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Modelling the corporate deposits of Irish financial institutions: 2009 - 2010

Kieran McQuinn and Maria Woods



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Central Bank of Ireland

Eurosystem



An Empirical Analysis of Irish Banks' Corporate Deposits: 2009-2010

Kieran McQuinn & Maria Woods*

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Abstract

This paper examines the corporate funding flows of Irish credit institutions over the period 2009 to end-2010. The analysis examines the daily net movement across the consolidated corporate and retail deposit books of the domestic Irish banking sector and models these flows as a function of bank specific measures of risk, sovereign influences and general macro-financial conditions. The international financial crisis resulted in Irish banking institutions experiencing more acute funding difficulties than institutions elsewhere. Over the period 1995 to 2007, Irish credit institutions had engaged in a remarkable surge in concentrated lending to the commercial and residential property sector. The collapse in prices and activity in both markets post-2007 coupled with the downturn in general economic activity are the main reasons why Irish banks now rely substantially on liquidity support from the ECB and the Irish Central Bank. This situation is clearly unsustainable in the longer term and, in returning these institutions to a more viable longer-term path of market based funding, a greater understanding of the deposit flows of financial institutions is required.

JEL classification: G21.

Keywords: Banks, Deposit, Financial Crisis.

*E-mail: kieran.mcquinn@centralbank.ie and maria.woods@centralbank.ie. The views expressed in this paper are those of the authors and do not necessarily reflect those of the Central Bank of Ireland or the European Central Bank. We would like to thank Stefan Gerlach, Gerard O'Reilly, Trevor Fitzpatrick (all Central Bank of Ireland) and all those who participated in an internal Central Bank seminar and at a European Central Bank (ECB), Financial Stability Committee Workshop on Analytical Tools to support Systemic Risk Assessments: Stress Testing and Network Analysis, for comments on an earlier draft. We would also like to acknowledge the assistance of David Doran in the Financial Markets Division of the Central Bank of Ireland with the net deposit flow data. Any errors are the responsibility of the authors.

Non Technical Summary

While the recent financial crisis revealed the precariously short-term sources of wholesale funding for many international financial institutions, the relatively fragile nature of Irish banks' funding structure pre-2007 was particularly evident. The Irish banking sector, which had witnessed significantly concentrated lending in the property market throughout the past decade, was funded throughout this period by increasingly short-term non-retail liabilities. As a result, since late-2008 the funding position of the domestic banking system has been somewhat challenging. Several factors ostensibly explain this development ranging from general financial market turmoil to institution and country-specific issues. Concerns in 2009 about the financial soundness of individual credit institutions given the significant correction¹ taking place in the domestic residential and commercial property markets allied to the increased risk aversion attitudes towards peripheral European sovereigns from mid-2010 lead to certain difficulties in funding conditions. This gave rise to a self-reinforcing negative dynamic between the Irish sovereign and the domestic banking system. Consequently, over the period 2009 to mid-2010 the funding durations of Irish institutions moved to ever shorter maturities, wholesale funding costs increased and the ability of these institutions to access certain categories of funding became limited. Compounding the difficulties was the deterioration in the state of the Irish public finances. The situation confronting the Irish system exacerbated considerably in the final quarter of 2010 as the sovereign crisis escalated. The net consequence was that the Irish financial system became substantially reliant on liquidity support from the ECB and the Irish Central Bank. Inevitably, Ireland, in November 2010, negotiated an IMF-EU fiscal support programme. A key requirement of the programme negotiated was for Irish institutions to take active deleveraging measures which would enable institutions to obtain market-based funding at sustainable rates, once market conditions normalise.

As a result, a key policy question which arises is the capacity of the future Irish banking system to retain and increase the share of stable funding such as customer deposits. To address this issue, a comprehensive understanding of the dynamics of the historical funding patterns of Irish credit institutions is required. Of particular interest is the experience of the customer deposit book during the current crisis. The term "customer deposits" refers to both corporate and retail deposits. Therefore, this paper draws on a unique dataset of daily net customer deposit flows over the period February 2009 to December 2010 for the Irish banks and examines a number of empirical issues.

First, a model of corporate flows is estimated using weekly data. Coverage is limited to the Irish

¹As of January 2012, Irish house prices have been falling every month since December 2007 according to the CSO's Residential Property Index. Similarly Irish commercial property prices as recorded by IPD's Irish Quarterly Index declined in every quarter over the period 2008Q1 through 2011Q3.

banks that were listed over the full sample period up to early-December 2010.² The model focuses on the period early-March 2009 to mid-August 2010. The specification for corporate deposits controls for bank-specific indicators of financial soundness such as the implied credit rating for Irish banks as estimated by Kamakura, 5-year senior CDS spreads and aggregate funding market conditions as proxied by the 3-month Euribor/OIS spread. Therefore, the model links the perceived creditworthiness of the deposit-taking institution and the level of counterparty credit risk in international funding markets with the banks' funding position. The CDS spread also captures an increase in sovereign risk. Due to the banking stabilisation measures undertaken by the Irish authorities, a negative dynamic between the banking sector and the Irish sovereign emerged from 2009. Over our estimation period, there is a notable positive correlation between the sovereign and bank CDS spread. Once we control for banking sector risk, sovereign measures of risk become insignificant.

The paper also investigates the relative “stickiness” of retail deposits compared with corporate deposits. A long-run relationship is hypothesised to exist between the stock of retail and corporate deposits and the degree of stickiness between retail and corporate deposits is estimated within an error correction framework. In accordance with a priori expectations, the model finds that the scale of the daily correction between actual and the long-run level of retail deposits is quite small.

²Allied Irish Banks plc, Bank of Ireland and Irish Life & Permanent plc.

1 Introduction

While the recent financial crisis revealed the precariously short-term sources of wholesale funding for many international financial institutions, the relatively fragile nature of Irish banks' funding structure pre-2007 was particularly evident. The Irish banking sector, which had witnessed significantly concentrated lending in the property market throughout the past decade, was funded throughout this period by increasingly short-term non-retail liabilities. As a result, since late-2008 the funding position of the domestic banking system has been somewhat challenging. Several factors ostensibly explain this development ranging from general financial market turmoil to institution and country-specific issues. Concerns in 2009 about the financial soundness of individual credit institutions given the significant correction³ taking place in the domestic residential and commercial property markets allied to the increased risk aversion attitudes towards peripheral European sovereigns from mid-2010 lead to certain difficulties in funding conditions. This gave rise to a self-reinforcing negative dynamic between the Irish sovereign and the domestic banking system. Consequently, over the period 2009 to mid-2010 the funding durations of Irish institutions moved to ever shorter maturities, wholesale funding costs increased and the ability of these institutions to access certain categories of funding became limited. Compounding the difficulties was the deterioration in the state of the Irish public finances. The situation confronting the Irish system exacerbated considerably in the final quarter of 2010 as the sovereign crisis escalated. The net consequence was that the Irish financial system became substantially reliant on liquidity support from the ECB and the Irish central bank. Inevitably, Ireland, in November 2010, negotiated an IMF-EU fiscal support programme. A key requirement of the programme negotiated was for Irish institutions to take active deleveraging measures which would enable institutions to obtain market based funding at sustainable rates, once market conditions normalise.

Given the present unsustainable reliance of Irish institutions on Central Bank emergency funding, a key policy question which arises, is the capacity of the future Irish banking system to retain and build a strong customer deposit base. To address this issue, a comprehensive understanding of the dynamics of the historical funding patterns of Irish credit institutions is required. Of particular interest is the experience of the customer deposit book during the current crisis. The term "customer deposits" refers to both corporate and retail deposits. Therefore, in addressing this question, this paper draws on a unique dataset of daily net customer deposit flows over the period February 2009 to December 2010 for the Irish banks and posits a model of corporate deposits.

Drawing on the market discipline literature, deposit flows are linked to measures of financial soundness. The long-run specification for corporate deposits controls for bank-specific indicators of risk such as implied credit ratings and 5-year senior Credit Default Swap (CDS) spreads and aggregate funding market conditions as proxied by the 3-month Euribor/OIS spread. A deterioration in the aforementioned bank-specific indicators is found to exert a negative influence on the demand for corporate deposits. Therefore, this model links perceived credit worthiness of the deposit-taking institution to liquidity funding risk. Over the sample period, investors were extremely concerned

³As of January 2012, Irish house prices have been falling every month since December 2007 according to the CSO's Residential Property Index. Similarly Irish commercial property prices as recorded by IPD's Irish Quarterly Index declined in every quarter over the period 2008Q1 through 2011Q3.

about the scale of credit losses on the balance sheets of Irish institutions and possible implications for solvency. This was due to the sharp fall in Irish commercial and residential property values and the heavy concentration of lending in the domestic banking system to the property market. Although the introduction of the National Asset Management Agency (NAMA)⁴ may have added some clarity on loan losses, the higher-than-anticipated haircuts on the various tranches of transferred assets may have contributed to concerns about residual loan portfolios. The continued decline in Irish house price levels since 2007 combined with high levels of unemployment created fears about potential future losses on the mortgage books of Irish banks. Furthermore, concerns regarding counterparty credit risk and liquidity risk among the international banking sector, as captured by the Euribor/OIS spread during the crisis, are also found to contribute to a deterioration of the Irish banks' funding position.

The model focuses on a period of relative stability identified within the time period under question. While the period in general occurs after the initiation of the financial crisis of 2008, a relatively prolonged period of stability is observed in the aggregate customer deposit books of Irish institutions up to August 2010. A key turning point for both retail and corporate deposits series is found to be 20 August 2010. The levels of both series are found to exhibit a marked downward trend from this date until the end of the sample (i.e., end 2010).

While our analysis is confined to the Irish market, it is clear that the results will be of interest to financial institutions in an international context. While the recent financial crisis may have had particularly severe implications for the Irish banking sector, it is clear that common trends are now apparent in the underlying vulnerabilities, particularly, across European financial institutions. Not least of these is the dynamic between the perceived fiscal weakness of the sovereign and the respective banking sector. Further, our analysis shows that any deterioration in the financial soundness of a deposit-taking entity will have implications for its deposit-gathering capacity and ability to retain existing funds, especially in the corporate market. This will be an important consideration for many European banks seeking to re-orientate their funding structures towards a higher reliance on customer deposits in anticipation of future regulatory changes and in view of current strains in some wholesale funding markets.

The paper also investigates the relative “stickiness” of retail deposits compared with corporate deposits. During the crisis, it was observed that corporate deposit figures were much more volatile than those of retail deposits and relatively more sensitive to financial market developments and news up to Summer 2010. The corporate deposit book appeared to behave more like wholesale funding. We examine for the presence of a long-run relationship between the stock of retail and corporate deposits within an error correction framework, thereby allowing the perceived “stickiness” of retail versus corporate deposits to be estimated.

The rest of the paper is structured as follow; Section 2 provides a description of the data and illustrates movements in customer flows for the Irish financial system. Some relevant literature is

⁴NAMA was established by the Irish State in December 2009 and its main function was to acquire loans (land and development and associated loans) with a nominal value of €72.3 billion from participating financial institutions. Its objective is to obtain the best achievable financial return for the State on this portfolio over an expected lifetime of up to 10 years.

then discussed and a model is specified accordingly with estimation results presented. A subsequent section presents some analysis on the relative stickiness of retail versus corporate deposit flows. A final section concludes and provides a discussion of further work.

2 Movements in Irish Customer Deposit Data

This paper draws on a Central Bank internal dataset containing the net movement across a number of key funding sources for six Irish financial institutions. In general, an increase in assets should be matched to some extent by increased funding such as deposits or debt issuance. Further, in order to be in a position to meet funding commitments, the duration of assets should be similar to the maturity of funding categories. Funding liabilities can be broadly decomposed into three categories, namely, deposits both customer and interbank, debt securities and other secured funding such as repurchase agreements.

The daily net flow is defined as the difference between the value of total funding inflows and outflows for each funding category. The full dataset covers the categories, customer deposits and debt capital markets and begins on 23 February 2009. Our analysis focuses primarily on the aggregate retail and corporate deposit books of the Irish banks. Deposit figures for Non-Bank Financial Intermediaries (NBFI) are included in the corporate category. The data are consolidated on a group basis and are available at a daily frequency. To facilitate empirical analysis, the daily net flows were transformed into stocks using internal supervisory funding profile data. In particular, using the historical net flow data, the value of outstanding corporate and retail deposits, as at February 2011, were adjusted to back out a time-series of outstanding amounts for both categories. These data may not, however, correspond exactly to funding profile data at various points in time given potential timing issues with underlying transactions for the net flows data (e.g., trade date versus value date, etc). However, this series should capture broad trends in the underlying net flows data. We focus on the period 23 February 2009 to 2 December 2010 as this interval covers a phase of considerable financial stress in Ireland.

Figure 1 plots the aggregate series (i.e., across the six covered Irish financial institutions) of our transformed data. The base for the index is end-August 2010. What is immediately observable is the sharp decline in the series from late-August 2010 to the end of the sample. This holds for both corporate and retail deposits. As a result, for much of our analysis, we separate the sample both into pre and post end-August 2010.

There may be a number of factors explaining the decline in deposits from late-August 2010. First, the expiration of the original guarantee scheme, the Credit Institutions Financial Support (CIFS) scheme in end-September 2010 resulted in a significant proportion of the Irish banks' term debt falling due during this month. There were concerns about the scale of the Irish banks' refinancing commitments during this time. It was not clear if there was sufficient market appetite to roll this debt and re-issue under the revised guarantee scheme, the credit institutions Eligible Liabilities Guarantee (ELG).

Furthermore, from late-Summer 2010, there was an intensification of the self-reinforcing negative

dynamic between the Irish sovereign and the banking sector in the context of the initial phase of the European sovereign debt crisis. Investors were concerned about the capacity of the Irish sovereign to meet the costs of restructuring and recapitalising the banking sector. Moody's downgraded the Irish sovereign on 19 July 2010 while Standard and Poor's (S&P) cut the long-term rating on 24 August 2010. The Irish 10-year sovereign bond yields reached 6 per cent per annum for the first time on 16 August 2010 before following a general upward trend until the end of our sample. An application for external assistance by the Irish Government from the EU/IMF and ECB followed in late-November 2010 amidst a continuing outflow of deposit levels from the Irish system. The deterioration in the measures of sovereign risk from end-August 2010 may have had implications for the perceived protection of Government support by depositors in Irish banks. The literature on market discipline and deposit protection contend that depositors care about the solvency of the guarantor.⁵

In Table 1 we present summary statistics for aggregate deposit data for the total period and for the two sub-samples. The summary statistics for the corporate deposit flows show that the mean daily percentage outflow for this category exceeds that of retail deposits over all samples. The relatively higher standard error and min/max range also confirm the volatility of corporate deposits during the crisis. The average daily percentage outflow across both categories increased after end-August 2010. The largest daily outflow for both categories also occurs in the latter period.

For comparison purposes, we also include a graph of the published figures by the Central Bank of Ireland on resident private-sector deposits in Figure 1. The latter data are published on a monthly basis. These private-sector deposits include deposits from households, non-financial corporates (NFCs) and other financial corporates (OFIs). These data differ from the net flows in one important respect, namely with regard to the consolidation basis. These data are not consolidated on a group basis. The Central Bank data refer solely to deposits maintained by the offices of credit institutions, which are located within the Republic of Ireland. These deposits can be held by both residents and non-residents. However our chart focuses on the resident component and those deposits that are held by the Irish covered institutions.⁶ By contrast, the net flows data are consolidated on a group basis for the six Irish banks. Therefore, the net flows data cover deposits held by overseas subsidiaries and branches of the Irish banks. Also the consolidated data net out intra-group positions. A further difference relates to the slightly differing aims of monetary and prudential data, implying that definitions may vary across deposit category. The retail category, for example in the consolidated data may not correspond exactly to the household category in the Central Bank data.

These differences notwithstanding, the sharp decline from late-2010 is also evident in the resident data. The published data also indicate that following earlier gains the Irish resident private-sector deposits begun to decline gradually from late-2009.

⁵See Flannery (1998) for a review.

⁶See Table A4.2: Credit Institutions (Covered Group) - Aggregate Balance Sheet

3 A Model of Corporate Deposits

3.1 Some relevant literature

In specifying a model of corporate deposits, particularly over a period of some distress in general market funding conditions, it is necessary to draw from a relatively disparate literature on financial institutions' deposits.

Corroborating some of the empirical evidence already observed for the Irish data, a number of papers contend that a certain definition of deposits, namely, "core" deposits are more sticky than other forms of deposits and are rate inelastic. Feldman and Schmidt (2001) define core deposits as checking/savings accounts, money market deposits and time deposits, while Berlin and Mester (1999) measure core deposits as those with a value less than \$100,000.⁷ Song and Thakor (2007) use the provision of liquidity and advisory services as the defining factor for core deposits. They exclude brokered certificates of deposit, large time deposits and any other deposits where no services are provided from the definition and instead label this category as "purchased money".

The presence of deposit insurance and potential switching costs are posited as reasons for higher levels of inertia on these types of deposit. The varying definitions of core deposits in the literature imply that both retail and corporate deposits held in the Irish banks could be defined as "core". In the Irish case, both retail and corporate deposits were covered by an Irish Government guarantee during the period under study. The Deposit Protection Scheme (DPS) covered retail deposits up to €100,000 while the Eligible Liabilities Guarantee offered protection on new retail deposits over the DPS threshold and on all new corporate deposits. Therefore, it would be expected that both categories should be relatively stable.

As the financial crisis has progressed, the duration on corporate deposits shortened significantly and this category appeared very sensitive to adverse developments in market indicators. In short, this category behaved more like wholesale funding with the current crisis illustrating the fragility of wholesale funding categories.

A recent paper by Huang and Ratnovski (2010) shows how, under certain circumstances, wholesale funding can be destabilising to financial stability. In extending the Calomiris and Kahn (1991) model (CK), which shows the socially optimal disciplining effects of wholesale funding, Huang and Ratnovski (2010) introduce a costless but noisy public signal into the CK theoretical framework. This extension shows the potentially negative effects of wholesale funding on financial stability in addition to the positive first order effects of market discipline in the CK model.

The results of Huang and Ratnovski (2010) show that the actions of wholesale financiers can be socially optimal only when fully informed. In the 2009/2010 period, there was considerable uncertainty in the Irish market regarding the scale of losses on the balance sheets of the Irish banks. This factor may have contributed to the observed volatility among corporate deposits.

A number of papers deal with movements in deposit flows when deposit-taking institution are under stress. These papers are concerned with investigating the market disciplining forces of de-

⁷In an alternative specification, small value time deposits are also excluded from the definition.

positors and their ability to distinguish between healthy banks and those that are less financially sound. Bologna (2011) provides a review of this literature. The origins of the market discipline literature can be traced to the theoretical models of Diamond and Dybig (1983) and Calamoris and Kahn (1991). The former paper contends that deposits are costly and renders banks vulnerable to deposit runs due to asset/liability mismatch, thereby, justifying deposit insurance. However, there is a counter strand of literature which contends that demand deposits can offer market discipline. As previously mentioned, Calamoris and Kahn (1991) offer similar arguments for the benefits of wholesale funding such as subordinated debt. Other related papers on subordinated debt include Diamond and Rajan (2001) and Flannery and Sorescu (1996).

Returning to deposits, Hori, Ito and Murata (2009) make use of a large panel of deposit-taking institutions in Japan over the period 1992 to 2002 to examine if depositors are able to distinguish between healthy and risky institutions. Using bank-level indicators of risk on both deposit growth and deposit interest rates, they find that size is important as large institutions appear to be more sensitive to changes in bank risk than smaller institutions.

A recent paper by Berger and Turk-Ariss (2010) tests for the presence of market discipline by depositors across US and European banks over the period 1997 to 2007. The paper examines how deposit growth and deposit risk premia respond to changes in measures of bank risk through a number of empirical applications in the period prior to the crisis. The results show that depositor discipline is lower for larger institutions which contrasts with Hori *et al.* (2009). Depositor discipline is found to be higher at listed institutions, reflecting the availability of financial information as Hori *et al.* (2009) find higher discipline at larger listed institutions relative to large unlisted banks.

Looking specifically at the United States, Goldberg and Hudgins, (1996 and 2002) investigate the existence of depositor discipline during the Savings and Loan crisis. These authors find evidence that depositors reduced their deposits at Savings and Loan Associations between 1984 and 1994 in response to potential failure.

3.2 Model specification

In specifying a model for Irish corporate deposits a number of possible explanatory variables are identified. Borrowing from the market discipline literature and conjunctural analysis of events in 2009/2010, these variables fall into three categories, namely, measures of institution/sector specific risk, indicators for sovereign risk and for the prevailing macro-financial environment. Given the high frequency nature of the deposit data, we focus, where possible, on market-based indicators. Therefore, we restrict the sample to Irish banks listed over the full period under study (i.e., late-February 2009 to early-December 2010), namely, Allied Irish Banks, Bank of Ireland and Irish Life & Permanent plc.⁸ To minimise the presence of noise in daily observations, we move to weekly data for the estimation of the model.⁹ We decided to shorten our estimation sample to the period prior to 20 August 2010 as a clear turning point emerges subsequent to this date in terms of the movements

⁸Anglo Irish Bank was delisted in January 2009 following nationalisation and so is excluded from the sample

⁹Daily data were converted to weekly averages using the RATS software programme.

of corporate deposits in the Irish financial system. Consequently, there are 74 observations in the sample covering the period from the week beginning 2 March 2009 through to 20 August 2010.

The Appendix shows the range of variables identified as possible explanatory variables for movements in corporate deposits. It is expected that a deterioration in measures of financial soundness and profitability such as CDS spreads, default probabilities, ratings and equity prices will lead to a decline in corporate deposits flows. This is also the case for an increase in the various measures of sovereign risk. As previously mentioned, the European sovereign crisis emerged in May 2010 with concerns about the fiscal sustainability of Greece. By late-Summer market concerns spread to other peripheral countries such as Ireland. International investors were worried about the capacity of peripheral European states to meet fiscal obligations. Attention in international markets began to focuss on Ireland given the scale of the banking stabilisation measures being undertaken by the Government at that time and the strains emerging in the Irish public finances.

The policy response to the crisis created a link between the sovereign and the Irish banks. Such measures began in September 2008 with the introduction of the Government guarantee on banks' liabilities and also included recapitalisations, nationalisations and the establishment of NAMA over the course of 2009 and 2010. See the Office of the Comptroller and Auditor General (2011) for more details on the banking stabilisation measures. Some details on the various international guarantee schemes introduced in 2008 and deposit insurance schemes are discussed in Schich (2008).

The Irish stock exchange index (the ISEQ general) is used as a proxy for the macroeconomic environment; returns for financial institutions are deliberately excluded from this index. As a result only non-financial listed companies are included. A positive relationship is expected between corporate deposits and corporate stock prices. A proxy for general funding strains across the European banking sector is also included.

Using a general-to-specific approach the following parsimonious specification was chosen:¹⁰

$$c_t = \beta_0 + \beta_1 spread_t + \beta_2 aibirat_t + \beta_3 aggcds_t + \epsilon_t \quad (1)$$

where *spread* refers to the spread between 3-month Euribor and the euro 3-month overnight indexed swap (OIS) rate, *aibirat* refers to the implied credit rating of Allied Irish Banks plc (AIB) as estimated by Kamakura and *aggcds* represents the median CDS spread.

The 3-month Euribor/OIS spread is commonly used as a measure of tension in the euro money markets. Given the dislocation in the interbank market in late-2008, a significant body of literature has grown in which the relative importance of counterparty credit risk and a premium for liquidity risk is examined. Accepting that there are a number of concerns regarding trading volume in term unsecured markets and that there may have been tiering in the interbank market over the 2009/2010 period, we include this variable as a measure of general funding risk to which investors or corporate deposit holders may react. A negative relationship is expected. As is common practice the spread is measured in basis points.

The implied credit rating variable is estimated by Kamakura Risk Information Services (KRIS)

¹⁰Results of all specifications are available upon request from the authors.

and provides a quantitative measure of financial soundness. The implied credit rating model by KRIS is based on firm-specific attributes, the term structure of default probabilities for the firm as estimated by Kamakura, industry classifications, macroeconomic factors and the historical behaviour of ratings agencies. Based on all of these factors a measure of a likely credit rating, conditional on having a rating, is estimated for the public firm. Credit ratings data from Standard and Poor's are used by KRIS. The credit rating variable is added to the model using a linear scale where 1 corresponds to the highest rating, AAA and 21 to the lowest, D. Therefore, an increase in this variable is expected to lead to a decrease in corporate deposits. Implied ratings were available for all three listed banks over the estimation period. However, it was decided to go with AIB given the results of granger causality tests,¹¹ which suggested its leading role within the industry.

The median 5-year senior CDS spread in basis points for the three listed Irish banks in the sample is used as a measure of perceived credit worthiness. CDS spreads are not used by Kamakura in the implied rating model.

The sovereign variables (i.e., bond spreads, sovereign ratings) were found to be insignificant or had the wrong sign over the sample period once bank specific risk had been controlled for. The variable on Irish banks' CDS spreads for the banks may be picking up some of the sovereign issues given the aforementioned links between sovereign and bank. Figure 2 shows the high levels of positive correlation between the sovereign CDS spreads and median CDS spreads for the Irish banks between end-February 2009 and-August 2010.

The interest-rate variable is also found to be insignificant in the model. Data deficiencies may explain this result. Our corporate interest rate measures the weighted-average monthly interest rate on new business deposits with agreed maturity offered by credit institutions operating in the Irish market. Unlike the levels data on deposits, these figures do not cover the consolidated operations of the Irish banks. A time series of interest rates on consolidated customer deposits is unfortunately not available. Also, the nature of the relationship between rates and deposit levels may change during a crisis. It would be expected that an increase in rates, all other things being equal, would lead to an increase in deposits if savings rates are high. However a negative relationship may also occur with deposit growth as banks attempt to increase rates to compensate for outflows raising endogeneity concerns. As deposit holders may demand a premium to retain their funds in riskier institutions during a period of financial stress it may be necessary to model interest rates separately as is the case in some of the market discipline literature.

3.3 Estimation

The model is estimated in an error correction framework using the well-known Engle-Granger (1987) two-step methodology. This model allows us to control for both long- and short-run dynamics. This approach is justified by the statistical properties of the data. All series, which are in log format, used in the analysis are first tested for the presence of a unit root.

¹¹To perform granger causality tests, a VAR is estimated using only the daily deposit flows of the covered institutions. Following standard lag length tests, our final application has a lag of 5 days and the estimation is conducted over the period February 2009 to August 2010.

The three unit root tests carried out are the ADF-GLS test by Elliot, Rothenberg and Stock (1996), with the lag length chosen on the basis of the modified AIC suggested by Ng and Perron (2001), the classical Dickey-Fuller (1981) and the Philips-Perron (1988) tests. To ensure robustness, a range of lag lengths were chosen for the latter two tests. The results are presented in Table 2.

A number of tests for the presence of a cointegrating vector were conducted on the residuals of the long-run equation. In addition to the ADF-GLS test, the Engle-Granger (1987) test and the cointegrating regression Durbin-Watson (CRDW) test by Sargan and Bhargava (1983) are applied. Critical values for both tests are from MacKinnon (1991) and Banerjee *et al.* (1993). The lag length for the Augmented Engle-Granger test was chosen on the basis of standard selection criteria (AIC, SBC). The tests were minimised at lag length of one. Both of these tests reject the null of a unit root. The ADF-GLS test, however, suggested that the residuals are not stationary.

The lagged residuals from the long run model (1) are incorporated into the following short-run model.

$$\Delta c_t = \lambda(c_{t-1} - \alpha_0 - \alpha_i X_{t-1}) + \sum_{i=0}^p \gamma_i \Delta X_{t-i} + u_t \quad (2)$$

where X represents the vector of explanatory variables from the short-run model. Using a standard general-to-specific approach results in only current values being included in the final specification.

Table 3 presents the results of both the long- and short-run models. As can be seen, all explanatory variables are found to have the expected negative relationship with our dependent variable in the long-run model. As the variables are in log format, the long-run elasticities show that the implied credit rating exerts the highest influence among the explanatory variables. As mentioned previously, this variable is itself estimated from a reduced form model which controls for other indicators of financial fragility such as default probabilities as well as the historical behaviour of the credit rating agency S&P and, therefore, may provide an early indication of future ratings actions. An increase in this rating implies that the fundamentals of the bank has deteriorated and may be downgraded (if the rating differs from the actual) if S&P assigned a rating based on default probabilities and applied a similar rating approach as it had used over the period 1990 to 2008 (KRIS, 2011). The negative relationship clearly shows that corporate deposit holders can exert market discipline by withdrawing funds when the financial condition of deposit-taking banks weakens. Also corporates and non-bank financial intermediaries such as pension funds and insurance corporations appear to be sensitive to indicators of perceived credit worthiness such as CDS premia.

The results suggest a number of policy conclusions. The model shows that there is a link between counterparty credit risk and liquidity funding risk. Corporate and NBFIs are sensitive to measures of financial soundness of the deposit-taking institution. Therefore, to retain and increase future corporate deposit flows, Irish banks must increase their resilience to future shocks. The recapitalisation and restructuring measures implemented under the 2011 FMP should facilitate this process. Additionally, the importance of external market conditions (Euribor/OIS spread) in the model indicate that normalisation of international funding markets will also be important for attracting future deposit flows. Furthermore, the dynamic between the Irish sovereign and

the banking sector as evidenced by the high correlations in Figure 2 further suggest that market sentiment towards the banks will be influenced by the future performance of the sovereign and vice versa. It is evident that the achievement of a clearly sustainable fiscal path by the sovereign is essential in this regard.

Diagnostic tests of the residuals reveal some evidence of serial correlation. We control for this by using fully-modified ordinary least squares (FM-OLS). All variables remain significant and have the hypothesised sign. Therefore, the results of the static OLS are included in the short-run model. In the short-run specification, the error correction term is found to be highly significant and negative. The equation is balanced due to the presence of cointegration between the variables in levels and the fact that the short-run variables are integrated of order zero. The estimated coefficients suggest that if there is a deviation between the actual and the long-run level of corporate deposits 37 per cent of this gap will be closed in a week. The other short-run explanatory variables turn out to be statistically insignificant and are, accordingly, omitted from the table. Figures 3 and 4 show the actual and fitted values of both models and the corresponding residuals.

We also ran a number of standard diagnostic tests on the model. The correlogram of the short-run residuals indicate stationarity; a finding further confirmed by the Ljung-Box (Q test). The Breusch-Godfrey test confirms the absence of serial correlation. White's test also does not reject the null of homoskedasticity and we find no evidence of ARCH effects in the residuals. The Jarque Bera test also shows that the residuals are normally distributed.

It is possible that there may be some structural change with the estimation period. To ensure the robustness of our error correction term, we check the stability of the coefficient using recursive estimation of the short-run model. We limit the initial estimation period for the exercise to between 23 February 2009 to 28 February 2010 being mindful of sample length (i.e., 52 observations). The end-date is extended sequentially up to the end of the full estimation sample. Figure 5 plots the value of each estimated coefficient and the corresponding estimated ± 2 standard deviation band or confidence interval. The coefficient appears relatively stable and statistically significant.

3.4 Out-of-Sample Performance

In the above estimation, the model was run on weekly data over the period early-March 2009 to mid-August 2010. We also simulate the short-run model beyond the end-date to see if it could have predicted the declining trend after late-August. Actual values for the explanatory variables are used in the exercise. The simulation period is up to late-October 2010. Figure 6 compares the estimation results of the short-run model and the actual weekly percentage changes of corporate deposits. The model clearly fails to predict the dislocated period in Q4. The significant difference between the two series indicates that other factors are driving the corporate deposits during this time. The intensification of sovereign risk concerns may be one such factor. Although the various measures of sovereign risk were not found to be significant in the initial estimation process, it may be possible that the relationship intensifies post-August 2010.

3.5 Examining inter-deposit dynamics

During the financial crisis, it has been observed how corporate deposit figures have been much more volatile than those of retail deposits. This is driven, in part, by the profile of the investor base as large corporate depositors may be more sensitive to negative news or financial-market developments. Moreover, institutional investors may have investment thresholds such as the level of CDS spreads or a certain credit rating that cannot be surpassed for regulatory reasons. Internal risk management thresholds such as limits to sovereigns or certain sectors may also dictate the investment practices of corporates or non-bank financial intermediaries.

Given the significant outflow of corporate deposits from the Irish system over the period in question, a key issue of significant policy importance is the likelihood that this could spill over into an outflow of retail deposits. While corporate flows tend to be more volatile in nature for a variety of institutional reasons, there is also likely to be a long-term relationship between the stock of corporate and retail deposits held by financial institutions. We explore the possibility of such a relationship within a vector autoregression framework (VAR) by initially running standard Granger-Causality tests for both the growth rate and levels of corporate and retail deposits. The results from the VAR are in Table 4.¹² For both the levels and growth rates of the flows, there would appear to be strong evidence of corporate flows granger causing retail movements.

Accordingly, we specify a two equation system for corporate and retail flows. Based on our VAR results, we include the error correction term for corporate flows regressed on retail flows in both equations. In each case, we employ a general to specific approach, removing any variables in the dynamic specification which are not significant. This results in the following system being estimated

¹²The lag length of the VAR are determined using standard AIC and SBC criteria.

$$\Delta r_t = \lambda_r (r_{t-1} - \alpha_0 - \alpha_1 c_{t-1}) + \gamma_1 \Delta r_{t-3} + \gamma_2 \Delta r_{t-5} + \gamma_3 \Delta c_{t-2} + \gamma_4 \Delta c_{t-8} + u_t$$

$$\Delta c_t = \lambda_c (r_{t-1} - \alpha_0 - \alpha_1 c_{t-1}) + \gamma_5 \Delta c_{t-1} + \zeta_t. \quad (3)$$

Coefficient estimates are presented in Table 5. Note that with this empirical approach both long-run and short-run coefficients are estimated simultaneously. Of particular interest is the coefficient on the error correction term in the retail flows regression - λ_r as this captures the speed of adjustment between the actual and the long-run level of retail deposits and, therefore, can be interpreted as an estimate of the stickiness of retail deposit flows.

From the estimates, it is clear that λ_r is quite small. It suggests that if there is a deviation between the actual and the long run level of retail deposits, only 5 per cent of this deviation would be closed on a daily basis.

4 Summary and Conclusion

The impact of the financial crisis on the Irish banking sector has been arguably the most significant across the euro zone. Irish institutions were particularly vulnerable to fragilities in the international wholesale money markets owing to the highly concentrated lending which had taken place in the domestic residential and commercial property sectors and the significant deterioration in the asset quality post-2007 of these books. The deterioration in a number of funding metrics resulted in Irish institutions having to avail of liquidity support both from the European Central Bank (ECB) and the Irish Central Bank. A cornerstone of the programme of support agreed between Irish authorities and the EU, the IMF and the ECB in November 2010 is the need for Irish institutions to wean themselves off this institutional support and return their funding profiles to a more sustainable, market-based path.

Availing of a relatively unique high frequency database on customer deposit flows within the Central Bank, this paper specifies a model of corporate deposit flows. This model is then estimated over a period in 2009 and 2010 when funding conditions were relatively stable. Borrowing from the market discipline literature, we relate deposit growth to changes in measures of bank risk, thereby linking credit risk and liquidity funding risk. In this regard, our results suggest that Irish financial institutions must increase their resilience to future shocks. The recent capitalisation measures undertaken by the Irish Government will clearly contribute to this process. Furthermore, central to any future stable funding path for Irish institutions is the need for normalisation in international funding markets as well as continued improved sentiment towards the performance of the sovereign. We also investigate the empirical relationship between corporate and retail flows over the same period in order to investigate what the implications of continued outflows of the former would be for the latter source of funding.

Given that the international financial system is facing a period of considerable uncertainty in

the years ahead, it is evident that much more analysis and understanding is required of these sources of institutional funding. While we believe the results presented here are of general interest, clearly there are a number of fruitful avenues for future research. These include extending the analysis to a model of retail deposits and comparing and contrasting the determinants of this source of funding with that of corporate deposits. Additionally, the underlying volatility of these deposits is a further likely subject of future work.

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Appendix

Explanatory Variables for Corporate Deposit Model

Bank-specific

Five year senior CDS spreads
Equity prices
S&P credit rating
Implied rating
1-month default probability
3-month default probability
6-month default probability
1-year default probability
2-year default probability
3-year default probability
5-year default probability
Corporate deposit rate

Sovereign

Spread between yields on 10-year Irish bonds and German bunds
Irish sovereign rating by S&P
Irish sovereign rating by Moody's
Irish sovereign rating by Fitch
Dummy variable for negative watch announcements

Macro-financial Environment

Spread between 3-month Euribor and 3-month Euro OIS spread
ISEQ general index

Table 1: Summary statistics on percentage daily customer deposits flows of the Irish financial institutions

Flows Category	Obs	Mean	Std Error	Minimum	Maximum
Sample: 23/02/2009 - 12/02/2011					
Total	452	-0.06	0.48	-1.85	1.90
Corporate	452	-0.16	1.56	-6.84	6.05
Retail	452	-0.02	0.15	-0.64	0.45
Sample: 23/02/2009 - 20/08/2010					
Total	378	-0.02	0.49	-1.85	1.90
Corporate	378	-0.04	1.55	-5.84	6.05
Retail	378	0.00	0.14	-0.48	0.32
Sample: 20/08/2010 - 02/12/2010					
Total	75	-0.27	0.40	-1.82	0.61
Corporate	75	-0.78	1.45	-6.84	2.38
Retail	75	-0.10	0.18	-0.64	0.45

Table 2: Unit Root and Cointegration Tests

Variable	Dickey-Fuller			Philips-Perron		ADF-GLS	
	0 lag	4 lag	8 lag	0 lag	4 lag	Ng-Perron lag length	
Δc_t	-9.06 +	-5.31 +	-2.32	-9.06 +	-9.76 ⁺		-1.67
$\Delta spread_t$	-7.06 +	-3.08 +	-2.51	-7.06 ⁺	-7.15 ⁺		-1.76
Δcds_t	-5.67 +	-2.71 ++	-3.14 +	-5.67 ⁺	-5.66 +		-3.74 ⁺
$\Delta aibirat_t$	-12.08 +	-4.94 ⁺	-4.10 +	-12.08 +	-13.18 +		-1.73
Test	Cointegration tests on long-run residuals						
Engle-Granger				-4.64 ⁺			
CRDW				0.69 +			
ADF-GLS				-2.51			

Note: + denotes rejection at 5% and ++ at 10%

Table 3: Short and long-run aggregate model of corporate deposits: 02/03/2009 - 20/08/2010

<i>Dependent variable: c_t</i>	
Constant	11.61 (64.92)
$spread_t$	-0.06 (-3.48)
$aibirat_t$	-0.18 (-2.55)
$medcds_t$	-0.04 (-2.46)
<i>Dependent variable: Δc_t</i>	
ecm_{t-1}	-0.37 (-4.30)
$\overline{R^2}$	0.21

Note: T-stats are in parentheses. Statistically insignificant variables are omitted from the table

Table 4: F-tests from VAR model of retail and corporate flows

	Δc_t	Δr_t	c_t	r_t
Δc_t	3.414 (0.00)	3.059 (0.00)		
Δr_t	1.023 (0.41)	6.018 (0.00)		
c_t			214.66 (0.00)	3.92 (0.00)
r_t			0.626 (0.71)	457.29 (0.00)

Note: P-values are in parentheses.

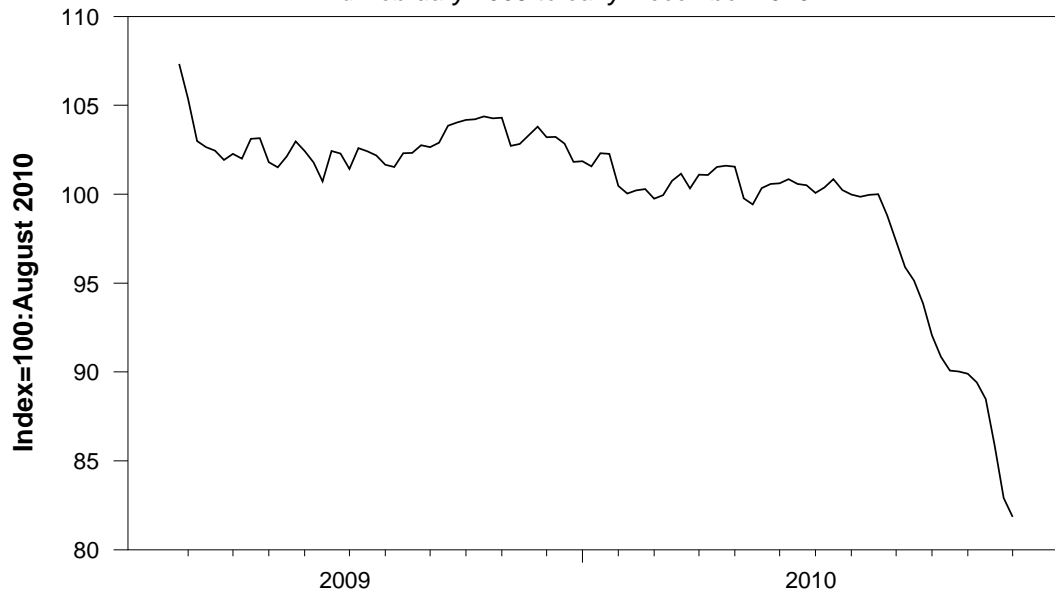
Table 5: Short and long-run aggregate retail and corporate deposit model results:
23/02/2009 - 20/08/2010

Coefficient	Estimate	T-Stat
α_0	10.33	29.83
α_1	0.142	4.55
λ_r	-0.048	-3.08
λ_c	0.539	2.92
γ_1	-0.186	-3.86
γ_2	0.168	3.58
γ_3	0.010	2.36
γ_4	0.010	2.41
γ_5	-0.147	-2.87

Figure 1

Customer Deposits

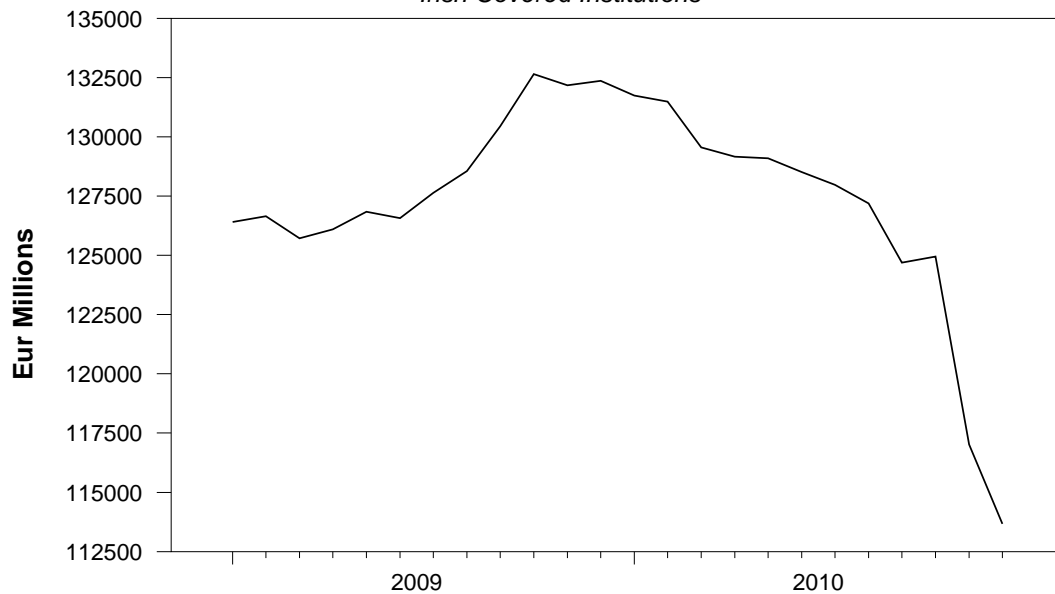
End-February 2009 to early-December 2010



Data are weekly frequency and cover the six domestic banks, AIB,BOI,ILP,Anglo,INBS,EBS.

Private-sector Deposits 2009 -2010

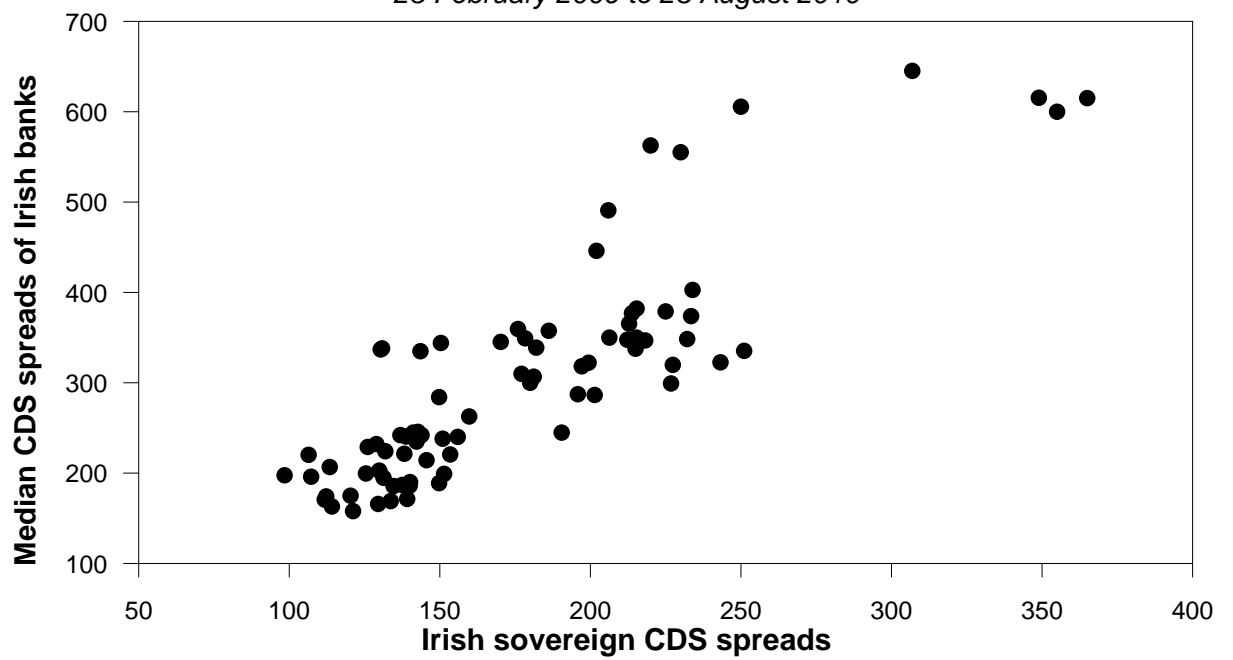
Irish Covered Institutions



Data refer to published MFI figures for Irish residents

Figure 2

23 February 2009 to 23 August 2010



Note: Data are expressed in basis points. Sample for Irish banks covers AIB, BOI & ILP

Figure 3

Long-run Corporate Deposits Model: Mar 2009-Aug 2010

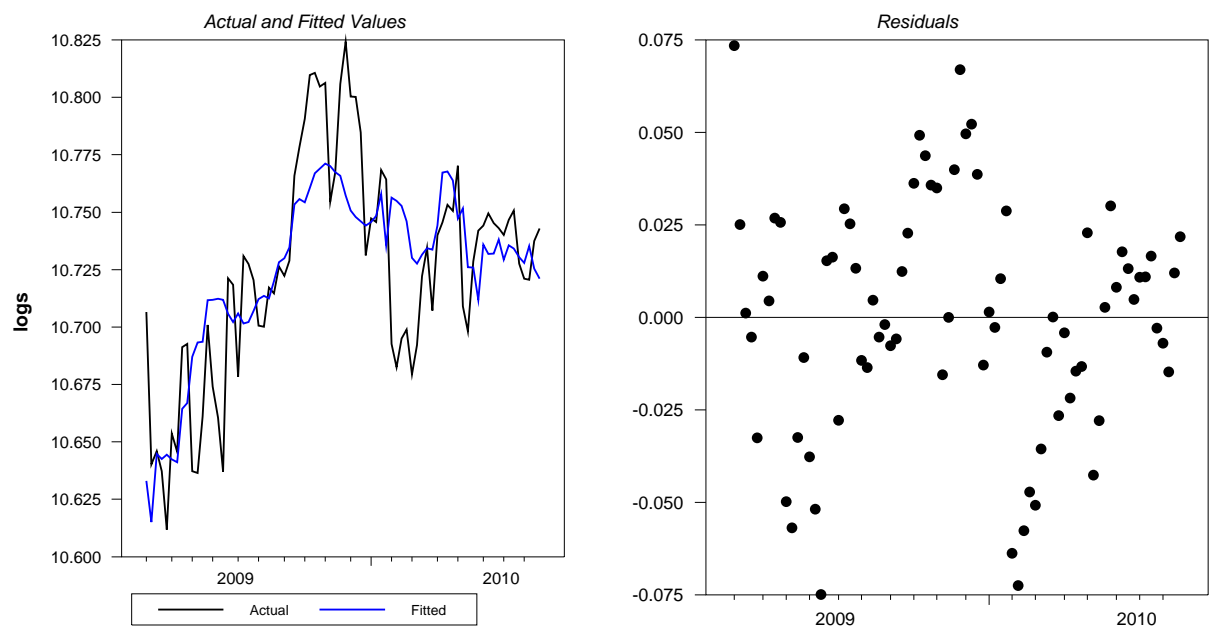


Figure 4

Short-run Corporate Deposits Model: Mar 2009-Aug 2010

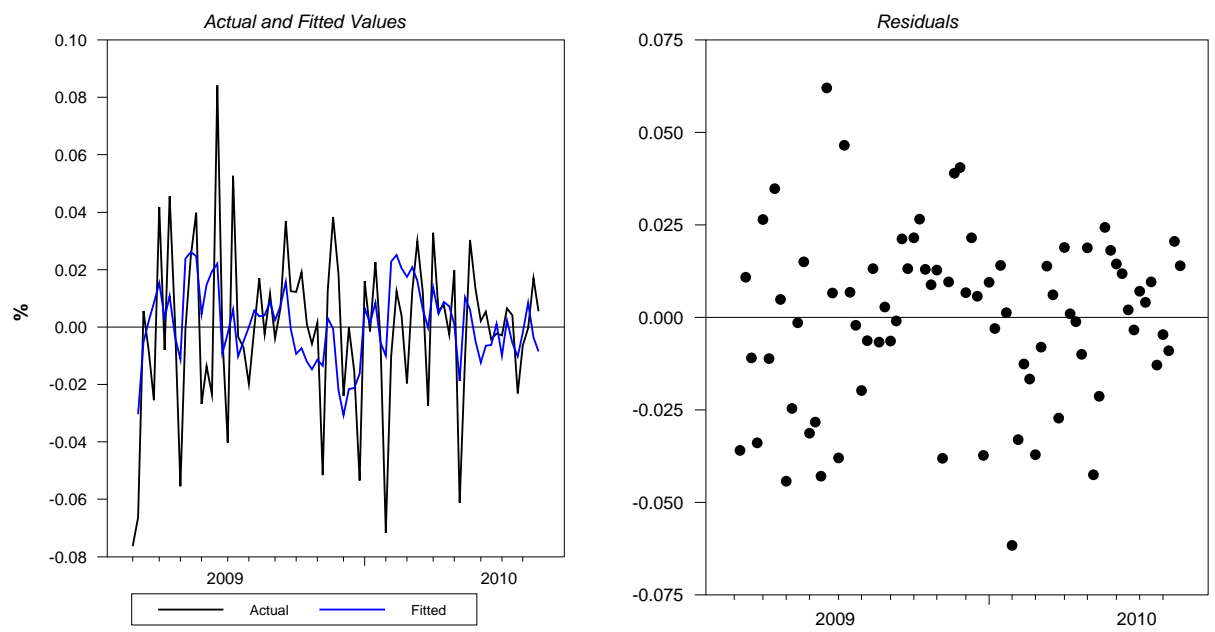


Figure 5

Sequential Estimation of ECM Coefficient

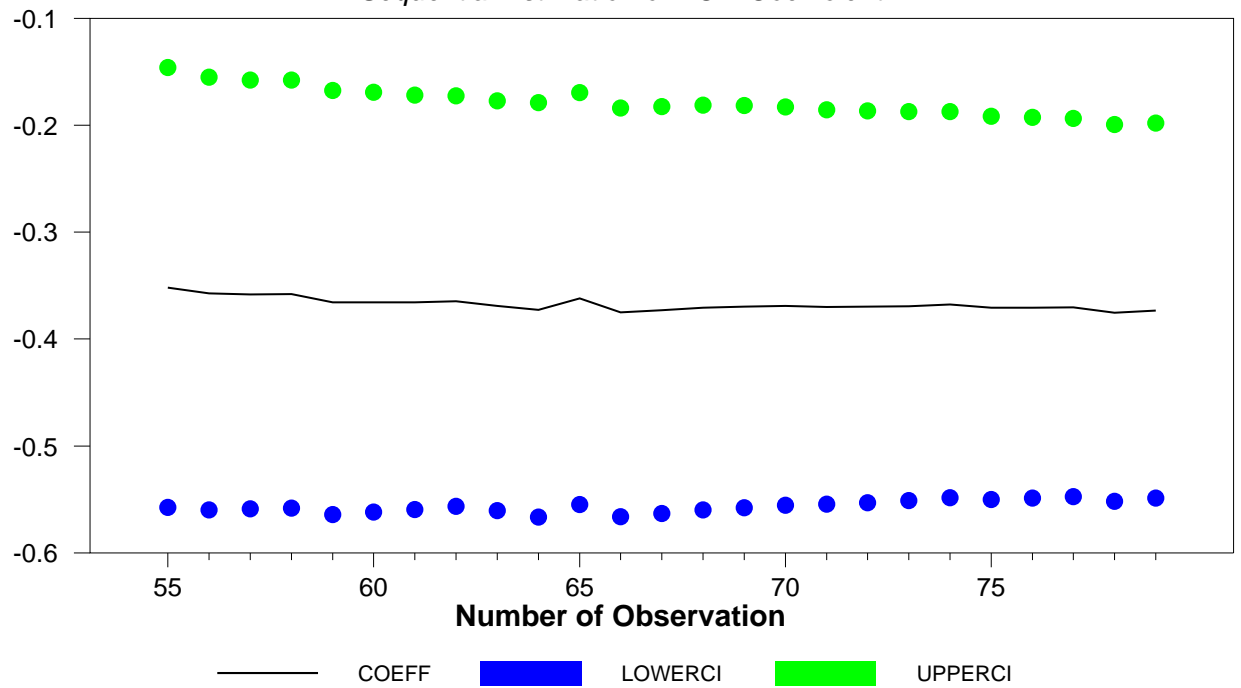


Figure 6

Performance of Corporate Deposit Model:2010:08:16 -2010:10:20

