Abstract

We examine whether and how main central banks responded to episodes of financial stress over the last three decades. For this reason, we employ a novel methodology for monetary policy rules estimation, which allows for time-varying coefficients as well as corrects for endogeneity. This flexible framework applied to the U.S., U.K., Australia, Canada and Sweden together with a new financial stress dataset developed by the International Monetary Fund allows not only testing whether the central banks responded to financial stress but also detecting the periods and type of stress that were for monetary authorities the most worrying. Our findings suggest that central banks loosen monetary policy in the face of high financial stress, but the size of such response stress varies substantially over time as well as across countries. As regards the specific components of financial stress, most central banks seemed to respond to stock market stress and bank stress, while exchange rate stress is found to drive the reaction of central banks only in more open economies.

JEL Classification: E43, E52, E58.

Keywords: financial stress, Taylor rule, monetary policy, time-varying parameter model, endogenous regressors.

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1 Introduction
Recent financial crisis has intensified the interest in exploring the interactions between monetary policy and financial stability. The official interest rates were driven sharply to historic lows and many unconventional measures were used to pump the liquidity into the international financial system. Central banks pursued monetary policy under high economic uncertainty coupled with large financial shocks in many countries. The financial crisis also raised new challenges to central bank policies, in particular how to operationalize the issues related to financial stability for monetary policy decision-making (Goodhart, 2006, Borio and Drehmann, 2009).

This paper seeks to analyze whether and how central banks reacted to the periods of financial instability and in particular whether and how the interest setting process evolved in response to financial instability over the last three decades. The central bank monetary policies are likely to react to financial instability in a non-linear way (Goodhart et al., 2009). When financial system is stable, monetary policy interest rate setting process largely reflect macroeconomic conditions and financial stability considerations enter the policy discussions only to a limited degree. On the other hand, central banks may alter its monetary policy to reduce financial imbalances. In this respect, Mishkin (2009) questions the traditional linear-quadratic (LQ) framework when financial markets are disrupted and puts forward the arguments for replacing it by nonlinear dynamics describing the economy and non-quadratic objective function resulting in the non-linear optimal policy.

To deal with the complexity of monetary policy and financial stability nexus and evaluate monetary policy in a systematic manner, this paper employs the recently developed time-varying parameter estimation of monetary policy rules with accounting to endogeneity in policy rules appropriately. This flexible framework together with a new comprehensive financial stress dataset developed by the International Monetary Fund will allow not only testing whether the central banks responded to financial stress but also quantification of the magnitude of this response and detection of the periods and type of stress that were for monetary authorities the most worrying.

Anticipating the results, although the theoretical studies disagree about the role of financial instability for central bank interest rate setting policy our empirical investigation aimed at the US Fed, the Bank of England (BoE), Reserve Bank of Australia (RBA), Bank of Canada (BoC) and Sveriges Riksbank (SR) over past three decades shows that central banks typically loosen its

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1 Linear behavior of economy and quadratic objective function of monetary authority.
monetary policy in the face of high financial stress and the size of this response to financial stress varies substantially over time as well as across countries. There is a certain cross-country and time heterogeneity as well when we look at central banks' consideration of specific types of financial stress. While most of them seemed to respond to stock market stress and bank stress and exchange rate stress drives central bank reaction only in more open economies.

The paper is organized as follows. Section 2 discusses the related literature. Section 3 describes our data and empirical methodology. Section 4 gives our results. Section 5 concludes. An appendix with detailed description of the methodology and additional results follows.

2 Related Literature

First, this section gives a brief overview of the theory as well as empirical evidence on the relationship between monetary policy (rules) and financial instability. Second, it provides a short summary of various measures of financial stress.

2.1 Monetary policy (rules) and financial instability – some theory

The financial frictions such as an unequal access to credits or debt collateralization were recognized to have important consequences for the monetary policy transmission and already Fisher (1933) presented the idea that adverse credit-market conditions can cause significant macroeconomic disequilibria.

The effects of monetary policy have been during approximately two decades studied mainly within New Keynesian (NK) dynamic stochastic general equilibrium (DSGE) models, which assume existence of nominal rigidities. The common approach to incorporate financial market friction within the DSGE framework is to introduce financial accelerator mechanism (Bernanke et al., 1996, 1999), who show that endogenous developments in credit markets work to amplify and propagate shocks to the macroeconomy. Tovar (2009) emphasizes that the major weakness of financial accelerator mechanism is that only deals with only one of many possible financial frictions. More generally, Goodhart et al. (2009) notes that many NK DSGE models lacked the financial sector completely or modeling of financial sector within these models was rather embryonic. Therefore, more recent contributions within this stream of literature examined other aspects of financial frictions such as the balance sheets in the banking sector (Choi and Cook, 2004), portfolio choice issue with complete (Engel or Matsumoto, 2009) or incomplete markets
(Devereux and Sutherland, 2007), collateral constraints (Iacovello and Neri, 2010). The survey of this literature is provided by Tovar (2009).

There are a few papers that focus more specifically on the relation between the monetary policy stance (or the monetary policy rule) and the financial stability. However, these contributions do not arrive to an unanimous view on whether monetary policy rule should include some measure of financial stability. Brousseau and Detken (2001) present a NK model where a conflict arise between a short-term price stability and financial stability due to a self-fulfilling belief linking the stability of inflation to the smoothness of the interest rate path and suggest that monetary policy should react to financial instability. Akram et al. (2007) investigate the macroeconomic implications of pursuing financial stability within a flexible inflation-targeting framework. Their model with policy rule augmented with financial stability indicators shows that the gains of augmented rule vis-à-vis the rule without financial stability indicators highly depend on the nature of the shocks. Akram and Eitrheim (2009) build on the previous framework adding evidence that the response to the variables such as excess growth in house prices, equity prices and credit can cause high interest rate volatility and actually lower financial stability in terms of indicators that are sensitive to interest rates. Cecchetti and Li (2008) show in static and dynamic model setting that a potential conflict between monetary policy and financial supervision can be avoided if the interest rate rule account of (procyclical) capital adequacy requirements meaning that policy interest rates are to be lowered under financial stress.

Bauducco et al. (2008) extends the current benchmark NK model to include the financial system and firms that require external financing. Their simulations show that if central bank responds to financial instability by policy easing it achieves better inflation and output stabilization in the short-run at the costs of greater inflation and output volatility in the long-term and vice versa.

Taylor (2008) proposes a modification of a standard Taylor rule to incorporate adjustment to credit spreads for U.S. Fed. Teranishi (2009) derives a Taylor rule augmented by the response to credit spreads as an optimal policy under heterogeneous loan interest rate contracts. He finds that the policy response to credit spread can be both positive and negative depending on the financial structure. However, he also puts forward that when nominal policy rates are close to zero a commitment rather than discretionary policy response is the key for reducing the credit spreads. Christiano et al. (2008) suggest augmenting the Taylor rule with aggregate private credit and find that such policy would raise welfare by reducing the magnitude of the output fluctuations. Cúrdia
and Woodford (2010) develop NK DSGE model with credit frictions to evaluate the performance of alternative policy rules augmented with the response to financial conditions, more specifically with credit spreads and with aggregate volume of private credit, in the face of different shocks affecting economy. They find that the response to credit spreads can be welfare improving, but the optimal size of this response is likely to be small. Similarly to Teranishi (2009), they find little support for augmenting the Taylor rule with the volume of credit, as the size and even the right sign of desired response is sensitive to the assumptions about the source and persistence of shocks.

Related literature focuses on the issue whether the monetary policy should respond to asset prices. Bernanke and Gertler (1999, 2001) argue that the stabilization of inflation and output provides a substantial contribution to financial stability and find little if any gains to responding to asset prices. Faia and Monacelli (2007) extend the model developed by Bernanke and Gertler (2001) and confirm that strict inflation stabilization offers the best solution. On the other hand, Cecchetti et al. (2000) take the opposite stand arguing that developments in asset markets can have a significant impact on both inflation and real economic activity. Similarly, Borio and Lowe (2002) support this view claiming that financial imbalances can build up even in a low inflation environment, though it is normally favorable for financial stability. The side effect of low inflation is that excess demand pressures may appear first in credit aggregated and asset prices rather than consumer prices to which policy makers typically respond to. Gruen et al. (2005) show that responding to asset bubble is feasible only when the monetary authority is able to make a correct judgment about the process driving the bubble. Finally, excellent surveys and the summary of this debate from policy perspective are offered in Roubini (2006) and Posen (2006).

2.2 Monetary policy (rules) and financial instability – empirical evidence

The empirical evidence on the central bank reaction to the financial instability is rather scant. Following the ongoing debate whether the central banks should respond to asset price volatility (e.g. Bernanke and Gertler, 1999, 2001, Cecchetti et al., 2000, Bordo and Jeanne, 2002), some studies tested the response of monetary policy to different asset prices, most commonly the stock prices (Rigobon and Sack, 2003, Chadha et al., 2004, Siklos and Bohl, 2008, Fuhrer and Tootel, 2008). They find some evidence that asset prices either entered the policy information set (because they contain information about future inflation) or that some central banks were directly
trying to offset its disequilibria. However, the estimated policy rules are time-invariant, which means that a permanent response to these variables is de-facto being studied. However, it seems more plausible that the central bank responds to asset prices in asymmetric manner and takes into account only when the degree of asset prices misalignment is substantial. Moreover, it is likely that the perception of misalignments is influenced by general economic conditions and possible response could evolve over time. There are two additional controversies related to the effects of asset prices on monetary policy decisions: (i) first concerns the measure, in particular whether the stock market index that is typically employed is sufficiently representative or whether some other assets, in particular the housing prices, should be considered as well and (ii) second issue is related to the (even ex-post) identification of the asset price misalignment.

Detken and Smets (2004) try to resume some stylized facts regarding the macroeconomic and monetary policy developments during asset price booms. They find that monetary policy during high-cost booms (those where investment and real estate prices crash in the post-boom period) is significantly looser (as measured by a deviation from the Taylor rule).

The following empirical studies measure the effect of monetary policy to broader measures of financial imbalances. Borio and Lowe (2004) estimate the response of four central banks (Reserve Bank of Australia, Bundesbank, Bank of Japan and the US Fed) to financial imbalances proxied by the ratio of private sector credit to GDP, inflation-adjusted equity prices and their composite. They find either negative or ambiguous evidence for all countries besides the US where they detect that the Fed responded to financial imbalances but clearly in asymmetric and reactive way, i.e. the policy rates were lowered further than normal in the face of imbalance unwinding but they were not tightened beyond normal as imbalances build up.

Next, Cecchetti and Li (2008) estimate a Taylor rule augmented with a measure of banking stress, in particular a deviation of leverage ratios (total loans to the sum of equity and subordinated debt; total assets to the sum of bank capital and reserves) from its Hodrick-Prescott trend. They find some empirical evidence that the Fed adjusted interest rate in order to counteract the procyclical impact of bank capital requirements, while the Bundesbank and the Bank of Japan did not.

Buliř and Čihák (2008) estimate a response of monetary policy to seven alternative measures of financial sector vulnerability (captured by the indicators such as crisis probability, time to crisis,

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2 Similar but somewhat less polemic debate applies to the role of the exchange rate, especially for small open economies (Taylor, 2001).
distance to default or credit default swap spreads) in a panel of 28 countries. The estimated policy rule is novel in the sense that the measures of domestic liquidity are used along with the short-term interest rate as policy variables besides controlling for external shocks. They find statistically significant negative response (policy easing) to many variables representing vulnerability in the panel setting but fail to uncover the significance of most these variables in country-level regressions.

Belke and Klose (2010) investigate the factors behinds the interest rate decision of the ECB and the Fed during the current crisis and find that the estimated policy rule was significantly altered only for the Fed and put forward that the ECB gave greater weight on inflation stabilization at the cost of some output loss, while the opposite holds for the Fed.

2.3 Measures of financial stress

The incidence and determinants of different types of crises have been typically in the literature traced by means of narrative (expert judgment) evidence, sometimes complemented by data on selected indicators (the exchange rate devaluation, the state of foreign reserves) that point to historical regularities (e.g. Eichengreen and Bordo, 2002, Kaminsky and Reinhart, 1999, Reinhart and Rogoff, 2008, Laeven and Valencia, 2008). The empirical studies (e.g. Goldstein et al., 2000) use binary variables constructed based on these narratives.

Alternative stream of literature provides the measures of financial stress that are more data driven. Most of the indices are based on high frequency data but they differ in the selected variables (such as bank capitalization, credit ratings, credit growth, interest rate spreads or volatility of different asset classes), country coverage as well as in the aggregation method. An important advantage is that such measure might reveal periods of small-scale stress that did not result in full-blown crisis.

The Bank Credit Analyst (BCA) reports a monthly financial stress index (FSI) for the US that is based on the performance of banking shares as compared to whole stock market, credit spreads and the slope of the yield curve, the new issues of stocks and bond and consumer confidence. JP Morgan calculates Liquidity, Credit and Volatility Index (LCVI) based on seven variables: the U.S. Treasury curve error (standard deviation of the spread between on-the-run and off-the-run US treasury bills and bonds along the entire maturity curve), the 10-year US swap spread, US high-yield spreads, JP Morgan’s Emerging Markets Bond Index, foreign exchange volatility
(weighted average of 12-month implied volatilities of several currencies), the Chicago Board of Exchange equity volatility index VIX, and the JP Morgan Global Risk Appetite Index.

Illing and Liu (2006) develop a comprehensive measure of FSI for Canada. The underlying data covers equity, bond and foreign exchange markets as well as banking sector. They use standard measure and refined measure of each stress component, where the former refers to the variables and their transformations that are commonly found in literature, while the latter incorporates the adjustments that allow better to extract the information about stressful periods. They also check the different weighting methods to aggregate the individual series (factor analysis, size of a corresponding market on total credit in economy, variance-equal weighting) and perform an expert survey in order to identify periods that were perceived as stressful. The authors conclude that their FSI matches these episodes very well.

Carlson et al. (2008) propose (for the Fed Board of Governors) a framework similar to option pricing model (Merton, 1974) that aims to provide a distance-to-default of the financial system, so called Index of Financial Health. The method uses the difference between the market value of firm’s assets and liabilities and the volatility of asset’s value in order to measure the proximity of firm’s assets being exceeded by its liabilities. They apply the measure to 25 largest US financial institutions confirming its impact on capital investments in the US economy. The FED of Kansas City developed the Kansas City Financial Stress Index (Hakkio and Keeton, 2009) that is published monthly and is based on eleven variables (seven spreads between different bonds by issuers, risk profiles and maturities, correlations between returns on stocks and Treasury bonds, expected volatility of overall stock prices, volatility of bank stock prices and cross-section dispersion of bank stock returns) that are aggregated by principal component analysis.

The International Monetary Fund (IMF) constructed financial stress index for various countries in the way to allow for cross-country comparisons. Cardarelli et al. (2009) propose a comprehensive index based on high-frequency data where the price changes are measured with respect to its previous levels or trend value. The underlying variables are standardized and aggregated into single index (FSI) using variance-equal weighting for each country and period. The FSI has three subcomponents: banking sector (the slope of the yield curve, TED spread, beta of banking sector stock), securities markets (corporate bonds spread, stock market returns and time-varying volatility of stock return) and exchange rate (time varying volatility of NEER change). Balaskrishnan et al. (2009) modify the original index to account for specific conditions.
of emerging economies; on one hand, including measure of exchange rate pressures (currency depreciation and decline in foreign reserves) and sovereign debt spread, on the other, downplaying somewhat the banking sector measures (slope of the yield curve and TED spread). The IMF Financial Stress Index has been recently applied by Melvin and Taylor (2009) to analyze the exchange rate crises.

3 Data and Empirical Methodology

3.1 The dataset


The dependent variable is the interest rate typically closely related to the official (censored) policy rate, in particular the federal fund rate (3M) for the US, the discount rate (3-month treasury bills) for the UK, Canada and Sweden and 3-month RBA accepted bills rate for Australia. It is evident that policy rate is not necessarily the only instrument that central bank uses, especially in time of 2008-2009 global financial crisis when many unconventional measures are implemented (see Borio and Disyatat, 2009, Reis, 2010). So as to address this issue in terms of estimated policy rules, we use for robustness check interbank interest rate (at maturity of 3 months). While both rates are used in empirical papers on the monetary policy rules estimation without a great controversy, the selection of the interest rate turns more delicate during the financial stress periods. While the former is more directly affected by genuine monetary policy decisions (carried by open market operations), the second additionally includes liquidity conditions on the interbank markets and as such can be affected by some unconventional policies, though these are usually insulated (often intentionally) from policy interest rate.3 This represent drawback but also potential advantage of this alternative dependent variable. On the one hand, the changes in official policy rate may not pass-through fully into interbank interest rate, in particular when the perceived counterparty risk is too high and the credit spreads widen (see Taylor and Williams, 2004).

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3 Borio and Disyatat (2009) characterize the unconventional policies as policies that affect the central bank’s balance sheet size and composition and that can be insulated from interest rate policy (so called “decoupling principle”). One common example of such policy not necessary used during time of crisis is a sterilized exchange rate intervention. Given that we aim not on single episode of stress but rather want identify if monetary authorities deviated from its systematic pattern (the policy rule) during these periods (by responding to indicators of financial stress), we need to use a consistent measure of policy actions, which is adjusted during the periods of financial stress, though other measures can be in place as well. Therefore, we assume that the monetary policy stance is fully reflected in interest rate, and we are aware that it can give a downward-bias on financial stress coefficient. The reader may wish to interpret our results on the importance of financial stress on interest rate setting as the conservative estimate.
2009), on the other hand, the interbank rate may also incorporate also effect policy actions such as quantitative easing aimed to supply additional liquidity into the system.4

The inflation is measured as year-on-year change of CPI, besides the UK where we use RPIX (retail price index excluding mortgage interest payments).

The output gap is taken as reported in the OECD Economic Outlook (production function method based on NAWRU - non-accelerating wages rate of unemployment) besides for NZ where this series is short and where we use the output gap derived from the Hodrick-Prescott filter applied at GDP series (at constant prices, seasonally adjusted).

We proxy the financial stress by means of the FSI published recently by the IMF (Cardarelli et al., 2009), which is a consistent measure for wide range of countries but at the same time comprehensive enough to include stress of different nature.5 It includes the main components of financial stress in an economy and is available for reasonably long period to be used for our empirical analysis (see Figure 1). We use both the overall index that is a sum of seven components as well as each sub-index and component separately: (i) banking-related sub-index components: the inverted term spread (difference between short-term and long-term government bonds), TED spread (difference between interbank rates and the yield on treasury bills), banking beta (12-month rolling beta, which is a measure of correlation of banking stock returns to total returns in line with the CAPM); (ii) securities-markets related sub-index components: corporate bond spread (difference between corporate bond and long-term government bond yields), stock markets returns (monthly returns multiplied by -1), time-varying stock return volatility (from GARCH(1,1) model); and (iii) foreign exchange related sub-index: time-varying volatility of monthly changes in NEER (from GARCH(1,1) model). We use alternative methods of

4 There are evidently other policy measures that can be used as a reactive or pre-emptive response to financial stress such as regulatory or administrative measures. Though, their effects appear only in long-term and cannot be reasonably included in our empirical analysis
5 The use of composite index has a number of benefits. First, it approximates the evolution of financial stress caused by different factors and thus, it is not limited to one specific type of instability. Second, the inclusion of additional variables into the stress index does not affect evolution of the indicator markedly (Cardarelli et al., 2009). Third, the composition of the indicator allows decomposing the reactions of the central bank with respect to different stress sub-components. Nevertheless, one has to be cautious about the interpretation. The composite indicator might suggest misleading interpretation as long as the stress is caused by variables not included within the FSI but highly correlated with some sub-component. An example is the case of Sweden during the ERM crisis. At the time of the crisis, Sweden maintained a fixed exchange rate and Riksbank increased sharply interest rates in order to sustain the parity. However, this is not captured by the exchange rate sub-component of FSI, which measures exchange rate volatility, because the volatility was actually close to zero. Closer look at the data shows that this period of stress is captured by the inverted term structure; hence it is (wrongly) attributed to bank stress. A similar pattern can be observed for the U.K., where the FSI increases after the announcement of the withdrawal from the ERM.
aggregation: simple sum, variance-equal weighting, and PCA weighting that does not materially affect the overall index and consecutively the empirical results.

**Figure 1 – IMF Financial Stress Indicator**

Note: The figure presents the evolution of IMF stress index over time. Higher numbers indicate more stress.

3.2 The empirical model
Following Clarida et al. (1998, 2000), most empirical studies assumes that the central bank sets the nominal interest rate in line with the state of the economy typically in a forward-looking manner:

\[
\begin{align*}
\hat{r}_t^* = \bar{r} + \beta \left( E \left[ \pi_{t+i} \mid \Omega_t \right] - \pi_{t+i}^* \right) + \gamma E \left[ y_{t+j} \mid \Omega_t \right]
\end{align*}
\] (1)

where \( r_t^* \) denotes the targeted interest rate, \( \bar{r} \) is the policy neutral rate, \( \pi_{t+i} \) stands for the central bank forecast of the yearly inflation rate \( i \) periods ahead, and \( \pi_{t+i}^* \) is the central bank’s inflation target.\(^7\) \( y_{t+j} \) represents a measure of the output gap.

Nevertheless, Eq. (1) was found to be too restrictive to provide a reasonable description of actual interest rate setting. Notably it does not account for interest rate smoothing of central banks, in particular the practice when the central bank adjusts the interest rate sluggishly to the targeted value. This is in empirical studies tracked by simple partial-adjustment mechanism:

\[
\begin{align*}
r_i &= \rho r_{i-1} + \left( 1 - \rho \right) r_t^*
\end{align*}
\] (2)

where \( \rho \in [0,1] \) is the smoothing parameter. There is ongoing controversy whether this parameter represent genuine policy inertia or reflect empirical problems related to omitted variables, dynamics or shocks (see e.g. Rudebusch, 2006). The linear policy rule Eq. (1) can be obtained as optimal monetary policy rule in LQ framework where central bank aims only at price stability and economic activity. Bauducco et al. (2008) propose NK model with financial system where monetary policy has privileged information on the health of financial sector (given its supervisory function). In such setting, the common policy rule represented by Eq. (1) shall be augmented by variables representing the health of financial sector. Following this contribution we consider the forward-looking rule where central banks may respond to a comprehensive measure of financial stress rather than stress in particular segment (Buliř and Čihák, 2008). Therefore, we substitute Eq. (2) into Eq. (1), eliminate unobserved forecast variables and include measures of financial stress described above, which results in Eq. (3):

\[
\begin{align*}
r_i &= \left( 1 - \rho \right) \left[ \alpha + \beta \left( \pi_{t+i} - \pi_{t+i}^* \right) + \gamma y_{t+j} \right] + \rho r_{t-1} + \delta x_{i+k} + \varepsilon_i
\end{align*}
\] (3)

While in Eq. (1) the term \( \alpha \) coincides with the policy neutral rate \( \bar{r} \), its interpretation is not straightforward once is the model augmented by additional variables. Note that the financial stress index \( x_{i+k} \) does not appear within the square brackets because it is macroeconomic

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\(^6\) Policy neutral rate is typically defined as the sum of real equilibrium rate and expected inflation.

\(^7\) An explicit definition of inflation target exists only for countries with inflation targeting (IT) regime. Most empirical studies assume in line with Taylor (1993) that this target does not vary in time and can be omitted in the empirical model.
variable that determines the target interest rate \( r_t^* \) but it is factor similar as the lagged interest rate, i.e. it may explain why the actual interest rate \( r_t \) deviates from the target. Moreover, placing in the regression on the same level as lagged interest rate, we can directly test whether this variable representing ad-hoc policy decision decreases the interest rate inertia \( \rho \) as suggested by Mishkin (2009). The common logic also suggest that the coefficients \( \rho \) and \( \delta \) shall move in the opposite direction, the central bank either responds to macroeconomic variables, additionally smoothing or adjust the rates in consideration of financial stress. In the latter case, the response must be quick and substantial. We set \( i \) equal to 2 and \( j \) and \( k \) equal to -1. Consequently, the disturbance term \( \varepsilon \) is a combination of forecast errors and is thus orthogonal to all information available at time \( t \) (\( \Omega_t \)).

The empirical studies on monetary policy rules have moved from using time-invariant estimates (Clarida et al., 1998) through sub-sample analysis (Taylor, 1999, Clarida et al., 2000) towards more complex methods that allow assessment of evolution in the conduct of monetary policy. There are two possible ways to model the structural changes in monetary policy rules that occur on unknown date: (i) regime switching models, or in particular the state-dependent Markov switching models (Valente, 2003, Assenmacher-Wesche, 2006, Sims and Zha 2006) and (ii) state space models where the changes are characterized by smooth transitions rather than abrupt switches (Boivin, 2006, Elkhoury, 2006, Kim and Nelson, 2006, Trecrocci and Vasalli, 2009). As we have argued before (Baxa et al., 2010), we consider the second approach being preferable for estimation of policy rules given that it is more flexible and allows incorporation of a simple correction of endogeneity (Kim, 2006, Kim and Nelson, 2006) that is a major issue in forward-looking policy rules estimated from ex-post data. The state space approach or time-varying coefficient model seems also suitable when one wants to evaluate the effect of factors such as

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8 Although the targeting horizon of central banks is usually longer (4-8 quarters), we prefer to proxy inflation expectations by inflation in \( t+2 \) for the following reasons. First, the endogeneity correction requires strong correlation between the endogenous regressor and its instruments. Second, the prediction error logically increases in longer horizons. In case of the output gap, we assume rather backward-looking reaction. The reason is that in absence of real time data we have to rely for the output gap construction on statistical methods. It is arguable that besides the prediction error there is also a construction error that both might be even magnified if unobserved forecast is substituted by the output gap estimate for future periods. At last, we assume that central bankers’ response (if any) to financial stress is rather immediate (see Mishkin, 2009). Therefore, we use one lag of FSI and its subcomponents in the benchmark case. However, as a robustness check we allow for different lags and lead, allowing the central bankers’ response being rather preemptive than reactive.

9 The time-varying parameter model with specific treatment of endogeneity is still relevant when the real-time data are used (Orphanides, 2001). When the real-time forecast is not derived under assumption that nominal interest rates will remain constant within the forecasting horizon (Boivin, 2006) or in case of the measurement error and the heteroscedasticity (Kim et al., 2006).
financial stress that can for a limited length of time alter (rather than permanently change) the monetary policy conduct.

The state space model has been typically estimated by means of maximum likelihood estimator via the Kalman filter. However, this approach has several limitations that can turn problematic in applied work. First, the results are sensitive to the initial values of parameters, which are logically unknown, especially in case of variables whose impact on interest rate is not permanent and whose size is unknown, which is the case of the financial stress. The problem is even reinforced in small samples. Second, the Kalman filter employs only past information and the estimates are less efficient at the beginning of the sample. One potential alternative is a moment-based estimator proposed by Schlicht (1981, 2005) and Schlicht and Ludsteck (2006), which is employed in our paper and very briefly described below. This framework is it is flexible enough so to incorporate the endogeneity correction proposed by Kim (2006).

Kim (2006) shows that the conventional time-varying parameter model delivers inconsistent estimates when explanatory variables are correlated with the disturbance term and proposes an estimator of the time-varying coefficient model with endogenous regressors. The endogeneity may arise not only in forward-looking policy rules based on ex-post data (Kim and Nelson, 2006, Baxa et al., 2010), but also in the case of variables that have a two-sided relation with monetary policy. A financial stress is unquestionably enters this category. Following Kim (2006) we rewrite Eq. (3) as follows:

\[ r_t = (1 - \rho_t) \left[ \alpha_t + \beta_t \left( \pi_{t+1} + \gamma_t y_{t+1} \right) + \rho_t r_{t-1} + \delta x_{t+k} + \epsilon_t \right] \quad (4) \]

\[ \alpha_t = \alpha_{t-1} + \theta_1, \quad \theta_1 \sim i.i.d.N \left( 0, \sigma_{\alpha_1}^2 \right) \quad (5) \]

\[ \beta_t = \beta_{t-1} + \theta_2, \quad \theta_2 \sim i.i.d.N \left( 0, \sigma_{\beta}^2 \right) \quad (6) \]

\[ \gamma_t = \gamma_{t-1} + \theta_3, \quad \theta_3 \sim i.i.d.N \left( 0, \sigma_{\gamma}^2 \right) \quad (7) \]

\[ \delta_t = \delta_{t-1} + \theta_4, \quad \theta_4 \sim i.i.d.N \left( 0, \sigma_{\delta}^2 \right) \quad (8) \]

\[ \rho_t = \rho_{t-1} + \theta_5, \quad \theta_5 \sim i.i.d.N \left( 0, \sigma_{\rho}^2 \right) \quad (9) \]

\[ \pi_{t+1} = Z_{t+m} \xi + \sigma_\pi \phi_t, \quad \phi_t \sim i.i.d.N \left( 0, 1 \right) \quad (10) \]

\[ y_{t+1} = Z_{t+m} \psi + \sigma_\psi \nu_t, \quad \nu_t \sim i.i.d.N \left( 0, 1 \right) \quad (11) \]

\[ x_{t+k} = Z_{t+m} \sigma + \sigma_x \zeta_t, \quad \zeta_t \sim i.i.d.N \left( 0, 1 \right) \quad (12) \]
The measurement equation (4) of the state-space representation is the monetary policy rule. The transition equations (5) – (9) describe the time-varying coefficients as a random walk process without drift. The Eqs. (10) - (12) track the relationship between the potentially endogenous regressors \( (\pi_{t+1}, y_{t+1}, x_{t+1}) \) and their instruments, \( Z_t \). We use the following instruments:

\[
\pi_{t-1}, \pi_{t-2} (\pi_{t-4} \text{ for SWE}), y_{t-1}, y_{t-2}, r_{t-1}, \text{ and when } k \geq 0 \text{ also } x_{t-1} \text{ and } x_{t-2}.
\]

As in Kim (2006), we assume that the parameters in Eqs. (10) - (12) are time-invariant. The correlation between the standardized residuals \( \phi_t, \nu_t, \) and \( \zeta_t \) and the error term \( \epsilon_t \) is \( \kappa_{\phi,\epsilon}, \kappa_{\nu,\epsilon}, \) and \( \kappa_{\zeta,\epsilon} \) respectively (note that \( \sigma_{\phi}, \sigma_{\nu}, \) and \( \sigma_{\zeta} \) are standard errors of \( \phi_t, \nu_t, \) and \( \zeta_t \), respectively). The consistent estimates of the coefficients in Eq. (4) are obtained in two steps. In the first step, we estimate the equations (10)-(12) and save the standardized residuals \( \phi_t, \nu_t, \) and \( \zeta_t \). In the second step, we estimate Eq. (13) below along with Eq. (5)-(9). Note that (13) now includes bias correction terms, i.e. (standardized) residuals from Eqs. (10)-(12), to address the aforementioned endogeneity of the regressors. Consequently, the estimated parameters in Eq. (13) are consistent, as \( \epsilon_t \) is uncorrelated with the regressors.

\[
\begin{align*}
\rho_i = (1 - \rho_i) \left[ \alpha_i + \beta_i (\pi_{i+2}) + \gamma_i, y_{i-1} \right] + \rho_i r_{i-1} + \delta_i, x_{i-1} + \kappa_{\phi,\epsilon}, \epsilon_{i-1} + \kappa_{\nu,\epsilon}, \nu_{i-1} + \kappa_{\zeta,\epsilon}, \zeta_{i-1} + \epsilon_t, \\
\zeta_t \sim N \left( 0, (1 - \kappa_{\phi,\epsilon}^2 - \kappa_{\nu,\epsilon}^2 - \kappa_{\zeta,\epsilon}^2) \sigma_{\epsilon,t}^2 \right)
\end{align*}
\]  

(13)

As we noted below, instead of the standard framework for second-step estimation, the maximum likelihood estimator via the Kalman filter (Kim, 2006), we use an alternative estimation framework, the “varying coefficients” (VC) method (Schlicht, 1981, 2005, Schlicht and Ludsteck, 2006). This method is a generalization of the ordinary least squares approach that instead of minimizing the sum of squares of residuals \( \sum_{t=1}^{T} \epsilon_t^2 \) uses the minimization of the weighted sum of squares:

\[
\sum_{t=1}^{T} \epsilon_t^2 + \theta_1 \sum_{t=1}^{T} \varphi_1^2 + \theta_2 \sum_{t=1}^{T} \varphi_2^2 + \ldots + \theta_n \sum_{t=1}^{T} \varphi_n^2
\]

(14)

where the weights \( \theta_i \) are the inverse variance ratios of the regression residuals \( \epsilon_t \) and the shocks in time-varying coefficients \( \varphi_i \), that is \( \theta_i = \sigma_i^2 / \sigma_{\epsilon,i}^2 \). This approach balances the fit of the model and the parameter stability. Additionally, the time averages of the regression coefficients, estimated by such weighted least squares estimator, are identical to their GLS estimates of the

---

10 Note that while typical time-invariant regression assumes that \( a_i = a_{i-1} \), while in this case it is assumed that \( E[a_i] = a_{i-1} \).
corresponding regression with fixed coefficients, that is \( \frac{1}{T} \sum_{t=1}^{T} \hat{a}_t = \hat{a}_{GLS} \).\(^{11}\) The method is useful in our case because (i) it does not require the knowledge of initial values as it uses orthogonal parameterization instead of parameterization by initial values, (ii) it uses both past and future observations and therefore as a two-sided filter is more efficient at the beginning of the sample, (iii) it coincides with the MLE estimator via Kalman filter if time series are sufficiently long and outperforms it in small and poorly conditioned samples.\(^{12}\) However, note that this method suffers certain limitations of its own. In particular, (i) it requires that the time-varying coefficients are described as random walks and at the same time (ii) the shocks in time-varying coefficients \( \vartheta_t \) are minimized (see Eq. (14)). While this does not represent a major problem for estimation of coefficients of common variables such as inflation where the monetary policy response is permanent, it can lead to a loss of some information about responses ad-hoc factors in monetary policy making that are considered by the policy infrequently but once they are in place the policy response can be substantial. A financial stress indicator \( x_{r+k} \) is unquestionably this kind of factor. The way to deal with this problem is estimation-independent calibration of the variance ratios in Eq. (14) such that the estimated coefficient is consistent with economic logic, i.e. it is mostly insignificant and it can turn significant (with no prior restriction on its sign) during the periods of financial stress, i.e. when the financial stress indicator is different than zero. As a robustness check, we evaluate alternative variance ratios in terms of quality of out-of-sample prediction (Schlicht, 1981).\(^{13}\)

The results of our empirical analysis should reveal whether central banks adjusted its interest rate policy in the face of financial stress. However, our time-varying framework allows also inferring whether any response to financial stress led to temporal dismissal of other targets, in particular the inflation rate. Therefore, we are mainly interested in evolution of the financial stress coefficient \( \delta_t \). We expect it to be mostly insignificant given that episodes of financial stress are rather infrequent and even if they occur the monetary authorities may not always respond to it. Moreover, the size of the estimated coefficient does not have any obvious interpretation as the FSI is an artificial variable. Consequently, we define the stress effect as a product of the estimated coefficient \( \delta_t \) and the value of IMF financial stress index \( x_{r+k} \). The interpretations of the stress

\(^{11}\) See Schlicht and Ludsteck (2006) and Baxa et al. (2010) for more details.

\(^{12}\) The Kalman filter as implemented in common econometric packages typically uses the diffusion of priors for its initiation but still it produces a lot of corner solutions and often it does not achieve convergence.

\(^{13}\) Stock and Watson (2006) propose a medium unbiased estimator for variance in time-varying parameter model but it is application is straightforward only in case of one time-varying coefficient and, more importantly, it requires the variables being stationary. Finally, the authors are addressing an opposite problem to ours, i.e. when the estimates of the shocks are too big.
effect is straightforward, as it shows the magnitude of interest rate reaction to financial stress in percentage points or in other words the deviation from the target interest rate implied by the macroeconomic variables due to the response to financial stress.

4 Results

This section gives our results on the effect of financial stress on interest rate setting. First, the results on the effect of overall measure of financial stress on interest rate setting are presented. Second, the effect of specific components of financial stress on monetary policy is examined. Third, we shortly comment on monetary policy rule estimates that served as the input for the assessment of financial stress effect. Finally, we perform a series of robustness checks.

Figure 2 has our results on the effect of financial stress on interest rate setting in all our five countries (labeled as financial stress effect hereinafter). The effect of financial stress varies over time. Although there is some cross-country heterogeneity, some global trends in the effect of financial stress are apparent. While in good times such as in the second half of 1990s there is virtually no effect of financial stress on interest rate setting, the reaction of monetary authorities to financial stress is present during the 2008-2009 global financial crisis. While the previous evidence on the effect of financial stress on monetary policy is somewhat limited, our results broadly confirm the time-invariant findings of Cecchetti and Li (2008), which show that the U.S. Fed adjusted the interest rates to the procyclical impact of bank capital requirements in 1989-2000. Similarly, Belke and Klose (2010) estimate Taylor rule on two sub-samples (before and during 2008-2009 global financial crisis) and find that the Fed reacted systematically not only to inflation and output gap, but to asset prices, credit and money as well.
Figure 2 – The Effect of Financial Stress on Interest Rate Setting

Notes: The figure depicts the evolution of financial stress effect. The stress effect (y-axis) is defined as the product of the estimated coefficient on financial stress indicator in monetary policy rule and the value of IMF financial stress indicator. The stress effect shows the magnitude of interest rate reaction to financial stress in percentage points.

The size of financial stress effects on interest rate setting during recent financial crisis is somewhat heterogeneous. The result suggest that all central bank except the Bank of England kept its policy rates by about 50 basis points lower, as compared to the counterfactual of no reaction to financial stress. The size of this effect for the U.K. is assessed to be about five times
stronger (i.e. 250 basis points). This implies that about 50% of overall policy rate decrease during recent financial crisis was motivated by the financial stability concerns in the U.K. (10-30% in the remaining sample countries), while remaining half falls on unfavorable developments in domestic economic activity. The results for the U.S. and especially for the U.K. suggest that the reaction of central banks to financial stress during recent financial crisis was larger than any time three decades before. This finding is interesting to confront with the BoE's very low consideration of expected inflation over the last decade (Baxa et al., 2010) that further decreased during the current crisis similarly as for the US and less so for the other central banks. It is also evident that the magnitude of the response is unusual for all five central banks. On the other hand, the results for Australia, Canada and Sweden show that central banks in these countries reacted to financial stress in the magnitude similar to the recent financial crisis already before.14

The question of which components of financial stress influence the interest rate setting is examined in Figure 3. Some cross-country heterogeneity is again apparent; although it seems that bank stress and stock market stress were dominant the central bankers in less open economies. On the other hand, exchange rate stress matters in more open countries - Canada and Sweden.

More specifically, the US Fed seemed to be worried about the financial instability especially during the 1980’s. We can see that the main concern in early 1980's was the banking stress, which is arguably related to Savings and Loans crisis. Another concern was that of the stock market stress, in particular during the stock market crash of 1987 when interest rates were lower by 30 b.p. with respect to the benchmark case. The Bank of England was in general much more perceptive to financial stress. We find response mainly to stock market stress, again notably in 1987. Somewhat surprisingly, we find little response to exchange rate stress, not even during the 1992 ERM crisis. Nevertheless, it has to be emphasized that the interest rate reaction to speculative attack was subdued in comparison to, for example, the Riksbank (Buiter et al., 1998).

The Reserve Bank of Australia significantly loosened its policy during the 1980s, which can be attributed to the stress in banking sector (see Figure 3). Exchange rate as well as bank stress seem to matter for interest rate considerations at the Bank of Canada. Interestingly, the results suggest that the Bank of Canada often responded to the higher exchange rate stress by monetary tightening. A possible explanation for this finding could be that the Canadian central bank

14 Given that the 2008-2009 global crisis occurred right at the end of our sample (there is a peak in stress indicator of 5 standard deviation and it have not returned to normal values yet), we have performed an additional check to avoid possible end-point bias. In particular, we have run our estimation excluding the observation from the 2008-2009 crisis period. These results that are available upon request confirmed the robustness our the reported findings.
tightened the policy, when the currency stabilized at the level that was considered to be undervalued. At last, for Sveriges Bank we find again both negative and positive response to the overall FSI. Though our sample start only in 1983, which does not allow detecting the response during the Scandinavian banking crisis, we find several periods of policy loosening in face of stock market stress and notably the strong response to foreign exchange stress during the ERM crisis.

At last, we would like to draw the attention to a comparison of Figures 2 and 3. First, it should be noted that the positive response to one stress subcomponent may cancel out with a negative response to another one, making the response to the overall stress negligible (as in the case of Canada). Second, the stress effects related to individual subcomponents need not necessarily sum up to the stress effect related to entire FSI. The use of each subcomponent at one after the other may be a subject to the omission bias if more types of stress are in place at the same time.

All in all, the results suggest that the central bank tend to react to financial stress and different components of financial stress matter in different time periods. The effect of financial stress on interest rate setting is found to be virtually zero in good times and economically sizable during the period of high financial stress. These findings are to a certain extent robust to the case, where we include interbank rate as the dependent variable for the monetary policy rule estimation (see Appendix 2). The effect of financial stress on this interest rate is found to be a bit larger, but as we already noted interbank rate is not our preferred measure, see Taylor (2008).
Figure 3 – The Effect of Financial Stress Components on Interest Rate Setting:
Bank Stress, Exchange Rate Stress and Stock Market Stress

Notes: The figure depicts the evolution of the components of financial stress effect, namely bank stress effect, exchange rate stress effect and stock market stress effect. The stress effect (y-axis) is defined as the product of the estimated coefficient on the given component of financial stress indicator in monetary policy rule and the value of corresponding component of IMF financial stress indicator. The stress effect shows the magnitude of interest rate reaction to financial stress in percentage points.
Next, we shortly comment on our monetary policy rule estimates. The plot of the evolution of estimated parameters over time for all countries is available in Appendix 1. All in all, the results are in line with theory and point to the usefulness of our framework. Our results indicate that the interest rate smoothing is much lower than what time-invariant estimates of monetary policy rules typically report (see for example, Clarida et al., 1998, 2000). Our estimates of interest rate smoothing seem to be reasonable given the recent critique of Rudebush (2006), who argues that the degree of interest rate smoothing is rather low. Moreover, for some central banks such as the RBA and the BoE today or the Sveriges Riksbank in late 1980’s we find support for Mishkin’s (2009, 2010) argument that central banks are less inertial during the crisis. The response of interest rates on inflation is particularly strong during the periods, when central bankers want to break the record of high inflation such as in the U.K. or in Australia at the beginning of 1980s and it becomes less aggressive in the low inflation environment with subdued shocks. Some central banks are also found to react to output gap developments with the estimated parameter to be on average slightly positive.

Finally, we perform a battery of robustness check. First, following the argument put forward above, we use interbank interest rates as dependent variable. These results are reported in Figure A.2.1-A.2.2. We can see that the overall stress effect is very similar in all countries but Australia where we in the latter case found rather strong negative stress effect during the 1980’s.

Second, in the benchmark model we use the first lag of FSI in the policy rule estimation. We motivate this choice by the use of monthly data, the frequency of monetary policy meetings of most central bank boards and the assumption that the policy actions are likely to be implemented in a timely fashion. Nevertheless, we have employed different lags and leads, in the latter case allowing the policy being preemptive rather than reactive. In this case, we use the future realized value of FSI as a proxy of central bank’s expectation (in a similar matter as it is routinely done for inflation expectations) and consequently treat FSI as an endogenous variable (see Figure A.3.1 for the results). The different assumptions about the reaction to the stress imply slightly different variances of time-varying coefficients but do not lead to substantially different results in terms of the effect of financial stress on interest rate setting in most countries.

Third, we evaluate the contribution of each underlying component to the FSI sub-indices, in particular the bank stress and the stock market stress (foreign exchange stress is represented by a single variable). The stress effects appear in Figures A.4.1-A.4.2.
Forth, we use alternative ways to aggregate the individual stress variables in the FSI such as by the principal components. The results remain very similar to the benchmark case when simple sum of normalized subcomponents. The results are available upon request.

Fifth, although the checks related to our econometric framework to obvious alternatives such as, first, the use of maximum likelihood via Kalman filter instead of moment-based time-varying coefficient framework of Schlicht and second, the use of Markov-switching model instead of state-space model were provided in Baxa et al. (2010), we estimate simple time invariant monetary policy rules for each country by the generalized method of moments, including various subsamples. While the FSI is always statistically significant with negative sign of magnitude between 0.05-0.20, its subcomponents are not always significant and the exchange rate subcomponent has in some cases positive sign. These results are available upon request.

5 Concluding Remarks

The 2008-2009 global financial crisis awoke a significant interest in exploring the interactions between monetary policy and financial stability. This paper aims to examine in a systematic manner whether and how selected main central banks (US Fed, the Bank of England, Reserve Bank of Australia, Bank of Canada and Sveriges Riksbank) responded to episodes of financial stress over the last three decades. Instead of using individual alternative measures of financial stress in different markets, we employ a comprehensive indicator of financial stress recently developed by the International Monetary Fund, which tracks the overall financial stress as well as its main subcomponents, in particular banking stress, stock market stress and exchange rate stress.

Compared to previous research, we adopt more flexible methodology for the evaluation of the time-varying effect of financial stress that allows for time-varying coefficients as well as corrects for endogeneity (Kim and Nelson, 2006). Main advantage of this framework is that it allows not only testing whether the central banks responded to financial stress at all but also is able to detect the periods and type of stress that were for monetary authorities the most worrying. Our results indicate that the response of central bank to financial stress varies substantially over time. The impact of financial stress on interest rate setting is essentially zero in good time when the levels of stress are very moderate. However, central banks typically loosen monetary policy in the face of high financial stress. There is a certain cross-country and time heterogeneity when we look at
central banks’ considerations of specific types of financial stress. While most central bank seem to respond to stock market stress and bank stress, exchange rate stress is found to drive the reaction of central banks only in more open economies.

Consistently with our expectations, the results indicate that a sizeable fraction of the monetary policy easing during the 2008-2009 financial crisis can be explained by the response to overall financial stress. The size of financial stress effect is however somewhat heterogeneous. The result suggest that all central bank except the Bank of England kept its policy rates by about 50 basis points on average lower solely due to financial stress during the crisis, as compared to the counterfactual of no reaction to financial stress. Interestingly, the size of this effect for the U.K. is assessed to be about five times stronger (i.e. 250 basis points). This implies that about 50% of overall policy rate decrease during recent financial crisis was motivated by the financial stability concerns in the U.K. (10-30% in the remaining sample countries), while remaining half falls on unfavorable developments in domestic economic activity. For the US Fed, the macroeconomic developments themselves (low inflation environment and output substantially below its potential) explain the major fraction of the policy interest rate decreases during the crisis, leaving the further response to financial stress to be constrained by zero interest rate bound.

All in all, the results point to the usefulness of time-varying framework for monetary policy rules estimation and to augmenting the standard version of policy rules by some measure of financial conditions for understanding interest rate setting process especially when financial markets are not stable.
References


Appendix 1

Figure A.1 – Time-Varying Monetary Policy Rules: U.S.

Note: The estimated coefficients of time-varying monetary policy rule are depicted with 95% confidence interval.
Figure A.2 – Time-Varying Monetary Policy Rules: U.K.

Response on inflation

Response on output gap

Interest rate smoothing

Response on financial stress

Note: The estimated coefficients of time-varying monetary policy rule are depicted with 95% confidence interval.
Figure A.3 – Time-Varying Monetary Policy Rules: Sweden

Response on inflation

Response on output gap

Interest rate smoothing

Response on financial stress

Note: The estimated coefficients of time-varying monetary policy rule are depicted with 95% confidence interval.
Figure A.4 – Time-Varying Monetary Policy Rules: Australia

Response on inflation

Response on output gap

Interest rate smoothing

Response on financial stress

Note: The estimated coefficients of time-varying monetary policy rule are depicted with 95% confidence interval.
Figure A.5 – Time-Varying Monetary Policy Rules: Canada

Response on inflation

Response on output gap

Interest rate smoothing

Response on financial stress

Note: The estimated coefficients of time-varying monetary policy rule are depicted with 95% confidence interval.
Appendix 2

The Results with Interbank Rate as the Dependent Variable in the Policy Rule

Figure A2.1 – The Effect of Financial Stress on Interest Rate Setting

Notes: The figure depicts the evolution of financial stress effect. The stress effect (y-axis) is defined as the product of the estimated coefficient on financial stress indicator in monetary policy rule and the value of IMF financial stress indicator. The stress effect shows the magnitude of interest rate reaction to financial stress in percentage points.
Figure A2.2 – The Effect of Financial Stress Components on Interest Rate Setting: Bank Stress, Exchange Rate Stress and Stock Market Stress

Notes: The figure depicts the evolution of the components of financial stress effect, namely bank stress effect, exchange rate stress effect and stock market stress effect. The stress effect (y-axis) is defined as the product of the estimated coefficient on the given component of financial stress indicator in monetary policy rule and the value of corresponding component of IMF financial stress indicator. The stress effect shows the magnitude of interest rate reaction to financial stress in percentage points.
Appendix 3

The Results with Differs Leads and Lag of the FSI

Figure A3.1 – The Effect of Financial Stress (t-1 vs. t-2, t, t+1, t+2) on Interest Rate Setting

TO BE COMPLETED
Appendix 4

The Results with Individual Variables of Bank Stress and Stock Market Stress

Figure A4.1 – The Effect of Bank Stress on Interest Rate Setting

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Figure A4.2 – The Effect of Stock Market Stress on Interest Rate Setting

TO BE COMPLETED