Do Emerging Financial Markets React to Monetary Policy Announcements? Evidence from Poland*

Dobromił Serwa

Abstract

This paper provides evidence on the short-run reactions of an emerging financial market to monetary policy announcements. We employ an instrumental variable estimation approach based on the "identification through heteroscedasticity" technique to estimate the impact of a change in the official interest rate and its surprise component on asset prices in Poland. The recently introduced methodology controls for possible feedback relationships between financial variables and official interest rate changes. In our analysis, the short-term interest rates respond significantly to official interest rate changes, but neither the long-term interest rates, stock indices, nor foreign exchange rates react to monetary announcements in the expected direction.

JEL-Classification: C30, C52, E44, E52

Keywords: Emerging Market, Monetary Policy Changes, Official Interest Rate, Asset Prices

* Running title: Do Emerging Financial Markets React to Monetary Policy Announcements?

1. Introduction

The increasing number of studies covering the evaluation of the interaction between monetary policy and financial markets suggests a growing significance of this relationship. Assessing the impact of monetary policy announcements on financial markets is especially important for investors interested in rational asset pricing and an efficient allocation of financial capital and for monetary authorities concerned with formulating effective monetary policy (Rigobon and Sack, 2004). It enables economists to study channels of monetary transmission and to improve the precision of their macroeconomic forecasts.

Monetary policy changes affect the economy mostly through the money market, but Mishkin (2001) and Cai (2003) provide some theoretical explanations on how changes in the official interest rate affect the economy through the stock and foreign exchange markets. Stock prices influence the performance and investment spending of public companies as well as lending to those firms. They also affect household wealth and consumption. The role of the foreign exchange rate is particularly important in small, open, emerging economies, where it influences net exports, inflation, and the debt of local firms, denominated in foreign currencies.

Numerous empirical studies have investigated shifts in monetary policy and their short-run impact on major financial markets. Changes in the official interest rate significantly affect short-term market interest rates, but the findings regarding the effects on long-term interest rates are mixed. Thornton (1998), Roley and Sellon (1998), Ellingsen and Söderström (2001a, 2001b), and Kuttner (2001) analyze the US market and find no significant response to monetary policy changes for interest rates with a maturity beyond five years. The long-term interest rates rise after increases in the official interest rate that have been unexpected by financial markets (Thornton, 1998, Kuttner, 2001, Rigobon and Sack, 2004). Additionally, Haldane and Read (2000) find that German and Italian interest rates with a maturity beyond

one year do not react to unexpected changes in the official interest rate and the UK's long-term interest rates decline after an increase of the official interest rate.[1]

Similar studies examine the impact of monetary changes on capital and foreign exchange markets. The stock prices of industrial companies and general market indices rise (fall) after unexpected reductions (increases) of the reference interest rate on the US market (Thorbecke, 1997, Bomfim, 2003, Rigobon and Sack, 2004). On the other hand, Bomfim and Reinhart (2000) and Newby (2002) argue that neither stock market indices nor the foreign exchange rates respond to unexpected interest rate changes.

However, to the author's best knowledge, none of the previous studies investigated the short-run impact of changes in the official interest rate on emerging financial markets. Emerging markets may react poorly to monetary events due to the weakness of the monetary authorities, limited confidence in their actions, and the inefficiency of the financial market itself. Hence, such an investigation provides an opportunity to directly test the effectiveness of the transmission process between monetary policy decisions and financial market adjustments. A comparison of the results for emerging and mature markets uncovers behavioral differences between the markets and reveals potential areas for further development of emerging financial markets. Both enforcement of monetary policy and financial market efficiency are important for international investors interested in diversifying their capital portfolios on emerging markets.

Poland, as an open and developing economy, is well suited to such a study. Poland possesses considerably liquid money and foreign exchange markets, and one of the highest capitalized stock markets in Central and Eastern Europe. This emerging market is an example

[1] Ellingsen and Söderström (2001a, 2001b) distinguish between endogenous and exogenous shifts in monetary policy and find that long-term interest rates respond in the same and in the opposite direction, respectively.

of a successful transformation from a centrally planned to a capitalist economy. In the context of Poland's future membership in the European Monetary Union, the results concerning the monetary transmission process are of interest to the European Central Bank, other monetary authorities in the region, and all emerging markets planning to join the Union.

In this paper, we concentrate on the Polish market instead of analyzing a group of developing markets, because recently many emerging economies have undergone financial crises that could have possibly destabilized the linkages between monetary policy actions and financial markets. For instance, financial crises typically cause stock prices and foreign exchange to fall and short-term interest rates to rise simultaneously, which may bias empirical results towards the hypothesis of a significant relationship between these variables. Thus, a common reaction of stock prices and monetary policy instruments to the crisis may be wrongly interpreted as a reaction of financial markets to monetary policy decisions. During the past decade Poland's consistent monetary policy avoided financial crises in contrast to other emerging markets in the region (e.g. the Czech Republic in 1996, Russia in 1998, and Turkey in 2000) and on other continents (e.g. East Asia in 1997, Brazil in 1999, and Argentina in 2002). The results from this study may still have implications for the emerging economies that avoid financial crises in the future and in times of low volatility of asset prices on these markets.

The monetary policy changes anticipated by financial markets usually have a less significant impact on prices of financial instruments, therefore in our analysis we concentrate on the immediate reactions to the surprise component of the change in the official interest rate (Kuttner, 2001). We refer to such unanticipated elements of the official interest rate changes as monetary policy surprises.

The usual methods used to measure the reactions of financial markets to monetary policy changes include impulse-response analysis based on VAR models and event-study methods (Christiano, Eichenbaum, and Evans, 1996, Bagliano and Favero, 1999, Peersman,

2002, Cook and Hahn, 1989, Thorbecke, 1997, Kuttner, 2001, and Bomfim, 2003 among others). However, Rudebusch (1998a) argues that VAR models deliver estimates of interest rate surprises that are not precise and not correlated with other measures of monetary policy innovations derived from financial markets (see also Sims, 1998 and Rudebusch, 1998b). Rigobon and Sack (2004) find that parameters of the event-study regressions are usually estimated with a bias when there exists a feedback relationship between monetary policy surprises and asset price changes or when some important explanatory variables are omitted in the equations under investigation.

In this study, we analyze the impact of changes in the official interest rate on the stock, money, and foreign exchange markets using the "identification through heteroscedasticity" methodology recently introduced by Rigobon (2003) and Rigobon and Sack (2004). This technique is adjusted for the bias of the event study method. It accounts for the presence of common shocks to asset prices and official interest rates, and controls for feedback relations between financial markets and monetary policy actions. To our best knowledge our paper is the first application of this technique (in the context of monetary policy transmission) to the market other than the US market. Moreover, in our analysis the measure of monetary policy surprises is extracted from financial market instruments, as in Söderlind and Svensonsson (1997), Kuttner (2001), and Ellingsen and Söderström (2001a).

The paper is organized as follows. The next section presents the methodology used in the study. Section 3 provides a description of the data and the measure of the monetary policy surprises. The theoretical hypotheses and empirical results are described in Section 4. Section 5 concludes.

2. Methodology

The method used in this paper follows the estimation and testing technique developed by Rigobon (2003) and Rigobon and Sack (2004). It consists of identifying and estimating the parameter measuring the impact of monetary policy surprises on asset prices. The standard t-

statistic is then used to test for a significant response of asset prices to (unexpected) changes in the official interest rate. As a robustness check, we propose a bootstrap technique to estimate p-values of the t-statistics in small samples.

Following Rigobon and Sack, we assume that asset price changes, Δs_t, and monetary policy changes (or a measure of monetary policy surprises), Δi_t, are described by the following system of equations:

$$\Delta i_t = \beta \Delta s_t + \gamma z_t + \varepsilon_t \tag{1}$$

$$\Delta s_t = \alpha \Delta i_t + z_t + \eta_t, \tag{2}$$

where z_t denotes all unobservable shocks influencing both interest rates and asset prices on the days when monetary policy decisions are undertaken. The disturbances ε_t and η_t are idiosyncratic shocks to monetary policy changes and to shifts in asset price, respectively; they are neither serially correlated nor correlated with each other. The parameter α measures the average reaction of asset price changes to monetary policy changes. The estimate of α will be biased when the ordinary least square method (OLS) is applied to equation (2). In such a case the mean of estimated parameter will be given by:

$$E\hat{\alpha} = \alpha + (1 - \alpha\beta)\frac{\beta\sigma_\eta + (\beta + \gamma)\sigma_z}{\sigma_\varepsilon + \beta^2\sigma_\eta + (\beta + \gamma)^2\sigma_z}, \tag{3}$$

where σ_x represents the variance of shock *x*. Under typical assumptions that $\beta \neq 0$, $\sigma_z > 0$, $\sigma_\varepsilon > 0$, and $\sigma_\eta > 0$, the mean of the OLS estimate will be different from its true value α. Therefore we apply an instrumental variable approach to estimate α, based on the "identification through heteroscedasticity" technique introduced by Rigobon (2003) and implemented by Rigobon and Sack (2004).

Let T be the number of monetary policy council meetings, where decisions regarding the shift in the reference interest rate were undertaken. Possible changes in the reference interest rate take place a day after the Monetary Policy Council (MPC) announces the new

official interest rates. Therefore, we define a set F, consisting of all dates of the days following the MPC meetings. Additionally, we construct a set F^* from all the dates which precede the policy meetings by one working day. The interest rate changes (or a measure of monetary policy surprises), Δi_t, and the asset price changes, Δs_t, taking place on the days contained in both sets F and F^* are included in the $(2T \times 1)$ vectors Δi and Δs, respectively:

$$\Delta i = [\Delta i_{t(1)}, \Delta i_{t(2)}, ... \Delta i_{t(2T)}]', \tag{3}$$

$$\Delta s = [\Delta s_{t(1)}, \Delta s_{t(2)}, ... \Delta s_{t(2T)}]', \tag{4}$$

where the date indices, $t(k)$, $k = 1, 2, ... \, 2T$, are placed in chronological order and $t(k) \in F \cup F^*$. Next, we construct the following $2T \times 1$ vector of observations of the instrumental variable:

$$w_i = [\Delta i^*_{t(1)}, \Delta i^*_{t(2)}, ... \Delta i^*_{t(2T)}]', \tag{5}$$

where

$$\Delta i^*_{t(k)} = \begin{cases} \Delta i_{t(k)} / (T\text{-}1), & t(k) \in F \\ -\Delta i_{t(k)} / (T\text{-}1), & t(k) \in F^* \end{cases}. \tag{6}$$

We assume that all parameters in equations (1) and (2), and the volatility of external shocks η_t and z_t remain approximately constant over the estimated period, while the variance of ε_t increases on the days when unexpected interest rate changes take place.[2] The identification procedure exploits the fact that volatility of the monetary instrument is usually considerably higher on the day of the meeting than before this day. The volatility of changes in the official interest rate is actually zero one day before the meeting, but some measures of monetary

[2] However, Rigobon and Sack show that asymptotic results are also valid in case of heteroscedastic shocks η_t and z_t.

policy surprises based on financial instruments have a positive variance on that day.[3] The vector w_i is a valid instrument for estimating α, and the estimator of α is given by:

$$\hat{\alpha} = (w_i' \Delta i)^{-1} (w_i' \Delta s) \tag{7}$$

Rigobon and Sack (2004) prove that this estimator is consistent and asymptotically normally distributed, therefore a standard t-statistic may be used to test the null hypothesis that $\alpha = 0$ against the alternative $\alpha \neq 0$. Under the null hypothesis the t-statistic has an asymptotic standard normal distribution. If the null hypothesis is rejected, then the impact of monetary policy changes on asset price changes is interpreted as significant.

Asymptotic results from the instrumental variable estimation may not be accurate in small samples. As a robustness check, we propose the following bootstrap technique to approximate p-values of the t-statistic in small samples. We construct a set F^{**}, consisting of all working days in the analyzed period (from January 1, 1999 to December 31, 2002), but without the days of the MPC meetings and the days after. We start the bootstrap procedure by replacing the set F with a set G consisting of the same values as *F*. Next, we draw T dates with replacement from the set F^{**} and construct a set G^* using these dates. The vectors Δi, Δs, and w_i are then rebuilt employing the sets G and G^* instead of F and F^*, respectively. We estimate the parameter α using the formula (7) and calculate the t-statistic. We repeat the whole procedure a large number of times (e.g. 1000) to receive an empirical distribution of the t-statistic, which approximates the true distribution of the t-statistic in small samples. The empirical bootstrap p-values from the t-statistic are used in our sensitivity analysis.

3. Data

a) Analysis period

This subsection discusses the choice of the time interval for our investigation. In our empirical analysis, we utilize data covering the period from January 1, 1999 to July 10, 2005.

[3] We discuss possible instruments in the next section.

We chose this interval taking into account Poland's monetary institutions, policy development, and enhancement of financial instruments.

The Monetary Policy Council was created on February 17, 1998, under the new Constitution and the National Bank of Poland (NBP) Act. The Council was given the right to decide monetary policy strategies and the instruments to implement them. During its first meeting in April, 1998 the MPC adopted a yield on 28-day NBP money market bills as the reference rate and this definition of the reference rate remained constant until December 2002, when it was changed into the yield on 14-day NBP money market bills.[4] In September 1998 the MPC revealed its medium-term strategy for the years 1999-2003 and implemented it consistently in the following years (National Bank of Poland, 1999, 2000, 2001, 2002, 2003). Consistent monetary policy is necessary in order to gain the confidence of financial investors. This stability is important for our analysis.

An analysis of the money, capital, and foreign exchange markets is possible in the period from 1999 to 2005, since both capital and money markets were already created by 1991, and their main indices were introduced before 1999. The złoty, the Polish currency, has been floating since April 2000, but even earlier it moved freely within a growing crawling band. The National Bank of Poland had already withdrawn from active interventions on the foreign exchange market in July 1998. Therefore, the exchange rate movements, particularly in the short-run, should not have been affected by the band.

b) Selection of financial instruments

In this section we describe the assets selected to reflect reactions of the money, foreign exchange, and capital markets to monetary policy changes. The inter-bank market is the biggest and most liquid market for short-term borrowings denominated in złoty, therefore

[4] The other official interest rates of the National Bank of Poland are the lombard rate, NBP deposit rate, and rediscount rate. See the NBP web pages (www.nbp.pl) for details.

daily closing quotes of short-term interest rates from this market with a maturity of three, six, nine, and twelve months (denoted by i(3M), i(6M), i(9M), and i(12M), respectively) are utilized in the study. Long-term transactions are also mostly conducted on the inter-bank market, but daily quotes are also available on the Warsaw Stock Exchange (WSE). We use treasury bonds with a maturity of two, five, and ten years (denoted by TB(2Y), TB(5Y), and TB(10Y), respectively) which are traded on both markets.

The WSE, with the highest capitalization among the stock exchanges in Central Europe, is the main market for local stocks. Therefore in our investigation we employ the exchange's leading WIG index that includes all stocks from the main market. Since WIG is a value-weighted index, the large and medium-size companies have the most influence on its value. Therefore, we consider the WIG20 index of the 20 largest and most liquid stocks, the MIDWIG index consisting of maximum 40 medium-size companies that are not included in WIG20, and the WIRR index of the smallest firms on the exchange to check whether reactions to monetary decisions depend on the capitalization of firms.

Additionally, we analyze changes in the futures index based on WIG20, denoted by FWIG20. This has been the most frequently-traded derivative index on the Warsaw Stock Exchange (www.wse.com.pl). Similarly, we utilize the TechWIG index of high-tech companies and the futures instrument based on this index, FtechWIG. The interesting part of the investigation is analyzing the reactions of stocks from the financial sector to changes in the official interest rate, therefore we add a sub-index built from stocks of companies from the financial sector, WIG-banking, into our data set. We also include official non-financial sub-indices from the telecommunication (WIG-tele), information technology (WIG-IT), food (WIG-food), and construction (WIG-constr) sectors that are less dependent on financial markets and may respond to monetary announcements in a different way than the financial-sector index.

Most of the foreign exchange transactions with the złoty take place on the inter-bank market. Although the European Union was Poland's most important trading partner over the investigated period, the US dollar was traditionally the base and most traded currency on this market. The złoty-euro exchange rate depends on the ratio of the złoty-dollar to the euro-dollar exchange rate and the euro-dollar rate is independent of the situation on the Polish market. Thus, we use the daily złoty-dollar exchange rate from the inter-bank market in our analysis. We also utilize the quotes of one- and three-month forward złoty-dollar exchange rates, FoUSD(1M) and FoUSD(3M), calculated using data from the inter-bank market and the futures index based on the złoty-dollar exchange rate, FUSD, quoted on the WSE to study investors' expectations regarding changes in future exchange rates after current monetary policy decisions.

c) Monetary policy surprises

The changes in the official interest rate have more influence on financial assets when they are unexpected. Thus, we construct a measure of monetary policy surprises, based on the changes in expectations of market participants. Typically, monetary policy surprises are derived from instruments heavily-traded on financial markets. For instance, changes in the three-month eurodollar or treasury bill rate, changes in the current month federal funds futures contract, and results from surveys of market economists are used to approximate unexpected changes in the federal funds target rate on the US market (Rigobon and Sack, 2004, Ellingsen and Söderström, 2001a, 2001b, Kuttner, 2001, Bomfim and Reinhart, 2000).

We analogously define shifts in the implied forward rate as the measure of monetary policy surprises in Poland. The implied forward rate is the hypothetical rate of the forward

contract, implied from the term structure of interest rates.[5] In our analysis, shifts in the implied forward rate with a settlement in one month and maturity in three months have been used to express monetary surprises for several reasons. First, the three-month interest rate is usually employed to express the markets' short-term expectations regarding monetary policy decisions. Second, using one-month settlement dates excludes from our expectations measure the highly volatile interest rates with a maturity below one month. These noisy short-term interest rates are typical to the Polish market due to temporarily illiquid banks attempting to reach their average monthly reserve limits. We calculate the implied forward rate on the basis of three-month and one-month WIBOR (Warsaw Inter-Bank Offered Rate) indices. The WIBOR indices are good instruments to express market expectations, because they come from the most liquid inter-bank market with a limited credit risk (due to low lending limits), as suggested by Söderlind and Svensson (1997).

Although, our surprise component is similar to those investigated in the literature, in general it could be possible that it was not estimated in an unbiased way. Therefore, we also investigate changes in the three-month interest rate and changes in the implied forward rate with a settlement in one week and maturity in one month. The results are qualitatively the same and are discussed in our sensitivity analysis.[6]

The time series of the reference interest rate and the dates of the meetings of the Monetary Policy Council were obtained from the National Bank of Poland. Daily data on

[5] Söderlind and Svensson (1997) provide a detailed discussion on deriving expectations from financial instruments. We use the discrete time definition of implied forward rate analogous to their one for continuous time.

[6] Other possible measures of monetary surprises could be calculated from residuals of monetary VAR models (Valente, 2003, Florio 2005) or using results from survey polls of financial market participants. We leave investigation of these measures for further research.

stock indices and futures instruments come from the Parkiet internet database and money market interest rates, treasury bond rates, and the foreign exchange instruments were adopted from the National Bank of Poland and from the Hoga internet database. The websites can be found at www.nbp.pl, pieniadz.hoga.pl, and www.parkiet.com.

4. Empirical results

In this section we present the empirical results from measuring the influence of the changes in the reference interest rate and the monetary policy surprises on the capital, foreign exchange, and money markets. We investigate the response of financial markets to monetary policy changes in the short term, therefore we chose one-day, two-day, and one-week (five working days) reaction periods. The one-day reaction is defined as a change in the asset price from the day of the MPC announcement to the next day . The two-day (one-week) reaction is a change in the asset price from the day of the MPC announcement to two working days (five working days) after the MPC announcement. During the Monetary Policy Council meetings interest rate changes were debated 79 times, which corresponds to 158 observations in our analysis. In our sensitivity analysis we also investigate reactions defined as a change from the day before the MPC announcement to the day after the MPC announcement.

The methodology consists of estimating the parameter α which measures the reaction of financial indices to monetary policy changes. The value of α is defined as the amount of change in the price of the selected financial index to the actual or unanticipated 100-basis point increase in the reference interest rate. Next, the t-statistic is used to verify whether α is significantly different from zero. A significant statistic value indicates that monetary policy changes influence the selected financial variables in the short run.

a) Market interest rates

Standard monetary theory suggests that monetary policy tightening (easing) increases (decreases) short-term and long-term market interest rates (Mehra, 1996, Thornton, 1998,

Ellingsen and Söderström, 2001). According to the expectations hypothesis long-term interest rates depend on the expected future short-term interest rates and the term premium. Therefore, they are less sensitive to monetary policy changes than short term interest rates (Cook and Hahn, 1989, Mehra, 1996, Edelberg and Marshall, 1996, Rigobon and Sack, 2004, Kuttner, 2001). Contrary to the expectations theory, the Fisher hypothesis assumes that an increase in the short-term interest rate is followed by a decrease in expected inflation. The falling expected inflation then pushes the long-term interest rates down (Edelberg and Marshall, 1996, Mehra, 1996, Romer and Romer, 2000, Haldane and Read, 2000, Peersman, 2002). The theoretical hypotheses are mixed and an empirical investigation is needed to find the actual reaction of short-term and long-term interest rates to monetary policy changes.

Results from estimating the response of short-term interest rates with a maturity of up to twelve months to monetary policy changes are presented in Table 1. For each pair of the short-term interest rate and the monetary policy variable we show values of the parameter α together with its corresponding t-statistic (in parenthesis).

Table 1 about here

The main finding from Table 1 is that both the official interest rate changes (ΔOIR) and their surprise components (ΔIFR) influence the short-term interest rates. Significant t-statistic values and positive values of the parameter α indicate that the official interest rate changes are followed by shifts in the short-term interest rates already on the day after the Monetary Policy Council's announcement. The highest t-values correspond to the one-day reactions to the unexpected component of the monetary changes, which suggests that short-term interest rates react more to monetary policy surprises that to official interest rate changes. Over the following days, the changes in the official interest rate usually have lower impact on the money market than the monetary policy surprises. However, the one-week impact of the monetary surprises is not significant for the interest rates with a maturity beyond six months.

Table 2 about here

In Table 2 we present the results from estimating the impact of the monetary policy announcements on the long-term interest rates (treasury bonds with a maturity of two, five, and ten years). Although the t-statistic values are usually higher for the parameters corresponding to monetary surprises rather than to official interest rate changes, they are significant only for the positive one-day reaction of two-year interest rates and the adverse two-day reaction of ten-year interest rates. These results suggest that the response of long-term interest rates to monetary policy changes is very limited in the short-run and it changes its direction with increasing maturity.

b) Stock market indices

Economic theory posits that stock prices should fall after an increase in the official interest rate. The price of a given company is assumed to equal the expected present value of future net cash flows of this company. Thus, monetary policy tightening reduces futures cash flows, increases the discount factors at which the cash flows are cumulated, and makes bonds more attractive relative to stocks (Thorbecke, 1997, Mishkin, 2001, Cai, 2003).

The empirical results are presented in Table 3, where the values of the parameter α from the model (1)-(2) and their corresponding t-statistics describe reactions of the general stock indices (WIG, WIG20), sub-indices (TechWIG for hi-tech companies, WIG-banking for the banking sector, WIG-tele for the telecommunication sector, WIG-IT for the information technology companies, WIG-food for the food sector, and WIG-constr for the construction companies), and indices of futures instruments based on the stock market indices (FWIG20, FTechWIG) to announcements of monetary policy changes.

Table 3 about here

The results from Table 3 demonstrate some plausible reaction patterns of stock market variables to monetary changes. Reactions are defined here as a change in the natural logarithm of the asset price (log return) from the day before the MPC announcement to the day of the

MPC announcement or to the days following the MPC announcement. Most stock market indices generally do not react significantly to either a change in the official interest rate or its surprise component. However, all indices fall on average on the days of unexpected increases of the official interest rate. The reaction of WIG, WIG-tele, and WIG-IT is significant at the 5% level. On the following day there is still no impact of the change in the official interest rate on the market indices. The WIRR index values increase slightly after a surprise monetary change. One-week reactions to changes in the official interest rate are only significant for the TechWIG, WIG-IT, and WIRR indices. Their magnitude is also limited. After a week, indices are no longer influenced by unexpected changes in the official interest rate.

Although the economic literature suggests that increases in interest rates should lead to decreases in stock market indices, our results only partly confirm this hypothesis. Insignificant response of most indices could suggest a limited effectiveness of emerging capital markets in processing the monetary news. Investors may act irrationally on this market or they may interpret the monetary surprises in a different way than the money market investors do. The existence of changing risk premium and trading costs could also affect the results.

c) Foreign exchange indices

According to the uncovered interest rate parity hypothesis, the expected return from the investment of capital at home should equal the expected return from investing this capital on a foreign market plus an unobservable risk premium (additional expected earnings compensating for the risk associated with investing in the foreign currency). An increase in the official interest rate causes an increase of the ratio of the expected future exchange rate to the present exchange rate. Thus, monetary policy tightening (increase in the reference interest rate) would most likely be followed by a drop in the actual złoty-dollar exchange rate, rise in

the expected future exchange rate, or a combination of these two effects.[7] If neither the spot exchange rate nor the expected future exchange rate changes after the monetary policy change takes place, one may interpret the result as evidence of a shift in the risk premium or the ineffectiveness of the foreign exchange market.

Table 4 about here

Results from estimating the short-run impact of the monetary policy changes on the foreign exchange market variables are shown in Table 4. The general finding from Table 4 is that both official interest rate changes and monetary surprises do not influence the złoty-dollar exchange rate in the short run. As expected, the spot rate falls and the futures index rises on the day of the increase of interest rates, but other derivative indices usually do not rise. Neither, the spot (USD), futures (FUSD), or forward contracts (FoUSD) seem to be significantly affected by the official and unexpected interest rate changes. No reaction of the spot exchange rate and the future expected exchange rate proxied by the futures contracts may indicate that the risk premium is mostly influenced by monetary policy decisions or the foreign exchange market is simply ineffective in processing the macroeconomic news.

This empirical investigation of the financial markets in Poland suggests that only the short-term market interest rates respond strongly to changes in the official interest rate and to the monetary surprises. As noted in the introduction, significant reactions of the short-term interest rates are also common for developed markets (Cook and Hahn, 1989, Roley and Sellon, 1998, Bomfim and Reinhart, 2000, Ellingsen and Söderström, 2001a, Kuttner, 2001, Rigobon and Sack, 2004 among others).

In our study, the long-term interest rates and stock indices in Poland react only to some extent and exchange rates do not react to monetary policy actions. Some analyses of the US market provide evidence that the long-term interest rates (Kuttner, 2001, Ellingsen and

[7] The złoty-dollar exchange rate equal to X denotes here that one dollar is worth X złotys.

Söderström, 2001a, Rigobon and Sack, 2004) and stock market indices (Thorbecke, 1997, Bomfim, 2003, Rigobon and Sack, 2004) are influenced by the interest rate changes in the short-run. Newby (2002) and Bomfim (2003) find no impact of monetary changes on the foreign exchange rate.

d) Sensitivity analysis

In order to check the robustness of our results we investigate different models, data, and methodologies. First, we use different definitions of monetary surprises. We experiment with changes in the 3-month WIBOR rate and changes in the implied forward rate with a settlement in one week and maturity in one month. Second, since the changes in the reference interest rate take place a day after the Monetary Policy Council announces the new official interest rates, we experiment with t as the announcement date instead of using the day following the announcement date. In this case we utilize two-day returns. Third, we investigate only the dates with official interest rate changes (30 dates corresponding to 60 observations). Fourth, we repeat all calculations for the shorter time period, which ends after the change in the definition of the reference interest rate (December, 2002). Finally, we employ the bootstrap technique to our original data set. The summary of our results for one-day reactions is provided in Table 5.

Table 5 about here

In most cases the short-term interest rates respond significantly to monetary surprises, but the other financial instruments react rarely, in a wrong direction, or after the official interest rate changes rather than after the monetary policy surprises. Hence, the robustness check does not change our conclusions. However, we note that some financial instruments, e.g. stock indices and long-term interest rates, respond more significantly to monetary announcements in the sample including the period after December 2002 that in the sample without this period. This finding points to an increasing impact of monetary policy on financial markets in the short-run.

5. Conclusions

In this paper we investigate the short-run impact of the Monetary Policy Council decisions regarding changes in the official interest rate on the money, capital, and foreign exchange markets in Poland. We employ the instrumental variable estimation approach described by Rigobon and Sack (2004), which controls for feedback linkages between financial variables and official interest rate changes, to estimate the reactions of financial variables quoted on these markets to monetary policy announcements.

We find that short-term interest rates respond significantly to monetary policy actions. Both official and surprise interest rate increases cause the short-term interest rates after the day of the monetary policy announcement to rise, but the surprise changes have a stronger impact than the official changes. On the other hand we observe only weak influence of monetary policy changes on long-term interest rates.

Similarly, the reactions of the variables from the foreign exchange market to interest rate changes are generally not significant in the short run. Not only the foreign exchange rate, but also expected shifts in the future foreign exchange rate (proxied by the US dollar futures rate) are independent of the monetary policy changes. The possible explanation of this phenomenon, based on the interest parity hypothesis, could be a changing risk premium present in the foreign exchange rate.

Our investigation of the stock market provides results suggesting that the main stock market indices are only to some extent influenced by monetary policy changes on the announcement day. All index values decrease (increase) on the days of unexpected decisions raising (lowering) interest rates, but the significance of these changes is limited. The results from this study correspond to those obtained for some more developed markets with two exceptions, i.e. in the US there is stronger evidence that both long-term interest rates and stock prices react significantly to monetary policy announcements.

In general our findings could suggest that the Polish financial markets are still ineffective in assessing macroeconomic news or they have limited confidence in actions of Polish monetary authorities. Having in mind the results of this study, monetary authorities could gain more credibility by increasing transparency of their decisions and improving communication with financial markets (e.g. Faust and Svensson, 2001). They could also increase effectiveness of their policies in the short-run by affecting the unexpected component of interest rate changes or employing other instruments, e.g. direct interventions on the foreign exchange market (e.g. Carlson and Lo, 2004). Other explanations of weak reactions of some instruments to monetary policy announcements include changing risk and term premia on the respective markets (Staikouras, 2005), high trading costs limiting arbitrage opportunities, and possible existence of insider traders introducing pre-announcement effects on the Polish financial market (Bomfim, 2003, Bohl and Wiśniewski, 2005).

An interesting extension of this study could be an investigation on how the impact of monetary policy decisions on financial markets develops after Poland joins the structures of the European Monetary Union. Nevertheless, economic theories do not unequivocally imply a significant reaction of the long-term interest rate and the foreign exchange rate to changes in the official interest rates. Moreover, an alternative explanation of the results related to the capital market is that financial investors may act irrationally on this market or they may interpret the monetary changes in a different way than the money market investors do. Thus, further research in these empirical and theoretical areas is necessary.

Acknowledgements

Martin T. Bohl, Shauna Selvarajah as well as seminar participants at the European University Viadrina, Frankfurt (Oder), 3rd International Conference of the Portuguese Finance Network, Lisbon, and the 30th MACROMODELS conference in Warsaw provided helpful comments. We would also like to thank the referee for his or her suggestions. The Foundation for Polish Science provided financial support.

References

Bagliano, F.C. and C. A. Favero (1999) Information from financial markets and VAR measures of monetary policy, European Economic Review, 43, 825--837.

Bohl M. T. and T. P. Wiśniewski (2005) The Information Content of Registered Insider Trading Under Lax Law Enforcement, forthcoming in International Review of Law and Economics.

Bomfim, A.N. (2003) Pre-Announcement Effects, News, and Volatility: Monetary Policy and the Stock Market, Journal of Banking and Finance, 27, 133--151.

Bomfim, A.N. and Vincent R. Reinhart (2000) Making News: Financial Market Effects of Federal Reserve Disclosure Practices, FEDS Working Paper 2000-14, Federal Reserve Board, Washington.

Cai, J., 2003, Asset Prices and Monetary Policies: Some Notes, mimeo, University of Hawaii at Manoa, Honolulu.

Carlson, J.A. and M. Lo (2004) Selective asymmetric intervention and sterilization, Applied Financial Economics, 14, 823--833.

Christiano, L., M. Eichenbaum, and Ch. Evans (1996) The Effects of Monetary Policy Shocks: Evidence from the Flow of Funds, Review of Economics and Statistics, 78, 16--34.

Cook, T. and T. Hahn (1989) The Effects of Changes in the Federal Funds Rate Target on Market Interest Rates in the 1970s, Journal of Monetary Economics, 24, 331--351.

Edelberg, W. and D. Marshall (1996) Monetary policy shocks and long term interest rates, Economic Perspectives, 20, 2--17.

Ellingsen, T. and U. Söderström (2001a) Monetary Policy and Market Interest Rates, American Economic Review, 91, 1594--1607.

Ellingsen, T. and U. Söderström (2001b) Classifying Monetary Policy, mimeo, Stockholm School of Economics, Stockholm.

Faust, J. and L.E.O. Svensson (2001) Transparency and Credibility: Monetary Policy with Unobservable Goals, International Economic Review, 42, 369--397.

Florio, A. (2005) Asymmetric monetary policy: empirical evidence for Italy, Applied Economics 37, 75--764.

Haldane, A.G. and V. Read (2000) Monetary policy surprises and the yield curve, Bank of England working paper 106, London.

Kuttner, K.N. (2001) Monetary Policy Surprises and Interest Rates: Evidence from the Fed Funds Futures Market, Journal of Monetary Economics, 47, 523--544.

Mehra, Y.P. (1996) Monetary Policy and Long-Term Interest Rates, Federal Reserve Bank of Richmond Economic Quarterly 82/3, 27--49.

Mishkin, F.S. (2001) The transmission mechanism and the role of asset prices in monetary policy, NBER Working Paper 8617, Cambridge, Massachusetts.

National Bank of Poland (1999, 2000, 2001, 2002, 2003) Annual Report, National Bank of Poland, Warsaw.

Newby, V.A. (2002) The effects of news on exchange rates when the risk premium is considered, Applied Financial Economics, 12, 147--153.

Peersman, G. (2002) Monetary Policy and Long Term Interest Rates in Germany, Economics Letters, 77, 271--277.

Rigobon, R. and B. Sack (2004) The Impact of Monetary Policy on Asset Prices, Journal of Monetary Economics, 51, 1553--1575.

Rigobon, R. (2003) Identification through Heteroskedasticity, Review of Economics and Statistics, 85, 777--792.

Roley, V.V. and G.H. Sellon (1998) The Response of Interest Rates to Anticipated and Unanticipated Monetary Policy Actions, mimeo, Federal Reserve Bank of Kansas City.

Romer, Ch. and D. Romer (2000) Federal Reserve Information and the Behavior of Interest Rates, American Economic Review, 90, 429--457.

Rudebusch, G.D. (1998a) Do Measures of Monetary Policy in a VAR Make Sense?, International Economic Review, 39, 907--931.

Rudebusch, G.D. (1998b) Do Measures of Monetary Policy in a VAR Make Sense? Reply to Christopher A. Sims, International Economic Review, 39, 943--948.

Sims, Ch.A. (1998) Comment on Glenn Rudebusch's "Do Measures of Monetary Policy in a VAR Make Sense?", International Economic Review, 39, 933--941.

Söderlind, P. and L.E.O. Svensson (1997) New techniques to extract market expectations from financial instruments, Journal of Monetary Economics, 40, 383--429.

Staikouras, S.K. (2005) Equity returns of financial institutions and the pricing of interest rate risk, Applied Financial Economics, 15, 49--508.

Thorbecke, W. (1997) On Stock Market Returns and Monetary Policy, Journal of Finance, 52, 635--654.

Thornton, D.L. (1998) Tests of the Market's Reaction to Federal Funds Rate Target Changes, The Federal Reserve Bank of St. Louis Review, 80, 25--36.

Valente, G. (2005) Monetary policy rules and regime shifts, Applied Financial Economics, 13, 52--535.

Table 1. Reaction of the short-term interest rates to changes in the official interest rate

	one-day reaction		two-day reaction		one-week reaction	
	ΔOIR	ΔIFR	ΔOIR	ΔIFR	ΔOIR	ΔIFR
$\Delta i(3M)$	0.188	1.016	0.204	0.718	0.172	0.999
	(7.460)**	(11.122)**	(5.995)**	(7.211)**	(3.279)**	(6.569)**
$\Delta i(6M)$	0.122	0.634	0.133	0.542	0.097	0.654
	(5.519)**	(7.590)**	(4.349)**	(6.007)**	(2.062)**	(4.837)**
$\Delta i(9M)$	0.066	0.701	0.098	0.579	0.164	0.325
	(2.535)**	(9.720)**	(2.706)**	(5.759)**	(3.461)**	(1.347)
$\Delta i(12M)$	0.078	0.657	0.100	0.591	0.169	0.115
	(3.088)**	(9.796)**	(2.919)**	(6.102)**	(3.423)**	(0.365)

Note: ΔOIR indicates changes in the official interest rate; ΔIFR denotes monetary policy surprises measured as changes in the implied forward rate; $\Delta i(3M)$ indicates changes in the three-month interest rate on the inter-bank market, $\Delta i(6M)$ indicates changes in the six-month interest rate, etc; * and ** denote significance at the 5% and 1% levels, respectively.

Table 2. Reaction of the long-term interest rates to changes in the official interest rate

	one-day reaction		two-day reaction		one-week reaction	
	ΔOIR	ΔIFR	ΔOIR	ΔIFR	ΔOIR	ΔIFR
$\Delta TB(2Y)$	0.073	0.571	-0.005	0.163	-0.007	0.265
	(2.718)**	(4.262)**	(0.141)	(1.107)	(0.135)	(1.096)
$\Delta TB(5Y)$	0.008	0.148	-0.014	-0.012	-0.058	0.227
	(0.346)	(1.281)	(0.455)	(0.091)	(1.118)	(0.956)
$\Delta TB(10Y)$	-0.021	-0.173	-0.060	-0.309	-0.054	-0.291
	(0.870)	(1.085)	(2.002)*	(1.968)*	(1.108)	(0.980)

Note: ΔOIR indicates changes in the official interest rate; ΔIFR denotes monetary policy surprises measured as changes in the implied forward rate; $\Delta TB(2Y)$ indicates changes in the two-year interest rate, $\Delta TB(5Y)$ indicates changes in the five-year interest rate, etc; * and ** denote significance at the 5% and 1% levels, respectively.

Table 3. Reaction of the stock indices to changes in the official interest rate

	one-day reaction		two-day reaction		one-week reaction	
	ΔOIR	ΔIFR	ΔOIR	ΔIFR	ΔOIR	ΔIFR
ΔWIG	-0.001	-0.183	-0.003	0.025	0.005	0.046
	(0.455)	(2.006)*	(1.074)	(1.388)	(1.045)	(1.041)
$\Delta WIG20$	0.001	-0.129	0.001	0.019	0.008	0.013
	(0.204)	(1.565)	(0.337)	(0.968)	(1.418)	(0.270)
$\Delta FWIG20$	0.005	-0.176	0.005	0.031	0.011	0.028
	(1.640)	(1.755)	(1.448)	(1.570)	(1.840)	(0.549)
$\Delta TechWIG$	0.004	-0.478	0.008	0.043	0.031	0.031
	(0.890)	(1.884)	(1.172)	(1.148)	(2.627)**	(0.446)
$\Delta FTechWIG$	0.009	-0.682	0.010	0.049	0.031	0.049
	(1.697)	(1.808)	(1.539)	(1.288)	(2.979)	(0.834)
$\Delta MIDWIG$	0.000	-0.068	0.000	0.010	0.004	0.028
	(0.092)	(1.307)	(0.150)	(0.751)	(0.872)	(0.782)
$\Delta WIRR$	0.002	-0.100	0.002	0.031	0.012	0.089
	(1.240)	(1.616)	(0.789)	(2.026)*	(2.597)**	(1.748)
$\Delta WIG - banking$	-0.002	-0.002	0.002	0.036	0.006	-0.016
	(0.756)	(0.283)	(0.602)	(1.452)	(0.971)	(0.576)
$\Delta WIG - tele$	-0.004	-0.361	-0.008	0.029	0.010	0.067
	(0.868)	(2.180)*	(1.309)	(0.932)	(1.148)	(0.901)
$\Delta WIG - IT$	0.001	-0.340	-0.003	0.052	0.018	0.125
	(0.231)	(2.091)*	(0.524)	(1.626)	(2.048)*	(1.421)
$\Delta WIG - food$	-0.003	-0.033	-0.002	-0.009	0.004	0.029
	(1.334)	(0.562)	(0.761)	(0.566)	(0.785)	(0.702)
$\Delta WIG - constr$	-0.002	-0.108	-0.005	0.016	0.004	0.080
	(1.014)	(1.624)	(1.624)	(0.903)	(0.733)	(1.408)

Note: ΔOIR indicates changes in the official interest rate; ΔIFR denotes monetary policy surprises measured as changes in the implied forward rate; Δ indicates changes in the respective index, e.g. $\Delta WIG20$ denotes changes in the WIG20 index; * and ** denote significance at the 5% and 1% levels, respectively.

Table 4. Reaction of the foreign exchange rate to changes in the official interest rate

	one-day reaction		two-day reaction		one-week reaction	
	ΔOIR	ΔIFR	ΔOIR	ΔIFR	ΔOIR	ΔIFR
ΔUSD	-0.001	-0.010	-0.001	-0.005	-0.002	0.020
	(1,002)	(1,604)	(0,296)	(0,613)	(0,570)	(1,319)
$\Delta FUSD$	0.002	0.010	0.003	0.007	0.002	0.018
	(1,457)	(1,525)	(1,529)	(0,835)	(0,484)	(1,184)
$\Delta FoUSD(1M)$	-0.001	-0.013	0.000	-0.006	-0.002	0.020
	(0,762)	(1,910)	(0,267)	(0,740)	(0,519)	(1,326)
$\Delta FoUSD(3M)$	-0.001	-0.011	0.000	-0.004	-0.001	0.021
	(0,564)	(1,690)	(0,086)	(0,538)	(0,447)	(1,400)

Note: ΔOIR indicates changes in the official interest rate; ΔIFR denotes monetary policy surprises measured as changes in the implied forward rate; ΔUSD indicates changes in the US dollar-Polish złoty exchange rate, $\Delta FUSD$ indicates changes in the futures contract based on the US dollar-Polish złoty exchange rate; $\Delta FoUSD(1M)$ and $\Delta FoUSD(3M)$ denote changes in the one-month and three-month forward contracts based on the US dollar-Polish złoty exchange rate, respectively; * and ** denote significance at the 5% and 1% levels, respectively.

Table 5. Robustness check of one-day reactions

Robustness check	Short-term interest rates	Long-term interest rates	Stock indices	Derivative indices	Foreign exchange rates	FX derivative indices
Different definitions of monetary surprises	15/0/0	3/0/9	0/3/39	0/0/8	0/0/4	0/0/12
Days of the MPC meetings as dates in F	8/0/0	2/0/4	1/0/19	0/0/4	0/0/2	0/0/6
Only the dates with changes in the official interest rate	7/0/1	2/1/3	0/4/16	0/1/3	0/1/1	0/2/4
Sample from January 1999 to December 2002	7/0/1	2/0/4	0/0/20	0/0/4	0/1/1	0/2/4
Bootstrap p-values $^{(*)}$	8/0/0	2/1/3	0/6/14	0/0/4	0/1/1	1/2/3

Note: $^{(*)}$ A/B/C denote the number of positive (A), negative (B), and no (C) reactions of asset prices to interest rate changes at the 5% significance level, respectively. Short-term interest rates are: $i(3M)$, $i(6M)$, $i(9M)$, and $i(12M)$. Long-term interest rates are: $TB(2Y)$, $TB(5Y)$, and $TB(2Y)$. Stock indices are: WIG, $WIG20$, $MIDWIG$, $WIRR$ $TechWIG$, $WIG-banking$, $WIG-tele$, $WIG-food$, $WIG-constr$, and $WIG-IT$. Derivative indices are: $FWIG20$ and $FTechWIG$. Foreign exchange rate is USD and FX derivative indices are $FUSD$, $FoUSD(1M)$, and $\Delta FoUSD(3M)$.