Economic Modelling 35 (2013) 536–545

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/ecmod

How do banks' stock returns respond to monetary policy committee announcements in Turkey? Evidence from traditional versus new monetary policy episodes

Güray Küçükkocaoğlu [a], Deren Ünalmış [b,*], İbrahim Ünalmış [b]

[a] Başkent University, Turkey
[b] Central Bank of the Republic of Turkey, Turkey

ARTICLE INFO

Article history:
Accepted 16 July 2013
Available online xxxx

JEL classification:
E43
E44
E52

Keywords:
Monetary policy
Stock market
Banking system
Emerging markets
Identification through heteroscedasticity

ABSTRACT

Using a methodology that is robust to endogeneity and omitted variable problems, it is found that the stock returns of all banks that are listed in Borsa Istanbul (BIST) respond significantly to the monetary policy surprises on Monetary Policy Committee (MPC) meeting days prior to May 2010. It is also shown that stock returns of banks for which interest payments constitute an important share in their balance sheets respond more aggressively to the changes in policy rates. In addition, foreign banks and participation banks give relatively less responses to monetary policy surprises. Finally, the estimation results suggest that since the Central Bank of the Republic of Turkey has started adopting a new monetary policy framework in May 2010, with various instruments and flexible timing, aggregate and individual bank indices have not responded significantly to the surprises on MPC meeting days.

1. Introduction

Measurement of the reaction of asset prices to monetary policy changes is complicated due to endogeneity and omitted variable bias problems. In the literature, to overcome these problems, the most commonly adopted estimation method is the event study (ES) approach.[1] Rigobon and Sack (2004) (henceforth, RS) develop and use the heteroscedasticity-based estimation technique as an alternative to the event study (ES) approach. This technique is considered more reliable as it is valid under much weaker assumptions.[2] The results from the heteroscedasticity-based estimation in RS suggest a significant negative impact of monetary policy on stock indices in the United States. Recently, an increasing number of studies have investigated the impact of monetary policy on stock indices using the heteroscedasticity-based methods and find similar results with RS (see Ehrmann et al. (2011) for the United States and the Euro Area; Bohl et al. (2008) for the largest four European countries and Kholodilin et al. (2009) for all the European countries). Rosa (2011) documents the effects of changes in US monetary policy on stock prices in 51 countries.[3]

Studies using the heteroscedasticity-based methods developed by RS as an alternative to the ES approach are rare for emerging markets.[4] Duran et al. (2012) find that an increase in the policy rate leads to a decline in aggregate stock indices in Turkey. In addition, monetary policy has the greatest impact on the financial sector index, 70% of which consists of bank stocks. As a complement to Duran et al. (2012), the aim of this study is to measure the response of individual banks' stock returns to monetary policy in Turkey, using the heteroscedasticity-based GMM method suggested by RS and then relate the results to some bank specific characteristics.

Banks' or firms' balance sheet, size and ownership structure may be possible reasons of the heterogeneity in their responses to monetary policy. For example, Kwan (1991), who shows that US commercial bank stock returns are significantly sensitive to the monetary policy decisions, reveals that sensitivity of bank stock returns positively depends on the maturity mismatch between assets and liabilities of

* Corresponding author. Tel.: +90 312 5075413; fax: +90 312 5075733.
E-mail address: deren.unalmis@tcmb.gov.tr (D. Ünalmış).

[1] This method basically compares asset prices immediately after monetary policy announcements with those immediately before, and attributes the changes to monetary policy surprises. For details and two notable examples using the ES approach, see Kuttner (2001) and Gürkaynak et al. (2005).

[2] For a comparison of assumptions under the ES and the GMM approaches, see Rigobon and Sack (2004).

[3] Please see Wickens (2008) for the theoretical backgrounds of the relationship between monetary policy and stock markets.

[4] Duran et al. (2012) and Duran et al. (2010) focuse on the aggregate stock indices in Turkey. Rezessy (2005) and Goncalves and Guimaraes (2011) apply the heteroscedasticity-based methodology to the asset prices in Hungary and Brazil, respectively.

0264-9993/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.econmod.2013.07.019

banks. Using several different techniques and measures for monetary policy Thorbecke (1997) finds that monetary policy has a significant effect on stock returns in the US. He shows that the effect of monetary policy shocks on small firms is higher than larger firms.

From the financial stability point of view, analyzing the impact of monetary policy on a bank specific level is important. For example in case of a hike in the policy rate, if a bank's stock market value is severely affected this may impair the bank's access to funding in financial markets. This in turn negatively affects the overall financial stability if this bank is systemically important. Hence, the policy makers may want to know the banks that are mostly affected from the MPC decisions and why these banks' behave differently than others.

1.1. Structure of the Turkish banking system

In terms of their functions, Turkish banks can be classified in three different groups: deposit banks, participation banks, and development and investment banks. There are 32 deposit banks, 4 participation banks and 13 development and investment banks operating as of the end-2012. Deposit banks, participation banks, and development and investment banks constitute 91.5%, 5.1% and 3.4% of the total asset size of the banking system respectively. Total asset size of the banking system relative to GDP is 97% in 2012, which was 62.7% in 2005. Accordingly, average growth rate of the total assets/GDP ratio of the Turkish banking system between 2005 and 2012 is about 6%. There are 20 banks that are partly or totally owned by foreigners and their asset size is about 17% of the total banking system. Although 16 out of 49 banks are traded in Borsa Istanbul, their asset size is about 88% of the total banking system.

In summary, according to the asset size, more than 90% of the Turkish banking system is occupied with traditional deposit banking, which is dominated by domestic banks. The banks whose shares are traded in Borsa Istanbul constitute most of the banking system.

1.2. Monetary policy framework in Turkey

The conduct of monetary policy in Turkey has changed considerably in May 2010. Central Bank of the Republic of Turkey (hereafter CBRT) had implemented a traditional inflation targeting policy until then. In this period, sole objective of the CBRT was to keep inflation low and at stable levels. We name the period before May 2010 as "the traditional monetary policy episode". However, the global financial crisis, erupted with the collapse of the Lehman Brothers in 2008, has changed the shape of the central banking. As the financial crisis deepened, interest rates in advanced economies have declined following the very low or negative growth rates. On the other hand, interest rates in emerging markets were relatively high and their economic growth prospects were strong. In such an environment liquidity released by advanced economies' central banks was channeled to emerging markets. This caused overvaluation of domestic currencies, rapid growth in domestic credits and current account imbalances. Therefore, many emerging market central banks including Turkey have been forced to modify their monetary policy approach to cope with the challenges caused by the excessive capital inflows. In 2010, CBRT has begun to reshape its monetary policy. In order to discourage volatile short-term capital inflows and excessive credit growth, CBRT has increasingly used a policy mix composed of an interest rate corridor, reserve requirements and a liquidity policy.[5] We name the period after May 2010 as "the new monetary policy episode".

The margin between the overnight lending and borrowing rates of the CBRT is defined as the "interest rate corridor", which constitute the upper and lower bounds for the overnight market rate. Before May 2010, the overnight borrowing rate of the CBRT was the policy rate; whereas since May 2010, the CBRT has adopted the weekly repo funding rate as its primary policy rate. Now, the CBRT can adjust the width of the overnight interest rate corridor when necessary, and at the same time can adjust the corridor around the policy rate in an asymmetrical way. In the traditional inflation targeting framework, the policy rates were generally fixed for one month. However, under the new framework, market rates can be changed on a daily basis by adjusting the quantity of funds provided through one-week repo auctions. Hence, the overnight rate can be targeted anywhere inside the corridor. In other words, under the new framework, the short rates can be amended at any time, not only during the MPC days.

In this study, for the sample period prior to May 2010 (the traditional policy episode), we show that an increase in the policy rate leads to a significant decline in all of the individual banks' stock prices, the aggregate bank index (BIST-Bank) and the aggregate stock index (BIST-100). According to our estimates, on an MPC day, a 100 basis point surprise hike in the short-term rate leads to a 3.66% decline in BIST-Bank.[6] This figure is in line with the findings of other studies in the literature.

Then, we question whether the MPC surprises are still important in the period of new monetary policy implemented since May 2010. For this purpose, we compare the responses of banks' stock indices to MPC surprises in traditional and new monetary policy episodes. Interestingly, we find that, once the CBRT has begun following a new monetary policy approach, the effect of MPC surprises became insignificant.[7] Note that this does not mean that the transmission from monetary policy rate to financial markets is completely broken. Our findings only suggest that the monetary policy surprises on MPC meeting days have lost their significance in the new policy episode. Since the monetary policy now has flexible timing and many important decisions, announcements and actions are made in days other than MPC meeting days, monetary policy can still significantly affect the asset markets in other days. The monetary policy surprises in the new framework can arrive on any day and on consecutive days. This is particularly true for the periods of additional tightening. In such a period, CBRT does not provide liquidity from the policy rate and forces the banks to seek funds from alternative sources (i.e., the overnight interbank money market or the overnight lending of CBRT) with a higher cost. In addition, banks do not know when the additional tightening will start and finalize beforehand. Hence, a monetary policy impulse could be given in any day during an additional tightening period. In this case, we cannot identify the policy and pre-policy days. Therefore, our methodology in this paper is not suitable to measure the effects of all the monetary policy surprises during the new monetary policy episode. For that reason we focus on the MPC days for the new period as well.

We also detect heterogeneity in the responses of bank returns to monetary policy for the traditional monetary policy episode. The responses of banks' stock returns; although all of them are statistically significant at conventional levels, posit a wide range between −1.82 and −9.49. We show that the response of 8 out of 16 banks' stock returns significantly diverge from the aggregate bank index. Intuitively, we provide evidence which suggests that banks that are dependent on money market funding and which incur higher interest rate payments are more likely to give larger responses to the monetary policy surprises. In addition, the banks which earn higher net interest income respond significantly less to monetary policy surprises.

The plan of the remainder of the paper is as follows. We present the methods employed in Section 2. Section 3 describes the data. We discuss the empirical evidence in Section 4 and finally Section 5 concludes.

[5] For details of the new monetary policy framework, please see CBRT (2013).

[6] This figure is 3.26 for BIST-100, somewhat lower in magnitude than BIST-Bank.

[7] Unfortunately, we could not find other studies, which compare the findings for the traditional and non-traditional policy episodes. Our study seems to be unique in that area. Hence, we could not compare our findings for the new monetary policy period with the rest of the related literature.

2. Model dynamics and methodology

Following RS, the dynamics of the short-term interest rate and stock prices are assumed to be as follows:

$$\Delta i_t = \beta \Delta s_t + \gamma z_t + \varepsilon_t \quad (1)$$

$$\Delta s_t = \alpha \Delta i_t + z_t + \eta_t \quad (2)$$

where Δi_t is the change in the policy rate, Δs_t is the change in the stock price and z_t is a vector of exogenous variables which affect both Δi_t and Δs_t. Eq. (1) can be interpreted as a monetary policy reaction function, where the policy rate responds to the stock price and a set of variables z_t, which may or may not be observed. Eq. (2) represents the asset price equation, which captures the response of the stock price to the monetary policy and other variables z_t. In our setup, z_t is taken as a single unobservable variable, which represents all the omitted common factors in both equations. Since z_t is an unobservable variable, its coefficient is normalized to one in Eq. (2).[8] The variable ε_t is the monetary policy shock and η_t is the asset price shock. The shocks ε_t and η_t are assumed to be serially uncorrelated and to be uncorrelated with each other and with the common shock z_t.

In this paper, we are interested in estimating α, which measures the impact of a change in the policy rate Δi_t on the change in the stock price Δs_t. The ES approach estimates only Eq. (2) and uses the asset price changes directly after the announcement of the monetary policy committee (MPC) decision. The ES approach implicitly assumes that, in the limit, the variance of the policy shock becomes infinitely large relative to the variances of other shocks on policy dates.

The heteroscedasticity-based identification technique suggested by RS does not require such a strong assumption. In this approach, we only need to observe a rise in the variance of the policy shock when the MPC decision is announced, while the variances of other shocks remain constant, given that the parameters α, β and γ are stable. Since the GMM technique requires weaker assumptions, it can give more reliable estimates than the ES approach.[9]

Two subsamples are essential to implement the GMM technique. The policy dates (days when the MPC decisions are announced) and the non-policy dates (days immediately preceding the policy days). The GMM method uses a comparison of the covariance matrices of the variables on the policy and the non-policy dates. There are two parameters to be estimated, namely; α and a measure of the degree of heteroscedasticity that is present in the data. In the GMM method, there are three moment conditions and two parameters to estimate. Therefore, overidentification restrictions enable us to test the model as a whole.

3. Data

We use daily data from Borsa Istanbul (BIST). The policy rate is proxied by the yield on government bonds with one-month maturity, which is traded in a relatively more liquid market among the other alternative short rates. We take stock return indices BIST-100, BIST-Bank and individual indices for 16 banks: Akbank (AKBNK), Alternatifbank (ALNTF), Denizbank (DENIZ), Finansbank (FNBNK), Garanti Bankası (GARAN), İş Bankası (ISCTR), Kalkınma Bankası (KLNMA), Şekerbank (SKBNK), Türkiye Ekonomi Bankası (TEBNK), Tekstil Bankası (TEKST), Türkiye Sınai Kalkınma Bankası (TSKB), Yapı ve Kredi Bankası (YKBNK), Albaraka Türk (ALBRK), Asya Bankası (ASYAB), Halk Bankası (HALKB) and Vakıflar Bankası (VAKBN). We take the daily change of the interest rate in basis points while the stock returns are in daily percentage changes of the return indices.

The sample covers the January 2005–January 2013 period with 99 policy decisions. There are four exceptions due to data availability: the data for ALBRK, ASYAB, HALKB and VAKBN start from July 2007, May 2006, May 2007 and December 2005 respectively. The traditional and new monetary policy episodes include 65 and 34 MPC announcements, respectively.

While the ES methodology uses only changes in the asset prices on policy dates, the heteroscedasticity-based GMM estimates compare the changes in asset prices before and after the announcement of the policy decision. The data are plotted in levels in Fig. 1. The major bank return index, BIST-Bank generally moves in the opposite direction with the short-rate. However, this relationship has weakened in recent years, with the short rate generally following a flat course except for the period of additional monetary tightening in the first half of 2012.

The descriptive statistics for the daily changes of the policy rate and stock returns are reported in Table 1. The standard deviations of the policy rate and the bank returns are generally higher on policy days when compared with the nonpolicy days (this evidence is stronger in the traditional policy period). Though the correlations between the policy rate and the stock returns of banks are positive and small in absolute value (between 0.03 and 0.14) one day before the policy announcement, they all become negative and larger in absolute value (between −0.10 and −0.38) after the announcement of the policy decision. The correlations in policy and nonpolicy days differ even more sharply during the traditional policy episode. The fact that the interaction between the policy rate and the financial markets change considerably on the days when the policy shock arrives enables the parameter α to be estimated using the GMM method.

4. Empirical results

4.1. Full sample estimates

The full sample estimates for the parameter α using both the ES approach and the heteroscedasticity-based GMM method are reported in the second and fourth columns of Table 2. According to the GMM method, which is theoretically more reliable, the responses of aggregate indices and most of the individual stock indices to a rise in the short-term rate are significant and negative. According to the GMM estimates, a 100 basis point increase in the short-term interest rate decreases BIST-100 by 2.8% and BIST-Bank by 3.3%. It is interesting to see that the GMM method gives consistently higher and more significant parameter estimates than the ES approach. The results at the bank level suggest

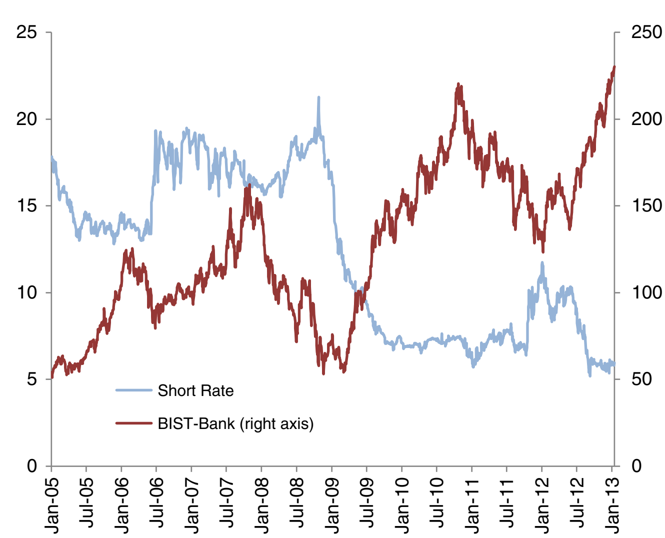

Fig. 1. Short rate and the BIST-Bank return index. Note: Short rate is the 1 month t-bill rate.

[8] The setup is flexible enough to include observable common factors as well.

[9] For further details on the technical comparison of ES and GMM approaches and the estimation methodology the reader is referred to RS or the Appendix A of this study.

Table 1
Standard deviations and correlations with the policy rate.

	Standard Deviations				Correlations with the Policy Rate			
	Full Sample (Jan05-Jan13)		Traditional Monetary Policy (Jan05-Apr10)		Full Sample (Jan05-Jan13)		Traditional Monetary Policy (Jan05-Apr10)	
	Policy Days	Nonpolicy Days	Policy Days	Nonpolicy Days	Policy Days	Nonpolicy Days	Policy Days	Nonpolicy Days
Policy Rate	0.32	0.15	0.32	0.15	–	–	–	–
Stock Returns								
BIST-100	2.14	1.82	2.16	1.85	−0.33	−0.12	−0.40	−0.10
BIST-BANK	2.65	2.26	2.65	2.28	−0.31	−0.12	−0.37	−0.12
AKBNK	3.47	2.65	3.78	2.62	−0.18	0.05	−0.24	0.07
ALTNF	3.44	3.54	3.60	3.45	−0.29	0.06	−0.32	0.07
DENIZ	3.46	3.51	3.60	3.71	−0.10	0.03	−0.15	−0.02
FNBNK	3.24	2.38	3.42	2.54	−0.11	0.06	−0.13	0.10
GARAN	3.12	3.11	3.37	3.21	−0.27	0.12	−0.36	0.14
ISCTR	3.18	2.50	3.45	2.50	−0.27	0.14	−0.35	0.21
KLNMA	2.90	2.34	3.05	2.40	−0.13	0.05	−0.20	0.11
SKBNK	3.56	3.63	3.87	3.84	−0.26	0.06	−0.32	0.08
TEBNK	3.42	2.68	3.69	2.83	−0.14	0.10	−0.18	0.08
TEKST	3.70	2.78	3.96	2.94	−0.38	0.09	−0.50	0.12
TSKB	2.92	2.70	3.02	2.77	−0.32	0.14	−0.45	0.23
YKBNK	2.65	2.81	2.74	2.89	−0.22	0.14	−0.26	0.16
ALBRK	2.27	1.85	2.29	1.69	−0.14	0.03	−0.19	0.13
ASYAB	2.44	2.79	2.51	3.02	−0.18	0.05	−0.30	0.14
HALKB	3.67	2.63	4.18	2.68	−0.16	0.03	−0.31	0.11
VAKBN	3.28	2.79	3.67	2.92	−0.30	0.07	−0.36	0.07

Notes: The policy rate is in daily changes in basis points and the stock market returns are in daily percent changes.

Table 2
Estimation results and diagnostic tests. Full sample (January 2005–January 2013).

	$\widehat{\alpha}_{ES}$	$\widehat{\alpha}_{GMM}$	$\widehat{\lambda}_{GMM}$	OIR test	GMM vs. ES	Number of obs.
BIST-100	−2.14*** (0.64)	−2.77*** (0.79)	0.084*** (0.022)	0.42	1.85	99
BIST-BANK	−2.54*** (0.80)	−3.31*** (0.89)	0.085*** (0.021)	0.58	3.58*	99
AKBNK	−2.00* (1.08)	−2.91** (1.20)	0.082*** (0.022)	0.89	2.99	99
ALNTF	−3.11*** (1.04)	−4.16*** (1.51)	0.075*** (0.021)	0.24	0.93	99
DENIZ	−1.02 (1.08)	−1.55 (1.10)	0.078*** (0.022)	0.10	9.99***	99
FNBNK	−1.07 (1.01)	−1.43 (1.14)	0.081*** (0.022)	2.81*	0.51	99
GARAN	−2.67*** (0.94)	−4.00*** (1.06)	0.077*** (0.022)	0.12	7.67***	99
ISCTR	−2.68*** (0.96)	−4.47*** (1.36)	0.082*** (0.022)	0.51	3.51*	99
KLNMA	−1.06 (0.91)	−1.97** (0.90)	0.087*** (0.022)	1.38	32.1***	99
SKBNK	−2.91*** (1.08)	−4.07*** (1.30)	0.074*** (0.020)	0.12	2.56	99
TEBNK	−1.45 (1.07)	−2.59** (1.09)	0.081*** (0.022)	1.02	28.4***	99
TEKST	−4.38*** (1.08)	−8.16*** (2.00)	0.093*** (0.020)	0.84	5.01**	99
TSKB	−2.98*** (0.87)	−4.39*** (1.35)	0.077*** (0.021)	0.02	1.88	99
YKBNK	−1.82** (0.81)	−2.68*** (0.90)	0.075*** (0.022)	0.56	4.85**	99
ALBRK	−1.03 (1.00)	−2.04** (0.83)	0.054*** (0.019)	1.52	3.23*	68
ASYAB	−1.31 (0.80)	−1.65** (0.75)	0.082*** (0.025)	0.89	1.44	83
HALKB	−2.17 (1.59)	−3.06* (1.82)	0.053*** (0.018)	0.91	1.04	70
VAKBN	−3.01*** (1.04)	−4.30*** (1.11)	0.083*** (0.024)	0.13	10.7***	88

Notes: The standard errors are in parentheses. ***, ** and *, indicate the significance levels at 1%, 5% and 10% levels respectively. GMM over-identification test has a $\chi^2(1)$ distribution. $F_{1,T-1}$ distribution is used for the Hausman-type biasedness test.

strong heterogeneity in the responses of individual banks. While TEKST gives the largest significant response (with a coefficient of around −8.2), DENIZ and FNBNK give low and insignificant responses (with coefficients of around −1.6 and −1.4 respectively).

The diagnostics for the estimates are also reported in Table 2. The results of the tests confirm that the assumptions of the GMM method are more reliable. The fact that λ is significant suggests that the increase in the volatility of the policy date is sufficiently large for the GMM estimation. The over-identification test results, reported in the “OIR Test” column, do not point to model misspecification.[10] The difference between the ES and the heteroscedasticity-based GMM likely reflects a bias in the ES estimates. The potential biasedness of the event-study estimates compared to the GMM method is tested and reported in the “GMM vs. ES” column. The empirical results for the stock indices suggest that the ES estimates are not statistically biased for BIST-100, but are biased for BIST-Bank and some of the individual bank returns compared to the GMM estimates.

In 2010, there is a substantial change in the way CBRT conducted its monetary policy. Under the new framework, called a policy mix, CBRT has started to implement its policy with flexible timing, multiple instruments and targets. The policy mix has included an active use of reserve requirements, an interest rate corridor of overnight borrowing and lending rates, as well as a liquidity management strategy. In this period, the CBRT has adopted financial stability as its supplementary objective besides price stability. Variables like credit growth and foreign exchange rate were set as intermediate targets while CBRT pursues its objective of

[10] The overidentification restrictions are rejected only for FNBNK, at 10% significance level.

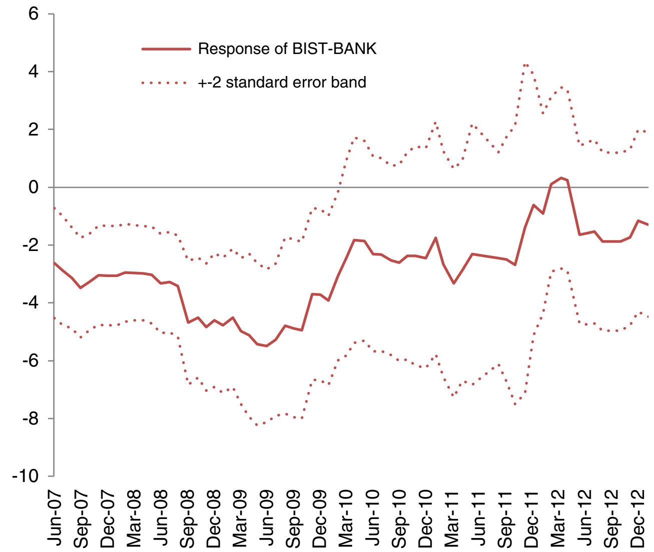

Fig. 2. Rolling window GMM estimates of the response of BIST-Bank to monetary policy committee surprises. Notes: Each window includes 30 observations. The first window is January 2005–June 2007.

financial stability. Under this new framework, the policy rate has not been the main instrument of the monetary policy. It has been less actively used. Besides, other policy instruments like the interest rate corridor and liquidity management were often used on a daily basis. Since monetary policy now had flexible timing, the policy surprises on MPC days might have lost their importance. In that respect, it would be interesting and informative to see whether the monetary policy surprises on MPC days have lost their significance in affecting the banks' stock returns. In order to see this, we first carry out rolling window GMM estimations for the BIST-Bank index. We report these estimation results in Fig. 2.

In Fig. 2, we see that there is indeed a breakpoint in the first half of 2010. In May 2010, CBRT has adopted the 1 week repo rate as its policy rate. Before this date, the overnight borrowing rate was the policy rate. The policy rate can only be changed at an MPC meeting and MPC meeting are usually held once a month. However, by changing the maturity of the policy rate from overnight to weekly frequency, and setting a wide corridor of overnight lending and borrowing rates, CBRT now had more room to affect the overnight repo rate, which is determined at BIST. This was done by setting high reserve requirement ratios and hence using an effective short-term liquidity policy.

4.2. Estimation results for the traditional monetary policy episode

In Table 3, we report the estimation results for the traditional policy episode. In this period, according to the *t*-statistic values, the monetary policy surprises are statistically significant for all banks at conventional levels. The estimated coefficients are now larger in magnitude and range from −1.82 (for DENIZ) to −9.49 (for TEKST). For the traditional policy period, the ES estimates are found to be biased for the responses of most banks compared to the GMM estimates. We again observe heterogeneity in the responses of banks to monetary policy surprises.

Fig. 3 reports the estimation results for the full sample and the traditional policy episode pictorially. We again observe that, all of the estimated coefficients are higher in magnitude than the full sample estimates. We also observe the wide variation in the degree of the response to MPC surprises among banks.

4.3. Estimation results for the new monetary policy episode

For comparison purposes, in Table 4, we report the estimation results for the new policy episode. These results suggest that the MPC surprises have lost their significance not only for the aggregate indices but also for the individual bank indices. Note that this does not mean that the transmission from monetary policy to financial markets is completely broken in this period. Our findings only suggest that the monetary policy surprises on MPC meeting days have lost their significance in the new policy episode. Since the monetary policy now has flexible timing and many important decisions, announcements and actions are made in days other than MPC meeting days, the policy rate can still significantly affect the asset markets in other days. Hence, the methodology we use might not be suitable for the second subsample. Under our current methodology, one implicit assumption is that monetary policy surprises generally arrive on MPC meeting days. Obviously, this has not been the case in Turkey recently. Measuring the impact of monetary policy in the new policy episode necessitates using a modified methodology, which is out of the scope of this paper.

Table 3
Estimation results and diagnostic tests. Traditional monetary policy episode (January 2005–April 2010).

	$\widehat{\alpha}_{ES}$	$\widehat{\alpha}_{GMM}$	$\widehat{\lambda}_{GMM}$	OIR test	GMM vs. ES	Number of obs.
BIST-100	−2.69*** (0.73)	−3.26*** (0.89)	0.098*** (0.029)	0.04	1.24	65
BIST-BANK	−3.11*** (0.89)	−3.66*** (0.99)	0.098*** (0.029)	0.05	1.67	65
AKBNK	−2.88** (1.38)	−4.15*** (1.42)	0.104*** (0.031)	1.18	16.6***	65
ALNTF	−3.45*** (1.29)	−4.74*** (1.82)	0.092*** (0.029)	0.05	0.99	65
DENIZ	−1.67 (1.34)	−1.82* (1.09)	0.094*** (0.030)	0.04	0.03	65
FNBNK	−1.31 (1.19)	−2.62** (1.26)	0.103*** (0.031)	2.78*	10.4***	65
GARAN	−3.81*** (1.17)	−5.37*** (1.16)	0.093*** (0.030)	0.06	91.9***	65
ISCTR	−3.75*** (1.20)	−6.21*** (1.54)	0.104*** (0.030)	0.39	6.47**	65
KLNMA	−1.44 (0.99)	−2.64*** (0.96)	0.104*** (0.030)	0.40	25.3***	65
SKBNK	−3.85*** (1.38)	−5.26*** (1.55)	0.087*** (0.026)	0.13	4.22**	65
TEBNK	−2.10 (1.37)	−3.32** (1.33)	0.100*** (0.031)	0.87	14.4***	65
TEKST	−6.16*** (1.30)	−9.49*** (1.90)	0.106*** (0.021)	0.11	5.81**	65
TSKB	−4.22*** (0.99)	−5.76*** (1.33)	0.081*** (0.025)	0.40	2.97*	65
YKBNK	−2.21** (0.98)	−3.05*** (1.06)	0.090*** (0.030)	0.46	4.42***	65
ALBRK	−1.43 (1.30)	−3.07*** (0.89)	0.068** (0.027)	1.56	2.91*	33
ASYAB	−2.13** (0.90)	−2.85*** (0.78)	0.099*** (0.038)	1.98	2.43	47
HALKB	−5.01** (2.54)	−8.16*** (2.17)	0.062*** (0.026)	0.59	5.78**	35
VAKBN	−3.97*** (1.37)	−5.52*** (1.34)	0.109*** (0.035)	0.17	41.8***	53

Notes: The standard errors are in parentheses. ***, ** and *, indicate the significance levels at 1%, 5% and 10% levels respectively. GMM over-identification test has a $\chi^2(1)$ distribution. $F_{1,T-1}$ distribution is used for the Hausman-type biasedness test.

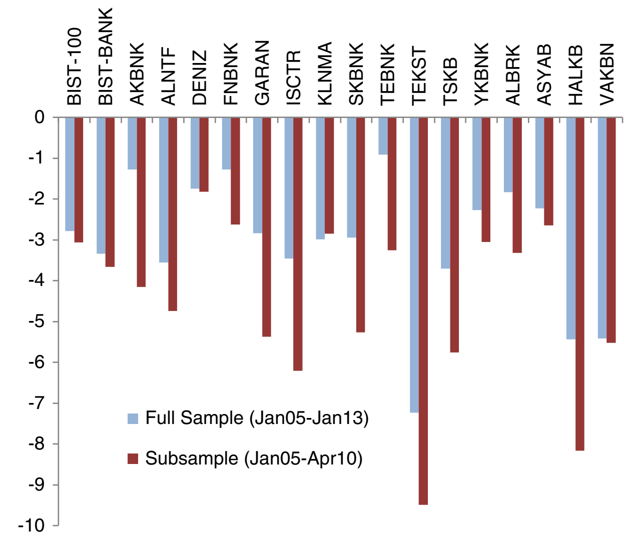

Fig. 3. The Estimated impact of monetary policy committee surprises on banks' stock returns. Notes: Estimated parameters are obtained using the GMM approach of Rigobon and Sack (2004) with identification through heteroscedasticity. For the subsample (traditional policy episode), all the coefficients are statistically significant at conventional levels. For the full sample, all the coefficients except the ones for Denizbank and Finansbank are statistically significant.

4.4. Heterogeneity in the responses of banks to MPC surprises

Next, we test whether the heterogeneities in banks' responses are significant. Since MPC surprises are found to be significant only for the first subsample, we do this analysis for the traditional monetary policy episode. In order to carry out this analysis, we subtract the BIST-Bank return from the individual bank returns and repeat the estimations with this data. The results are reported in Table 5. According to these results 8 out of 16 banks face statistically significant heterogeneity at conventional levels. Among these, 4 banks are affected significantly more seriously than average (namely, TEKST, HALKB, TSKB and ISCTR) and 4 banks are affected significantly less (namely, DENIZ, FNBNK, KLNMA and ASYAB) from the monetary policy surprises on MPC days.

We further question whether the bank-level heterogeneity detected above is related to any bank specific characteristics. We collect the quarterly balance sheet data for the banks from BIST and using this data, calculate and report some bank specific ratios in Table 6. In addition to these bank specific characteristics, the last column of Table 6 shows the degree of heterogeneity, i.e., the GMM estimates of the heterogeneity in banks responses that are reported in Table 5. A positive/negative coefficient indicates that the bank's stock price is affected less/more seriously from monetary policy than the sector index. Shaded rows are the banks whose heterogeneous responses to monetary policy surprises are statistically significant. In order to understand how each bank's balance sheet structure is related to the degree of bank's heterogeneity, we calculate the correlations of some balance sheet ratios with the degree of heterogeneity. In the last two rows, the first row (Correl1) includes the correlations for all 16 banks. In the last row (Correl2), we report the correlations between balance sheet ratios and the degree of heterogeneity only for banks that show significant heterogeneity.

The ownership structures and the type of banking practice are important determinants of banks' heterogeneous responses. For example, banks owned by foreigners (DENIZ, FINBN and TEBNK) respond less than the sector average. In addition, responses of participation banks (ALBRK and ASYAB) are also less than the sector average. Domestically owned deposit money banks are the mostly affected banks from the monetary policy surprises. Considering the balance sheet structure of banks, asset size and the ratio of “equity capital/total assets” are not highly correlated with the degree of heterogeneity (with around 20% correlations in magnitude). However, ratios related to interest payments and receipts are relatively highly correlated with the degree of heterogeneity. Specifically, the ratios of “net interest income/total assets”, “interest payments/interest receipts”, and “interest payments to money market instruments/total assets” have much higher correlations (in absolute value) with the degree of heterogeneity. Besides, these correlations increase in magnitude when we only include the banks which posit statistically significant heterogeneity. The three bank specific ratios mentioned above are plotted in Figs. 4, 5 and 6.

In Fig. 4, we plot “net interest income/total assets” ratio for the banks. All the banks that are affected significantly less from the MPC decisions earn high net interest income (shown in light color and in patterns), whereas all banks that are affected significantly more from the MPC surprises earn low net interest income (shown in dark color and in patterns).

Fig. 5 shows banks' “total interest payments/total interest receipts” ratio. All the banks that are affected significantly less from the MPC decisions borrow less than the sector average, whereas all banks except TSKB which are affected significantly more from the MPC surprises borrow heavily overall.

Table 4
Estimation results and diagnostic tests. New monetary policy episode (May 2010–January 2013).

	$\widehat{\alpha}_{ES}$	$\widehat{\alpha}_{GMM}$	$\widehat{\lambda}_{GMM}$	OIR test	GMM vs. ES	Number of obs.
BIST-100	−0.08 (1.26)	−0.10 (1.17)	0.050** (0.023)	0.81	0.00	34
BIST-BANK	−0.45 (1.69)	−0.71 (1.84)	0.052** (0.024)	1.00	0.12	34
AKBNK	1.27 (1.38)	1.08 (1.83)	0.034 (0.021)	1.18	0.03	34
ALNTF	−1.85 (1.72)	−1.77 (1.72)	0.041* (0.023)	0.37	0.38	34
DENIZ	1.38 (1.79)	−0.34 (3.21)	0.043** (0.022)	0.11	0.42	34
FNBNK	−0.15 (1.99)	1.44 (2.11)	0.047** (0.024)	0.19	4.96**	34
GARAN	1.54 (1.35)	1.00 (1.95)	0.032 (0.020)	1.39	0.15	34
ISCTR	1.28 (1.37)	1.84 (1.71)	0.034* (0.020)	0.33	0.29	34
KLNMA	0.33 (2.10)	3.05 (2.23)	0.046* (0.024)	1.25	13.66***	34
SKBNK	0.55 (1.41)	1.38 (1.37)	0.043* (0.024)	0.23	5.97**	34
TEBNK	0.95 (1.46)	−0.01 (1.72)	0.042* (0.024)	0.23	1.09	34
TEKST	2.20 (1.50)	3.24 (2.74)	0.044* (0.023)	0.00	1.43	34
TSKB	1.63 (1.60)	3.40 (2.42)	0.045** (0.023)	0.01	0.96	34
YKBNK	−0.39 (1.49)	−0.61 (1.64)	0.043* (0.024)	0.14	0.11	34
ALBRK	−0.47 (1.56)	−0.35 (1.60)	0.044* (0.024)	0.12	0.10	34
ASYAB	1.37 (1.59)	3.24 (2.03)	0.052** (0.024)	0.69	2.18	34
HALKB	1.77 (1.50)	2.95 (2.49)	0.039** (0.020)	0.06	0.36	34
VAKBN	0.15 (1.33)	0.04 (1.43)	0.042* (0.023)	0.66	0.04	34

Notes: The standard errors are in parentheses. ***, ** and *, indicate the significance levels at 1%, 5% and 10% levels respectively. GMM over-identification test has a $\chi^2(1)$ distribution. $F_{1,T-1}$ distribution is used for the Hausman-type biasedness test.

Table 5
Estimation results and diagnostic tests. For the deviations of individual bank returns from the BIST-Bank return. Traditional monetary policy episode (January 2005–April 2010).

	$\widehat{\alpha}_{ES}$	$\widehat{\alpha}_{GMM}$	$\widehat{\lambda}_{GMM}$	OIR test	GMM vs. ES	Number of obs.
AKBNK	0.233 (1.111)	−0.455 (0.800)	0.085*** (0.028)	1.033	0.795	65
ALNTF	−0.328 (1.175)	−0.502 (1.338)	0.086*** (0.028)	0.045	0.074	65
DENIZ	1.439 (1.137)	1.669** (0.804)	0.078*** (0.028)	4.459**	0.082	65
FNBNK	1.783 (1.367)	2.524** (1.085)	0.089*** (0.028)	0.278	0.795	65
GARAN	−0.736 (1.020)	−1.103 (0.922)	0.087*** (0.028)	0.415	0.707	65
ISCTR	−0.636 (0.908)	−1.375* (0.815)	0.087*** (0.028)	0.016	3.432*	65
KLNMA	1.583 (0.959)	1.559*** (0.567)	0.083*** (0.028)	0.687	0.001	65
SKBNK	−0.746 (1.200)	−1.331 (1.105)	0.074*** (0.027)	1.313	1.558	65
TEBNK	1.022 (1.109)	1.224 (0.963)	0.086*** (0.028)	0.247	0.136	65
TEKST	−3.017*** (1.145)	−4.060** (2.105)	0.086*** (0.028)	0.003	0.349	65
TSKB	−1.114 (1.164)	−1.762* (1.063)	0.088*** (0.028)	0.258	1.855	65
YKBNK	0.895 (0.953)	0.845 (1.124)	0.086*** (0.028)	0.012	0.007	65
ALBRK	2.142 (1.572)	1.972 (1.237)	0.051** (0.023)	0.546	0.031	33
ASYAB	1.507* (0.885)	1.220* (0.700)	0.102*** (0.035)	2.268	0.281	47
HALKB	−1.364 (1.811)	−4.328*** (1.346)	0.069*** (0.021)	2.691	5.980**	35
VAKBN	−0.299 (1.119)	−0.822 (1.099)	0.091*** (0.033)	1.251	5.962**	53

Notes: The standard errors are in parentheses. ***, ** and *, indicate the significance levels at 1%, 5% and 10% levels respectively. GMM over-identification test has a $\chi^2(1)$ distribution. $F_{1,T-1}$ distribution is used for the Hausman-type biasedness test.

Fig. 6 reports "interest paid to money market operations/total assets" ratio for the banks. All the banks that are affected significantly less from the MPC decisions borrow less than the sector average in the money market, whereas all banks except HALKB which are affected significantly more from the MPC surprises borrow more from the money market.

5. Conclusions

This study estimates the impact of monetary policy committee (MPC) announcements on banks' stock returns in Turkey using the heteroscedasticity-based GMM technique suggested by Rigobon and Sack (2004), which takes into account both the simultaneity and the

Table 6
Bank specific characteristics and heterogeneity in banks' responses to MPC decisions (traditional monetary policy episode).

	Ownership structure	Type of banking practice	Asset size	Equity capital/ total assets	Net interest income/ total assets	Interest payments/ interest receipts	Interest payments to money market/ total assets	Degree of heterogeneity
AKBNK	D	DM	16.43	−0.15	0.23	2.40	0.23	−0.46
ALBRK	D	P	1.04	−3.10	−0.10	0.77	−0.29	1.97
ALNTF	D	DM	0.59	−4.63	−0.09	−0.72	−0.05	−0.50
ASYAB	D	P	1.64	−0.62	0.42	−3.47	−0.29	1.22
DENIZ	F	DM	3.44	−3.17	0.34	−4.05	−0.08	1.67
FINBN	F	DM	4.79	−2.34	0.93	−5.32	−0.11	2.52
GARAN	D	DM	15.47	−3.28	−0.62	4.05	0.23	−1.10
HALKB	D	DM	9.85	−4.02	−0.16	14.47	−0.09	−4.33
ISCTR	D	DM	19.34	−0.74	−0.58	6.47	0.00	−1.38
KLNMA	D	ID	0.22	36.95	1.16	−32.62	−0.29	1.56
SKBNK	D	DM	1.40	−3.91	1.00	−4.83	0.03	−1.33
TEBNK	F	DM	2.45	−4.68	−0.04	3.42	0.15	1.22
TEKST	D	DM	0.56	−0.09	−0.55	5.23	0.17	−4.06
TSKB	D	ID	1.13	0.71	−0.52	−1.65	0.51	−1.76
VAKBN	D	DM	10.47	−4.33	−0.57	9.45	−0.10	−0.82
YKBNK	D	DM	11.17	−2.59	−0.87	6.39	0.00	0.85
Correl1	–	–	−0.22	0.21	0.45	−0.51	−0.46	–
Correl2	–	–	−0.24	0.30	0.81	−0.68	−0.51	–

Notes: D stands for domestic ownership and F stands for foreign ownership. DM stands for Deposit Money Banks (conventional banking activities), ID stands for Investment and Development Banks and P stands for Participation Banks. All balance sheet ratios are averages for the period 2005Q1-2010Q2. All balance sheet ratios are also deviations from the average of all banks; except the asset size, which represents the size of an individual bank in our sample of 16 banks. Correl1 stands for the correlation of the bank specific ratios with the parameters reflecting the heterogeneity in responses to MPC surprises. Correl2 also stands for the correlation of the bank specific ratios with the parameters reflecting the heterogeneity in responses to MPC surprises, only for the banks which shows statistically significant heterogeneity.

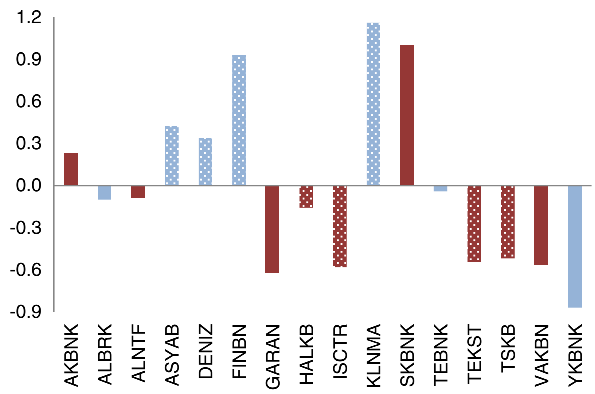

Fig. 4. Net interest income/total assets (%). (Difference from averages of all banks for 2005Q1–2010Q2.) Notes: The values for banks whose responses are more/less than the response of the BIST-Bank Index are marked in dark/light color. The values for banks whose responses differ significantly from BIST-Bank are marked with a pattern fill. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

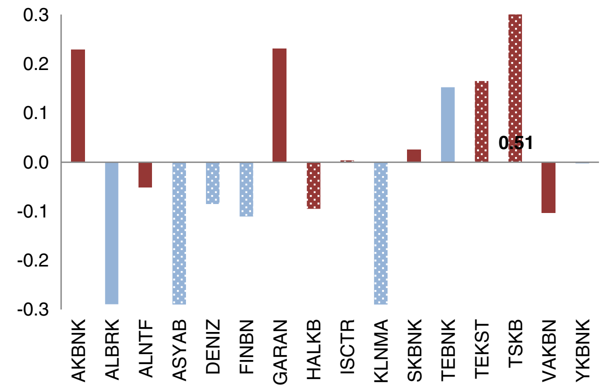

Fig. 6. Interest paid to money market operations/total assets (%). (Difference from averages of all banks for 2005Q1–2010Q2.) Notes: The values for banks whose responses are more/less than the response of the BIST-Bank Index are marked in dark/light color. The values for banks whose responses differ significantly from BIST-Bank are marked with a pattern fill. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

omitted variable problems. The empirical results show that, in the traditional policy episode of traditional inflation targeting, increases in the policy rate on MPC days lead to significant declines in stock returns of all individual banks. Comparing the results with the more widely applied event study method, we find that the event study gives biased results for most of the bank stock returns.

Turkey is one of the many countries in the world which adopted a new monetary policy approach after the global financial crisis. One interesting finding in this study is that since the Central Bank of the Republic of Turkey has started adopting a new monetary policy framework in May 2010, with various instruments and flexible timing, aggregate and individual bank indices have stopped giving significant responses to the surprises on MPC meeting days.

We also detect heterogeneity in the responses of bank indices to MPC surprises for the traditional monetary policy episode. Domestically owned deposit money banks are among the most affected. It is also shown that the bank specific ratios related to banks' interest payments and receipts are important determinants of the degree of heterogeneity. For examples, the stock returns of banks which are dependent on money market funding and for which interest payments constitute an important share in their balance sheets respond more aggressively to the changes in policy rates, whereas the stock returns of banks with higher net interest income respond less to the monetary policy.

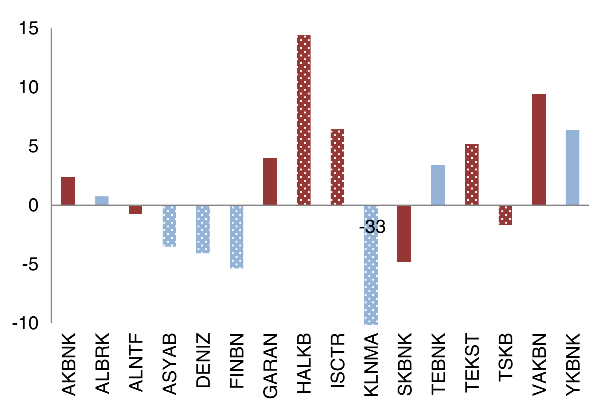

Fig. 5. Interest payments/interest receipts (%). (Difference from averages of all banks for 2005Q1–2010Q2.) Notes: The values for banks whose responses are more/less than the response of the BIST-Bank Index are marked in dark/light color. The values for banks whose responses differ significantly from BIST-Bank are marked with a pattern fill. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Appendix A. Details on methodology

This appendix makes a technical comparison between the event study (ES) and the generalized method of moments (GMM) approaches in estimating parameter α and then details the implementation through GMM.

A.1. Event study versus GMM approaches

The ES approach estimates only Eq. (2) with OLS. Therefore, the ES estimate of α is as follows:

$$\widehat{\alpha}_{ES} = \left(\Delta i_t{}' \Delta i_t\right)^{-1} \Delta i_t{}' \Delta s_t. \tag{3}$$

The mean of $\widehat{\alpha}_{ES}$ is:

$$E\left(\widehat{\alpha}_{ES}\right) = \alpha + (1-\alpha\beta)\frac{\beta\sigma_\eta + (\beta+\gamma)\sigma_z}{\sigma_\varepsilon + \beta^2\sigma_\eta + (\beta+\gamma)^2\sigma_z} \tag{4}$$

where $E(.)$ is the expectation operator and σ_η, σ_z and $\sigma\varepsilon$ represent the variances of shocks η_t (the asset price shock), z_t (the common shock) and ε_t (the monetary policy shock), respectively. According to Eq. (4), estimating Eq. (2) with OLS may suffer from both the presence of simultaneity bias (if $\beta \neq 0$ and $\sigma_\eta > 0$) and omitted variable bias (if $\gamma \neq 0$ and $\sigma_z > 0$). To overcome these problems, researchers applying the ES approach use the asset price changes directly after the announcement of the monetary policy committee (MPC) decision. In that case, the assumptions required by the ES approach is that in the limit, the variance of the policy shock becomes infinitely large relative to the variance of other shocks, that is $\sigma_\varepsilon/\sigma\eta \rightarrow \infty$ and $\sigma_\varepsilon/\sigma\eta \rightarrow \infty$ on policy dates. That is, it is assumed that within the policy day, the effects of the asset price shock and the common shock (simultaneity and omitted variable problems) on the monetary policy decision are negligible.

The heteroscedasticity-based identification technique suggested by RS does not require such a strong assumption. In this approach, we only need to observe a rise in the variance of the policy shock when the MPC decision is announced, while the variances of other shocks remain constant, given that the parameters α, β and γ are stable. Since the GMM technique requires weaker assumptions, it can give more reliable estimates than the ES approach.

Two subsamples, denoted by *P* and *N* are essential to implement the GMM technique. *P* stands for the policy dates (days when the MPC decisions are announced) and *N* stands for the non-policy dates (days immediately preceding the policy days). There are two assumptions for the heteroscedasticity-based identification method and they are as follows:

(i) The parameters of the model, α, β and γ are stable across the two subsamples.
(ii) The policy shock is heteroscedastic and the other shocks are homoscedastic, which are represented by the following equations:

$$\sigma_\varepsilon{}^P > \sigma_\varepsilon{}^N \tag{5}$$

$$\sigma_z{}^P = \sigma_z{}^N \tag{6}$$

$$\sigma_\eta{}^P = \sigma_\eta{}^N. \tag{7}$$

Under the assumptions (i) and (ii), a detailed analysis of the heteroscedasticity-based identification approach is presented below.

Reduced form equations for (1) and (2) are as follows:

$$\Delta i_t = \frac{1}{1-\alpha\beta}\left[(\beta+\gamma)z_t + \beta\eta_t + \varepsilon_t\right] \tag{1$'$}$$

$$\Delta s_t = \frac{1}{1-\alpha\beta}\left[(1+\alpha\beta)z_t + \eta_t + \alpha\varepsilon_t\right]. \tag{2$'$}$$

The covariance matrices of the variables in each subsample are the following:

$$\Omega_P = \frac{1}{(1-\alpha\beta)^2}\begin{bmatrix} \sigma_\varepsilon{}^P + (\beta+\gamma)^2\sigma_z{}^P + \beta^2\sigma_\eta{}^P & \alpha\sigma_\varepsilon{}^P + (\beta+\gamma)(1+\alpha\gamma)\sigma_z{}^P + \beta\sigma_\eta{}^P \\ & \alpha^2\sigma_\varepsilon{}^P + (1+\alpha\gamma)^2\sigma_z{}^P + \sigma_\eta{}^P \end{bmatrix}.$$

$$\Omega_N = \frac{1}{(1-\alpha\beta)^2}\begin{bmatrix} \sigma_\varepsilon{}^N + (\beta+\gamma)^2\sigma_z{}^N + \beta^2\sigma_\eta{}^N & \alpha\sigma_\varepsilon{}^N + (\beta+\gamma)(1+\alpha\gamma)\sigma_z{}^N + \beta\sigma_\eta{}^N \\ & \alpha^2\sigma_\varepsilon{}^N + (1+\alpha\gamma)^2\sigma_z{}^N + \sigma_\eta{}^N \end{bmatrix}.$$

The heteroscedasticity-based GMM technique uses a comparison of the covariance matrices on the policy and the non-policy dates.[11] Under the assumptions (i) and (ii) of the model, the difference in the covariance matrices Ω_P and Ω_N is as follows:

$$\Delta\Omega = \Omega_P - \Omega_N = \frac{\left(\sigma_\varepsilon{}^P - \sigma_\varepsilon{}^N\right)}{(1-\alpha\beta)^2}\begin{bmatrix} 1 & \alpha \\ \alpha & \alpha^2 \end{bmatrix}. \tag{8}$$

Denoting $\lambda = \frac{(\sigma_\varepsilon{}^P - \sigma_\varepsilon{}^N)}{(1-\alpha\beta)^2}$, Eq. (8) becomes the following:

$$\Delta\Omega = \lambda\begin{bmatrix} 1 & \alpha \\ \alpha & \alpha^2 \end{bmatrix}. \tag{8$'$}$$

Thus, the impact of policy changes on the asset prices, namely the parameter α, can be identified from the change in the covariance matrix $\Delta\Omega$.

There are two parameters to be estimated, namely; α, the response to monetary policy surprise, and λ, a measure of the degree of heteroscedasticity that is present in the data. In RS, these coefficients are estimated in two different ways: by GMM estimation and IV regression. However, as shown in RS, IV estimation makes use of only two equations in Eq. (8′) at a time, resulting in multiple estimates of α. On the other hand, GMM utilizes all three orthogonality conditions in Eq. (8′). That is, there is an improvement in efficiency from incorporating the additional moment conditions into the estimation in the GMM approach compared to the IV approach. Thus, in this paper, GMM estimation will be used to obtain an estimate of the asset price response to the monetary policy changes. Besides, in the GMM approach, the overidentification restrictions enable us to test the model as a whole.[12]

A.2. Implementation through GMM

As we have stated above, there are two parameters to be estimated, α, the response to monetary policy surprise, and $\lambda = \frac{(\sigma_\varepsilon{}^P - \sigma_\varepsilon{}^N)}{(1-\alpha\beta)^2}$, a measure of the degree of heteroscedasticity that is present in the data. The second coefficient can be used to test whether the change in the volatility is enough to identify parameter α. Hence, in order to estimate α with this approach, we need λ to be statistically significant.

Under assumptions (i) and (ii) of the heteroscedasticity-based identification, the sample estimate of the difference in the covariance matrix is:

$$\Delta\widehat{\Omega} = \widehat{\Omega}_P - \widehat{\Omega}_N \tag{9}$$

where

$$\widehat{\Omega}_j = \frac{1}{T_j}\sum_{t\in T}\delta_t{}^j[\Delta i_t \quad \Delta s_t]'[\Delta i_t \quad \Delta s_t] \text{ for } j = P, N$$

and δ_t^j are dummy variables taking on the value 1 for the days in each subsample and $T^j = \sum_{t\in(1,T)}\delta_t^j$ are sample sizes of the subsamples, for $j = P, N$. The assumptions imply that the following moment conditions hold:

$$E[b_t] = 0$$
where
$$b_t = vech\left(\Delta\widehat{\Omega} - \Delta\Omega\right), \text{ or}$$
$$b_t = vech\left(\left(\frac{T}{T^P}\delta_t{}^P - \frac{T}{T^N}\delta_t{}^N\right)[\Delta i_t \quad \Delta s_t]'[\Delta i_t \quad \Delta s_t] - \lambda[1 \quad \alpha]'[1 \quad \alpha]\right).$$

The GMM estimator is based on the condition that $\lim_{T\to\infty}\frac{1}{T}\sum t\in(1,T)b_t = 0$.

The intuition behind GMM is to choose an estimator for $\Delta\Omega$, $\Delta\widehat{\Omega}$, that sets the three sample moments as close to zero as possible. Since there are more moment conditions than unknowns, Eq. (8′) is overidentified and it may not be possible to find an estimator setting all three moment conditions to exactly zero. In this case we take a 3×3 weighting matrix W_3 and use it to construct a quadratic form in the moment conditions. The estimates of α and λ will be obtained by minimizing the following loss function:

$$\left[\widehat{\alpha}_{GMM}, \widehat{\lambda}\right] = \arg\min\left[\sum_{t\in[1,T]} b_t\right]' W_3 \left[\sum_{t\in[1,T]} b_t\right]. \tag{10}$$

Practically, GMM estimation proceeds in two steps. Initially GMM estimation with an identity-weighting matrix, i.e. taking $W_3 = I_3$, is conducted to obtain a consistent estimator of coefficients. In the second step, W_3 is formed based on obtained residuals. Accordingly, W_3 the optimal weighting matrix equal to the inverse of the estimated covariance matrix of the moment conditions is obtained. The efficient GMM estimator is obtained based on Eq. (10).

[11] For details of the heteroscedasticity-based identification methods, see Rigobon (2003) Page: 18.

[12] Notice that, in Eq. (8′) there are three moment conditions and two parameters to estimate. Therefore, in GMM, overidentification restrictions enable us to test the model as a whole.

References

Bohl, M.T., Siklos, P.L., Sondermann, D., 2008. European stock markets and the ECB's monetary policy surprises. International Finance 11 (2), 117–130.

CBRT, 2013. Monetary and Exchange Rate Policy for 2013. web address: http://www.tcmb.gov.tr/yeni/announce/2013/monetary_2013.php.

Duran, M., Özlü, P., Ünalmış, D., 2010. TCMB faiz kararlarının hisse senedi piyasaları üzerine etkisi. Central Bank Review 10 (2), 23–32.

Duran, M., Özcan, G., Özlü, P., Ünalmış, D., 2012. Measuring the impact of monetary policy on asset prices in Turkey. Economics Letters 114, 29–31.

Ehrmann, M., Fratzscher, M., Rigobon, R., 2011. Stocks, bonds, money markets and exchange rates: measuring international financial transmission. Journal of Applied Econometrics 26, 948–974.

Goncalves, C.E.S., Guimaraes, B., 2011. Monetary policy, default risk and the exchange rate. Revista Brasileira de Economia 65 (1), 33–45.

Gürkaynak, R., Sack, B., Swanson, E., 2005. Do actions speak louder than words? International Journal of Central Banking 1 (1), 55–93.

Kholodilin, K., Montagnoli, A., Napolitano, O., Siliverstovs, B., 2009. Assessing the impact of the ECB's monetary policy on the stock markets: a sectoral view. Economics Letters 105, 211–213.

Kuttner, K., 2001. Monetary policy surprises and interest rates: evidence from the Fed funds futures market. Journal of Monetary Economics 47 (3), 523–544.

Kwan, S.H., 1991. Re-examination of interest rate sensitivity of commercial bank stock returns using a random coefficient model. Journal of Financial Services Research 5, 61–76.

Rezessy, A., 2005. Estimating the immediate impact of monetary policy shocks on the exchange rate and other asset prices in Hungary. MNB Occasional Papers, 2005/38.

Rigobon, R., 2003. Identification through heteroskedasticity. The Review of Economics and Statistics 85 (4), 777–792.

Rigobon, R., Sack, B., 2004. The impact of monetary policy on asset prices. Journal of Monetary Economics 51, 1553–1575.

Rosa, C., 2011. The validity of the event-study approach: evidence from the impact of the Fed's monetary policy on US and foreign asset prices. Economica 78 (311), 429–439.

Thorbecke, W., 1997. On stock market returns and monetary policy. Journal of Finance 2, 635–654.

Wickens, M.R., 2008. Macroeconomic Theory: A Dynamic General Equilibrium Approach. Princeton University Press.