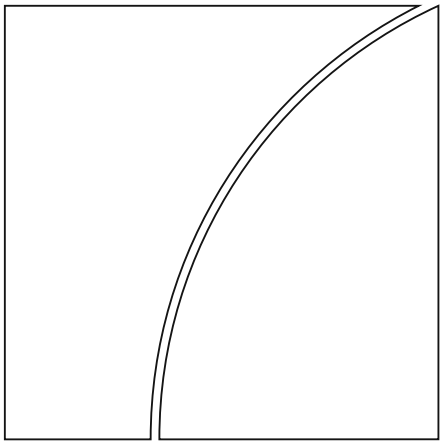


BANK FOR INTERNATIONAL SETTLEMENTS

BIS Working Papers

No 486

Why did bank lending rates diverge from policy rates after the financial crisis?

by Anamaria Illes, Marco Lombardi and Paul Mizen

Monetary and Economic Department

February 2015

JEL classification: E43, E52, G21

Keywords: lending rates, policy rates, panel cointegration, financial crisis

BIS Working Papers are written by members of the Monetary and Economic Department of the Bank for International Settlements, and from time to time by other economists, and are published by the Bank. The papers are on subjects of topical interest and are technical in character. The views expressed in them are those of their authors and not necessarily the views of the BIS.

This publication is available on the BIS website (www.bis.org).

ISSN 1020-0959 (print)
ISSN 1682-7678 (online)

Why did bank lending rates diverge from policy rates after the financial crisis?[1]

Anamaria Illes[2], Marco Lombardi[2] and Paul Mizen[3]

Abstract

The global finance crisis prompted central banks in many countries to cut short-term policy rates to near zero levels. Yet, lending rates did not fall as much as the decline in policy rates would have suggested. We argue that comparing lending rates to policy rates is misleading: banks do not obtain all their funds at policy rates, and after the crisis, costs of funding rose substantially. Comparing lending rates with a weighted average cost of funds suggests that banks did not substantially change their rate setting behaviour after the financial crisis: interest rate pass-through relationships across eleven countries in Europe appear to have remained stable.

JEL: E43, E52, G21

Keywords: lending rates, policy rates, panel cointegration, financial crisis

[1] The views are those of the authors and not necessarily those of the Bank for International Settlements. We thank seminar participants at the European Central Bank and Anindya Banerjee, Claudio Borio, Jonathan Crook, Andrea Cipollini, Markus Eberhardt, Leonardo Gambacorta, Boris Hofmann, Dubravko Mihaljek, Adrian van Rixtel, Hyun Song Shin, Ron Smith, Kostas Tsatsaronis and Philip Turner for their comments. Errors remain the responsibility of the authors.

[2] Bank for International Settlements, Basel.

[3] School of Economics, University of Nottingham.

1. Introduction

The global financial crisis prompted central banks in many countries to cut short-term policy rates to near zero levels after the Lehman collapse in September 2008. Based on the pre-crisis relationship between bank lending rates on mortgages or loans to businesses with policy rates, it would have been reasonable to expect lending rates to have fallen by similar amounts. But examination of the lending rates reveals they did not fall that much. In fact, the margins over policy rates have widened as policy rates have fallen (Graph 1).[4] Comparing the average margins on short-term and long-term loans to small business for nine Euro area countries, Denmark and the United Kingdom in the pre-crisis (January 2003 – August 2008) and post-crisis period (September 2008 – April 2014) shows that they rose by 19.5%, while margins on short-term and long-term mortgage loans rose by 41.8% and 37.5% respectively. Inevitably this has raised the question of whether banks were taking advantage of the low interest rate environment by failing to pass on lower rates to loans.[5]

There are three reasons why bank lending rates do not reflect the behaviour of policy rates in the post crisis period. First, the policy rate is a very short-term rate, while the lending rates to business and households normally reflect longer-term loans. The spread between the lending and policy rates therefore reflects the maturity risk premium alongside other factors that determine the transmission of policy to lending rates. Second, even if we correct for the maturity risk premium using an appropriately adjusted swap rate, the adjusted policy rate is not the marginal cost of funds for banks. Third, banks obtain funds from a variety of sources including retail deposits, senior unsecured or covered bond markets and the interbank market, and these differ in nature from policy rates since they comprise a range of liabilities of differing maturities and risk characteristics.[6,7]

Since the global financial crisis there have been a number of changes that have increased the cost of market funding. Larger risk premia associated with securities issued by banks and interbank borrowing, have raised the cost of market funding for banks (see ECB 2009, 2010a,b; Zoli, 2013). Financial market conditions have

[4] This is documented extensively by Illes and Lombardi (2013). Gambacorta et al. (2014) build on that and relate the disconnect to changes in the demand and supply determinants of banks' lending behaviour.

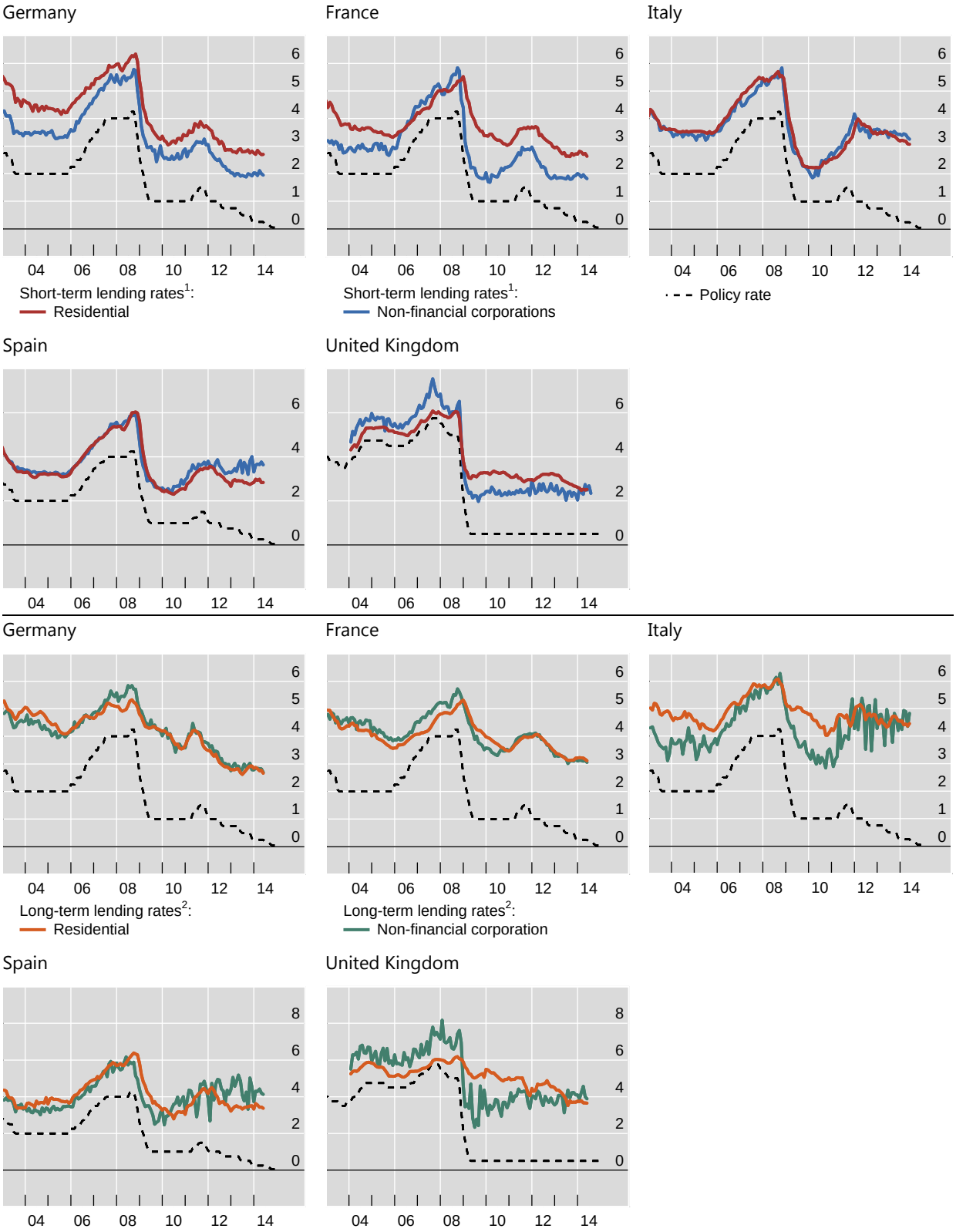
[5] For example, Arestei and Gallo (2014) argue that since the financial crisis greater risk and high volatility has decreased the influence of policy rates (or market rates which they use as a proxy for policy rates) over lending rates. They then conclude that this reflects 'opportunistic behaviour by banks, which have taken advantage of the reduction in official interest rates without transferring these benefits to borrowers'.

[6] ECB (2013) gives a reason for divergence of lending rates between countries in the euro area, which also results in a breakdown of the relationship between policy rates and lending rates, but our interest is in the differences between underlying funding costs and policy rates.

[7] Berlin and Mester (1999) pointed out that banks make multi-period loan contracts in a context where liabilities comprise relatively low cost deposits and higher cost market finance; this paper resurrects the discussion over liability structure on funding costs from their paper. Banks rely heavily of deposits and bond finance, but these sources of funding are relatively inelastic to changes in interest rates, and there are fixed costs associated with obtaining additional funds from alternative market sources e.g. covered and uncovered bonds.

MFI lending rates: short- and long-term

In per cent — Graph 1



[1] The short-term concerns rates less than 1-year maturity. [2] The long-term concerns rates above 1-year maturity. The average maturity assumed for the long-term securities is 5-years.

Sources: European Central Bank; national data.

become heterogeneous reversing a trend of lower and more similar rates since the late 1990s. The financial crisis is primarily responsible for the impairment of money markets and the divergence of bond yields across borders; but the sovereign debt crisis is also contributed to a divergence in costs of funds for banks from financial markets. The ability of governments to recapitalise their banks has declined as their own debt has increased, which has widened bond spreads (ECB, 2012). In addition, deposit rates, which would normally be marked down along with the policy rates, have been constrained by the zero lower bound, which forced banks to reduce the mark-downs. On top of that, there has been greater competition among banks for deposits, which further raised rates on time deposits, as higher-yield assets such as fixed-term securities issued by governments have increasingly been seen as substitutes for low-yield deposits by savers (see Darracq-Paries et al. 2014).

So comparing lending rates with policy rates, as is commonplace in the empirical pass-through literature, is highly misleading, since the latter do not reflect the effective cost of funding of banks. We rather suggest that greater focus should be placed on the whole range of liabilities that banks use to acquire funds (see Adrian et al. 2013; Turner, 2013). We argue that the focus should shift to the spread between lending rates versus a measure of effective bank funding costs, i.e. the weighted-average cost of liabilities.[8]

We devote the first part of the paper to carefully construct a weighted average cost of liabilities for banks, which reflects the cost of funds and any increase that they have experienced since the crisis. We then investigate the relationship between lending rates, bank funding and policy rates for European countries in the euro area (Austria, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal and Spain) and those outside of the euro area (Denmark and the United Kingdom) in the framework of a non-stationary dynamic heterogeneous panel model (Peseran and Smith (1995), Peseran, Shin and Smith (1999)) over the period 2003–2014. The framework allows for cointegration between these variables, where the short-term adjustment can be country-specific, but the long-term relationships between lending rates and funding costs are common. This is in line with country-level studies, see e.g. Banerjee et al. (2013) and Gambacorta (2008).

Our results point to a stable relationship between the lending rates and funding costs of banks over the full sample comprising the pre-crisis and post-crisis periods. We only find a very small reduction in the reported pass-through coefficients when the post-crisis period is added to the sample. Importantly, our weighted average cost of funds in the pre-crisis sample works as well as the policy rate in explaining the relationship between the lending rates and funding costs of banks, which is a useful cross-check on the stability of our results. Conversely, the relationship between the lending rates and the policy rate shows a break at the time of the financial crisis.

The implications of our findings are twofold. First, we demonstrate that policy rates are currently not an appropriate measure of the funding costs underlying

[8] In the circumstances of the pre-crisis period we can see why this was not as bad an approximation as it is now. First, the risk premium associated with lending to banks was compressed. Second, deposit rates were below the policy rate, so that weighing them with senior unsecured bond rates (slightly above policy rates) and interbank rates (approximately equal to the policy rate, with a small margin of 10-20 basis points), the volume-weighted average cost of funds was reasonably approximated by the policy rate. However, what was true then does not apply now.

banks' lending rates. An analysis of lending rates in the post crisis period requires a properly constructed measure of the cost of funds. Second, using this measure we find that bank lending rates did not substantially deviate from banks' funding costs in the post-crisis period. So, banks do not appear to have changed their pricing behaviour after the crisis.[9]

The rest of the paper is organised as follows. In Section 2, we present a model to frame our results on solid theoretical grounds. Section 3 discusses the construction of the weighted average cost of liabilities, including details on the data sources and their characteristics. This new measure of average funding costs is the cornerstone of our empirical analysis. We present our modelling strategy in Section 4, and our empirical results in Section 5. Finally, we discuss the policy implications of our results in Section 6.

2. An illustrative model and some background literature

2.1 The Berlin-Mester model

To set our empirical analysis in a theoretical framework, we consider a simple illustrative model based on Berlin and Mester (1999), which considers the contracting relationship between a firm and a bank. The core feature of the model is the setting of lending rates subject to the liability structure of the bank, which we will generalise to make our point.

The decisions of the firm and the bank are made over two periods, 0 and 1. The state of the world s in period 1 is unknown to the bank or the firm, and it can be good (g) or bad (b): $s \in \{g, b\}$. The probability of a good period is p, and of a bad period ($1–p$). Firms have positive earnings in good times, $E_g>0$, and no earnings in bad times, $E_b=0$. The state is revealed at the start of period 1 and the economic conditions are observable to all parties. It is assumed that the firm must borrow from the bank to invest, or liquidate some of its assets $A(k)$, where $k \in [0, K]$; this reduces the future value of the firm in order to generate liquid assets in the present.

The bank has a representative liability structure: deposits and market funds are held in proportions w and ($1–w$). For the purpose of exposition, we generalise this set of liabilities held by the bank to include deposits, unsecured market funds of various types and maturities that embrace interbank deposits and bonds, and secured market funds that contain covered bonds. We assume rates on deposits are fixed but rates of interest on other liabilities are state-contingent $s \in \{b, g\}$. We therefore have a weighted average cost of liabilities measure defined as:

$$L_s = C_s(w_j, R_j) = \sum_{j=1}^{J} w_j R_j \qquad (1)$$

[9] It is likely that banks have changed their lending criteria however, as the ECB Bank Lending Survey in the euro area and the Bank of England Credit Conditions Survey in the UK indicates a tightening of lending standards since 2008Q3. This may well have affected the volume of lending, but it does not appear to have changed the banks' setting of lending rates once funding costs are taken into account.

where j indexes the type of liability, with a weight, w_j, based on the proportional share in total liabilities and the rate of interest R_j. Certain restrictions are assumed: the cost of funding is state dependent and higher in bad times ($R_b > R_g$); the expected value of market funds exceeds the cost of core deposits, the cheapest available source of funding. Shares of certain liabilities can be zero. Further assumptions ensure earnings in good times cover the returns to depositors ($E_g > R_g$), although in bad times liquidation is required, since $R_b > 0$. The capital, K, is always larger than the weighted average cost of liabilities (1) even in the bad state of the world. These assumptions ensure that liquidation levels in good times are zero, and in bad times are just sufficient to cover the cost of liabilities for the bank., L_d.

The bank and firm both maximise profits, defined in each case as revenue minus costs in each state of the world times the probability that each state of the world will occur. Thus

$$\Pi^f = p[E_b + k_b + A(k_b) - r_b] + (1-p)[E_g + k_g + A(k_g) - r_g] \tag{2}$$

$$\Pi^b = pr_b^l + (1-p)r_g^l - [pL_b + (1-p)L_g] \tag{3}$$

where r_s^l is the lending rate of interest in for $s \in \{b, g\}$, and k_s is the liquidation level. The bank faces Bertrand competition in the loan market, treats its liability structure as given in the present period, and maximises its own profits, which results in a lending rate equal to the weighted average cost of liabilities defined in each state of the world:[10]

$$r_s^* = L_s \tag{4}$$

In this framework, pass through occurs between the weighted average cost of liabilities and the loan rates, not the policy rate and loan rates. Lending rates will be lower in good times than in bad times because the cost of funds will be lower in good times than bad times, but the pass through in each state of the world will be one-for-one, since $\frac{dr_s^*}{dL_s} = 1$ for $s \in \{b, g\}$.

Berlin and Mester (1999) also assume that a bank could choose to divert funds to marketable securities instead of loans, which implies the bank only participates in the loan market if the return from loans under each state of the world exceeds the return on marketable securities, S_g, which for simplicity we will take to be government bonds. In our context this implies

$$pr_b^l + (1 - pr_g^l) \geq pS_b + (1-p)S_g \equiv S^e. \tag{5}$$

This being the case, the return on marketable securities acts as a floor under lending rates. If policy rates were lower than the return on marketable securities as they were in the financial crisis, then lending rates would not fall to those levels.

[10] In Berlin and Mester (1999) the bank maximises the joint profit then the optimal contract maximises the profit of the firm and the bank, and should ensure that (4) holds when $s=b$, but when $s=g$ then $r_g^* = \frac{pL_b + (1-p)L_g - pk_b^*}{(1-p)}$. This is a 'relationship lending' result that causes the relationship between cost of funds and loan rates to differ between good and bad periods. Gambacorta and Mistrulli (2014) find that relationship lending did indeed shield Italian firms from the worst effects of the crisis after the Lehman bankruptcy.

The model can be generalised to a game-theoretic context with double Bertrand competition for deposits and loans. Stahl (1988) shows that double Bertrand competition is not neutral, and competition occurs first in the market for deposits and then in the market for loans. This results in an equilibrium loan rate that maximises the return from loans, which then ties down the equilibrium deposit rate. Competition in the deposit market (by offering higher rates on deposits) can corner the market for one bank, which will then be able to act as a monopolist in the market for loans (raising loan rates due to monopoly power). This can be avoided where there is an alternative source of funds (market funds). But the outcome of the Bertrand competition is also sensitive to the timing of the game, as Yanelle (1997) explains. While competing for deposits first and then for loans seems more natural, the alternative order cannot be ruled out. Yanelle (1997) describes such a model as a non-cooperative game played between a small number of banks in an oligopoly, that compete to corner the market for depositors on the one hand and for customers for loans on the other. A coordination problem arises, and although coalition-proof equilibria can be found to overcome the coordination failure, it does not yield a competitive loan rate in all circumstances. When banks first compete for loans, the rate may be competitive, but loans may be rationed, and when banks compete first for deposits, loan rates are not competitive. These models allow for the possibility of market finance as an alternative for the firm to bank finance, but ignore the possibility that the banks may obtain market finance as an alternative to deposits to fund their loans. In this respect, Berlin and Mester (1999) extends the literature into new territory that we consider in our empirical approach below.

2.2 Empirical approaches to the pass-through

The modelling framework described above stands in contrast with the assumptions behind the majority of the empirical literature on the relationship between lending rates and market rates. It is assumed that banks obtain funds for short-term lending at contemporary market rates (or policy rates), while longer term lending rates on mortgages or business lending are funded by 5- or 10-year sovereign bond yields (as a proxy for longer term market finance for banks). There is little discussion about deposit rates or the liability structure of banks, despite extensive discussion of pass-through by banks (see Borio and Fritz, 1995; De Bondt, 2002; Ehrmann et al. 2003; Hofmann and Mizen, 2004; De Graeve et al. 2007; Kwapil and Sharler, 2010). In other words, full maturity matching is assumed to occur between one policy rate (or market-determined cost of funds) and the lending rate.[11] Papers summarised in De Bondt (2002, 2005) and ECB (2009) all take this view, and demonstrate a high degree of pass-through to lending and deposit rates in the short- and the long-run. De Bondt (2002) himself finds that the correlation between the levels of deposit and lending rates set by banks and these maturity-matched market rates over the long run is close to one in the sample 1996-2001. Papers that employ pre-crisis samples of data find similar results (see references in Banerjee *et al.* (2013), European Central Bank (2009) and Darracq-Paries *et al.* (2014)). Pass-through is essentially complete

[11] The danger with a maturity matching approach is that it may find what it imposes on the data, since a high correlation between rates tends to occur between funding and lending rates that are maturity-matched at an early stage. Kok-Sørensen and Werner (2006) represents one of the most sophisticated approaches to the issue of benchmark rate selection to avoid this problem.

in the long run, once allowance is made for potential asymmetries in adjustment, nonlinear relationships between lending rates and market rates, and market efficiency. However, price rigidities and non-price competition tend to result in incomplete pass-through behaviour, and changes to market rates are not automatically reflected in bank retail rates in the short run (See Borio and Fritz, 1995; De Bondt, 2002; Ehrmann *et al*. 2003; Hofmann and Mizen, 2004; De Graeve *et al*. 2007; Kwapil and Sharler, 2010; Kopecky and Van Hoose, 2012).

With the onset of the global financial crisis, the consensus over matching maturities and using certain benchmark funding rates has begun to look questionable, reflecting the fragmentation of funding arrangements that has been noted by Darracq-Paries et al. (2014). Short-term wholesale market rates on unsecured interbank lending and collateralised repurchase agreements have deviated substantially from policy rates as liquidity and counterparty risk has increased. Moreover, the sovereign bond yields are no longer good proxies for the cost of market finance for banks in the period after the financial crisis. The higher default risk associated with banks in 2007-2009 caused bank bond yields to deviate from sovereign bond yields. As yields on senior unsecured bonds issued by banks rose, gross issuance fell to near zero in the peripheral countries and was replaced by covered bond issuance in other euro area countries (see Van Rixtel and Gasperini, 2013). This intensified in the sovereign debt crisis and the lending costs of these banks rose, particularly in the peripheral countries (see Zoli, 2013). All in all, this suggests it is no longer valid practice to take a policy rate, a short-term wholesale market rate or a sovereign bond yield as a proxy for bank funding costs.[12]

3. An alternative benchmark

An important contribution of this paper is the construction of a weighted average cost of liabilities (WACL henceforth) as an alternative benchmark for bank funding costs in each country. This section explains in detail how we compiled this measure, our data sources, and the dynamics of the WACL in relation to changes in the policy rate and its transmission to the MFIs lending rates. The WACL is a volume-weighted average of the rates at which banks can obtain finance:

$$WACL_{it} = \sum_{j=1}^{J} w_{ijt} r_{ijt}$$

where r_{ijt} are the rates on the different component liabilities that the banks use to provide funds, and w_{ijt} are the weights on those rates based on the component share in total liabilities for the banks in each country. Taking i to be the country index, j the index of the types of liabilities held by banks, and t the time period, we sum over liabilities to provide an index of the weighted average cost of liabilities for each country i at each point in time t.

The weights used in the calculation are based on outstanding stock of liabilities while the interest rates are based on new transactions. As a result, the WACL can be

[12] Eickmeier et al (2015) also construct an average measure of bank funding costs, which is then employed to assess the transmission of monetary policy shocks to lending rates in a FAVAR framework. The two projects were conducted independently and without knowledge of each other.

interpreted as the marginal cost of funding for the MFIs, assuming that they keep the composition of the balance sheet unchanged. This is a realistic assumption as the MFIs cannot easily change their source of funding from month to month.

In order to check the robustness of the results we have also calculated an entirely marginal cost of funding, which is based on volume of transactions which imply marginal weights. We were not able to include all the component liabilities discussed above, and as a result we do not use this calculation as the base case, but it is a very useful comparison for our weighting scheme based on outstanding stock of liabilities. The results show that there similar outcomes in both cases regardless of the weight measure.

Our sample covers a total of 11 countries, nine euro area countries and in addition Denmark and United Kingdom.[13] The data starts in 2003, based on the availability of the Monetary and Financial Institutions Interest Rates (MIR) by the ECB. Depending on data availability, we used the national central banks in order to complete the database; this is often the case for Denmark and the United Kingdom. We calculate two sets of WACL based on different maturities: one for the short-term and one for the long-term. We calibrate the short-term measure with a maturity of less than 1-year, whereas the long-term measure reflects maturities of more than 1-year, with an average of 5-years.

3.1 Components and weights

The WACL is constructed using five types of liabilities. Table 1A and 1B provide a summary, and compare the average weights (based on outstanding amounts), over different samples. This provides insights on how funding patterns have changed after the crisis.

The first two components are respectively, funding from **deposit liabilities** (in all currencies, and excluding the general government) vis-à-vis the euro area[14] to MFIs and to non-MFIs. Deposit liabilities to MFIs are equivalent to interbank deposits, while deposits to non-MFIs correspond to deposits of the private non-financial sector. Data is obtained from the ECB, which reports the MFIs aggregate balance sheet on a national basis (excluding the ESCB). We use the same data for the short- and the long-term calculation, since there is no breakdown by maturity for outstanding deposits. Although deposits are short-term in nature, they may be rolled over to provide a flexible source of additional funds even for longer-term lending, although this involves some risk.

Banks have a substantial deposit base in most countries, so that the first two components account for a large share of funding for lending: over 90 percent of total funding in the short-term (see Table 1A) and 70 percent of total long-term funding (Table 1B). Deposits from non-MFI sources are the largest component of the funding measure. In the short-term, the weights are approximately 60-75 percent of the total, with Ireland and France having lower proportions than the rest.

[13] The rationale for including non-euro area countries is to test whether the issue spreads to more countries, or is just associated with the monetary union.

[14] For Denmark and the United Kingdom, we take the country itself as reference area, as opposed to the euro area as a whole.

Weight components of the short-term WACL[1]

In per cent

Table 1A

	MFI deposits			Non-MFI deposits			Short-term securities other than shares			Central bank operations[2]		
	All	Pre	Post	**All**	Pre	Post	**All**	Pre	Post	**All**	Pre	Post
Austria	**40.1**	38.8	41.2	**57.9**	58.5	57.3	**1.1**	1.1	1.1	**0.9**	1.6	0.4
Finland	**17.9**	17.7	18.1	**69.8**	67.3	72.1	**11.8**	14.0	9.7	**0.5**	1.1	0.0
France	**47.2**	47.2	47.2	**44.5**	44.2	44.8	**8.3**	8.6	8.0	**0.0**	0.0	0.1
Germany	**35.5**	38.7	32.6	**61.7**	57.1	65.9	**1.0**	1.1	0.9	**1.8**	3.1	0.6
Ireland	**55.2**	53.6	56.7	**39.1**	39.9	38.3	**3.1**	4.5	1.9	**2.6**	2.0	3.1
Italy	**38.1**	40.5	35.9	**61.0**	58.4	63.5	**0.1**	0.0	0.1	**0.8**	1.1	0.5
Netherlands	**22.1**	29.2	15.5	**74.9**	68.5	80.8	**3.0**	2.3	3.7			
Portugal	**30.4**	31.5	29.3	**68.1**	68.3	67.8	**0.4**	0.1	0.7	**1.2**	0.2	2.1
Spain	**25.3**	25.9	24.7	**71.1**	69.3	72.8	**2.3**	3.2	1.5	**1.3**	1.6	1.0
Denmark	**34.7**	30.2	38.9	**64.2**	69.1	59.6	**1.1**	0.7	1.4			
United Kingdom	**30.3**	36.4	24.7	**63.8**	57.5	69.8	**5.8**	6.2	5.5			

[1] All refers to the full sample, pre-crisis is from January 2003 (depending on data availability) to August 2008; post-crisis is from September 2008 to the latest data available. [2] ECB main refinancing operations.

Sources: European Central Bank; national data.

In the long-term, the proportion is between 40-60 percent of the total. Interbank deposits provide up to 30-40 percent of short-term funding for most countries. The exceptions are Finland, the Netherlands and Spain, where the proportions are somewhat smaller, i.e. less than 25 percent. There were noticeable changes in the deposit base after the crisis. Germany saw the proportion of short-term funding from non-MFI deposits rise from 57 percent to 66 percent, while Austria, Ireland and Portugal saw these deposits fall slightly. Such a pattern is also visible in long-term funding: weights on non-MFI deposits rise from 35 percent pre-crisis to 48 percent in Germany, while weights in all other countries fell with the exception of the United Kingdom.

The third component of liabilities in the WACL is funding from **debt securities**, issued in all currencies in the euro area by the MFIs. This is obtained from the MFIs balance sheets, which also report breakdowns of maturities up to and over one year. Bond markets are segmented to a large extent on national lines (van Rixtel and Gasperini, 2013) and tend to be influenced in different ways at times of crisis, yields showing substantial spikes. According to Table 1, conventional bonds comprise a small share of short-term funding, while they account for approximately 15-30 percent of funding in the long term. We conclude that these securities are used much more extensively for long-term funding. Due to the sharp increase in credit spreads on conventional bonds issued by banks after the crisis it is necessary to correct the weight on long-term funding by imposing the assumption that the banks will use cheapest available funding, and will not borrow at rates above lending rates of the same maturity. Therefore, if the WACL measure is higher than the lending rate at the same maturity, we assume the banks would resort to funding through covered bonds. In such cases, we allocate greater weight to the covered bonds category by reducing the weight on conventional bonds to zero. This

produces an adjusted WACL – WACL_s hereafter – that has less pronounced peaks in the long term funding costs that banks face because covered bond yields are lower than conventional bond yields.

Weight components of the long-term WACL[1]

In per cent Table 1B

	MFI deposits			Non-MFI deposits			Long-term securities other than shares			Covered bonds			Central bank operations[2]		
	All	Pre	Post	All	Pre	Post	All	Pre	Post	All	Pre	Post	All	Pre	Post
Austria	**28.0**	27.3	28.6	**40.3**	41.2	39.4	**28.8**	29.1	28.4	**1.5**	0.9	2.1	**1.5**	1.5	1.5
Finland	**15.6**	17.0	14.3	**61.0**	64.6	57.5	**19.9**	16.5	23.3	**2.1**	0.2	3.9	**1.3**	1.6	1.0
France	**40.7**	42.0	39.5	**38.3**	39.4	37.3	**16.3**	15.5	17.0	**4.1**	3.1	5.1	**0.6**	0.0	1.2
Germany	**23.8**	24.0	23.5	**41.6**	35.4	47.6	**22.0**	23.4	20.6	**10.4**	14.2	6.6	**2.3**	2.9	1.6
Ireland	**44.1**	43.4	44.9	**31.0**	32.5	29.5	**14.2**	16.3	12.1	**3.2**	3.6	2.8	**7.5**	4.2	10.8
Italy	**27.5**	29.6	25.4	**43.6**	42.7	44.5	**27.0**	26.2	27.7	**0.8**	0.0	1.6	**1.2**	1.6	0.8
Netherlands	**16.3**	22.0	10.8	**53.3**	50.9	55.7	**25.8**	24.7	26.9	**0.8**	0.3	1.3	**3.7**	2.1	5.2
Portugal	**24.4**	27.6	21.3	**54.3**	59.9	49.0	**14.7**	11.0	18.4	**1.9**	0.4	3.3	**4.7**	1.2	8.0
Spain	**19.8**	21.6	18.0	**55.4**	57.5	53.3	**11.7**	11.4	12.0	**9.6**	7.8	11.4	**3.5**	1.6	5.3
Denmark	**13.5**	11.7	15.2	**24.9**	26.5	23.3	**61.4**	61.8	61.0	**0.3**	0.0	0.5			
United Kingdom	**27.6**	33.6	21.7	**56.8**	53.0	60.5	**14.0**	13.0	15.1	**1.6**	0.5	2.7			

[1] All refers to the full sample, pre-crisis is from January 2003 (depending on data availability) to August 2008; post-crisis is from September 2008 to the latest data available. [2] ECB main refinancing operations and long-term refinancing operations.

Sources: European Central Bank; Dealogic; national data.

The fourth component is funding from **covered bonds,** which are obtained from Dealogic. This component is only used for the long-term calculations, as we assume that all of the covered bonds have a maturity of more than one year. The volume of covered bonds outstanding is not large,[15] but has grown since the crisis. Banks in Austria, Finland, France, Italy, Netherland, Portugal, Spain and the United Kingdom all increased the proportion of funding from this source after the financial crisis.

The fifth and last component of the calculation is funding from **central bank operations**. We only use this for the euro area countries as we believe that the cheap funding given by the ECB in crisis time slightly lowered the funding cost of the MFIs. Liquidity provided by the central bank is a component that becomes important in the period after 2009. Van Rixtel and Gasperini (2013) show that Spain and Italy relied most heavily on liquidity operations provided by the ECB having borrowed, respectively, €400bn and €277bn in September 2012. For the short-term, we include the amounts of the Main Refinancing Operations (MROs), while for the long-term we sum up the amounts of MROs and the long-term refinancing operations (LTROs). The dependence on central bank liquidity amounted to thirty percent of total bank assets in Greece, eleven per cent in Ireland, eight percent in

[15] Exceptions are Germany and Spain.

Spain and five percent in Portugal over the post-crisis period. At the peak of the sovereign debt crisis, the proportion was even larger. Banks also benefited indirectly from liquidity operations and outright monetary transactions (OMT) announcements, since they reduced the default risks of euro area banks, lowering bank bond spreads. These effects also spilled over to banks in non-euro area countries such as the UK and Denmark, via their cross-exposure.

We exclude funding from **equity issuance** from the WACL since it accounts for a small percentage of the outstanding balances, and it is arguably not used by banks as a source of regular finance for bank lending, but rather as a structural adjustment (e.g. adjustment of capital ratios in response to regulatory requirements). Besides, Adrian *et al.* (2013) show that while changes in banks' assets (including loans) and changes in their debt move proportionally, equity remains 'sticky', i.e. it does not adjust when there is a change in assets.

In order to check the robustness of our results to the weighting scheme, we also compute an **entirely marginal WACL**: the weights are based on flows rather than outstanding amounts;[16] this will be referred to as WACL_f. To compute the WACL_f, we collected data from the ECB on new deposits with agreed maturity for non-MFIs. Since there is no new deposits data for the MFIs, we approximated this by multiplying the flow data of the non-MFIs with the ratio between the outstanding amounts of interbank and private deposit liabilities.

Data on debt securities is obtained from the ECB debt securities database, which reports the gross issuance by sector of securities other than shares for the short- (less than one year) and the long-term (more than one year). The covered bonds are obtained from Dealogic, which reports the gross issuance by the financial sector; this is used only in the long-term calculation. As above, a reallocation from securities to covered bonds in the long-run is performed, based on the assumption that the banks will use the most efficient funding method.

3.2 Interest rates

Each type of liability has a matching interest rate, which is always based on new transactions.[17] For the MFIs deposits to other MFIs we use the interbank money market rates. For the short-term we use the overnight rates, while for the long-term the 1-year rates. The deposit rate of the non-MFI deposits is obtained from the ECB MFI interest rate statistics, and is the rate on euro deposits with agreed maturity for the non-financial corporations and households with maturities up to 1 year for the short-term and over 1-year for the long-term. For Denmark and United Kingdom similar rates have been obtained from the national central banks. Since Denmark reports no breakdown of interest rate by maturity, we use the same rates for both short-term and long term deposits.

As for the cost of debt securities, we assume that the banks are able to issue bonds at a cost equal to the interest rate swap rate plus a mark-up representing the industry risk amounting to the credit default swap (CDS) rate for the banking sector

[16] We could not access volumes of funding at the individual country level for the ECB operations, we had to exclude this type of liability from the calculations.

[17] This implies both the baseline and the fully marginal WACL rely on the same interest rates.

in each country. To calculate the financial CDS we use a simple average over the CDS of selected financial institutions in each country. In order to measure the long term rate we use the 5-year interest rate swap plus the 5-year financial CDS while for the short-term the 1-year interest rate swap plus the 1-year financial CDS. The interest rate on covered bonds is obtained from Barclays, which reports the yield to maturity for the outstanding amount of bonds (see the appendix where we plot the data). For the central bank operations we use the Main Refinancing Rate of the euro area.

The short-term and long-term interest rates are reported in Tables 1C and 1D respectively. These figures indicate one source of the differences between the funding costs for different countries in our sample. When multiplied by the relevant weights they provide the short- or long-term WACL funding costs used in our analysis.

Interest rate components of the short-term WACL[1]

In per cent — Table 1C

	MFI deposits[2]			Non-MFI deposits[3]			Short-term securities other than shares[4]			Central bank operations[5]		
	All	Pre	Post	**All**	Pre	Post	**All**	Pre	Post	**All**	Pre	Post
Austria	1.67	2.80	0.60	1.98	2.77	1.22	2.89	3.33	2.48	1.81	2.75	0.98
Finland	1.67	2.80	0.60	1.92	2.80	1.05	2.58	3.32	1.88	1.81	2.75	0.98
France	1.67	2.80	0.60	2.06	2.81	1.33	2.63	3.29	2.01	1.81	2.75	0.98
Germany	1.67	2.80	0.60	1.82	2.73	0.93	2.61	3.35	1.91	1.81	2.75	0.98
Ireland	1.67	2.80	0.60	2.08	2.62	1.55	5.65	3.36	7.81	1.81	2.75	0.98
Italy	1.67	2.80	0.60	2.16	2.47	1.85	3.22	3.31	3.13	1.81	2.75	0.98
Netherlands	1.67	2.80	0.60	1.90	2.87	0.95	3.35	3.62	3.09	1.81	2.75	0.98
Portugal	1.67	2.80	0.60	2.49	2.74	2.24	4.67	3.34	5.91	1.81	2.75	0.98
Spain	1.67	2.80	0.60	2.45	2.80	2.12	3.54	3.35	3.71	1.81	2.75	0.98
Denmark	1.81	2.89	0.79	1.75	2.11	1.38	2.86	3.41	2.35	1.71	2.75	0.78
United Kingdom	2.66	4.70	0.74	3.01	4.65	1.65	3.55	5.12	2.06	2.54	4.64	0.69

[1] All refers to the full the sample, pre-crisis is from January 2003 (depending on data availability) to August 2008; post-crisis is from September 2008 to the latest data available. [2] Interbank overnight rates. [3] Deposit rate on euro deposits with agreed maturity for the non-financial corporations and households with maturities up to 1 year; if data not available close approximation to this rate. [4] The 1-year interest rate swap plus the 1-year financial CDS for selected banks in each country. [5] The central bank policy rate.

Sources: European Central Bank; national data.

Interest rate components of the long-term WACL[1]

In per cent — Table 1D

	MFI deposits[2]			Non-MFI deposits[3]			Long-term securities other than shares[4]			Covered bonds			Central bank operations[5]		
	All	Pre	Post	**All**	Pre	Post	**All**	Pre	Post	**All**	Pre	Post	**All**	Pre	Post
Austria	2.28	3.20	1.42	2.57	3.15	2.01	3.91	4.02	3.81	3.14	4.02	2.27	1.81	2.75	0.98
Finland	2.28	3.20	1.42	2.47	2.97	1.99	3.44	3.95	2.96	2.82	3.62	2.03	1.81	2.75	0.98
France	2.28	3.20	1.42	2.82	3.02	2.63	3.66	3.93	3.40	3.14	3.74	2.54	1.81	2.75	0.98
Germany	2.28	3.20	1.42	2.78	3.33	2.25	3.65	4.04	3.28	2.66	3.54	1.80	1.81	2.75	0.98
Ireland	2.28	3.20	1.42	2.08	2.62	1.55	5.91	4.07	7.65	4.10	3.71	4.48	1.81	2.75	0.98
Italy	2.28	3.20	1.42	2.30	2.35	2.25	4.23	3.97	4.48	3.79	4.20	3.39	1.81	2.75	0.98
Netherlands	2.28	3.20	1.42	3.82	4.22	3.44	4.24	4.22	4.26	3.19	3.80	2.58	1.81	2.75	0.98
Portugal	2.28	3.20	1.42	2.68	2.56	2.81	5.39	4.04	6.66	4.83	4.40	5.25	1.81	2.75	0.98
Spain	2.28	3.20	1.42	2.62	2.70	2.55	4.51	4.02	4.97	4.17	4.01	4.34	1.81	2.75	0.98
Denmark	2.54	3.33	1.79	1.75	2.11	1.38	3.82	4.04	3.60	2.89	3.36	2.43	1.71	2.75	0.78
United Kingdom	3.28	5.06	1.59	3.97	4.95	3.16	4.49	5.28	3.73	3.49	4.05	2.95	2.54	4.64	0.69

[1] All refers to the full sample, pre-crisis is from January 2003 (depending on data availability) to August 2008; post-crisis is from September 2008 to the latest data available. [2] Interbank overnight rates. [3] Deposit rate on euro deposits with agreed maturity for the non-financial corporations and households with maturities over to 1 year; if data not available close approximation to this rate. [4] The 5-year interest rate swap plus the 5-year financial CDS for selected banks in each country. [5] The central bank policy rate.

Sources: European Central Bank; Barclays; national data.

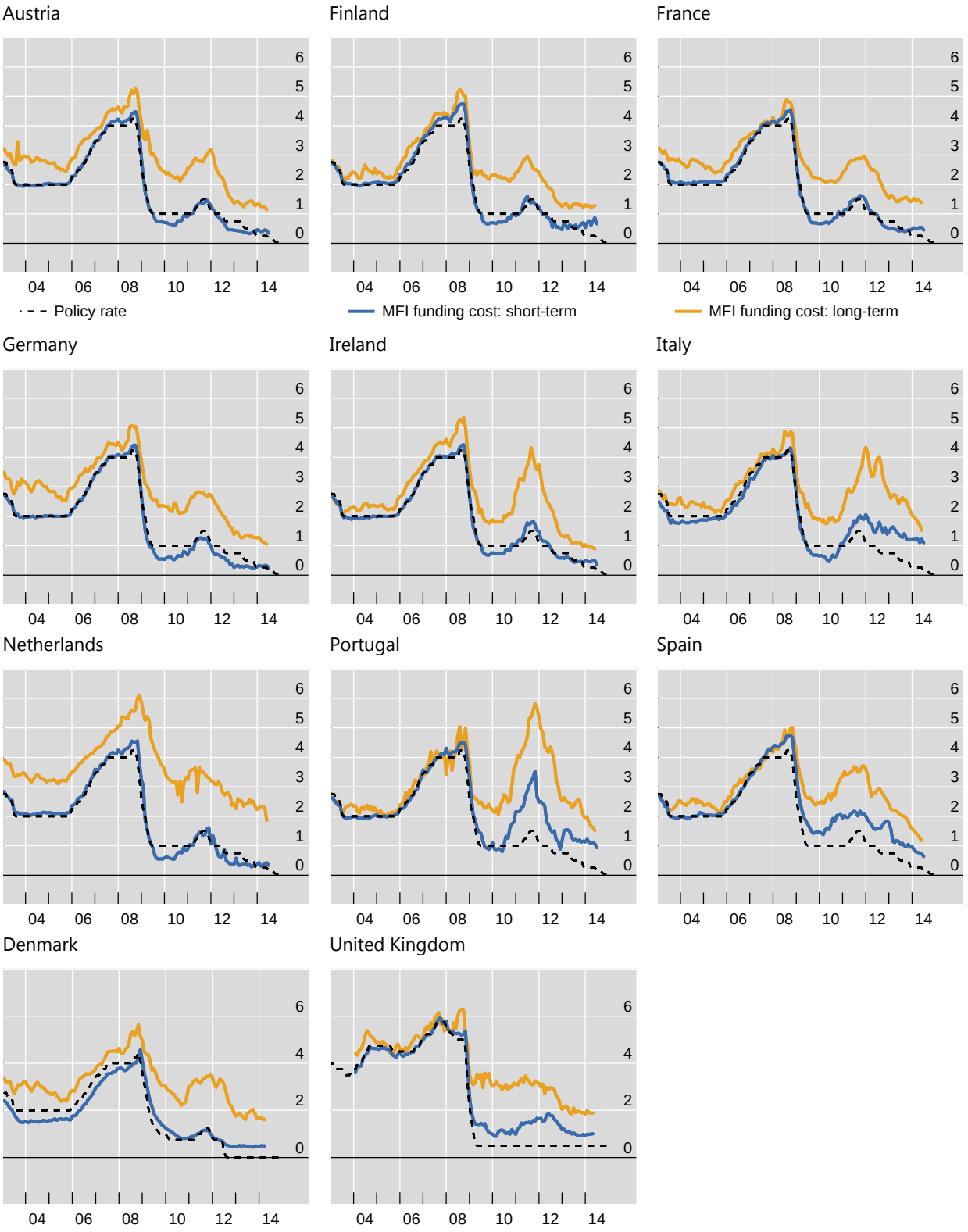
3.3 A comparison between WACL and the policy rate

WACL funding costs are plotted in Graph 2, together with policy rates. Funding costs follow policy rates quite closely in the pre-crisis period, although there is some evidence that costs did not fall as much as policy rates in the core euro area countries during the 2003-2004 downturn. Short-term funding costs followed policy rates very closely in all the countries in our sample, while long-term funding costs were higher than policy rates, reflecting a term premium and compensation for risk. After the Lehman bankruptcy, credit risk was re-assessed, and the risk premium jumped upwards significantly. While the rates fell as policy rates were reduced, market funding added a larger margin for credit risk than in the pre-crisis period (see Gilchrist and Mojon, 2013, Darracq-Paries *et al*. 2014). In most countries there are wider margins between short-term or long-term funding costs and the policy rate in the post crisis period compared with the pre-crisis period, and this is most evident in the peripheral countries, Italy, Portugal, Spain, but also in the UK, which was more heavily exposed to the effects of the crisis at an early stage. It is already apparent from Graph 2 that there is an upward movement in long-term rates, particularly for peripheral countries as well as for Austria, whose banks were heavily exposed to Central and Eastern European countries. Sharp spikes from 2010Q1 reflected the higher yields on conventional and, to a lesser extent, covered bonds following the sovereign debt crisis. To some extent, recourse to ECB liquidity cut the cost of funding but the influence was rather small.

Bank funding costs (WACL) and policy rates[1]

In per cent

Graph 2



[1] The short-term represents rates less than 1-year maturity, while the long-term rates more than 1-year maturity, assuming an average of 5-years.

Sources: European Central Bank; Barclays; Dealogic; national data.

3.4 The comparison between WACL and lending rates

We now turn to the main subject of our paper: a comparison of the WACL and lending rates offered by MFIs to households and the non-financial corporations. For households we collect from the ECB lending rates on new loans for house purchases (excluding revolving loans), overdrafts and credit card debt for maturities of up to 1-year and over 1-year. For non-financial corporates we collect the lending rates on new loans (other than revolving loans) and overdrafts and credit card debt, for the same breakdown of maturities as above. For Denmark data are obtained from the national central bank.

We examine separately short- and long-term lending. Graph 3 shows the rates on mortgage lending to households and loans to non-financial corporations for terms of less than one year versus the WACL. The movements in lending rates and funding costs are fairly similar within each country: there is a co-movement between these variables and policy rates. However, in the post-crisis period funding costs diverge from policy rates, and lending rates to households and firms tend to follow more closely the movement of funding costs.

For the long term lending rates (over one year) we see a different pattern that is most evident in the peripheral countries (Ireland, Italy, Portugal and Spain), and to some extent Austria. It can be seen in Graph 4 that funding costs peaked from 2010-12 and slowly decreased after this period.

4. Methodology

The basic form of the relationship between y_{it}, (the lending rate which is the focus of our analysis), and x_{it}, the driver of the lending rate (i.e. the policy rate or the WACL) is an ARDL model with lags *P, Q* as follows:

$$y_{it} = \sum_{p=1}^{P} \chi_{ip} y_{it-p} + \sum_{q=0}^{Q} \delta_{iq} x_{it-q} + \mu_i + e_{it} \tag{7}$$

The number of lags (*P, Q*) is determined by the Bayesian Information Criterion (BIC). This can be rewritten as a stacked set of *N* individual equations relating y_{it} and x_{it} for groups $i = 1,2,...N$ over the time period t=1,2,...T as

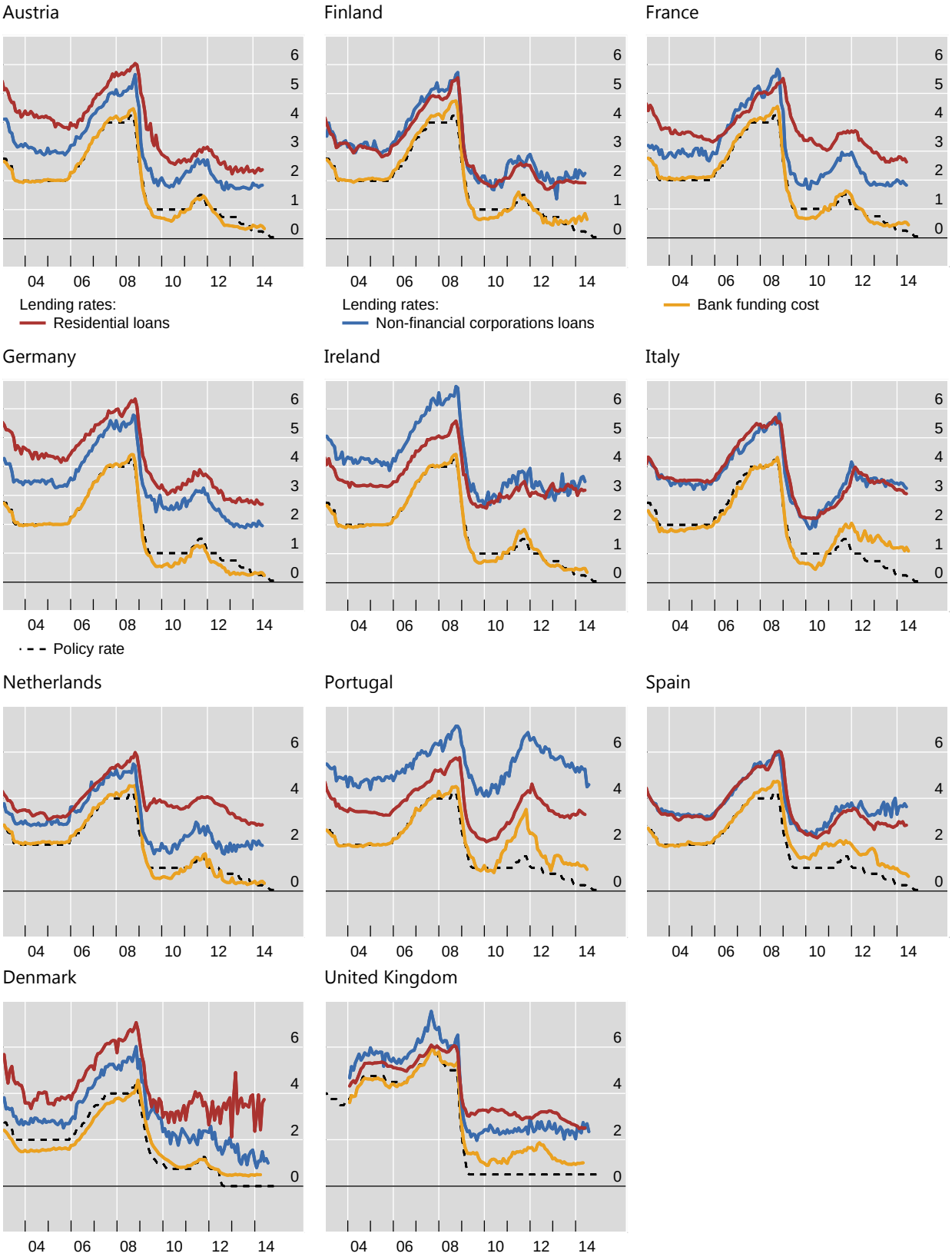
$$\Delta Y_i = \alpha_i Y_{i,-1} + \beta_i X_i + \sum_{p=1}^{P-1} \chi_{ip} \Delta Y_{i,-p} + \sum_{q=0}^{Q-1} \delta_{iq} \Delta X_{i,-q} + \mu_i 1 + \varepsilon_i \tag{8}$$

where $Y_i = (y_{i1}, \ldots y_{iT})'$, $X_i = (x_{i1}, \ldots x_{iT})'$, $1 = (1,\ldots, 1)'$, $\varepsilon_i = (e_{i1}, \ldots e_{iT})'$ are all *T x 1* vectors of observations, ones and residual errors, and Δ is the first difference operator. We first test whether the data are non-stationary, using the Im, Pesaran and Shin (2003) panel unit root test. In the case where the roots lie outside the unit circle we then search for evidence of cointegration, using Westerlund panel cointegration tests. Failure to find cointegration suggests that there is no long-run relationship between the variables of interest. But whenever the series are found to be non-stationary and cointegrated, we can use the dynamic heterogeneous panel pooled mean group (PMG) estimator first proposed by Pesaran and Smith (1995) and Pesaran, Shin and Smith (1999). The model has the following specification:

$$\Delta Y_i = \alpha_i (Y_{i,-1} - \theta_i X_i) + \sum_{p=1}^{P-1} \chi_{ip} \Delta Y_{i,-p} + \sum_{q=0}^{Q-1} \delta_{iq} \Delta X_{i,-q} + \mu_i 1 + \varepsilon_i \tag{9}$$

MFI lending rates and funding costs: short-term[1]

In per cent — Graph 3



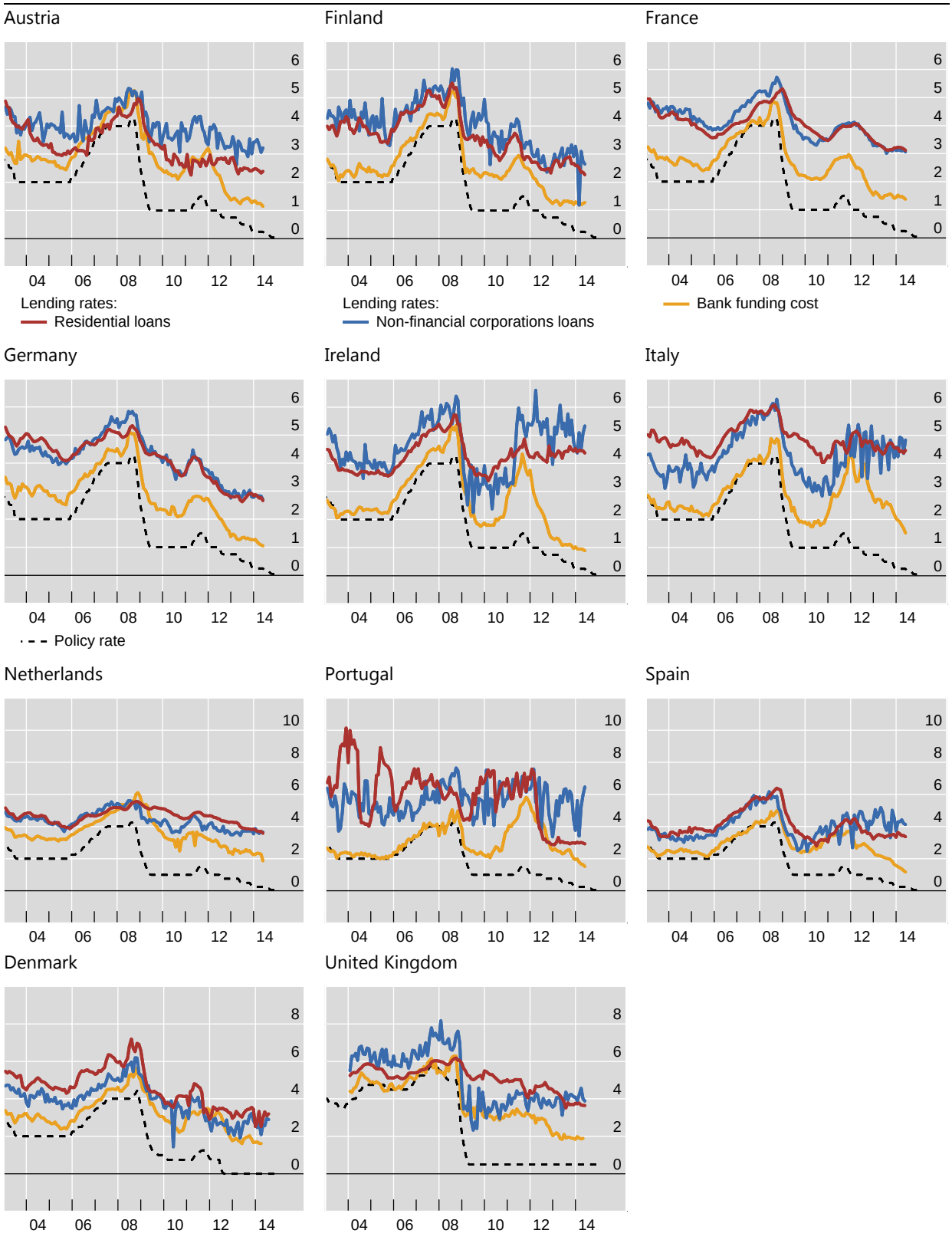
[1] The short-term is represented by rates less than 1-year in maturity.

Sources: European Central Bank; national data.

MFI lending rates and funding costs: long-term[1]

In per cent

Graph 4



[1] The long-term is represented byrates above 1-year maturity. The average maturity assumed for the long-term is 5-years.

Sources: European Central Bank; Barclays; Dealogic; national data.

where the relationship $\alpha_i(Y_{i,-1} - \theta_i X_i)$ for the levels provides information on the long-run relation between lending rates and driving variables i.e. policy rates or funding costs, the $\beta_i = \alpha_i\theta_i$ coefficient is an estimate of the long-run pass-through coefficient and α_i is the adjustment speed of rates to deviations from this long-run for the individual country i. If there is no long-run relationship, then the estimate of α_i and β_i from equation (8) are just re-parameterisations of coefficients in equation (7).

It is possible to test the homogeneity of the long-run coefficient value, which would restrict $\theta_i = \theta$. The mean group estimator (MGE), which is a plain average of individual group i estimates of equations stacked in (8), is consistent but inefficient if there is a common slope coefficient. A Hausman (1978) test can be employed to discriminate whether slope homogeneity can be imposed.

5. Results

5.1 Preliminary analysis of the data

As anticipated, we first explore the integration properties of the variables of interest using the Im-Pesaran-Shin (2003) panel unit root test. The test statistic and its p-values are reported in the first panel of Table 2. The null hypothesis is that no variable in the panel has unit roots. We comfortably fail to reject the null in all cases, which confirms that our data are non-stationary.

Next, we explore whether variables are cointegrated, i.e. they tend to move together in the long run. Panel cointegration tests are reported in the second panel of Table 2. The table reports results using WACL, WACL_s, WACL_f and the policy rate. We compute two test statistics, G_τ and P_π from Westerlund (2007) for each case. The first, G_π relates to a null hypothesis of no cointegration against an alternative where there is at least one country with a cointegrating relationship. The second, P_π relates to a null hypothesis of no cointegration against alternative where all countries have a cointegrating relationship. Results for the WACL and WACL_s measures lead to reject the null of no cointegrating relationship against the first alternative with no exceptions. For WACL_f we find the same result, except for short-term lending to businesses for which we cannot reject the null of no cointegration.

If one applies the same tests to policy rates, the null hypothesis of cointegration is rejected much more often. The G_τ test indicates three out of four rejections, and the P_τ test two out of four rejections using data over the full sample. When we reduce the sample to the period prior to the global financial crisis we find that the null hypothesis of cointegration is rejected in every case, so it appears there is a break in this behaviour around the time of the financial crisis. To explore this issue, we use a test for panel cointegration allowing for a structural break, based on Westerlund (2006) and Banerjee and Carrion-I-Silvestre (2004).[18] Examining the data for policy rates reveals a level shift when short term policy rates were reduced in response to the crisis. Table 2 reports the Westerlund parametric tests PZ_τ and

[18] We are grateful for the provision of the Gauss codes from the website of Jaokim Westerlund, and from Josep Carrion-I-Silvestre directly.

PZ_ρ for panel cointegration in the presence of a structural break in the intercept at an unknown date, which is determined in the model endogenously. The test statistics fail to reject the null of no cointegration at conventional levels of significance for all four lending rates and policy rates. We use Banerjee and Carrion-I-Silvestre (2004) tests with cross sectional independence, which we label Z_c and Z_{cb}, allow for a break in the intercept and a break in the intercept and slope. With only

Unit root and cointegration tests

Table 2

Im–Pesaran–Shin panel unit root test	W–stat	p-value				
Long rate to NFCs	–2.531	0.006				
Short rate to NFCs	1.437	0.925				
Long mortgage rate	0.690	0.755				
Short mortgage rate	–0.119	0.453				
Bank funding costs (short term)						
WACL(stock, unadjusted)	0.693	0.756				
WACL (stock, adjusted)	0.693	0.756				
WACL (flow, adjusted)	1.593	0.945				
Bank funding costs (long term)						
WACL (stock, unadjusted)	1.832	0.967				
WACL (stock, adjusted)	1.988	0.978				
WACL (flow, adjusted)	2.220	0.987				
Policy rate	2.593	0.995				
Cointegration test			Short rate to NFCs	Long rate to NFCs	Short mortgage rate	Long mortgage rate
Weighted Average Cost of Liabilities (WACL)						
WACL (stock, unadjusted)	G_τ		-4.288***	-1.730**	-3.340***	-2.987***
WACL (stock, unadjusted)	P_τ		-2.571***	-4.073***	-3.712***	-3.450***
WACL (stock adjusted)	G_τ		-4.288***	-3.449***	-3.340***	-3.540***
WACL (stock, adjusted)	P_τ		-2.571***	-2.554***	-3.712***	-3.645***
WACL (flow, adjusted)	G_τ		0.270	-2.508***	-2.734***	-1.919**
WACL (flow, adjusted)	P_τ		0.737	-3.521***	-2.087**	-3.052***
Policy Rate						
Policy rate (full sample)	G_τ		-1.253	-2.564***	1.069	-1.197
Policy rate (full sample)	P_τ		-0.196	-4.409***	-0.398	-3.600***
Policy rate (Pre-GFC sample)	G_τ		-6.392***	-3.681***	-3.802***	-2.080**
Policy rate (Pre-GFC sample)	P_τ		-6.673***	-5.566***	-3.868***	-1.892**
Policy rate (full sample, C break)	PZ_τ		5.220	1.475	12.950	10.414
Policy rate (full sample, C break)	PZ_ρ		0.471	0.341	0.657	0.697
Policy rate (full sample, C break)	Z_c		0.2826	-2.4617**	0.3687	-0.5963
Policy rate (full sample, C/B break)	Z_{cb}		0.9699	-1.0715	0.3658	0.6941

Note: The critical value for all tests are taken from the standard Normal, hence at the 5% level the critical value at the left tail of the distribution is -1.96.

one exception these tests do not reject the null of no cointegration allowing for a break at a known point (October 2008). This shows there is not a stable relationship between lending and policy rates even after allowance for a structural break at an unknown point in the sample.

The results of these tests lead us to conclude there is stronger evidence of a stable relationship between lending rates and the WACL_s or WACL_f funding costs than between lending rates and the policy rate.

5.2 Results from non-stationary dynamic panels

We consider the lending rates and the WACL_s funding costs one at a time to explore the relationships within our panel across countries and through time.

We report our baseline results in Table 3. The first panel gives results using WACL_s based on stocks of deposits, bonds and liquidity reported on the balance sheet, with adjusted weights to ensure the long run funding cost does not exceed the lending rate. The second panel reports the results for a similarly constructed WACL_f weighted using the flows of deposits, gross issuance of bonds and central bank liquidity. We split the sample of countries in each panel into three groups: the first one includes all 11 countries in the euro area as well as the UK and Denmark, the second refers only to the euro area and the third includes only core euro area countries (i.e. excluding Ireland, Italy, Portugal and Spain). The tables report common long-run coefficient estimates of the relationship between the four different interest rates (short-term and long-term loans to business and short-term and long term mortgages, in successive columns) versus funding costs, over the full sample period January 2003 – April 2014. We also report the estimate of the average adjustment to the long-run relationship for each group of countries.

Results for WACL_s are displayed in the first panel. We find that the common pass-through coefficient estimates take plausible values, which are significantly less than one. This implies that a 100bp increase the WACL_s funding cost for banks would result in an increase in lending rates between 66-87bp. Unsurprisingly, long-term lending rates are consistently less responsive than short-term lending rates. The relationship between short-term lending rates and WACL_s rates is fairly similar

Pesaran-Shin-Smith pooled mean group estimates of interest rate pass through using weighted average cost of liabilities (WACL) Table 3

	WACL (stock, adjusted)				WACL (flow, adjusted)			
	Short rate to NFCs	Long rate to NFCs	Short mortgage rate	Long mortgage rate	Short rate to NFCs	Long rate to NFCs	Short mortgage rate	Long mortgage rate
Countries: Euro Area, UK and Denmark								
Cointegrating relation								
Pass through estimate	0.871***	0.807***	0.844***	0.747***	0.876***	0.696***	0.868***	0.681***
	-0.011	-0.031	-0.012	-0.048	-0.014	-0.046	-0.019	-0.048
Short run adjustment								
coefficient	-0.265***	-0.253***	-0.135***	-0.084***	-0.169***	-0.192***	-0.096***	-0.074***
	-0.045	-0.045	-0.039	-0.021	-0.05	-0.031	-0.021	-0.014
Hausman test $\chi^2(1)$	0.674	0.018	0.914	0.211	0.255	0.270	0.021	0.388
Countries: Euro Area								
Cointegrating relation								
Pass through estimate	0.851***	0.672***	0.846***	0.703***	0.876***	0.699***	0.871***	0.695***
	-0.012	-0.037	-0.012	-0.054	-0.014	-0.046	-0.019	-0.056
Short run adjustment								
Coefficient	-0.263***	-0.248***	-0.118**	-0.072***	-0.196***	-0.205***	-0.104***	-0.072***
	-0.054	-0.048	-0.037	-0.018	-0.057	-0.036	-0.025	-0.016
Hausman test $\chi^2(1)$	0.924	0.517	0.842	0.298	0.577	0.387	0.124	0.460
Countries: Euro Area Core								
Cointegrating relation								
Pass through estimate	0.853***	0.659***	0.845***	0.721***	0.883***	0.766***	0.874***	0.715***
	-0.012	-0.039	-0.012	-0.06	-0.015	-0.05	-0.021	-0.062
Short run adjustment								
Coefficient	-0.360***	-0.237***	-0.152*	-0.080**	-0.255**	-0.185***	-0.120**	-0.076**
	-0.062	-0.062	-0.064	-0.028	-0.092	-0.022	-0.043	-0.027
Hausman test $\chi^2(1)$	0.583	0.342	0.059	0.032	0.388	0.647	0.334	0.033

across the three groups of countries, but when we compare the estimated coefficients for long-term rates we observe greater differences between the full set (top two rows) compared with the euro area (middle two rows) and the core (bottom two rows).

A similar pattern is observed in the second panel where we report the results for WACL_f, and estimated pass through coefficients have magnitudes that are not statistically different from those reported for WACL_s despite the use of a different weighting scheme to construct the funding cost measure. This makes an important point, since the similarity of the results using either stocks or flows to determine the weights in the construction of the funding costs does not alter the pass through estimates. This suggests that our results are robust to the choice of funding weights. As far as the interpretation of the funding cost is concerned the funding costs have constituent elements that accurately represent the marginal cost of funding for the banks irrespective of the mechanism for weighting them, which cannot be said of the policy rate.

The model imposes a common long-run pass-through coefficient across all eleven countries. We therefore need to test the validity of this assumption. We use a Hausman test for comparison of the equality of coefficients estimated from the baseline PMG model with coefficients obtained from the MGE model, where the long-run coefficient estimates are unconstrained. The reported p-values (Table 3) show that we cannot reject the null of equality in the majority of cases (there are four exceptions among 24 tests). This means that the restriction on the long-run relationship imposing a common pass-through coefficient is validated by the data.

In Table 3, we also report the average of short-run adjustment coefficients for each group of countries. The adjustment coefficients are negative and significant in every case for each of the panels. The adjustment speed is generally faster for short- and long-term lending rates to business than to households: the estimated coefficients are two or three times larger for lending rates to business using WACL_s or WACL_f compared to the adjustment coefficients for households. This may be a consequence of the bespoke nature of loans to business, which are likely to adjust to prevailing conditions more quickly than loans to households, which are generic products.

These findings contrast markedly with results for policy rates reported in Table 4. The pass-through estimates have smaller magnitudes compared with Table 3; a 100bp change in the policy rates implies a wider range of increases in lending rates between 52-92bp compared to a range of 66-87bp for the WACL_s results. Policy rates varied more than the WACL measures over the full sample; in the pre-crisis period they took values between 2-3% and rose to 6% immediately before the crisis, while after the crisis they were below 1%. The WACL measures took similar values to the policy rate before the crisis but did not fall below 1% for most countries in the post crisis period. Therefore there was no distinct break in the series around the time of the crisis.

There appears to be significant heterogeneity between the responses of banks within the countries; this does not permit us to impose a common long-run pass through coefficient: the p-values of the Hausman test reject the null of equality of coefficients between the restricted long-run relationships across countries in the PMG model versus an unrestricted long-run relationship in the MGE model. By contrast, we recall that our earlier results in Table 2 indicated that panel cointegration was present in a minority of cases when we explored the relationship

between our four lending rates and policy rates. So, there seems to be stronger and more consistent empirical evidence in favour of a stable and consistent relationship between lending rates and WACL_s funding costs.

Pesaran–Shin–Smith pooled mean group estimates of interest rate pass through using policy rates

Table 4

	Short rate to NFCs	Long rate to NFCs	Short mortgage rate	Long mortgage rate
Countries: Euro Area, UK and Denmark				
Cointegrating relation				
Pass through estimate	0.903***	0.598***	0.529***	0.722***
	0.015	*0.035*	*0.011*	*0.029*
Short run adjustment				
coefficient	–0.213***	–0.173***	–0.075**	–0.103**
	0.041	*0.029*	*0.029*	*0.038*
Hausman test $\chi^2(1)$	0.081	0.049	0.062	0.210
Countries: Euro Area				
Cointegrating relation				
Pass through estimate	0.923***	0.539***	0.951***	0.666***
	0.016	*0.039*	*0.022*	*0.044*
Short run adjustment				
coefficient	–0.205***	–0.157***	–0.073**	–0.080**
	0.051	*0.032*	*0.028*	*0.026*
Hausman test $\chi^2(1)$	0.048	0.173	0.837	0.366
Countries: Euro Area Core				
Cointegrating relation				
Pass through estimate	0.926***	0.556***	0.957***	0.674***
	0.016	*0.041*	*0.022*	*0.047*
Short run adjustment				
Coefficient	–0.316***	–0.199***	–0.117**	–0.095*
	0.027	*0.039*	*0.041*	*0.04*
Hausman test $\chi^2(1)$	-	0.324	0.327	0.000

5.3 Robustness checks

The previous tables have presented the long-run relationships and the average adjustment coefficients across countries when we estimate the pass-through relationship over the full 2003M1-2014M4 sample. We now consider sub-samples of the data to explore the pass-through of WACL to lending rates up to three alternative break points in the data. The first break point is the onset of the global financial crisis (GFC), July 2007, after which bank funding costs increased significantly. The second is the point just before Lehman collapsed and the recession took hold, August 2008, where the data show that there was

adeterioration in economic growth rates leading to a recession.[19] The third break point is just prior to the sovereign debt crisis, December 2009: banks in periphery countries were shut out of the bond market (or faced exceptionally very high costs), and perceptions of default risk for banks increased (as shown by the increased correlation of bank CDS spreads with sovereign CDS spreads).

Pesaran-Shin-Smith pooled mean group estimates of interest rate pass through using WACL for sub-samples (Euro area) Table 5

	Short rate to NFCs	Long rate to NFCs	Short mortgage rate	Long mortgage rate
Sample extends until global financial crisis (2003M1 - 2007M7)				
Cointegrating relation				
Pass through estimate	0.976***	0.886***	0.840***	0.839***
	-0.021	-0.068	-0.024	-0.062
Short run adjustment				
coefficient	-0.521***	-0.323***	-0.194**	-0.137***
	-0.107	-0.098	-0.062	-0.035
Hausman test $\chi^2(1)$	0.319	0.084	0.679	0.480
Sample extends until post crisis recession (2003M1 - 2008M8)				
Cointegrating relation				
Pass through estimate	0.957***	0.800***	0.892***	0.627***
	-0.01	-0.035	-0.016	-0.041
Short run adjustment				
coefficient	-0.455***	-0.333***	-0.210***	-0.128***
	-0.081	-0.07	-0.039	-0.031
Hausman test $\chi^2(1)$	0.924	0.270	0.300	0.561
Sample extends until sovereign debt crisis (2003M1 - 2009M12)				
Cointegrating relation				
Pass through estimate	0.971***	0.740***	0.898***	0.647***
	-0.012	-0.036	-0.019	-0.025
Short run adjustment				
coefficient	-0.397***	-0.312***	-0.167***	-0.141***
	-0.057	-0.065	-0.031	-0.036
Hausman test $\chi^2(1)$	0.358	0.415	0.092	0.727

Table 5 reports the pass-through coefficients for WACL_s data for these three break points for the euro area countries. The interesting finding is that coefficient estimates are slightly larger in magnitude compared with those reported in Table 4. When we stop the sample in July 2007, the pass-through is close to one for short term lending to business, and close to but significantly different from one for the remaining lending rates. While this does not imply pass through was complete before the crisis, it was slightly higher than the estimate for the full sample.

[19] The growing intensity of the recession is also reflected in the fact that, banks began to tighten credit conditions in 2008Q3 according to the ECB Bank Lending Survey, and house prices began to fall.

Adjustment speeds were also much higher, particularly for lending to business compared with Table 3. When we break the data in August 2008 the estimated coefficients are smaller in three cases out of four compared to the sample up to July 2007, but larger than the estimates from Table 3. Adjustment speeds fall a little or stay the same compared to estimates to July 2007. If we break the data in January 2010 at the start of the sovereign debt crisis, we find the estimated pass-through drops a little further in one case but is about the same for the others, and adjustment speeds are lower. Hausman tests do not reject the null that the estimate of pass-through is equal across countries is a valid restriction on an unrestricted model for the majority of cases. This evidence seems to suggest that pass-through has fallen after the crisis: this is highlighted by the reduction in pass-through for the pre-crisis sample versus the full sample and the progressive reduction in pass-through as the sub-sample is extended. But the magnitude of the reduction in the response to a one percentage point reduction in funding costs is about 100 bp higher for the pre-crisis period compared to the full sample.

The conclusion we draw from these tables is that the coefficient estimates from a carefully constructed weighted average cost of liabilities are not as low as the estimates provided using policy rates and extension of the sample period to later break points still gives results that imply substantial pass-through of funding costs to lending rates. These results are robust to different weighting schemes for construction of the funding costs. It is hard to argue from these results that in the post-crisis period, that banks response to funding costs has fundamentally changed, although there is some evidence that the adjustment speed associated with pass-through has declined.

6. Conclusions

Many observers have noted that lending rates set by banks have not fallen as much as policy rates. We suggest that the argument ignores three important facts: first, the policy rate is a very short-term rate compared to the maturities over which banks lend; second, banks do not obtain funding at policy rates; and third, banks face substantially higher funding costs in the post crisis period due to higher risk premiums and the effects of the zero lower bound on deposit rates.

We construct a weighted average cost of liabilities (WACL) for eleven countries using both stock- and flow-based weights and document that there were substantial differences in the evolution of policy rates and funding costs of banks. The use of a weighted average of many alternative sources of funds for banks instead of the conventional policy rate does affect the relationship between lending rates and funding costs over our sample Our results show that there is stronger evidence for a stable relationship between lending rate and the WACL measures we use to reflect funding costs of banks. We conclude that banks do not appear to have fundamentally changed their pricing behaviour in the post-crisis period even though bank lending surveys indicate that their credit standards have tightened since the financial crisis.

Further issues for research remain, including the question whether the effectiveness of the monetary policy transmission mechanism has been compromised by the breakdown in the relationship between policy rates and lending rates. Changes to policy rates may fulfil the Taylor principle, but retail rates

may not adjust by a corresponding degree (see Kwapil and Sharler, 2010). This issue involves analysis of the relationships between policy rates, weighted average cost of liabilities and lending rates, as well as lending volumes, which we leave for further analysis.

References

Adrian, Tobias, Paolo Colla and Hyun S. Shin (2013) "Which Financial Frictions? Parsing the Evidence from the Financial Crisis of 2007-9" 2012 *NBER Macroeconomics Annual*, Volume 27, Daron Acemoglu, Jonathan Parker, and Michael Woodford, (Eds), 159-214, 2013.

Arestei, David and Manuella Gallo, (2014) "Interest Rate Pass-Through in the Euro Area During the Financial Crisis: A Multivariate Regime Switching Approach", *Journal of Policy Modelling*, 36, 273-95.

Banerjee, Anindya, Victor Bystrov and Paul D. Mizen (2013) "How Do Anticipated Changes to Short-Term Market Rates Influence Banks' Retail Interest Rates? Evidence from the Four Major Euro Area Economies", *Journal of Money, Credit and Banking,* 45, 1375-1414.

Banerjee, Anindya and Josep Carrion-I-Silvestre (2004) "Breaking panel data cointegration", http://www.cass.city.ac.uk/__data/assets/pdf_file/0003/64911/Banerjee-and-Carrion-i-Silvestre-2004.pdf

Berlin, Mitchell and Lorretta J. Mester (1999) "Deposits and Relationship Lending", *Review of Financial Studies,* 12 (3), 579-607.

Borio, Claudio E.V., and Wilhelm Fritz (1995) "The Response of Short-Term Bank Lending Rates to Policy Rates: a Cross Country Perspective." *BIS Working Paper* No. 27.

Caruana, Jaime and Adrian van Rixtel (2013) "International Financial Markets and Bank Funding in the Euro Area: Dynamics and Participants", www.bis.org/publ/other18.pdf.

Darracq-Paries, Matthieu, Diego N. Moccero, Elizaveta Krylova and Claudia Marchini (2014) "The Retail Bank Interest Rate Pass-Through: The Case of the Euro Area During the Financial and Sovereign Debt Crisis", ECB Occasional Paper Series 155, September.

De Bondt, Gabe (2002) "Retail Bank Pass Through: New Evidence at the Euro Area Level." *ECB Working Paper* No. 136.

De Bondt, Gabe, (2005) Interest Rate Pass-Through: Empirical Results for the Euro Area. *German Economic Review* 6, 37–78

De Graeve, F., O. De Jonghe and R.V. Vennet (2007), "Competition, Transmission and Bank Pricing Policies: Evidence From Belgian Loan and Deposit Markets", *Journal of Banking and Finance* , 31,. 259-78.

ECB (2009) "Recent Development in the Retail Bank Interest Rate Pass-Through in the Euro Area", *ECB Monthly Bulletin, 93-105*..

ECB (2010a) "The ECB's Response to the Financial Crisis", *Monthly Bulletin*, October, 59-74.

ECB (2010b) *Euro Money Market Study*, December.

ECB (2012) "Heterogeneity in Euro Area Financial Conditions and Policy Implications", Monthly Bulletin, August 2012, 63-75.

ECB (2013) "Assessing the Retail bank Interest Rate Pass-Through in the Euro Area at Times of Financial Fragmentation", Monthly Bulletin, August 2013, 75-91.

Ehrmann, Michael, Leonardo Gambacorta, J. Martinez-Pages, Patrick Sevestre and Andreas Worms (2003), "Financial Systems and the Role of Banks on Monetary Policy Transmission in the Euro Area", in*: Monetary Policy Transmission in the Euro Area* , Cambridge University Press, 235-69.

Eickmeier, Sandra, Leo Krippner and Julia von Brostel (2015), "The interest rate pass-through in the euro area before and during the sovereign debt crisis", *mimeo*.

Elyasiani, Elyas, Kopecky, Kenneth J., and David Van Hoose. (1995) "Costs of Adjustment, Portfolio Selection, and the Dynamic Behavior of Bank Loans and Deposits." *Journal of Money, Credit, and Banking*, 27, 955-974.

Gambacorta, Leonardo. (2008) "How Do Banks Set Interest Rates?" *European Economic Review*, 52, 792-819.

Gambacorta, Leonardo, Anamaria Illes and Marco Lombardi (2014) "Has the transmission of policy rates to lending rates been impaired by the Global Financial Crisis?", *BIS working paper* No. 477.

Gambacorta, Leonardo and Paolo Emilio Mistrulli, (2014) "Bank Heterogeneity and Interest Rate Setting: What Lessons Have We Learned since Lehman Brothers?," *Journal of Money, Credit, and Banking*, 46, 753-778.

Gerali, Andrea, Stefano Neri, Luca Sessa, and Federico Signoretti (2010) "Credit and Banking in a DSGE Model of the Euro Area", *Journal of Money, Credit and Banking*, 42, 107–141.

Gilchrist, Simon and Benoit Mojon (2014) "Credit Risk in the Euro Area", NBER working paper.

Gregory, Allan M. and Bruce E. Hansen (1996) "Residual-based Tests for Cointegration in Models with Regime Shifts", *Journal of Econometrics*, 70, 96-126.

Hofmann, Boris and Paul D. Mizen. (2004) "Interest Rate Pass Through in the Monetary Transmission Mechanism: Evidence from Individual Financial Institutions' Retail Rates", *Economica*, 71, 99-125.

Illes, Anamaria and Marco Lombardi (2013) "Interest Rate Pass Through Since the Financial Crisis", *BIS Quarterly Review*, September 2013.

Im, Kyung So, Pesaran M. Hashem, and Youngcheol Shin (2003) "Testing for Unit Roots in Heterogeneous Panels", *Journal of Econometrics 115, 53-74*.

Kok-Sørensen, Christoffer, and Thomas Werner. (2006) "Bank Interest Rate Pass Through in the Euro Area", *ECB Working Paper* No 580.

Kopecky, Kenneth J., and David Van Hoose. (2012) "Imperfect Competition in Bank Retail Markets, Deposit and Loan Rate Dynamics, and Incomplete Pass Through", *Journal of Money, Credit, and Banking*, 44, 1185-1205.

Kwapil, Claudia and Johann Scharler (2010), "Interest Rate Pass-Through, Monetary Policy Rules and Macroeconomic Stability", *Journal of International Money and Finance* 29, 236-51.

Mojon, Benoit. (2000) "Financial Structure and the Interest Rate Channel of ECB Monetary Policy", *ECB Working Paper* No 40.

Pesaran, M.Hashem and Ron Smith (1995) "Estimating Long-Run Relationships From Dynamic Heterogeneous Panels", *Journal of Econometrics* 68: 79-113.

Pesaran, M. Hashem, Youngcheol Shin, and Ron Smith (1999) "Pooled Mean Group Estimation of Dynamic Heterogeneous Panels", *Journal of the American Statistical Association* 94: 621-634.

Stahl, D.O. (1988) "Bertrand competition for inputs and Walrasian outcomes", *American Economic Review* 78, 189-201.

Turner, Philip (2013) "Benign Neglect of the Long Term Interest Rate", *BIS working paper* 403.

Van Rixtel, Adrian and Gabrielle Gasperini (2013) "Financial crises and bank funding: Recent experience in the euro area" *BIS Working Paper* 406.

Westerlund, Joakim (2006) "Testing for Panel Cointegration with a Level Break", *Economics Letters*, 91, 27-33.

Westerlund, Joakim (2007) "Testing for Error Correction in a Panel Data", *Oxford Bulletin of Economics and Statistics,* 69, 709-748.

Yanelle, Marie-Odile (1997) "Banking Competition and Market Efficiency", *Review of Economic Studies* 64, 215-39.

Yanelle, Marie-Odile (1989) "The Strategic Analysis of Intermediation", *European Economic Review* 33, 294-301.

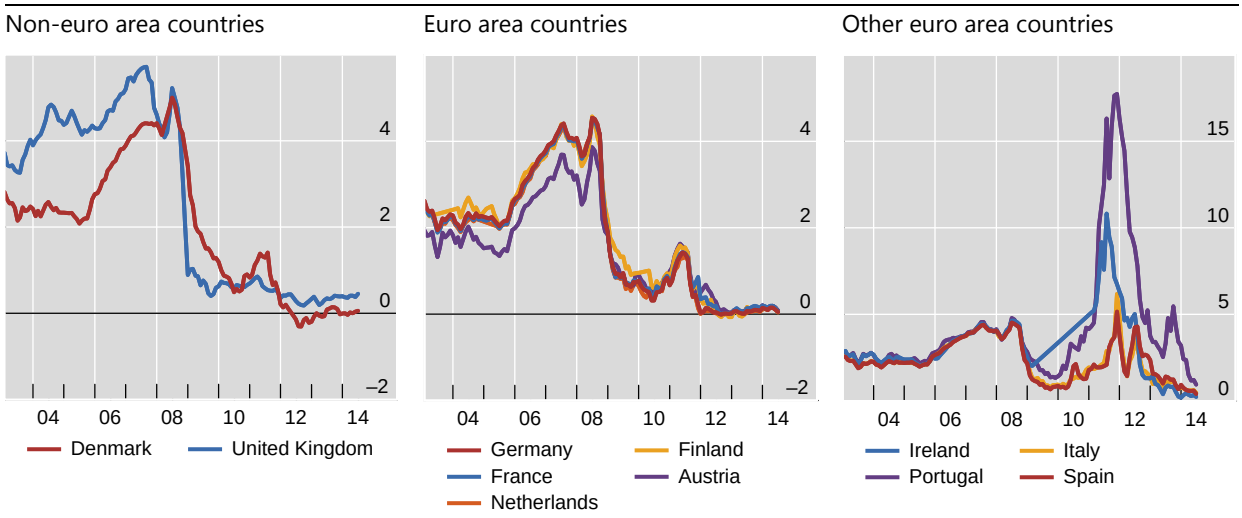
Zoli, Edda (2013) "Italian Sovereign Spreads: Their Determinants and Pass-Through to Bank Funding Costs and Lending Conditions", *IMF Working Paper* No. 13/84.

Appendix

Government bond yields: 1-year maturity

In per cent

Graph A1

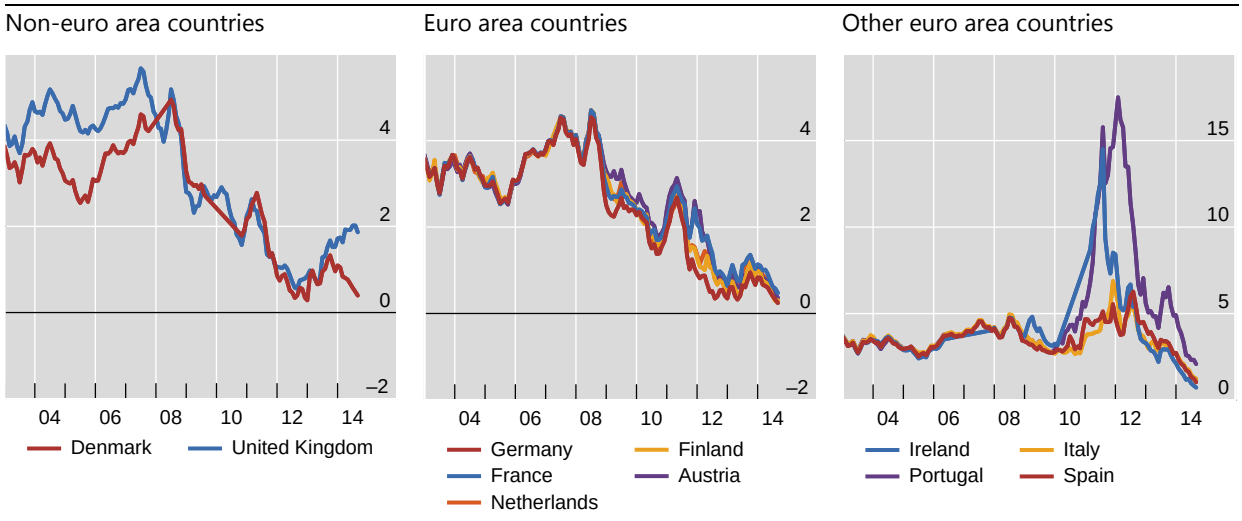


Source: Bloomberg.

Government bond yields: 5-year maturity

In per cent

Graph A2

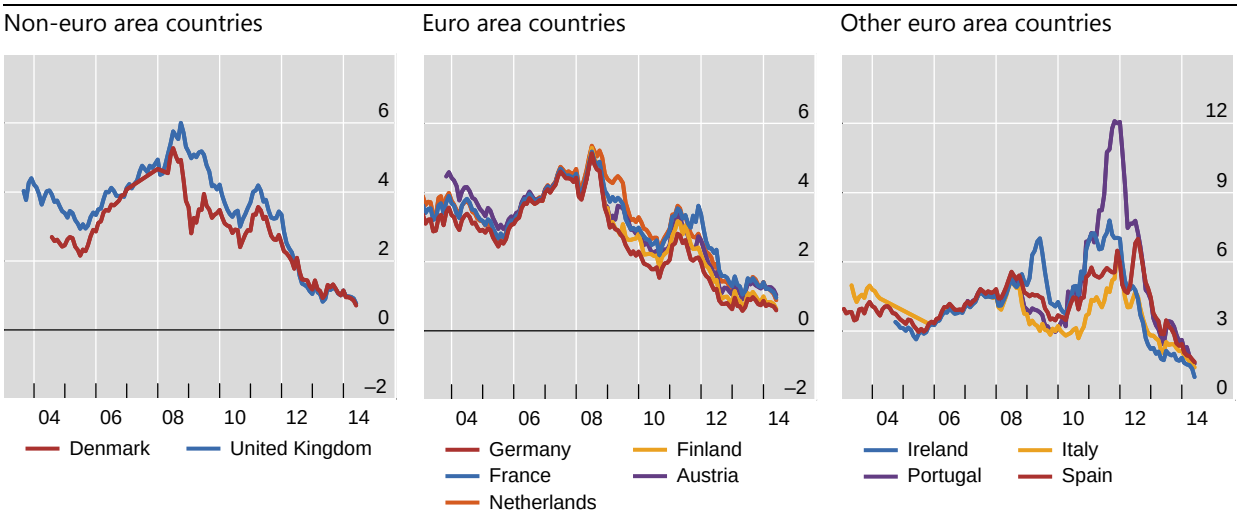


Source: Bloomberg.

Covered bond rates

In per cent

Graph A3



Source: Barclays.