and Jiang 2006; Carlin and Manso 2010). Thus, while depository institutions are expected to offer more deposit accounts in the hope of attracting more depositors' funds, it is acknowledged this may not always be the outcome. Specifically, since financial services markets are characterised by poor

customer comprehension (Bucks and Pence 2008, FSA 2006), and individuals face difficulties when comprehending monetary values and yields accurately (e.g. Butler and Loomes 1988; Shafir, Diamond, Tversky 1997), too many choices may create depositor confusion and actually reduce deposit quantities. We therefore examine:

> *Hypothesis 2. Deposit quantity change is associated with the scale of the branch network and/or the number of deposit accounts offered by an individual bank.*

Lastly, it is also acknowledged that there are further bank specific factors which may also influence deposit quantity change. We therefore also consider whether a depository institution has merged with another depository institution during each year, the percentage of new deposits obtained which are retail instant access deposits relative to all of the depository institution's deposits. This last factor is important if the depository institution has become reliant on funding from sources other than instant retail deposits, such as notice deposits.

3.2 Data

The choice of data employed is complicated due to depository institutions organisational structures. Many depository institutions operate through holding company structures and use a variety of subsidiaries through which deposited funds are often reallocated and transferred (see Cremers, Huang and Sautner 2010). This makes it challenging to determine where retail deposits are derived from within a depository institution and link the source of deposits to a particular deposit account and interest rate. Indeed the use of such organisational structures has potentially constrained research examining the relationship between deposit quantities and bank specific interest rates. To accommodate these concerns a relatively small and homogeneous sample of depository institutions are considered: UK building societies. These mutually owned institutions are often small, have a relatively simple organisational structure and do not operate multiple subsidiaries. Further due to both their relatively limited scale and legal restrictions most of these banks have been unable to receive external financing during the sample period. These features therefore make this form of depository institution particularly suited for this form of assessment due to their limited organisational complexity. This said we acknowledge that inference needs to reflect that this sample of depository institution has distinct features to other often larger commercial retail banks providing deposit services.

The geographic market considered is the entire United Kingdom. While there is evidence that the UK displays limited features of separate geographical banking markets (Ashton, 2001), this approach is consistent

with both past academic and regulatory assessments of this market (e.g. Competition Commission 2002; Fuertes and Heffernan 2009; Heffernan 2002). The product market considered is the instant access retail deposit account market. These accounts are distributed through both branch networks and also over the internet, by post, and using telephone networks. While it is acknowledged that branch and remotely distributed accounts could be separate product markets, past research has reported retail deposit interest rate setting does not significantly vary between these forms of distribution (Ashton 2002). Deposit accounts which require notice before withdrawal, impose penalties for immediate withdrawal or receive tax exemptions are excluded due to their differing product terms and conditions.

The deposit account interest rate data and the number of deposit accounts offered by each bank in each year was constructed using data issued by the Moneyfacts magazine; this data has also been employed within regulatory assessments of the banking industry (e.g. Competition Commission 2002) and past academic work (e.g. Ashton and Hudson 2008; Heffernan 2002; Fuertes and Heffernan 2009). This data includes all instant access retail deposit accounts recorded for the sample banks from January 1989 to December 2011. Deposit account features such as access to a cash card are not considered in the assessment. While these features have a real interest rate value (Ashton and Letza 2003) their measurement is problematic (Heffernan 2002). Throughout, the building society specific interest rates considered are for £5,000 to £9,999 deposited. This choice of interest rate tier or interval is made to reflect average customer deposit sizes. The Family Resource Survey, which provides estimates of UK individuals financing decisions, confirms that for the period 1995 to 2011 (for which data could be obtained), the average deposit, for persons with savings, is between £3,000 and £8,000. This range is consistent with the size of deposit accounts considered in this study (an average instant access deposit of £4,684)[3]. This data is used to provide both average and maximum interest rates for instant access deposit accounts for each building society annually. The UK policy or base rate is used to quantify the cost of funds. While the London Inter-Bank Offer Rate (LIBOR) has been employed in past studies, concerns exist as to its determination (Abrantes-Metz, Kraten, Metz and Seow 2012) and how well this interest rate actually reflects official monetary policy changes (Fuertes et al. 2010).

Data on deposit quantities and branch numbers is taken from annual regulatory accounts obtained from the Building Society Association. These regulatory accounts offer relatively more detail on the source and classification of deposits compared to annual reports and accounts provided by proprietary banks. Using these

[3] Data on depositors and the average deposits held by depositors using each building society was only obtained for some and not all years. Data for this estimate includes all sample building societies between 1989-99, 2005-06 and 2008-11.

regulatory accounts, instant access deposit quantities can be directly linked to the average level of building society specific interest rates offered for instant deposit accounts. The frequency of the data is assumed to be annual, reflecting the lowest frequency of data in this assessment. Whether a building society has merged in a particular year was also recorded as a control on deposit change; this variable was defined using the information drawn from the BSA (Building Society Association) year book (2013), within which all merger events over the sample period are recorded. In all cases the mergers undertaken have been with other building societies; when a merger has been undertaken with a commercial bank, the building society loses its mutual status (and its' relative organisation simplicity) and is excluded from the analysis. A summary of the variables used in the model is provided in Table 1.

Table 1. Variable definition

Variable name	Variable description	Data source
Δ deposits*$_{i,\ t+1}$	The change in the quantity of instant access retail deposits received over a year.	Annual regulatory accounts from the Building Societies Association and Annual reports and accounts of individual societies.
Average Bank Interest Rate	The average instant access interest rate on all such deposit accounts offered by the bank in the particular year. It is assumed £5,000 deposited is an average deposit.	MoneyFacts PLC
Maximum Bank Interest Rate	The maximum instant access interest rate on all such deposit accounts offered by the bank in the particular year. It is assumed £5,000 deposited is an average deposit.	MoneyFacts PLC
Base Rate	The policy, base or official interest rate.	Bank of England
Number of deposit accounts	The number of deposit accounts records the different instant access deposit account products offered by an individual bank in any year.	MoneyFacts PLC
Number of Branches	The number of branches in a building societies branch network. This includes only full branches and excludes for example associated estate agencies etc.	Annual regulatory accounts and various Building Society Association BSA year books.
Bank Merger	Whether a bank has merged in a particular year or not with another building society.	Information on building society mergers from the BSA (Building Society Association) year book (2013)
Proportion of funding from instant access deposits	The quantity of deposits which are instant access divided by total building society deposits.	Annual regulatory accounts and accounts of individual societies.

While this data set brings considerable advantages in terms of the simplicity of the organisations, markets and data assessed, there are also draw backs. The sample building societies are relatively small, are mutually owned, and potentially employ non-price forms of competition to a lesser extent than larger banks with more developed marketing functions. Also the overall dataset is small reflecting the challenges of linking deposit

quantity data accurately with retail interest rates in a meaningful manner. Moreover, within the sample period many building societies have operated in the UK, of which only a proportion are considered. This occurs as many of these building societies have merged and/or demutualised during the sample period. Also some building societies have incomplete interest rate or accounting data. For example two building societies altered how they reported deposits over the sample period and were subsequently dropped from the analysis. To avoid concerns with survivorship bias a sample of 26 building societies are considered for which data is available for at least 19 years. The average duration of a building society in the dataset is 21.8 years. The 26 building societies examined are listed in Appendix 1.

3.3 The Analytical Framework

To test the hypotheses a two part testing methodology is employed. This empirical design is influenced by challenges in quantifying the research questions and the data format. First, building societies and deposit quantities are exposed to similar systematic shocks over the sample period. This could lead to cross-building society residuals being contemporaneously correlated. Secondly, the variables considered are susceptible to endogeneity. For example setting retail interest rates or the number of branches could both influence the quantity of deposits and be actions triggered by a shortage or over-abundance of deposit funds. Such endogeneity can bias econometric results and needs to be addressed. Third, the influence of different price and non-price bank actions on deposit quantities may be interdependent and jointly determined. For example a building society requiring higher deposit funding may decide to offer more deposit accounts and provide higher interest rates to encourage depositors to use the building society, either distinctly or in combination. Lastly, the data considered could be influenced by further time series and cross-sectional dependencies not identified or included in the model. Accordingly concerns with contemporaneously correlated variables, endogeneity concerns, joint determination, possible unidentified data dependencies and a desire to test between explanatory variables leads to the following econometric procedures being adopted.

The models to be estimated are written as:

$$\begin{aligned}\left[\Delta deposits\right]_{(i,t)} &= \alpha_{i,t} + \beta_{1,i,t}\left(\text{Average building society interest rate}\right)_{i,t} + \gamma_{i,t}\left(\text{Policy Rate}\right)_{i,t} \\ &+ \beta_{2,i,t}\left(\left(\text{Mergers}\right)_{i,t} + \left(\text{Proportion of funding from short term deposits}\right)_{i,t}\right) + \varepsilon_{i,t}\end{aligned} \tag{1}$$

$$\begin{aligned}\left[\Delta deposits\right]_{(i,t)} &= \alpha_{i,t} + \beta_{1,i,t}\left(Number\ of\ Products\right)_{i,t} \\ &+ \beta_{2,i,t}\left[\left(Number\ of\ Branches\right)_{i,t} + \left(Fitted\ Values\right)_{i,t}\right] + \varepsilon_{i,t}\end{aligned} \tag{2}$$

where *i* represents the building societies and *t* denotes the annual time period; α_i captures the time-invariant unobserved building society-specific fixed effects, and the β_t captures the unobservable individual-invariant time effects. We also re-estimate (1) with average building society interest rate replaced by maximum interest rates. The fitted values of deposit change from model (1) are included in model (2), and then and vice versa. Thus the two equations (3) and (4) can be estimated as panel data models[4]. As before, these latter two models are estimated using maximum interest rates as well as average bank interest rates.

$$\begin{aligned}\left[\Delta deposits\right]_{(i,t)} &= \alpha_{i,t} + \beta_{1,i,t}\left(\text{Average building society interest rate}\right)_{i,t} + \gamma_{i,t}\left(\text{Policy Rate}\right)_{i,t} \\ &+ \beta_{2,i,t}\left(\left(\text{Mergers}\right)_{i,t} + \left(\text{Proportion of funding from short term deposits}\right)_{i,t}\right) \\ &+ \beta_{3,i,t}\left[\Delta deposits\right]^{*}_{i,t} + \varepsilon_{i,t}\end{aligned} \tag{3}$$

$$\begin{aligned}\left[\Delta deposits\right]_{(i,t)} &= \alpha_{i,t} + \beta_{1,i,t}\left(Number\ of\ Products\right)_{i,t} + \beta_{2,i,t}\left(Number\ of\ Branches\right)_{i,t} \\ &+ \beta_{3,i,t}\left[\Delta deposits\right]^{*}_{i,t} + \varepsilon_{i,t}\end{aligned} \tag{4}$$

Through capturing the effect of time varying fixed effects, further influences on the data can be captured in the estimation. The fixed and time effects are significant in all cases suggesting that the building society and time-specific shocks differ significantly across the building societies in our sample. A test for first order serial correlation is also undertaken and is insignificant suggesting that the panels do not suffer from serial correlation. The Jarque-Bera normality test is also undertaken to determine if the residuals of the models are normally distributed. These tests imply that the empirical estimates obtained are not due to any outliers in the data.

To accommodate joint determination of the explanatory factors, the model is estimated using a GMM system of equations in first differences and levels. This system estimator combines the standard set of transformed equations in first differences with an additional set of equations in levels. The first set of transformed equations uses the lag levels as instruments and the level equation uses the lagged first differences as instruments. Their validity is based on the following two moment conditions:[5]

$$E\begin{bmatrix}(a_{it} + e_{it})\Delta Deposits_{i,t-z} \\ (a_{it} + e_{it})\Delta W_{i,t-z}\end{bmatrix} = 0 \qquad for\ \mathrm{z} \geq 1, \tag{5}$$

[4] We conduct a Hausman test to determine if the explanatory variables are endogenously determined. This will also determine the choice of panel estimator for our econometric analysis.

[5] The time-varying matrix of instruments for the first difference GMM estimator can be observed in Blundell and Bond (1998).

where *W* denotes the explanatory variables in (1) and z represents the lag structure of the GMM estimator. The composite error term displayed in equation 5 is a result of the system error of the estimation of forward looking expectations obtained from the GMM System estimator model in a panel framework (see Ghosh and Gregoriou 2008). In addition to dealing with explanatory variables being jointly determined, the GMM system has the added advantage of reducing the poor precision of the GMM single equation estimators.

The GMM single equation estimator is employed instead of a Two Stage Least Squares method because the GMM is asymptotically efficient under non-restrictive assumptions about error autocorrelation and heteroscedasticity (Biorn and Klette 1999). The validity of the instruments is examined using a Sargan test under the null hypothesis that the instruments used are valid. This test reports a p-value of zero confirming that the instruments used are not valid; this indicates subsequent empirical findings based on this estimator would be weakened and the estimated coefficients suffer from poor precision (see Staiger and Stock 1997). A possible reason for these weak instruments is that the time dimensions of the panels are relatively small (23 annual observations) and implies there is a weak correlation between the regressors and the instruments. This problem is addressed by using the panel GMM system estimator proposed by Blundell and Bond (1998) which radically reduces the imprecision associated with the single equation estimator. The Sargan test confirms the validity of the instruments in both GMM system models with this approach. [6]

After equations 1) and 2) are estimated separately for each individual building society, we examine if the cross-building society residuals are contemporaneously correlated with the use of LM tests. To examine whether cross- building society residuals are contemporaneously correlated the Breusch and Pagan (1980) Lagrange Multiplier (LM), λ_{LM} statistic is undertaken:

$$\lambda_{LM} = T\sum_{i=2}^{n}\sum_{j=1}^{i-1} r_{ij}^2 \,, \qquad (6)$$

where r_{ij}^2 is the squared ij^{th} correlation coefficient of cross- building society residuals. Under the null of no contemporaneous error correlations across the building society, the test statistic is asymptotically χ^2 distributed with N(N-1)/2 degrees of freedom, where N denotes the number of building society in the panel. The p-value of

[6] The Three Stage Least Squares (3SLS) panel estimator also estimates a system of equations simultaneously and is regarded as an alternative to the GMM system estimator. However, we implement the GMM system estimator, given that it accommodates for the possibility of joint determination of an equation system with different instruments for different equations (Schmidt 1990).

the LM test statistic is zero, which rejects the null hypothesis, suggesting that error series are contemporaneously correlated across all the building society. To accommodate this concern a SUR econometric methodology is also employed for the empirical analysis.

Even though the SUR estimator takes into account contemporaneous correlation across building society, it fails to capture the second concern, that of endogeneity in the explanatory variables of the panel. In order to formally test the explanatory variables for endogeneity, a Hausman test for the hypothesis that the explanatory variables are strictly exogenous is performed. If the null hypothesis is rejected, it leads to the conclusion that the explanatory variables in equation (1) are endogenously determined. The Hausman test rejects the null hypothesis at all conventional significance levels. Endogeneity for the explanatory variables[7] is therefore addressed using the single equation GMM panel estimator developed by Arellano and Bond (1991).

4. Empirical Results

In this section descriptive statistics of the building society interest rates, deposit quantities, control variables and numbers of deposit accounts and branches are presented in Tables 2 and 3. The results from the two equations 3) and 4) are presented in Tables 4 and 5 for averaged and maximum deposit interest rates respectively.

The descriptive statistics are considered overall and also for four different 5 or 6 year periods to illustrate how variables have altered over time. It is reported that while the number of building society considered over time remains constant, the scale of the other variables rises significantly. The quantity of instant access retail deposits increases by over 73% over the sample period. The percentage change in instant access deposits for individual building society is also highly variable with extremes of change ranging from an 81% increase and a 35% decrease. Such large changes are generally associated with merger events, troubled building society and changes in the level of instant access deposits collected as a proportion of all deposits. The number of instant access deposit accounts offered by each building society increases from an average of 1 in 1989 to 6.7 in 2011. The number of deposit account products also varies between building society, increasingly greatly as the base rate has fallen. The returns on deposit accounts have also fallen reflecting the reduction in the base rate over time. There is also considerable difference between the average and maximum interest rate with an average difference of 1.1% interest. The size of branch networks gradually displays variation throughout the sample

[7] The results of the Hausman test are not reported by the authors, but are available upon request.

period, falling between 1989 and 2006, before a small increase in the last time period (2007-2011). The percentage of deposits which are instant access also varies over time displaying a gradually decline.

Table 2: Descriptive Statistics of Deposit Supply, Deposit Interest rates and Deposit Account Choice.

		Overall	1989-1994	1995-2000	2001-2006	2007-2011
Number of observations		584	154	156	156	118
Number of building societies		26	26	26	26	26
Annual average base rate		6.01	10.03	6.26	4.42	2.55
Average retail Interest rate		3.87	7.18	3.64	2.58	2.09
Maximum retail interest rate		5.01	8.22	4.66	3.75	3.49
Average % of merger observations		2.23	1.95	1.92	1.28	4.24
Quantity of instant retail deposits £m	Average	3063.91	1543.93	1543.93	39862.30	5149.05
	Minimum	6.66	7.95	6.66	11.95	85.38
	Maximum	93511.90	24950.70	39862.30	82092.60	93511.90
% of deposits which are Instant access	Average	88.28	93.09	87.96	90.58	80.47
	Minimum	32.71	35.63	41.95	60.56	32.71
	Maximum	100	100	100	100	100
% change in instant deposit quantities	Average	7.23	8.26	8.42	8.70	2.34
	Minimum	-35.88	-35.88	-12.47	-29.40	-28.41
	Maximum	81.20	56.75	61.71	61.46	81.20
Branch network size	Average	60.18	65.12	57.77	57.44	60.65
	Minimum	1	1	1	1	1
	Maximum	900	869	693	682	900
Number of instant account accounts	Average	3.00	1.24	2.06	3.61	5.47
	Minimum	1	1	0	0	1
	Maximum	28	3	12	21	28

Correlations between model variables are reported in Table 3. The strongest relationships are observed between the retail interest rates and the base rate. Significant positive correlations are also observed between the level of retail interest and the number of branches, and between the level of all interest rates and change in the quantity of instant access deposits. The incidence of mergers and branch numbers is also significantly positively correlated.

Table 3: Correlations between variables

Correlations between variables								
	Policy Rate Average	Average Bank Rate	Maximum Retail Interest Rate	Change in Deposit Supply	Branch Network	Number of Deposit Accounts	% of Merger Observations	% of Funding from Instant Access Deposit Accounts
Policy Rate Average	1	0.88*	0.79*	0.29*	0.02	-0.38*	0.02	0.28*
Average Retail Interest Rate		1	0.95*	0.21*	0.10*	-0.24*	0.02	0.17*
Maximum Retail Interest rate			1	0.23*	0.16*	-0.08	0.06	0.11*
Change in Deposit Supply				1	0.00	-0.03	0.09	0.13
Branch Network					1	0.06	0.19*	-0.01
Number of Deposit Accounts						1	0.05	-0.28*
% of Merger Observations							1	-0.15*
% of Funding from Instant Access Deposit Accounts								1

* denotes statistically significant at 10% significance.

The estimates of the equations 3) and 4) are provided in Table 4 for average retail instant access interest rates and in Table 5 for the maximum retail instant access interest rates. Within Table 4, the average building society interest rate and the number of deposit accounts are both statistically significant and the scale of branch network is statistically insignificant. The scale of the coefficient values in the two equations are similar for both the SUR model and the GMM System[8]. This indicates that both building society specific interest rates and the number of deposit products issued by a bank influence the quantity of deposits. This provides evidence supporting Hypothesis 1 – that deposit quantity change is positively associated with average, building society specific deposit account interest rates. For Hypothesis 2 - deposit quantity change is associated with the number of deposit accounts offered by an individual bank as significant positive values are recorded, yet not with choice

[8] We use a GMM system estimator with one lag structure as reported in equation 5. In empirical estimates of the GMM system estimator it is not common to report all lags of explanatory variables in both levels and first differences. This is because they are simply used for estimation purposes and add little value to the equation estimates. This is the case in previous empirical studies that use the GMM system estimator to derive their results. For example see among others Ghosh and Gregoriou (2008).

by more or fewer building society branches. Therefore while our prior expectation was that greater choice in deposit accounts could result in either an increase or a decrease in deposit quantity, increasing the level of deposit account choice has a positive impact in this market. This indicates concerns with customer confusion do not dominate and more choice has resulted in greater sums deposited. The relative scale of these influences indicates that while both deposit interest rates and the number of deposit accounts are significant influences, the former are marginally more influential on deposit quantities.

The model estimates also provides further information. Two control variables have been included to accommodate the influence of both mergers and also the proportion of deposits a building society has raised which are instant access. The merger variable is seen to be statistically significant while the proportion of instant access deposits is insignificant in both cases indicating notice deposits maybe a distinct product market. In all model estimates the influence of the base or policy rate is seen to be statistically significant. This finding is unsurprising in light of the emphasis placed on this variable within the transmission of monetary policy and the risk assessment of deposit quantities literatures. This said these results indicate that using only the base rate when predicting deposit quantities will only partially determine deposit quantities, and while this variable maybe a fair predictor of retail deposit quantities it is clearly not the only meaningful predictor of deposit change.

In Table 5 the influence of the maximum interest rate offered by a bank in a particular year is considered. It is observed that for both SUR and GMM models this variable has an insignificant influence on deposit quantities. This indicates the form of competition operating in the deposit market has a bearing on the transmission of interest rate change to deposit quantities. For example the low level of switching observed in deposit markets (see Independent Commission on Banking 2011) may have reduced the possible influence of maximum interest rates. In common with results from Table 4, the number of deposit accounts has a significant influence and the number of branches has an insignificant influence on deposit quantity change. Mergers are also a significant control variable and the percentage of instant access deposits from all deposits is an insignificant influence. Again the base rate has a large and statistically significant influence on change in the quantity of instant access deposits a bank receives or loses in a particular year.

Table 4. Model Estimates: Average Interest rate

Estimates from Equation 3		
Variable	**GMM System Estimates**	**SUR Estimates**
Constant	-3.69 **(-1.16)**	-3.02 **(-0.93)**
Average Bank Interest Rate	0.62 **(1.67)***	0.56 **(1.35)**
Base Rate	1.41 **(4.54)****	1.40 **(4.48)****
Mergers	7.09 **(2.07)****	7.03 **(2.06)****
% Instant Access Deposits	0.055 **(1.51)**	0.052 **(1.45)**
Δ deposits*$_{i, t+1}$	-0.73 **(-0.37)**	-0.90 **(-0.46)**
a_i	(0.00)	(0.00)
b_t	(0.00)	(0.00)
SE	0.55	0.62
AR(1)	(0.40)	(0.46)
NORM(2)	(0.56)	(0.62)
Diff Sargan	NA	(0.67)
Hausman test	NA	97.66 (0.00)
R^2	0.39	0.30
Observations	565	565

Estimates from Equation 4		
Variable	**GMM System Estimates**	**SUR Estimates**
Constant	7.28 **(10.47)****	7.13 **(10.88)****
Number of Deposit Accounts	0.21 **(2.88)****	0.16 **(2.66)****
Number of Branches	0.34 **(0.98)**	0.29 **(0.84)**
Δ deposits*$_{i, t+1}$	0.86 **(3.22)****	0.72 **(2.55)****
a_i	(0.00)	(0.00)
b_t	(0.00)	(0.00)
SE	0.22	0.16
AR(1)	(0.22)	(0.18)
NORM(2)	(0.24)	(0.20)
Diff Sargan	NA	(0.44)
Hausman test	NA	98.55 (0.00)
R^2	0.22	0.16
Observations	565	565

Notes: AR(1) is the first order Lagrange Multiplier test for residual serial correlation, undertaken on the residuals for the SUR estimates and on the first difference of the residuals for the GMM system because of the first difference transformations involved. SE represents the standard error of the panel estimator. a_i and b_t are the fixed and time effects. Sargan tests follow a χ^2 distribution with r degrees of freedom under the null hypothesis of valid instruments, for the four instruments in our empirical model. Note: the Difference-Sargan test is applicable to the GMM system estimator due to the first difference transformations involved. To establish the validity of the instrument set. NORM(2) is the Jarque-Bera normality test. The endogenous explanatory variables in the panel are GMM instrumented setting, $z \geq 1$. (.) are p values, **(.)** are t statistics, * indicate significant at the 10% level and ** indicates significant at the 5% level

While all estimated models have acceptable diagnostic test results, the degree of model fit reported in the models indicates there is still much variation in the data which is not fully explained by these models. Therefore both the transmission of policy or base rate changes to deposit quantities and the risk assessment of deposit quantities could prudently employ a wider set of price and non-price factors. Lastly, while these results could have arisen as building society depositors may be different from other depositors, it appears that assuming

price factors are the only influence on deposit quantities is a strong assumption and that non-price factors such as choice of deposit accounts are also influential.

Table 5. Model Estimates: Maximum Interest rates

Estimates from Equation 3		
Variable	**GMM System Estimates**	**SUR Estimates**
Constant	-3.06 **(-1.00)**	-2.92 **(-0.99)**
Maximum Bank Interest Rate	0.55 **(1.22)**	0.50 **(1.11)**
Base Rate	1.22 **(4.00)****	1.14 **(3.78)****
Mergers	6.87 **(2.13)****	6.76 **(2.04)****
% Instant Access Deposits	0.077 **(1.34)**	0.066 **(1.25)**
Δ deposits*$_{i, t+1}$	-0.79 **(-0.22)**	-0.66 **(-0.30)**
a_i	(0.00)	(0.00)
b_t	(0.00)	(0.00)
SE	0.59	0.67
AR(1)	(0.48)	(0.52)
NORM(2)	(0.60)	(0.67)
Diff Sargan	NA	(0.50)
Hausman test	NA	99.22 (0.00)
R^2	0.36	0.25
Observations	565	565

Estimates from Equation 4		
Variable	**GMM System Estimates**	**SUR Estimates**
Constant	7.11 **(10.00)****	7.01 **(9.80)****
Number of Deposit Accounts	0.15 **(2.77)****	0.10 **(2.60)****
Number of Branches	0.44 **(1.03)**	0.38 **(0.92)**
Δ deposits*$_{i, t+1}$	0.92 **(3.12)****	0.81 **(2.69)****
a_i	(0.00)	(0.00)
b_t	(0.00)	(0.00)
SE	0.26	0.32
AR(1)	(0.26)	(0.22)
NORM(2)	(0.29)	(0.33)
Diff Sargan	NA	(0.49)
Hausman test	NA	93.45 (0.00)
R^2	0.18	0.12
Observations	565	565

Notes: AR(1) is the first order Lagrange Multiplier test for residual serial correlation, undertaken on the residuals for the SUR estimates and on the first difference of the residuals for the GMM system because of the first difference transformations involved. SE represents the standard error of the panel estimator. a_i and b_t are the fixed and time effects. Sargan tests follow a χ^2 distribution with r degrees of freedom under the null hypothesis of valid instruments, for the four instruments in our empirical model. Note: the Difference-Sargan test is applicable to the GMM system estimator due to the first difference transformations involved. To establish the validity of the instrument set. NORM(2) is the Jarque-Bera normality test. The endogenous explanatory variables in the panel are GMM instrumented setting, $z \geq 1$. (.) are p values, **(.)** are t statistics, * indicate significant at the 10% level and ** indicates significant at the 5% level

5. Conclusions

This study examines the joint influence of price and non-price factors on changes in retail deposit quantities. The analysis examines the simultaneous influence of the cost of funds, the average and maximum depository

institution specific interest rates, and the number of branches and deposit accounts offered to depositors, on changes to the quantity of retail deposits held by depository institutions. To achieve this goal, twenty three years of deposit products, branches, interest rates and deposit quantities for a sample of UK building societies are examined. The testing procedure was undertaken over two stages in a panel framework to accommodate concerns with endogeneity of the explanatory variables, contemporaneous correlation of error terms, joint determination of the variables and potential unknown data dependencies. It is reported both price and non-price factors are significant influences on deposit quantities, with the former appearing to be marginally more influential.

It is concluded that when assessing what depository institution actions influence changes in deposit quantity it is important to persist in using price explanations and acknowledge that non-price factors are also influential. This finding has importance for both literatures examining risk profiles of depository institution and the transmission of monetary policy. When considering the risk profile of depository institution, both price and non-price factors are clearly influential and appear to operate in combination. When considering the transmission of monetary policy, the interest rate of deposits is not the only factor which affects the quantity of retail deposits; non-price factors are also influential.

It is recommended these literatures can be profitably advanced in two respects. Further assessment of bank specific price and non-price factors influencing the eventual deposit quantities needs to be undertaken, both for different types of bank and internationally. This will enable a clearer picture as to whether these results are an institutional or national irregularity or are pervasive concerns. In particular examination of other national markets where varying levels of market concentration may be identified and where data is available and appropriate, the examination of retail deposits from larger, proprietary banks would be welcome. Second, the focus of risk assessment of deposit quantity is based on a process which assumes depositors will switch from deposits to alternative investments. This explanation used widely in prudential regulation would benefit from further testing and may be a rewarding avenue of future research in light of the historically low levels of interest observed internationally in recent years.

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Appendix 1: Sample Institutions

Building Society	Start	End	Building Society	Start	End
Britannia	1989	2008	Melton Mowbray	1991	2011
Cambridge	1989	2011	National Counties**	1990	2011
Chelsea	1990	2008	Nationwide	1989	2011
Coventry	1989	2011	Newbury	1990	2011
Darlington	1990	2011	Newcastle	1989	2011
Furness	1991	2011	Norwich and Peterborough	1989	2008
Hanley Economic*	1991	2011	Principality	1989	2011
Hinckley and Rugby	1990	2011	Progressive	1989	2011
Ipswich	1991	2011	Saffron	1990	2011
Leeds and Holbeck	1989	2011	Skipton	1989	2011
Leek United	1990	2011	Stroud and Swindon	1989	2008
Market Harborough	1991	2011	Teachers'	1990	2011
Marsden	1990	2011	West Bromwich	1989	2011

* One year where no instant access accounts offered (2002)

** Two years where no instant access deposits were offered (1999-2000)