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# Are bank lending shocks important for economic fluctuations?

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# Are bank lending shocks important for economic fluctuations?*

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**Abstract**

We analyze the importance of bank lending shocks on real activity in Norway and the UK, using structural VARs and based on quarterly data for the past 21 years. The VARs are identified using a combination of sign and short-term zero restrictions, allowing for simultaneous interaction between various variables. We find that a negative bank lending shock causes output to contract. The significance of bank lending shocks seems evident as they explain a substantial share of output gap variability. This suggests that the banking sector is an important source of shocks. The empirical analysis comprises the Norwegian banking crisis (1988-1993) and the recent period of banking failures and recession in the UK. The results are clearly non-negligible also when omitting periods of systemic banking distress from the sample.

**Keywords:** Identification, VAR, Monetary Policy, Bank lending.

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# 1 Introduction

The recent financial crisis has drawn considerable attention towards financial intermediation and its influence on real activity. The discussion on whether the financial sector is an important source of shocks has been revived (Christiano, Motto, and Rostagno (2009), Gilchrist, Yankov, and Zakrajsek (2009)). Leading up to the financial crisis, the banking system underwent substantial changes especially due to extensive securitization. The result was a decline in lending standards that helped to fuel the housing market frenzy (Brunnermeier (2008)). Arguably, the current crisis has been triggered by the bursting of the US house price bubbles. Hence, changes in banks' lending behavior could be one of the prime movers of the financial crisis. But also regardless of the present crisis, banks play vital role in the system of financial intermediation: They specialize in overcoming informational problems and are the predominant source of intermediated credit. As such, bank lending shocks might have a major impact on economic activity, and a comprehension of the significance of bank lending shocks would illuminate the linkage between financial intermediation and economic activity.[1]

In this paper, we investigate empirically the existence of a bank lending channel of monetary policy. Specifically we investigate whether the banking system is an important source of shocks. The analysis is applied to Norway and the UK, using a structural vector autoregressive (VAR) model based on quarterly data from the

[1]The investigation of the subject is partly motivated by a likely widespread conception closely tied to Blanchard's self-awareness as an economist who, until recently, thought of financial intermediation as an issue of relatively little importance for economic fluctuations (Blanchard (2008)).

past 21 years. Our sample therefore comprises the Norwegian banking crisis (1988-1993) and the recent period of banking failures in the UK. The Norwegian banking crisis coincided with a severe economic slowdown, and the scope of that crisis has resemblances with the impact of the present crisis in the UK.

The bank lending channel of monetary policy clarifies the particular role of banks' balance sheets in propagating and amplifying monetary shocks (Bernanke and Blinder (1988)). Following a monetary contraction, if banks cannot compensate a reduction in reserves by portfolio changes or raicing funds by issuing non-reservable liabilities, banks' loan supply will be curbed.[2] Kashyap, Stein, and Wilcox (1993) used this feature of depository institutions to separate the effect of monetary policy on loan-demand and loan-supply. They constructed a mix variable, defined as the ratio of bank credit to the sum of bank and non-bank credit. As a change in general loan demand would leave the mix fairly unaltered since all types of credit should change in rough proportion, a significant decline in the mix following a monetary contraction was interpreted as evidence of a bank lending channel. The suggestion of a mix variable has also been utilized by Iacoviello and Minetti (2008) and Ludvigson (1998), who studied whether the bank lending channel is operative in the housing market and automobile market, respectively. While we make use of a mix variable and study the presence of a bank lending chan-

[2] Assuming a loss of deposits is not fully offset by a reduction in securities holdings, a sufficient condition for banks' balance sheets to contract is that wholesale funding is more expensive than retail deposits on the margin. If this holds, then banks will cut back on lending. A necessary condition for the bank lending channel to have real effects, is that credit from non-bank sources cannot be a perfect substitute to bank loans (at least not for all borrowers). If the latter condition is satisfied, then the external finance premium facing borrowers will increase if banks reduce their loan supply. The external finance premium is simply the wedge between internal and external finance, see e.g. Bernanke and Gertler (1995).

nel, the foremost contribution of this paper is to identify bank lending shocks and their importance for real activity. In fact, shifts in banks' loan supply could have a bearing on economic activity independently of the existence of a bank lending channel.[3]

Since we investigate the significance of bank lending shocks on economic activity, our mix incorporates a broad set of borrowers. The mix therefore consists of total bank lending to households and non-financial firms in the numerator, and total credit to the same borrowers in the denominator. As mentioned, the mix should not pick up credit demand shocks.[4] Moreover, general changes in risk appetite or other shifts in lending behavior among all types of lenders should also leave the mix relatively unaffected. A possible criticism is that the mix would respond to lending shocks from non-depository lenders, and would as such contaminate the identified bank lending shocks. However, we find it difficult to visualize exogenous lending shocks exclusive to non-depository lenders, that is, lending shocks that should not encompass banks. Still, if non-bank lending shocks are present in data, they should work in the same direction as bank lending shocks on real activity but have the opposite effect on the mix-variable. Non-bank lending shocks would then restrain our empirically identified effects of bank lending shocks on economic activity, not overstate them.

[3]With a lack of close substitutes to bank credit, disturbances to bank lending would shift the external finance premium facing bank-dependent borrowers even though the bank lending channel of monetary policy is trivial or absent.

[4]The actual existence of credit demand shocks is more controversial. As Bernanke and Blinder (1988) assess this issue: We find it difficult to think of or identify major shocks to credit demand, that is, sharp increases or decreases in the demand for loans at given interest rates and GNP. But shocks to credit supply are easy to conceptualize and to find in actual history.

How do we interpret bank lending shocks, what will we expect such shocks to comprise? Regular surveys of banks' credit standards show that banks furnish changes in the state of the economy as a major motive power for a tightening or loosening of credit standards.[5] Consistent with this, bank lending shocks can be thought of as changes in credit standards that are not caused by shifts in macro variables.[6] We therefore expect that alterations in banks' risk assessment, which are not in line with changes in macro fundamentals, will be identified as structural shocks. Moreover, during the sample period the banking system has been subject to comprehensive changes in regulation, in particular through implementation of Basel I and Basel II regarding capital requirements. The fairly recent implementation of Basel II (in Europe) has been a matter of particular interest due to the possibility of enhanced procyclical bank lending, see e.g. Kashyap and Stein (2004) and Benford and Nier (2007). Furthermore, during the past years a wide range of innovations in financial markets have occurred: Rapid growth in securitization (especially CDOs), new schemes for credit risk insurance (Credit Default Swaps), technological innovations that improve banks information processing and new loan products are some factors that could influence banks' lending standards (see e.g. Blanchard (2008) and Brunnermeier (2009)). Overall, we find it plausible that financial innovations, extensive changes in regulation and banks' misjudgment of the economic outlook, to be among the most important driving forces for bank

[5] In the countries under study, Norway and the UK, such surveys are regularly performed by the respective central bank: http://www.bankofengland.co.uk/publications/other/monetary/creditconditions.htm and http://www.norges-bank.no/templates/reportroot—-68571.aspx).

[6] This is quite analogous to the standard way of identifying monetary policy shocks using structural VARs.

lending shocks.

The paper combines sign and short-term zero restrictions to identify the structural VAR. The sign restrictions allow short-run interdependence between variables that zero restrictions fail to account for. The identified model provides supporting evidence of a bank lending channel. Furthermore, a contractionary bank lending shock has a negative effect on economic activity. Bank lending shocks explain about 15-20 per cent of the short-term variance in the output gap in Norway and correspondingly 10-15 percent in the UK.

The rest of the paper is organized as follows. In Section 2 we explain the VAR methodology, whereas Section 3 gives an account of empirical results. Section 4 concludes.

# 2 Empirical methodology

The empirical analysis is carried out using a structural VAR, since such a model comprises a set of equations that capture the dynamic behavior of an economic system. This section provides a description of the variables in the model, the identification scheme and a brief outline of our technical procedure to achieve identification of structural shocks.

The choice of variables included in our VAR model reflects the theoretical set up of a New-Keynesian small open economy model (see e.g. Svensson (2000) and Clarida, Gali, and Gertler (2001)), augmented with log of real house prices and the mix ratio. In addition to the two latter variables, denoted as $ph$ and *mix* respectively, the model therefore comprises: Annual changes of the log of a domestic consumer price index ($\pi$), detrended log of GDP ($ygap$), the log of the real exchange rate against a basket of trading partners ($e$) and the three month domestic money market rate ($i$). Moreover, we incorporate the foreign (trade weighted) three month interest rate ($i^*$) as an exogenous variable. The exogeneity assumption of the foreign interest rate relies on the conventional assessment of Norway and UK as small open economies.

Consistent with the discussion in section 1, we aim to identify monetary policy shocks and bank lending shocks. The nominal short term interest rate is chosen to capture monetary policy shocks, in accordance with the fact that policymakers use interest rate instruments in the monetary policy setting. This is in line with Rotemberg and Woodford (1997), which find central bank behavior to be well modeled by a policy rule that sets the interest rate as a function of variables such as output and inflation. We use the mix variable to capture bank lending shocks. The mix ratio contains bank lending to households and non-financial firms in the numerator, and the sum of bank and non-bank credit to the same borrowers in the denominator.

The discussion surrounding the recent financial crisis has highlighted the role of (the bursting of) house price bubbles. Furthermore, empirical studies demonstrate that shocks to house prices have a bearing on inflation, economic activity and monetary policy (Bjørnland and Jacobsen (2009)). Property price developments and credit trends are also considered as highly related elements, theoretically and empirically (see e.g. Kiyotaki and Moore (1997) and Borio and Lowe (2002)).

The reason for including house prices in the VAR is not to identify house price shocks, but to control for such shocks. If we didn't control for property price shocks, such shocks would contaminate the structural shocks we intend to identify as bank lending shocks. In this context, house prices are included to avoid potential misspecification problems (see for e.g. Fry and Pagan (2005) for a discussion).

## 2.1 The VAR model

Our variables can be jointly estimated in a VAR(p), which in matrix form (ignoring any deterministic terms and exogenous variables) can be expressed as

$$B(L)Z_t = e_t, \text{ with } \Sigma_e = E(e_t e_t') \tag{1}$$

where $Z_t = [\pi, ygap, mix, e, ph, i]_t$ is a vector of covariance stationary processes. $B(L)$ is a $(6 \times 6)$ matrix polynomial in the lag operator $L$, $B(L) = \sum_{i=0}^{p} B_i L^i$ with $B_0 = I_6$. $e_t$ is the error term of the model assumed to be normally distributed with a positive semidefinite covariance matrix $\Sigma_e$. As the $B(L)$ matrix is invertible (by assumption), we express the VAR model in terms of its moving average (MA) representation:

$$Z_t = C(L)e_t, \text{ where } C(L) = B(L)^{-1} \tag{2}$$

Following common standard, we let the error term $e_t$ be linearly related to vector $\epsilon_t$ of orthogonal structural shocks normalized to have unit variance, $e_t = A\epsilon_t$.

Inserting for this expression into (2) gives the MA representation in terms of the structural shocks. where $\epsilon_t \sim N(0, diag(I_6))$

$$Z_t = D(L)\epsilon_t, \text{ where } D(L) = C(L)A \tag{3}$$

## 2.2 Identification of the structural shocks

For the case of identification, we start by noting that the contemporaneous matrix $A$ is not unique since the covariance matrix of the residuals can lend itself to many different type of decompositions, e.g. $AA' = \Sigma_e$ and $\tilde{A}\tilde{A}' = \Sigma_e$. However, any two different decompositions must satisfy the fact that $A = \tilde{A}Q$, where $Q$ is an orthogonal matrix with property of (1) being mutually perpendicular, $< q_i, q_j >$=0 for for $i, j = 1, 2, ..., 6$ where $i \neq j$, and (2) of being orthonormal (i.e. have unit length), $||q_i|| = 1$.

Given the focus of the paper, we do not have any interest in seeking identification of all the structural shocks of the model. Specifically, from the vector $\epsilon_t$ of the model's structural shocks we restrict our attention to bank lending shock ($\epsilon_t^{BS}$), and monetary policy shock ($\epsilon_t^{MS}$). Motivated from the fact that we need identification of two structural shocks, we partition the $A$ matrix into two blocks $A = [A'A'']$. We let $A'$ be a (6x4) matrix containing the immediate impact from the structural shocks we do not identify, while $A''$ a (6x2) matrix containing immediate impact from the structural shocks we would like to identify. For the $A''$

matrix we impose the following set of zero and sign restrictions.

$$A'' = [\mathbf{a}^{BL}, \mathbf{a}^{MP}] = \begin{bmatrix} 0 & 0 \\ - & - \\ -1 & - \\ + & - \\ - & - \\ - & 1 \end{bmatrix} \tag{4}$$

The set of restrictions on the $A''$ matrix represents the identification scheme. The column to the left illustrates the sign of the immediate response to the bank lending shock and correspondingly, the column to the right responses to the monetary policy shock. We discuss the latter shock first, where the interest rate is normalized to increase by one percentage point (bottom row). Then, starting on top, we have placed a zero restriction on the contemporaneous inflation response. The restriction relies on the common assumption of short term price stickiness caused by some form of nominal rigidities. This is common practice in the VAR literature (see for e.g. Christiano, Eichenbaum, and Evans (1999). Regarding the output gap, we allow for an immediate negative response in the same quarter as the shock occurs. Naturally, the restriction doesn't rule out that the immediate effect may be rather small.[7]

[7] An alternative is to impose a zero restriction, which would not be inconsistent with much of the VAR literature. However, a zero restriction might be more credible when using times series more high-frequent than quarterly data. For instance, using over-identifying restrictions, Lanne and Lutkepohl (2006) provide clear statistical evidence for a zero restriction on inflation and a positive and small impact on output when using U.S. data.

Concerning the mix variable, the bank lending channel theory implies that the mix should fall in periods of tight money (c.f. earlier discussion). It doesn't follow from theory that the negative response must occur in the same quarter as the shock; however, theory doesn't imply a zero response in the first quarter either. Accordingly, we allow for an immediate negative response which is consistent with theory, yet could turn out to be small.

The exchange rate is assumed to appreciate contemporaneously to the shock, based on the conventional Dornbusch overshooting hypothesis. Concerning the other asset price - house prices - we allow for an immediate negative response. This is consistent with standard (user cost of capital) theory and that asset prices are forward-looking and therefore reacts swiftly to shocks. The assumption of immediate asset price responses are also in line with other empirical studies (see Bjørnland and Halvorsen (2008) and Bjørnland and Jacobsen (2009) + some additional references).

Next, we turn to bank lending shocks. A negative shock represents a sudden reduction in banks' loan supply, and the mix is normalized to fall by one basis point. Based on similar reasoning as for a monetary policy shock, a zero restriction is placed on the immediate inflation response. A sudden contraction in loan supply may have a rather quick effect on other key economic variables, such as investment, and the output gap is therefore allowed to open negatively in the same quarter as the credit squeeze occurs.

Regarding the domestic money market rate (bottom row), we assume an immediate negative response. First, a structural bank lending shock is in general anticipated to have a counterpart on the liability side of banks' balance sheets. So a negative (positive) bank lending shock is expected to decrease (increase) the liability side, where an important funding source is the money market.[8] Consequently, the negative (positive) shock is assumed to put downward (upward) pressure on the money market rate. Second, we want to allow for an immediate negative response as this may also reflect a reaction from the monetary policy-maker counteracting the negative shock, or possibly expectations in the money market of a subsequent policy response.

The exchange rate is assumed to depreciate in the same quarter as the credit squeeze occurs, as the shock is expected to weaken the economic outlook and put downward pressure on the money market rate. Moreover, we allow for an immediate negative response in house prices, and the restriction relies on the assumption that a sudden reduction in lending has a negative impact on the price of dwellings.[9]

Given the restrictions on the matrix $A''$, we would like to carry out inference (i.e. impulse responses and variance decompositions) of the impact the two structural shocks have on the variables in our VAR model. We approach this issue employing

[8] We would have expected an opposite effect on lending rates

[9] The strategy of combining sign and short term zero restrictions to identify the model is made in order to achieve a reliable identification of the model. Compared to identifying the shocks using only zero restrictions, the use of sign restrictions allow freedom in letting the the structural shocks to have an immediate or short-run impact on the variables of the VAR model. Yet, identification using only sign restrictions can be criticized as discussed in Fry and Pagan (2005) since the weakness of information contained in such restrictions will make identification non-unique. As shown in Paustian (2006), this could if the number of sign restrictions imposed on the system are few lead to very imprecise identification of the structural shocks. In this context our zero restrictions are potentially useful since they increases the information content and as such imply that that fewer sign restrictions need to be imposed in order to achieve a reliable identification of the model.

a Bayesian numerical procedure similar to what is advocated in Uhlig (2005). The procedure can be separated into two parts. In the first part $n1$ draws are taken from the reduced form coefficients from our VAR posterior. [10] Conditioned on each draw, the second part makes $n2$ candidate draws for our $A''$ matrix whereas the draws satisfying our sign restrictions are being kept. Based on the accepted draws error bands for our statistical inference are calculated.

In the second part we have slightly changed the procedure discussed in Uhlig (2005) due to two issues. First, we are interested in identifying not one but two types of structural shocks. Second, when searching for candidate draws for the $A''$ we would like to do this conditioned on our two zero restrictions. To implement the first issue, it is necessary to make the two vectors of $Q$ that determines the $A''$ matrix orthogonal to each other. For the second issue, we must restrict the first component of the two vector of draws are used to determine the two vectors of $Q$. It turns out that we can implement this using a Gram-Schmidt procedure based on input in the form of restricted draws.

Technically, we can describe our process as follows. We start by fixing $\tilde{A}$, by selecting $\tilde{A} = A^{chol}$ (i.e. the lower triangular matrix of the Cholesky decomposition). The two vector of our $A''$ matrix can now be written as.

$$\mathbf{a}^{BL} = A^{chol}\mathbf{q}^{BL} \text{ and } \mathbf{a}^{MP} = A^{chol}\mathbf{q}^{MP}$$

To find candidate draws for the $A''$ matrix, draws for $\mathbf{q}^{BL}$ and $\mathbf{q}^{MP}$ must be made. We do this using the following two step procedure. For the first step, the following

[10]For the prior of our reduced form coefficients a flat prior is selected.

vector of numerical draws are made:

$$\mathbf{v}^{BL} \sim i.i.d.N(0, diag(\sigma^{BL})) \text{ and } \mathbf{v}^{MP} \sim i.i.d.N(0, diag(\sigma^{MP}))$$

Where $\sigma^{BL} \equiv (0, 1, 1, 1, ..., 1)$ and $\sigma^{PS} \equiv (0, 1, 1, ..., 1)$. In the second step, the vector of numerical draws are used as input to determine $\mathbf{q}^{BL}$ and $\mathbf{q}^{MP}$. To preserve the mutually perpendicular and orthonormality properties for these two vectors we use the Gram-Schmidt process: [11]

$$\mathbf{u}^{BL} = \mathbf{v}^{BL} \qquad \mathbf{q}^{BL} = \frac{\mathbf{u}^{BL}}{||\mathbf{u}^{BL}||}$$

$$\mathbf{u}^{MP} = \mathbf{v}^{MP} - proj_{\mathbf{u}^{BL}}(\mathbf{v}^{MP}) \qquad \mathbf{q}^{MP} = \frac{\mathbf{u}^{MP}}{||\mathbf{u}^{MP}||}$$

By repeating the two steps above $n2$ times determines all the candidate draws for $\mathbf{a}^{BL}$ and $\mathbf{a}^{MP}$ needed to implement the second part of our numerical procedure.

# 3 Empirical results

The model is estimated for Norway and the UK, using quarterly data from 1988Q2/Q3 to 2009Q1.[12] The VAR comprises the domestic short term interest rate, annual inflation, output gap, real house prices, real exchange rate and the mix. The lat-

[11]The projection operator is defined as $proj_{\mathbf{u}^k}(\mathbf{v}^k) \equiv \frac{<\mathbf{u}^k, \mathbf{v}^k>}{<\mathbf{v}^k, \mathbf{v}^k>}\mathbf{u}^k$.

[12]The estimation period is 1988Q2-2009Q1 for Norway and 1988Q3-2009Q1 for the UK. The sample boundaries are due to data availability.

ter is a fraction where the numerator consists of bank lending to households and non-financial firms while the denominator assigns total credit to the same borrowers. In addition to endogenous variables, we also include the foreign short term interest rate as an exogenous variable. The appendix provides further information concerning data.

All variables are specified in levels, with the exception of consumer prices, implying that potential cointegrating relationships are being implicitly determined in the VAR, see Hamilton (1994). Instead of incorporating consumer prices in levels, we include annual changes in a consumer price index as it is a direct measure of the monetary policy target in the two inflation-targeting countries. Furthermore, as the core question we address relates to fluctuations in real activity, we include detrended GDP. Incorporating a measure of the output gap is also consistent with Giordanis view that using a model set up following Svensson (1997) as a data generating process, the output gap should enter into the VAR rather than output in levels. Moreover, some of the variables seem to be in the borderline of being (trend) stationary and non-stationary, which could be due to low power of the test used to disentangle a unit root process from a (trend) stationary variable. We therefore also include a linear trend in the VAR.

The estimated VAR satisfies the stability condition as all eigenvalues lie within the unit circle, and the VAR can therefore be inverted and analyzed using the MA representation. The lag order of the model is determined by applying the Schwarz and Hannan-Quinn information criteria and F-forms of likelihood ratio tests for model reductions. For both Norway and the UK, the tests suggested that two lags were acceptable. With two lags, the vector residual tests of null hypotheses of homoscedasticity and no autocorrelation were not rejected at the 1 per cent level. Yet, some non-normality remained in the model for Norway. For both countries, a few impulse dummies (that take the value 1 in the relevant quarter and 0 otherwise) were included in the VAR to control for severe outliers, see the appendix for a detailed description.

## 3.1 Empirical results of structural shocks

Figure 1 plots the responses in all six endogenous variables following a contractionary monetary policy shock in Norway and the UK respectively. The monetary policy shock is normalized to increase the (domestic) interest rate with one percentage point in the first quarter. The solid line shows the median response of the error bands while the dotted lines are the .16 and .84 fractiles, as suggested by Doan (2007). [13]

Insert figure 1 about here.

The contractionary monetary policy shock has the commonly found effect on the interest rate. There is a high degree of interest-rate inertia in the model, as the monetary policy shock is offset by a gradual decrease in the interest rate. For a period, the interest rate goes below steady state according to the median response. The policy reversal combined with interest-rate inertia is consistent with what is

[13]This is the Bayesian simulated distribution obtained by Monte Carlo integration with 2500 replications, using the approach for just-identified systems. The draws are made directly from the posterior distribution of the VAR coefficients Doan (2007).

commonly regarded as good monetary policy conduct Woodford (2003). As Woodford shows, interest-rate inertia is known to let the policymaker smooth out the effects of policy over time by influencing private-sector expectations. Furthermore, the reversal of the interest rate stance is consistent with the policymaker trying to counteract the adverse effects of the initial policy deviation from the systematic part of policy.

Concerning real activity, the output gap responses negatively and simultaneously (as assumed). The immediate UK median response is rather strong, but the fairly wide probability band in this case emphasizes the uncertainty in the immediate UK response. After a few quarters, the negative gap (median response) is between one and one and a half per cent in both countries before it eventually starts closing. With respect to consumer price inflation, the eventual negative response is significant after 4-6 quarters. Inflation is down by about 70-100 basis points after 2-3 years, and the effect thereafter dies out. Interestingly, we find no evidence of a price puzzle; that is, an initial increase in consumer prices in response to a contractionary monetary policy shock. The prize puzzle has been explained by a cost channel of the interest rate, where (some of) the increase in firms borrowing costs is passed on to consumers (Ravenna and Walsh (2006); Chowdhurry, Hoffmann, and Schabert (2006)). Figure 1 demonstrates that the initial inflation response is insignificant and the median response is effectively zero the first quarters.

The bank lending channel literature predicts the mix to drop in periods of tight money, and we allow the mix to respond negatively in the same quarter as the monetary policy shock occurs. The median response indicates that the mix may fall by about 1 basis point in Norway and nearly 2 basis points in the UK the first quarter.[14] The immediate effect is non-negligible, and also significant in the subsequent 4 quarters.[15] The mix response therefore provides supporting evidence of a bank lending channel in the two countries under study. [16]

## 3.2 How do macro variables respond to a bank lending shock?

We then turn to the main subject, namely the responses to a bank lending shock, illustrated by figure 2. The bank lending shock is normalized to lower the mix by 1 basis point. This corresponds to a sudden decline in bank lending by about 4 per

[14]In the estimation period, the mix ratio is on average .57 in Norway and .58 in the UK. Based on 2009Q1 figures and assuming that non-bank credit is fixed, an abrupt drop in the mix of 1 basis point corresponds to an immediate decline in bank credit of about 4 per cent in both countries.

[15]Iacoviello and Minetti (2008) find evidence of a bank lending channel in the mortgage market in UK, but not in the case of Norway. The somewhat dissimilar result could be due to differences concerning estimation periods, variables in the VAR, identification schemes and the borrower set that the mix comprises.

[16]Oliner and Rudebusch (1996) emphasize that changes in the mix could just reflect a shift in the quality composition of borrowers, not an operative bank lending channel. If banks lend to riskier borrowers than non-banks, then a drop in the mix in periods of tight money could be due to a composition effect (flight to quality) where lenders cut back on their loans to low-grade borrowers and direct their lending towards high-grade borrowers. The argument implies that the default share of total lending should fall when the non-bank lending share of total credit increases. Iacoviello and Minetti (2008) tested and rejected this hypothesis for the UK using data comprising mortgage lending and mortgage repossessions. Regarding the UK, we could not find non-depository institutions write-offs of lending to non-financial firms or to households, or other default proxies (other than what is covered by mortgage repossessions). But for Norway, we can test the hypothesis where data for credit and defaults encompass both households and non-financial firms. The flight to quality proposition is again rejected, which supports the existence of a bank lending channel of monetary policy when the mix falls significantly in periods of tight money. The test output can be obtained at request. The result holds for a static and dynamic regression equation and also when controlling for variables such as house prices, output, inflation and the exchange rate.

cent for a fixed level of non-bank lending. As argued in Section 2, the abrupt reduction in funding of firms and households is assumed to have a potentially negative effect on consumption and investment in the same quarter as the shock occurs. Therefore, the output gap is allowed to respond simultaneously and negatively. The median responses to the shock suggest that the output gap could be lowered by 20-40 basis points contemporaneously. The effect on the Norwegian output gap culminates after about one and a half year. In contrast, the effect on UK output is fairly stable the first 2-3 quarters, afterward the effect is insignificant. The timing of the inflation response is also somewhat different in the two countries. Indicated by the median response, inflation is down by a total of 30 basis points in Norway 2-3 years after the shock, whereas UK inflation is lowered by the same amount already 2-3 quarters following the shock.

Insert figure 2 about here.

The different output gap progress in the two countries, following the lending shock, may be viewed in light of somewhat diverse interest rate responses. The immediate interest rate response is negative by assumption, related to banks' funding dependency in the money market. The immediate dip in interest rates could nonetheless also capture a policy response and/or expectations in the money market of a subsequent policy response. Yet the response in Norway is insignificant already three quarters after the shock, whereas the UK interest rate reacts more strongly and reaches its lowest level after 2-3 quarters. This could reflect a more active policy response in the UK that counteracts and contains adverse effects of the negative lending shock. For instance, UK policymakers have responded to the current financial crisis by cutting interest rates to historically low levels.[17]

In contrast, Steigum (2004) argues that Norwegian monetary policy was in fact pro-cyclical during the banking crisis years due to the fixed exchange rate regime (that ended in late 1992). The different interest rate responses may also be due to a general diversity concerning how policymakers in the two countries – in inflation targeting regimes – emphasize trends in credit markets.

A more counteracting policy response in the UK compared to Norway could also explain why the exchange rate depreciates more strongly in the UK. The lending shock lowers house prices immediately by 2-3 per cent (median response) but the effect is insignificant already after 2 quarters. Again, wide error bands underscore the uncertainty in the house price response.

### 3.3 Are bank lending shocks important for output gap variability?

While the impulse responses render possible economical interpretations of how the system reacts to structural shocks, the variance decomposition clarifies the contributing share of each structural shock to the total variance of each variable. Our main purpose is to assess the importance of bank lending shocks on real activity. To that end, figure 3 plots the percentage share that bank lending shocks explain of the output gap variance. The results clearly suggest that bank lending

[17] Supplemented by other measures such as e.g. quantitative easing and expansionary fiscal policies.

shocks can be an important driving force for fluctuations in economic activity. Based on the median response, the lending shocks explain between 15 and 20 per cent of output gap variability in Norway during the first year following the shock. The corresponding UK amount is between 10 and 15 per cent. The long term contribution is slightly above 10 per cent in Norway and somewhat below 10 per cent in the UK. The substantial amounts indicate that a bank lending shock is effectively a considerable shock to the external finance premium: A broad set of borrowers may be highly bank dependent and shocks stemming from the banking sector have clear implications for economic activity.

Insert figure 3 about here.

Naturally, the identified importance of bank lending shocks could be influenced by the in-sample banking crises. Norway experienced a comprehensive banking crisis starting in 1988, it was deemed systemic from 1990/91 and ended in 1993 Vale (2004). The long-lasting banking crisis coincided with the (so far) most severe recession in Norway in the post-WWII period. To the extent that the crisis caused a credit crunch which contributed to the downturn in the early 1990s, it should influence the results. Correspondingly, the recent period of UK banking failures is also expected to affect the results. Hence we repeat the variance decomposition calculation on samples where the periods of banking crises are left out. The chosen estimation period for Norway is then 1994Q1-2009Q1, and the adjusted UK sample is 1988Q3-2006Q4. Figure 3 demonstrates that the short-term contribution is clearly lowered, especially during the first couple of years, while the long-term contribution is less affected. The immediate contribution is between 10 and 15 per cent in both countries. Unsurprisingly, the inclusion of periods of widespread banking failures seems to augment the effects of shocks to banks' loan supply on economic activity. Yet, the results also suggest that bank lending shocks have clear non-negligible effects on real activity absent of banking crises.

# 4 Concluding remarks

The global financial crisis has drawn renewed attention towards the role of banks and their importance for real activity fluctuations. Banking behavior prior to the crisis, in particular extensive securitization and the possible deterioration of lending standards, has spurred interest in the question whether the financial sector can be an important source of shocks. In this paper, we have aimed to identify bank lending shocks and investigate to what extent disturbances to banks' loan supply contribute to economic fluctuations in Norway and the UK.

We find that a contractive shock to bank lending induces a negative response of the output gap and a downward pressure on consumer prices. The effect on real activity has been far from trivial during the past 21 years: Bank lending shocks can explain 15-20 per cent of the short-term output gap variance in Norway and correspondingly 10-15 per cent in the UK. Consequently, the results provide supporting evidence to the claim that bank lending shocks matter for economic fluctuations. The findings should be viewed in relation to the Norwegian banking crisis (1988-1993) and the scope of the crisis in the UK in the late 2000s. The results are, however, non-trivial even when periods of banking crises are omitted from the sample.

Interestingly, the response in short term interest rates to a negative bank lending shock may suggest rather different policy responses in the two economies. While the UK interest rate remains lowered for several quarters, the initial reduction in Norwegian interest rates quickly becomes insignificant. UK monetary policymakers have responded to the recent crisis by cutting interest rates to historically low levels, whereas the former fixed exchange rate regime in Norway made monetary policy procyclical during the banking crisis. Different policy regimes (during the periods of crisis) may account for the diverse interest rate responses. Yet the disparity can also be influenced by how the two countries policymakers in general pay attention to credit market developments. A clear and more prolonged UK monetary policy response appears to pay off as the total negative effect on the output gap of the lending shock is smaller and restrained more swiftly than in Norway.

In general, the identified macroeconomic effects of disturbances to bank lending seem to support the (international) work concerning measures that aim to strengthen regulation, supervision and risk management of banks in order to reduce the probability of distress in the banking sector. In particular, to the extent that our bank lending shocks reflect several cases of too lax lending standards in upturns and too strict standards in downturns, our findings may support the Basel Committees suggested measures of countercyclical capital buffers intended to curb procyclical lending.

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# Appendix

The following data series were used:

- ($i^*$) Trade-weighted foreign 3-months money market rate. For Norway, the foreign interest rate is a weighted average of the interest rate in the major trading partners. For UK, the foreign interest rate is represented by the U.S. 3-month LIBOR rate as the U.S. comprises more than 50 per cent of the foreign trade weight. Sources: Norges Bank and EcoWin.

- ($ygap$) Output gap, based on Hodrick-Prescott filtered GDP. For Norway, we use the central banks regularly published output gap for mainland Norway (which is based on the HP-filter). For the UK, our output gap is the log transformed GDP HP-filtered with a smoothing parameter of 1600. Sources: Norges Bank and Office for National Statistics

- ($p$) Inflation, measured as annual change in the log of a consumer price index. For Norway, the consumer price index is adjusted for taxes and energy prices. For UK, we use the Retail Prices Index excluding mortgage interest payments (RPIX), as it has been the central inflation measure for the Bank of England during most of our sample period (The harmonized CPI replaced RPIX in December 2003). Sources: Statistics Norway and Office for National Statistics

- ($ph$) Log of real house prices. For UK, we use the BoE adjusted average of the indices from Halifax and Nationwide. Sources: Halifax, Nationwide, Bank of England, Norwegian Association of Real Estate Agents, Association of Real Estate Agency Firms, FINN.no, ECON Poyry

- ($i$) Three months money market rate (UK: LIBOR; Norway: NIBOR). Sources: Norges Bank and EcoWin
- ($e$) Log of the real effective exchange rate, measured against a basket of trading partners. The exchange rate is specified so that an increase implies depreciation. Sources: OECD and Norges Bank
- ($mix$) Fraction with bank lending to non-financial firms and households in the numerator and total credit to the same borrower sectors in the denominator. For the UK, the mix comprises lending to private non-financial firms in addition to households. Sources: Statistics Norway, Bank of England and Office for National Statistics

For UK, we included one impulse dummy; 1992Q4. The dummy controls for very large residuals in the equations for the interest rate and the exchange rate, likely related to the turbulence during the 1992 ERM crisis.

For Norway, three impulse dummies were incorporated: 1992Q4, 1993Q1 and 2000Q3. The first two dummies capture the ERM event and the resulting breakdown of the fixed exchange rate regime in December 1992. The 2000Q3 dummy adjusts for extremely large loan-raisings by two Norwegian firms (Telenor and Norske Skog) that affect the mix variable. Olsen et al. (2002) compute interest rates in accordance to Taylor rules and argue that in the period 1996/7- 1998, monetary policy in Norway deviated significantly from Taylor rules. To obtain a more proper identification of the monetary policy shocks, we therefore also include a dummy that takes the value 1 in the period 1996Q4-1998Q1, and 0 otherwise. The coefficient has the expected sign, and imply that the interest rate should have been kept higher from 1996 to 1998, had the Taylor rule been followed.

Figure 1: Responses to a contractionary monetary policy shock. Norway left hand column. UK right hand column.

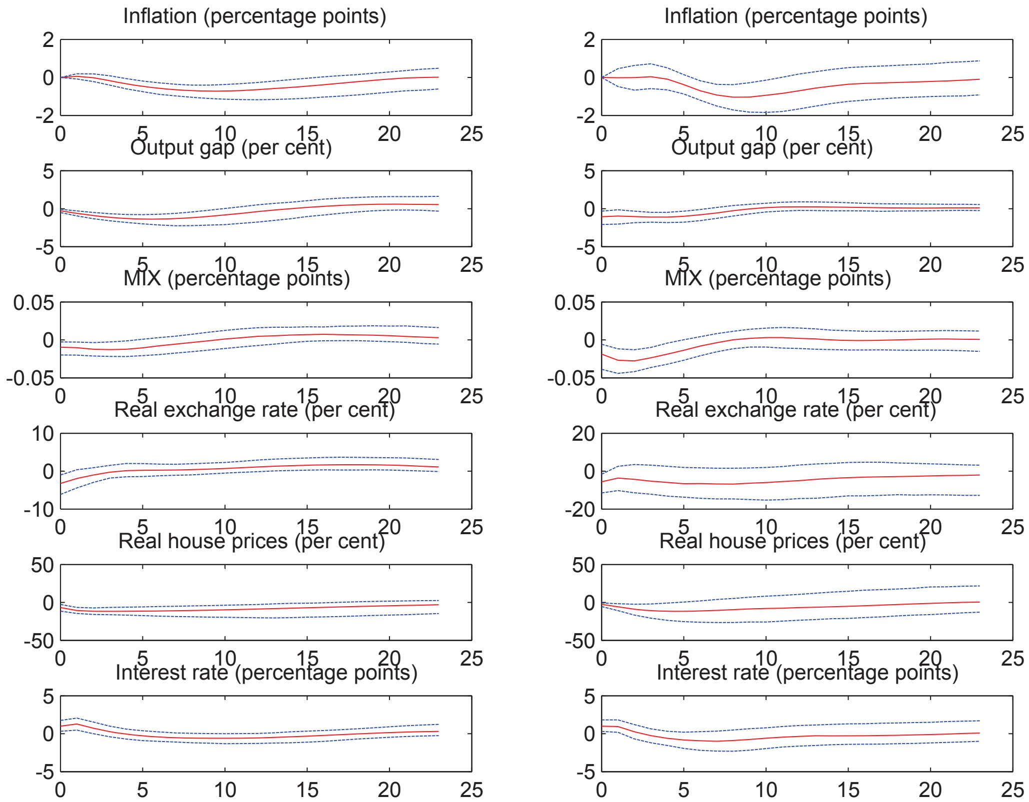

Figure 2: Responses to a negative bank lending shock. Norway left hand column. UK right hand column.

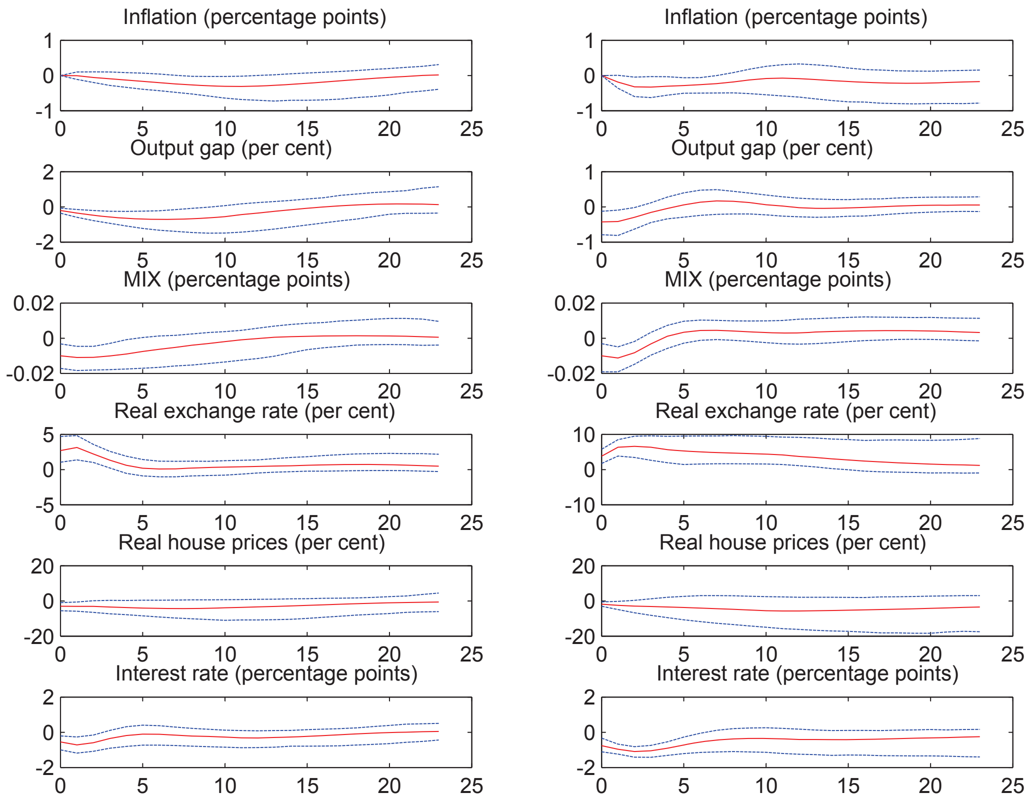

Figure 3: Variance decomposition: contribution from bank lending shocks to output gap variance. Per cent. Norway left hand column. UK right hand column.