

NBP Working Paper No. 216

Monetary policy and financial asset prices in Poland

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Abstract

The aim of this study is to investigate the effects of monetary policy on financial asset prices in Poland. Following Gürkaynak et al. (2005) I test how many factors adequately explain the variability of short-term interest rates around MPC meetings, finding that there are two such factors. The first one has a structural interpretation as a “current interest rate change” factor and the second one as a “future interest rate changes” factor, with the latter related to MPC communication. Regression analysis shows that, controlling for foreign interest rates and global risk aversion, both MPC actions and communication matter for government bond yields, and that communication is more important for stock prices. Furthermore, the foreign exchange rate used to depreciate (appreciate) after MPC statements signalling tighter (easier) future monetary policy. However, the effect disappeared at the end of the sample. For most of the sample the exchange rate would appreciate (depreciate) or would not change in a statistically significant manner after an increase (a decrease) of the current interest rate. The results indicate that not only changes of the current interest rate but also MPC communication matters for financial asset prices in Poland. It has important implications for the conduct of monetary policy, especially in a low inflation and low interest rate environment.

JEL codes: E51, G12.

Keywords: monetary policy, financial asset prices, Poland.

Introduction

Since the Great Recession (2007-2009) communication has become a more exploited dimension of monetary policy. For example, in December 2008 the Federal Reserve lowered the federal funds rate target to 0-0.25 percent, hitting the zero lower bound (ZLB). In a statement after the decision the Federal Open Market Committee (FOMC) indicated that “the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time”. Later on “some time” was replaced by other forms of *forward guidance*, defined as statements about the outlook for monetary policy in the future (Woodford 2012). Forward guidance was advocated by Krugman (1998) and Eggertsson and Woodford (2003) as a method of additional monetary policy accommodation at the ZLB. Specifically, they suggested a commitment of the central bank to maintain a zero interest rate for a longer period than according to the “standard” policy rule, in order to lower long-term interest rates and raise inflation expectations. Or – as Krugman (1998) put it – the central bank should “credibly promise to be irresponsible”.

However, one cannot say that forward guidance has started with the Great Recession. For instance, the Reserve Bank of New Zealand has published interest rate forecasts since 1997. On the use and effectiveness of forward guidance in other advanced economies see, for example, Woodford (2012).

Forward guidance as a form of communication policy was also used by Narodowy Bank Polski in 2013-2014. After lowering the reference rate to 2.5 percent in July 2013, in September 2013 the Monetary Policy Council (MPC) indicated in a statement that “in the Council's assessment interest rates should be kept unchanged at least until the end of 2013”. In November 2013 “the end of 2013” was replaced by “the first half of 2014”, again replaced by “the third quarter of 2014” in March 2014. It should be noted that, in contrast to forward guidance of the FOMC aimed at *lowering* the expected path of interest rates, the goal of the MPC was to *stabilise* expectations. According to the Inflation Report from November 2014, during the period of forward guidance expectations over the path of interest rates have indeed stabilised (NBP 2014).

The future policy stance was also signalled before, as well as after, explicit forward guidance. However, in a more subtle way. Nevertheless, the signals could influence financial markets. For example, the largest two-day change in 5-year government bond yield around MPC meetings between 2001 and 2015 (-109 bp)

occurred in October 2008, when the MPC did not change the interest rate, but replaced “The Council assessed the probability of inflation overshooting the inflation target in the medium term to be *higher* than the probability of inflation running below the target” in the statement with “The Council assessed the probability of inflation running above or below the target in the medium term to be *roughly equal*”, signalling the end of policy tightening. On the other hand, for instance, in March 2013 there was no significant change in the statement. However, the interest rate was lowered by 50 bp when a 25 bp cut was expected. Following the decision the yield decreased by 11 bp.

In the light of these considerations, the aim of this study is to investigate the effects of monetary policy – represented by both actions and statements (not only explicit forward guidance) – on financial asset prices (stock prices, government bond yields and the foreign exchange rate) in Poland. Compared to existing literature for Poland I explore this within an unified framework. Following Gürkaynak, Sack and Swanson (2005, GSS from now on) I test how many factors adequately explain the variability of short-term interest rates around MPC meetings, finding that there are two such factors. The first one has a structural interpretation as a “current interest rate change” factor and the second one as a “future interest rate changes” factor, with the latter related to MPC communication. Regression analysis shows that not only changes of the current interest rate but also MPC communication matters for financial asset prices in Poland.

The first section reviews relevant literature. The second one describes data used in the analysis. The third contains factor analysis (construction of independent variables for regression analysis, representing MPC actions and communication) and the fourth – regression analysis (including the main results – the effects of MPC actions and communication on financial asset prices). The last section concludes, providing policy implications.

1. Literature review

The relevant related literature has started with a paper of Cook and Hahn (1988) for the United States. They estimate the reaction of interest rates on instruments with maturities between 3 months and 20 years to changes in the federal funds rate target between 1974 and 1979, within a one-day window. They find that changes in the target cause large movements in short-term interest rates, moderate movements in

medium-term rates and small but significant movements in long-term rates. Kuttner (2000) shows that government bill and bond yields practically do not respond to *expected* changes in the federal funds rate target, but their reaction to *unexpected* changes is large and significant. He also uses a one-day window, however, his sample spans from 1989 to 2000, and the analysed set of instruments additionally includes government bonds with 30 years to maturity. GSS, using factor analysis, distinguish between monetary policy actions (unexpected changes in the federal funds rate) and statements. They use a 30-minute and a 60-minute window instead of changes within one day. According to their estimates, both actions and statements influence government bond yields (with 2, 5, and 10 years to maturity), and unexpected changes in the federal funds rate influence stock prices. Their analysis is based on a sample between 1990 and 2004. The results were confirmed on a longer sample (ending 2007) by Campbell et al. (2012), however, using a wider (one-day) window. Additionally, they show that corporate bond yields react to statements.

For Poland, the literature can be divided into two groups: the first related to the effects of changes in interest rates and the second related to the effects of communication on financial asset prices. Starting with the first one, Serwa and Smolińska-Skarżyńska (2004) analyse responses of the foreign exchange rate to changes in interest rates between 2000 and 2002, comparing observed exchange rate movements with theoretical ones (from regressions with a constant or with a constant and the USDHUF exchange rate). Firstly, they find that within one- to three-day windows around MPC meetings the exchange rate does not react to *actual* changes in the reference rate. Secondly, in a one-day window (however, in a sample not limited to MPC meetings) the exchange rate depreciates (appreciates) after *unexpected* increases (decreases) of the market interest rate – a reaction inconsistent with uncovered interest rate parity (UIP) and carry trade views. For a three-day window, only responses to unexpected decreases of the interest rate are statistically significant. Serwa (2006) uses an instrumental variable approach (allowing for feedback from financial asset prices to the reference rate) to estimate the reaction of short- and long-term interest rates, as well as the stock market and the exchange rate to actual and unexpected changes in the reference rate. His sample spans from 1999 to 2005, and he uses a one-day, a two-day and a one-week window. In essence, he finds that although short-term interest rates react to both actual and unexpected interest rate changes, the reactions of long-term rates, the

stock market and the exchange rate are not statistically significant. Serwa and Szymańska (2004) arrived at the same conclusions on a shorter sample (ending 2002), additionally using methods of Cook-Hahn (1988) and Kuttner (2000), mentioned above. Rembeza and Przekota (2008) estimate a VAR model for the reference rate, overnight interbank interest rate and stock prices. They use daily data for 2001-2006. According to their estimates, the response of stock prices to interest rate shocks is relatively weak. Janecki (2012) uses the method of Cook-Hahn (1988) to measure the reaction of short- and long-term interest rates to changes in the reference rate between 2001 and 2011, using one- to three-day windows. He finds statistically significant responses of both short- and long-term interest rates.

Moving to the second group of the literature, Włodarczyk (2008) investigates the reaction of FRA (forward rate agreement) and IRS (interest rate swap) rates to comments of MPC members between meetings, on a sample from 2004 to 2007. He uses an approach similar to the one employed by Serwa and Smolińska-Skarżyńska (2004), described above (however, he looks at a 4-day window). According to his estimates, FRA 1x4 (3-month interest rate in 1 month) and FRA 2x5 rates do react to MPC members comments, but FRA 1x2, FRA 2x3, IRS 2Y, and IRS 5Y rates do not. Finally, Rozkrut (2008) shows that both short- and long-term interest rates, as well as stock prices do respond to comments of MPC members between meetings and statements after interest rate decisions, but the exchange rate does not. He uses the EGARCH model, controlling for unexpected interest rate changes, macroeconomic releases, foreign interest rate and foreign stock prices. Interestingly, in one of the extensions he decomposes unexpected changes of the interest rate into “timing” (representing the change in the timing of policy actions) and “level” (influencing the general level of policy expectations) components, finding that “there must be other than “level” factors influencing market expectations. These would most likely include policy-makers’ statements and central bank press releases following the decision on interest rates”. This study shows that is exactly the case.

2. Data

The investigation is based on three groups of variables. The first one represents the expected path of interest rates over a 1-year period. For that purpose, GSS use current-month and 3-month-ahead federal funds futures contracts and 2-, 3-, and 4-quarter-ahead eurodollar futures contracts. For Poland, futures on WIBOR (Warsaw

interbank offered rate) are available on the Warsaw Stock Exchange (WSE) only since the end of 2013. Therefore, 1-month WIBOR and FRA 1x2, 2x3, 3x6, 6x9, and 9x12 rates are used instead. These are employed in factor analysis to construct variables representing MPC actions and communication.

The second group consists of other financial asset prices – dependent variables for regression analysis. The group includes the stock market index (WIG 20 – an index for the 20 biggest and most liquid corporations on the WSE), 2-, 5-, and 10-year government bond yields and the foreign exchange rate (EURPLN since European Union accession, USDPLN before).

The last group contains control variables for regression analysis – representing foreign interest rates (1-year OIS (overnight index swap) for the US dollar and the euro) and global risk aversion (VIX).

GSS use intraday data (30- and 60-minute changes around interest rate decisions and statements) for days of FOMC meetings. For Poland, data on WIBOR and FRA rates are based on fixings, which take place at 11 AM and 4.30 PM accordingly. Usually, the MPC announces interest rate decisions between 12 and 2 PM, and the statement is released at 4 PM, at the beginning of a press conference. Therefore, WIBOR fixing on days of the announcements would not reflect interest rate decisions, and FRA fixing might not fully reflect information from the statement and the press conference. Consequently, 2-day windows around MPC meetings (between the day before and the day after) are used. Using (relatively) high frequency data allows to better disentangle the effects of monetary policy from other factors. Furthermore, the feedback from financial asset prices to monetary policy is less likely.

Changes in interest rates are calculated in percentage points, while changes in stock prices and the exchange rate are calculated in percent. The sample consists of 165 observations for MPC meetings between January 2001 and March 2015 (with FRA rates, available from the end of 2000, being the bottleneck). Graphs of the series are available in Appendix 1.

3. Factor analysis

Using factor analysis, a vector of (many) variables can be represented as a linear combination of (less) unobserved factors. In this study it was employed to estimate

the measures of unexpected¹ current interest rate changes and MPC communication. In the former case, possibly more precisely than (conventionally) using change in WIBOR 1M (on the effects in that respect see footnote 2). Following GSS, let us denote X the $T \times n$ matrix, with rows corresponding to MPC meetings and columns corresponding to variables representing the expected path of interest rates over a 1-year period. Then X can be written in the form:

$$X = F\Lambda + \eta,$$

where F is a $T \times k$ matrix of unobserved factors, Λ is a $k \times n$ matrix of factor loadings, and η is a $T \times n$ matrix of white noise disturbances. T , n and k are numbers of MPC meetings, variables and factors accordingly. The number of factors adequately describing X was determined using the minimum average partial method (Velicer, 1976), supported by simulation evidence (Zwick and Velicer, 1986). The selected number of factors is two. Factors (let us denote them F_1 and F_2) were estimated using the principal components method. Average partial correlations, factor loadings and graphs of factors are provided in Appendix 2.

The interpretation of the results above is the following – the variability of short-term interest rates around MPC meetings cannot be adequately explained using changes in the reference rate only (or using only one variable in general). Because F_1 and F_2 do not have economic interpretation, GSS propose to rotate them so that the first factor corresponds to unexpected changes in the current reference rate, and the second factor corresponds to variations in the expected path of interest rates over a 1-year period not driven by changes in the current reference rate. In other words, the matrix of rotated factors Z is defined by:

$$Z = FU,$$

where

$$U = \begin{pmatrix} \alpha_1 & \beta_1 \\ \alpha_2 & \beta_2 \end{pmatrix}$$

¹ For analysed instruments, expected changes should already be internalised by financial markets around individual MPC meetings.

and U is identified by four restrictions:

- columns of U have unit length,
- Z_1 and Z_2 are orthogonal

$$\alpha_1\beta_1 + \alpha_2\beta_2 = 0,$$

- Z_2 does not influence WIBOR 1M (reflecting mainly the current policy surprise)

$$\gamma_2\alpha_1 - \gamma_1\alpha_2 = 0,$$

where γ_1 and γ_2 are loadings of WIBOR 1M on F_1 and F_2 accordingly.

After solving for U and calculating Z , rotated factors were rescaled so that Z_1 moves WIBOR 1M one-for-one, and Z_2 has the same effect on FRA 9x12 as Z_1 . Therefore, Z_1 can be interpreted as *an unexpected current interest rate change* and Z_2 as *communicated future interest rate changes, having the same effect on interest rates expected 9-12 months ahead as an unexpected current interest rate change*. Or – in short – Z_1 reflects MPC actions and Z_2 reflects MPC communication.

The first factor is depicted on Figure 1.

Figure 1. Z_1 – “current interest rate change” factor / MPC actions



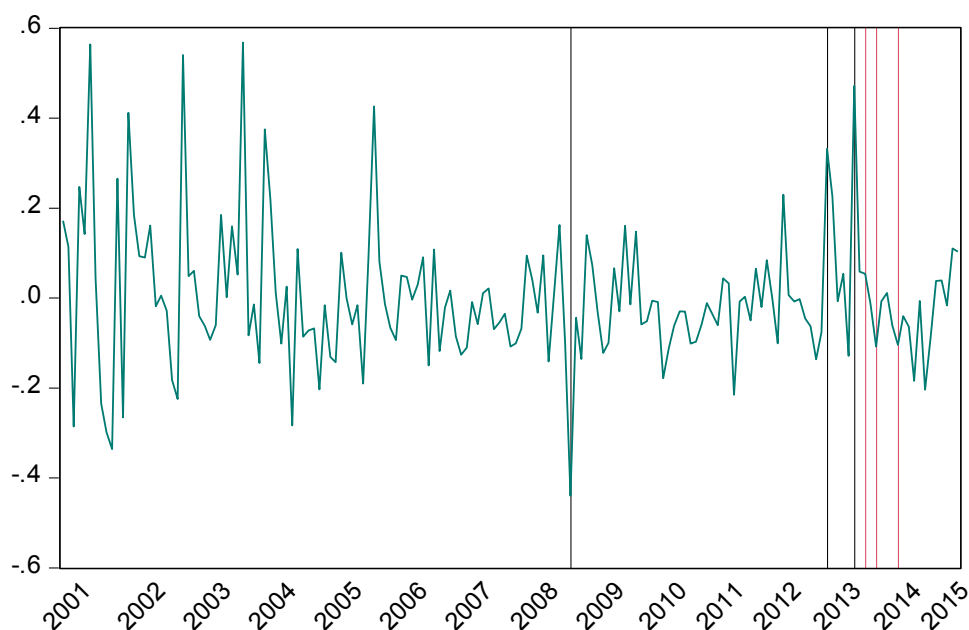
Source: own calculations.

In order to provide a sense of the quality of the generated variable, three illustrative dates (accompanying the largest absolute values in the second, less volatile half of the sample) are denoted by black bars on the graph:

- November 2008 – the MPC lowered the reference rate by 25 bp, when according to the Reuters poll no change was expected. Estimated MPC action amounts to -23 bp,
- March 2013 – the MPC lowered the reference rate by 50 bp – a 25 bp cut was expected – estimated MPC action: -31 bp,
- November 2014 – the MPC did not change the reference rate – a 25 bp cut was expected – estimated MPC action: 26 bp.

The same exercise was performed for the second factor, depicted on Figure 2:

Figure 2. Z_2 – “future interest rate changes” factor / MPC communication



Source: own calculations.

- October 2008 – the MPC replaced “The Council assessed the probability of inflation overshooting the inflation target in the medium term to be *higher* than the probability of inflation running below the target” in the statement with “The Council assessed the probability of inflation running above or below the target in the medium term to be *roughly equal*” – a signal of ending the monetary tightening cycle – the estimated measure of MPC communication: - 44 bp,

- January 2013 – the MPC replaced “Should the incoming information confirm a protracted economic slowdown, and should the risk of increase in inflationary pressure remain limited, the Council *will* further ease monetary policy” in the statement with “The Council *does not rule out* further monetary policy easing should the incoming data confirm a protracted economic slowdown and should the risk of increase in inflationary pressure remain limited”. On the press conference the Chairman of the MPC Marek Belka said “some round of interest rate cuts is near completion” – a signal of ending the monetary easing cycle – the estimated measure of MPC communication: 33 bp,
- June 2013 – the MPC removed “The Council's decisions in the coming months will depend on the assessment of the incoming data with regard to probability of inflation remaining markedly below the NBP target in the medium term” from the statement. On the press conference the Chairman of the MPC Marek Belka said “we are approaching the level of interest rates that for current economic conditions can be judged adequate” – a signal of ending the monetary easing cycle – the estimated measure of MPC communication: 47 bp.

In essence, Z_1 indeed reflects unexpected interest rate changes, and Z_2 reflects changes in communication, referring to future interest rates. Neither Z_1 is equal to WIBOR 1M nor Z_2 to FRA 9x12, however, the correlation between those variables is high – between Z_1 and WIBOR 1M 0.67², between Z_2 and FRA 9x12 – 0.84. The correlation between Z_1 and FRA 9x12 is 0.65, and between Z_2 and WIBOR 1M, by construction, 0. Similarity between those pairs of variables can also be noticed on graphs in Appendix 3.

Furthermore, dates of explicit forward guidance announcements are denoted by red bars on Figure 2. Interestingly, the absolute values of Z_2 for that time are

² In some cases WIBOR 1M probably overestimates monetary policy surprises. For instance, in December 2008 the MPC lowered the interest rate by 75 bp, when according to Reuters poll a 50 bp cut was expected. Nevertheless, WIBOR 1M points to a 61 bp policy surprise, whereas Z_1 – to a 16 bp surprise. This example shows the advantage from using factor analysis to estimate monetary policy surprises instead of simply employing WIBOR 1M.

relatively low (5-11 bp), probably indicating that forward guidance provided little new information on the future path of interest rates to the markets.³

4. Regression analysis⁴

For each dependent variable (the stock market index, 2-, 5-, and 10-year government bond yields and the foreign exchange rate) two linear regression models were estimated. Both include estimated measures of MPC actions (Z_1) and communication (Z_2) from the previous section as independent variables. However, one group additionally controls for international developments – foreign interest rates (OIS 1Y for the US dollar and the euro) and global risk aversion (VIX). Because OIS 1Y for the US dollar was available only since 2004, the second group of models was estimated on 129 instead of 165 observations. The results are shown in Table 1⁵.

Firstly, both MPC actions and communication matter for government bond yields. The reaction is of a “correct” sign (in line with expectations/liquidity premium/preferred habitat theories of the term structure of interest rates) – yields increase following current, and signals of future, monetary policy tightening (or decrease after easing – models are linear). Furthermore, international factors do not influence yields around MPC meetings in a statistically significant manner. However, their inclusion improves the adjusted R-squared for 2- and 5-year bonds. Moreover, estimated coefficients for the euro area interest rate are economically non-negligible.

Secondly, communication is more important for the stock market – prices decrease when the MPC signals higher future interest rates (as higher interest rates lower economic growth, profits, dividends and – therefore – stock prices). The response to increases of the current interest rate is of magnitude indistinguishable from zero. Furthermore, increase in global risk aversion decreases stock prices, and the estimated coefficient for the euro area interest rate is again economically non-negligible, but statistically insignificant.

³ Regressing dummy variable for forward guidance on absolute values of Z_2 (not reported, available on request) supports that finding – dummy variable is statistically insignificant.

⁴ Series from sections 2-4 are available at: <http://dx.doi.org/10.6084/m9.figshare.1414154>.

⁵ Additionally, Appendix 4 shows residual diagnostics. Normality was rejected in 8 out of 10 models. However, having a large sample, this does not affect inference. Lack of serial correlation was rejected only in 1 model (or in none of them for a 0.01 significance level). Homoskedasticity was rejected in 6 models. Therefore, White heteroskedasticity-consistent standard errors are used.

Table 1. Results from regression analysis

	Const.	Z ₁ / MPC actions	Z ₂ / MPC commu- nication	OIS 1Y USD	OIS 1Y EUR	VIX	R ²	Adj. R ²	Sample
Stock market index	0.20 (0.17)	0.45 (0.95)	-3.91*** (1.33)				0.07	0.06	January 2001- March 2015
	0.11 (0.18)	-0.50 (1.35)	-5.11*** (1.87)	0.17 (3.03)	-3.89 (4.17)	-0.39*** (0.13)	0.21	0.18	January 2004- March 2015
Government bond yield 2Y	-0.01 (0.01)	0.44*** (0.05)	0.41*** (0.07)				0.51	0.51	January 2001- March 2015
	0.00 (0.01)	0.52*** (0.05)	0.49*** (0.05)	-0.02 (0.09)	0.12 (0.11)	0.00 (0.00)	0.68	0.67	January 2004- March 2015
Government bond yield 5Y	-0.02*** (0.01)	0.38*** (0.06)	0.60*** (0.10)				0.54	0.54	January 2001- March 2015
	-0.01 (0.01)	0.40*** (0.05)	0.70*** (0.13)	0.06 (0.14)	0.27 (0.26)	0.01 (0.01)	0.59	0.57	January 2004- March 2015
Government bond yield 10Y	-0.01 (0.01)	0.26*** (0.07)	0.38*** (0.06)				0.48	0.47	January 2001- March 2015
	0.00 (0.01)	0.20*** (0.07)	0.42*** (0.06)	0.04 (0.08)	0.08 (0.12)	0.00 (0.00)	0.48	0.46	January 2004- March 2015
Foreign exchange rate	-0.13** (0.06)	0.35 (0.46)	1.61*** (0.34)				0.09	0.08	January 2001- March 2015
	0.04 (0.07)	0.23 (0.76)	1.81*** (0.51)	1.74 (1.25)	-1.71 (1.79)	0.19*** (0.04)	0.25	0.22	January 2004- March 2015

Note: White heteroskedasticity-consistent standard errors in parentheses. *, ** and *** denote statistical significance at 0.1, 0.05 and 0.01 levels accordingly.

Source: own calculations.

Thirdly, communication influences the foreign exchange rate, but the estimated sign is controversial (or not in line with UIP and carry trade views) – the exchange rate depreciates after MPC statements signalling tighter future monetary policy. Perhaps the influence over one interest-earning asset – shares (via economic growth) – exceeds the significance of the impact on the other one – interbank deposits. For a discussion on interest parity see, for example, Lavoie (2014). Following increases of the current interest rate the exchange rate does not change in a statistically significant manner. Moreover, rolling regression analysis (below) shows that the signs are time-varying. Among international factors, the influence of global risk aversion is the most robust.

For the effects of changes of the current interest rate, the findings are in line with those of Janecki (2012) on government bond yields and in some sense similar to those of Serwa and co-authors on stock prices and the exchange rate (namely, the impact on those two variables is ambiguous). For the effects of communication, except on the exchange rate, the results are in line with those of Rozkrut (2008).

The analysis was extended to determine whether the effects of MPC actions and communication varied over time. Time-variation might stem, for example, from the changing composition of the MPC (there were three tenures of the MPC between 2001 and 2015 – ending 2004, 2004-2010 and starting 2010), the deepening of financial markets or financial market disturbances. To that end, rolling regression for each dependent variable was estimated, using a 36-period window. In order to preserve the number of observations, only the euro area interest rate and VIX were used as control variables. Outliers and influential observations were removed using the DFFITS (difference in fits) criterion, qualitatively not affecting full sample results. Estimated rolling coefficients and p-values (for Student's *t* test) for monetary policy variables, as well as the DFFITS and historical decompositions, are shown in Appendix 5.

For stock market returns and government bond yields coefficients are similar at the beginning and at the end of the sample. However, the transmission of monetary policy was impaired during the global financial crisis and the euro area crisis. For stock prices the significance of MPC communication varied over time according to a very specific pattern – the higher the coefficient estimate, the higher the p-value (correlation – 0.69). Except for crises periods, coefficients for MPC actions and communication were similar. For 10-year government bond yield the transmission was weaker also at the beginning of the sample.⁶

The behaviour of coefficients and p-values for the foreign exchange rate is more complex. Since the middle of 2006 a positive relationship between the exchange rate and the estimated measure of MPC communication has been

⁶ In equations for government bond yields many observations at the beginning of the sample were removed as outliers or influential observations. Large number of those observations might explain the early finding of Serwa and co-authors (their samples cover periods ending 2002 or 2005) that interest rate changes do not affect government bond yields, not supported by other papers (including this one). The comparison of p-values removing and not removing outliers and influential observations in rolling regressions (not reported, available on request) supports this view.

disappearing. After the global financial crisis it has not been statistically significant. For most of the sample (since the crisis) the exchange rate would appreciate or would not change in a statistically significant manner after an increase of the current interest rate.

Conclusions

The study shows that not only changes of the current interest rate but also MPC communication (signalling future interest rate changes) matters for financial asset prices in Poland. Controlling for foreign interest rates and global risk aversion, both MPC actions and communication matter for government bond yields, and communication is more important for stock prices. Furthermore, the foreign exchange rate used to depreciate after MPC statements signalling tighter future monetary policy. However, the effect disappeared at the end of the sample. For most of the sample the exchange rate would appreciate or would not change in a statistically significant manner after an increase of the current interest rate.

The findings have important implications for the conduct of monetary policy, especially in a low inflation and low interest rate environment. Although the probability of falling into a liquidity trap for Poland remains low, it has been elevated in recent years (Brzoza-Brzezina et al., forthcoming). This paper implies that the MPC can use forward guidance to influence monetary conditions, also facing the ZLB.

However, as GSS indicate, the findings “do not imply that (...) statements represent an independent policy tool. In particular, (...) statements likely exert their effects on financial markets through their influence on financial market expectations of future policy actions. Viewed in this light, (...) results do not indicate that policy actions are secondary so much as that their influence comes earlier – when investors build in expectations of those actions in response to (...) statements”.

Furthermore, it should be noted that during the last crisis the ability of the MPC to influence financial asset prices was impaired. Also, for stock prices, Tobin's q and wealth channels of the monetary transmission mechanism in Poland remain to a large extent unexplored.⁷ The same goes for the role of long-term interest rates. Finally, the results for the foreign exchange rate are unstable.

⁷ Zachłód-Jelec (2010) being an exception.

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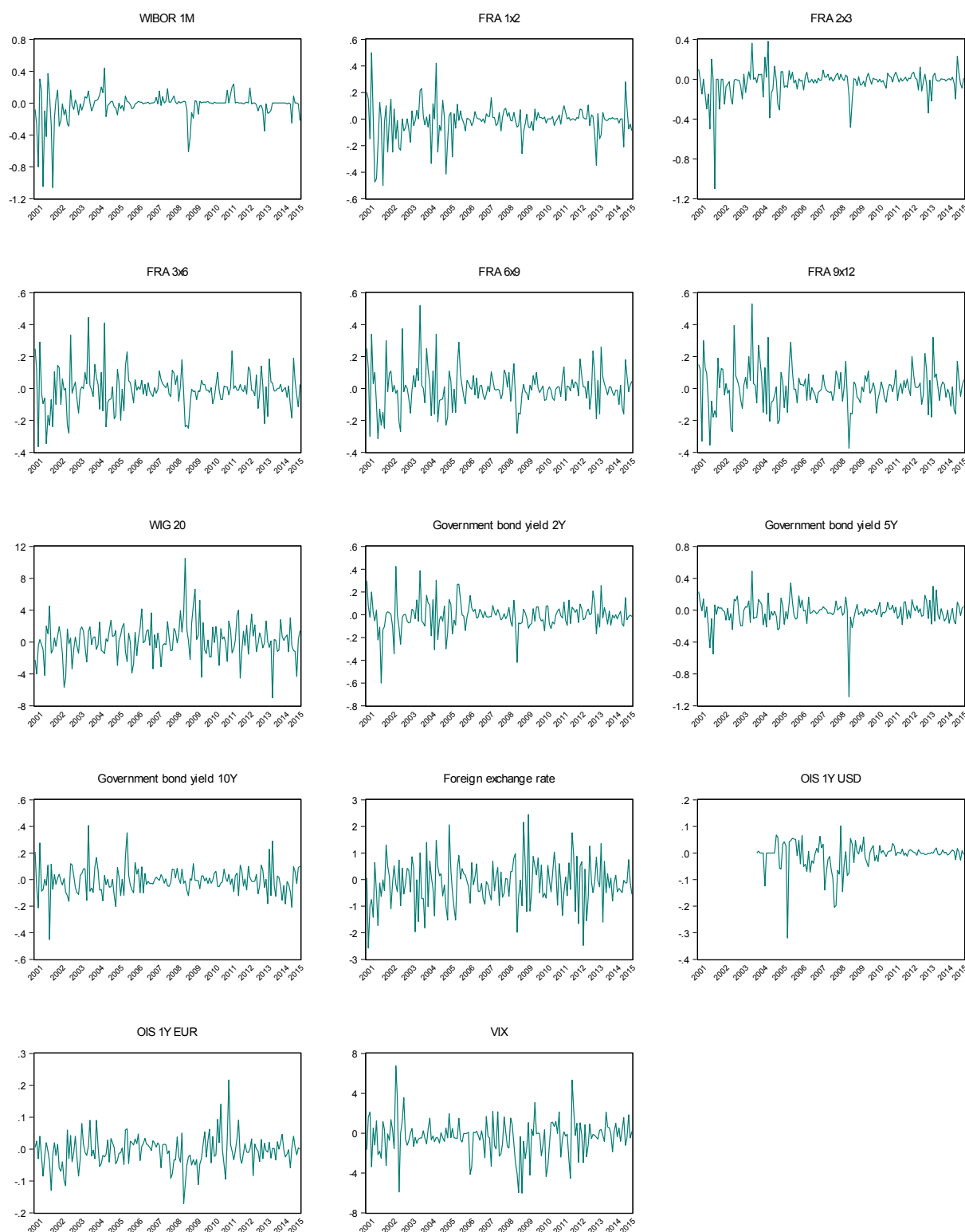
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Appendix 1. Data



Note: graphs show changes (in percentage points or percent) within 2-day windows around MPC meetings.

Source: Datastream, own calculations.

Appendix 2.

Average partial correlations

Number of components	Average intervariable correlation
0	0.4066
1	0.2832
2	0.1426
3	0.2738
4	0.5570
5	1

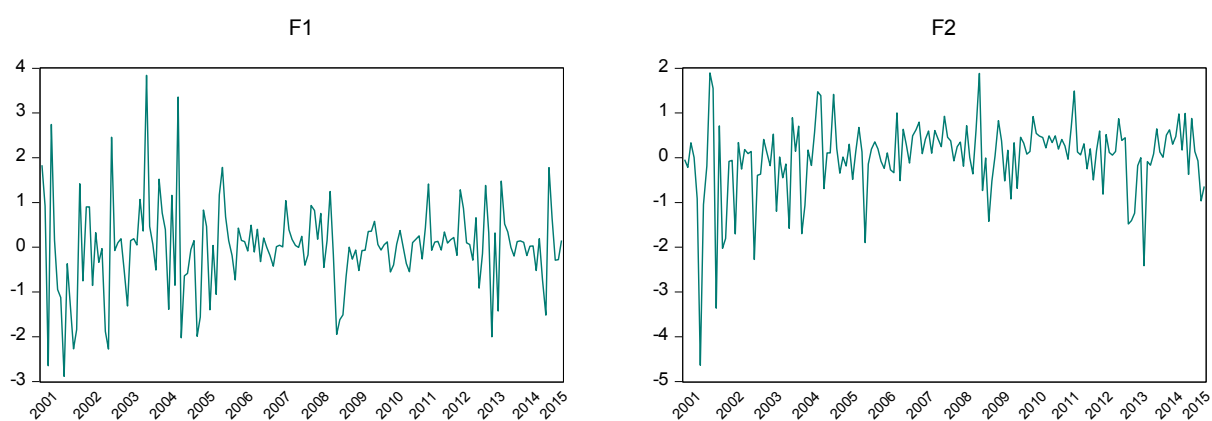
Source: own calculations.

Factor loadings

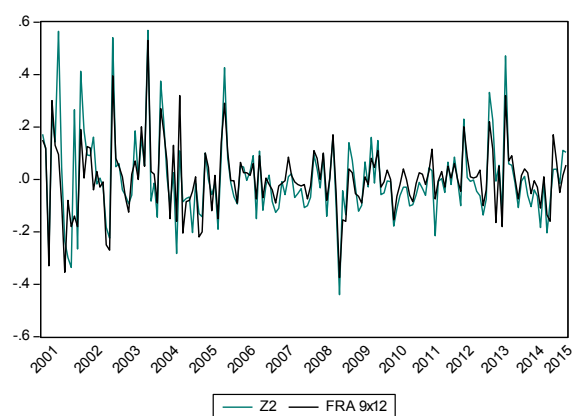
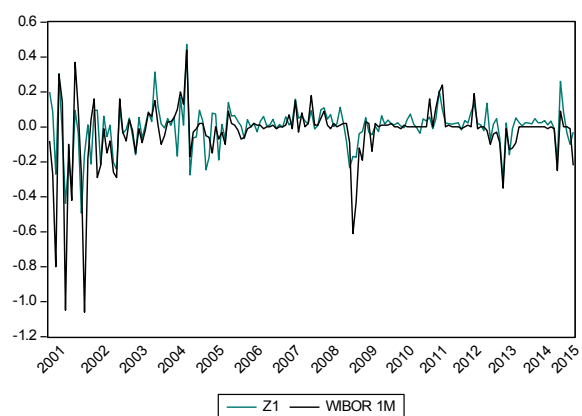
	F ₁	F ₂
WIBOR 1M	0.5150	0.3319
FRA 1x2	0.7180	0.4063
FRA 2x3	0.7066	0.3540
FRA 3x6	0.9516	-0.1263
FRA 6x9	0.9393	-0.3071
FRA 9x12	0.9195	-0.3308

Source: own calculations.

Factors



Source: own calculations.

Appendix 3. Z_1 versus WIBOR 1M, Z_2 versus FRA 9x12

Source: Datastream, own calculations.

Appendix 4. Residual diagnostics

Model		Jarque-Bera test (normality)		Breusch-Godfrey test, 1 lag (serial correlation)		White test (heteroskedasticity)	
Dependent variable	Independent variables	JB stat.	p-val.	F-stat.	p-val.	F-stat.	p-val.
Stock market index	Z ₁ , Z ₂	21.88	0.00	1.89	0.17	2.67	0.02
	Z ₁ , Z ₂ , OIS 1Y USD, OIS 1Y EUR, VIX	12.82	0.00	0.06	0.80	1.00	0.46
Government bond yield 2Y	Z ₁ , Z ₂	522.96	0.00	2.04	0.16	2.82	0.02
	Z ₁ , Z ₂ , OIS 1Y USD, OIS 1Y EUR, VIX	0.71	0.70	0.00	0.96	2.17	0.01
Government bond yield 5Y	Z ₁ , Z ₂	2664.14	0.00	1.88	0.17	13.18	0.00
	Z ₁ , Z ₂ , OIS 1Y USD, OIS 1Y EUR, VIX	3032.15	0.00	3.24	0.07	10.95	0.00
Government bond yield 10Y	Z ₁ , Z ₂	38.67	0.00	4.98	0.03	6.69	0.00
	Z ₁ , Z ₂ , OIS 1Y USD, OIS 1Y EUR, VIX	38.47	0.00	0.66	0.42	1.42	0.13
Foreign exchange rate	Z ₁ , Z ₂	7.59	0.02	3.95	0.05	0.41	0.84
	Z ₁ , Z ₂ , OIS 1Y USD, OIS 1Y EUR, VIX	2.00	0.37	3.68	0.06	0.71	0.81

Source: own calculations.

Appendix 5.

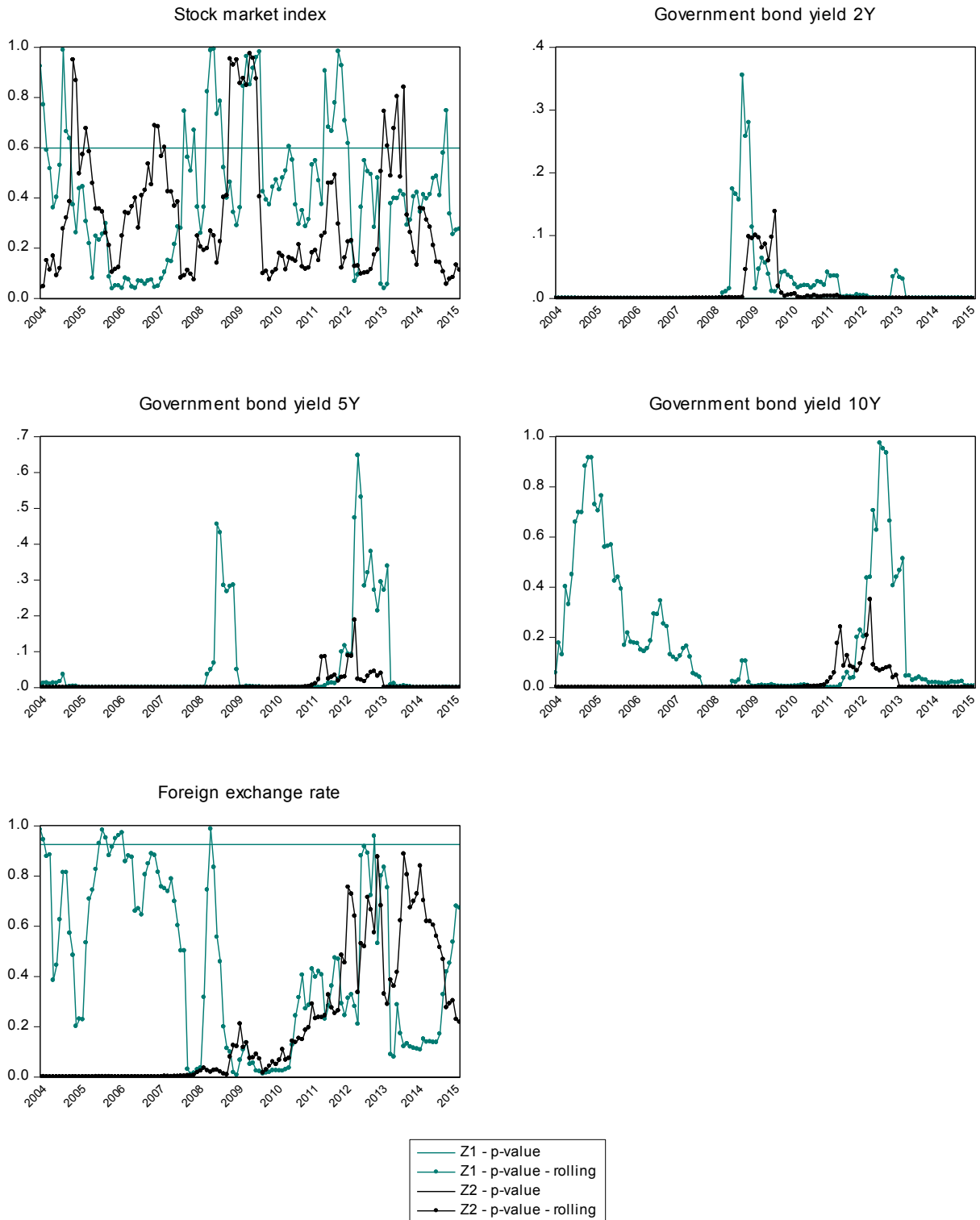
Rolling regression coefficients



Note: panels correspond to equations.

Source: own calculations.

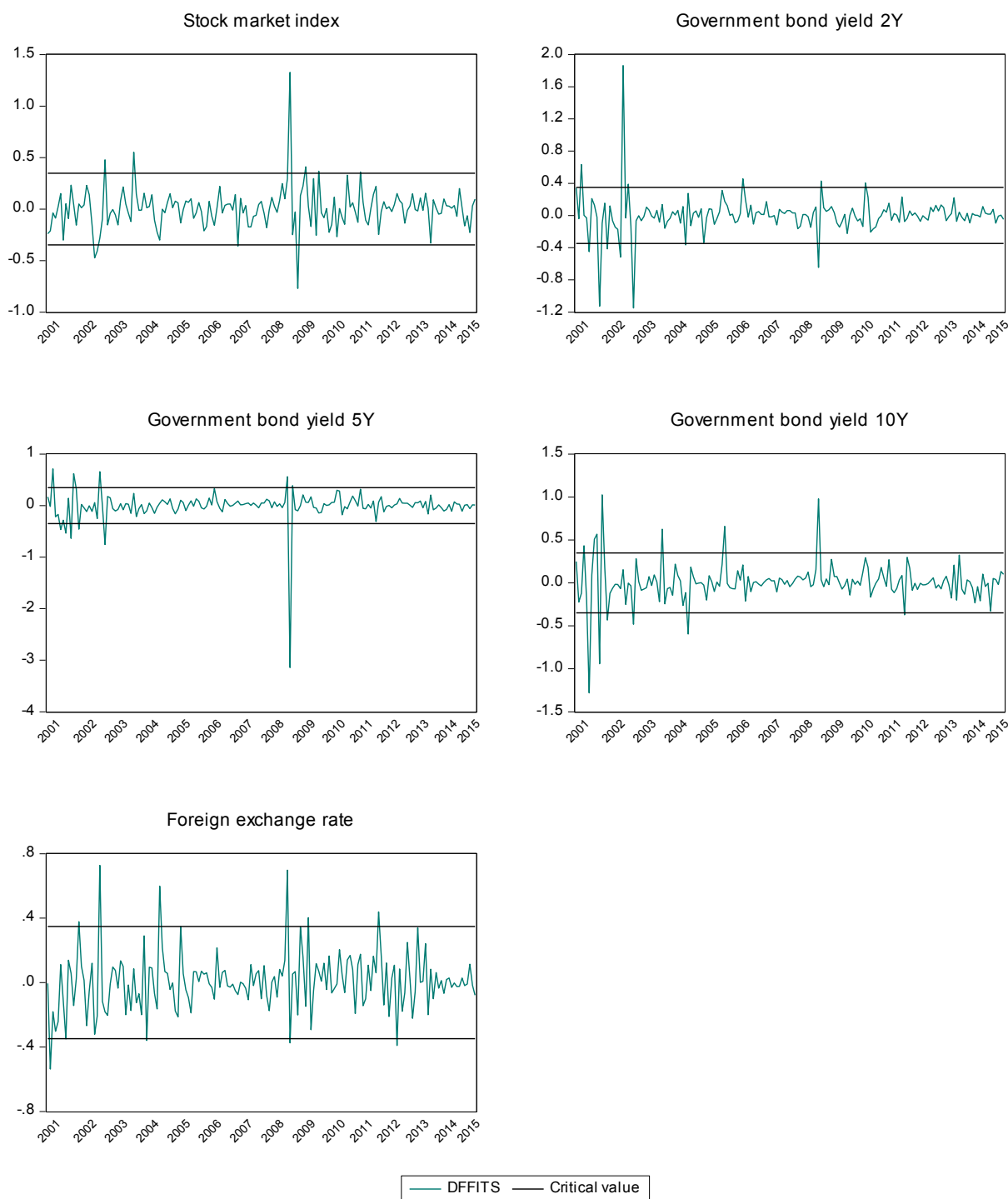
P-values



Note: panels correspond to equations.

Source: own calculations.

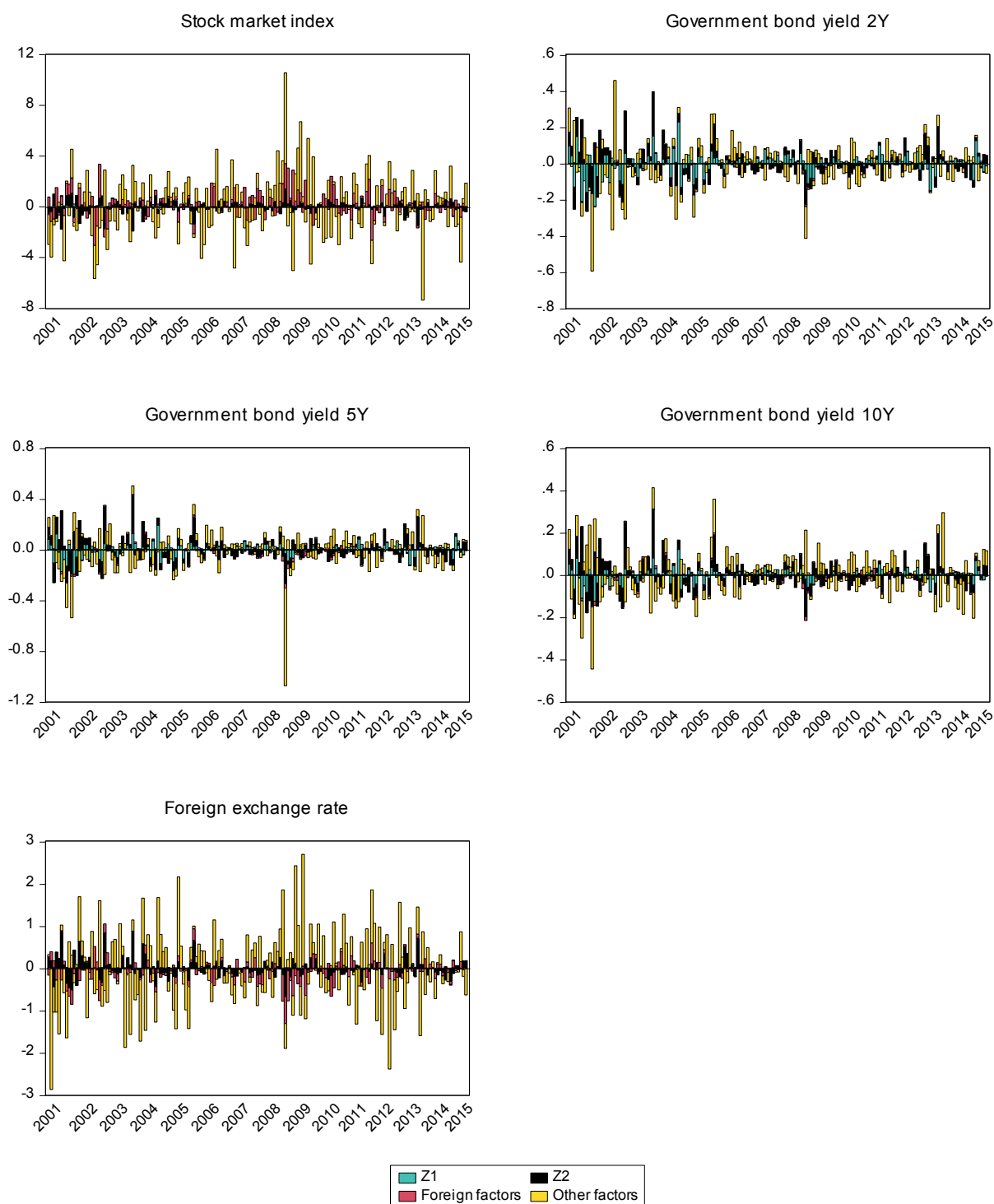
DFFITS



Note: panels correspond to equations. The absolute value of the DFFITS above critical value indicates an outlier or an influential observation.

Source: own calculations.

Historical decompositions



Note: historical decompositions are based on fixed coefficients from regressions without outliers and influential observations. Foreign factors include OIS 1Y EUR and VIX.

Source: own calculations.

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