MONETARY POLICY COMMUNICATIONS AND INFLATION EXPECTATIONS

by

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Abstract

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Inflation expectations consistent with a Central Bank target serve as a prerequisite for achieving stable inflation. In this thesis I study the properties of private-sector expectations in Ukraine and a coordinating role of CB communications for those expectations. While the experts' forecast is the most accurate, their expectations do not seem to fully account for some of the macroeconomic indicators. All surveyed groups have biased expectations; however, bias decreases after the implementation of inflation targeting. CB communication in the form of press-briefings reduces the disagreement in individual forecasts of financial experts.

TABLE OF CONTENTS

LIST OF FIGURES

Number *Page*

LIST OF TABLES

Number *Page*

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GLOSSARY

BOJ – Bank of Japan

CB – Central Bank

CPI – Consumer Price Index

ECB – European Central Bank

ER – Exchange rate

FOMC – Federal Open Market Committee

IT – Inflation targeting

MPC – Monetary Policy Committee

NBU – National Bank of Ukraine

SSSU – State Statistic Service of Ukraine

Chapter 1

INTRODUCTION

For Central Banks (CB) information transmission is an essential issue in the context of achieving price stability. Until the 1990s, monetary policy decisions aimed to surprise the markets, while today they are communicated far ahead.[1] A success of monetary policy in achieving stability depends on a knowledgeable public, which is aware of the monetary policy strategy (Weidmann 2018).

Independence obliges CB to be accountable to the public, and communication ensures its transparency. CB communicates to explain its monetary policy and build public confidence in its commitment and ability to ensure price stability. Also, communication serves as a monetary policy instrument that guides expectations.

Inflation expectations of the public play the role of a nominal anchor and directly affect their economic choices. They influence wage negotiations, demand for durable goods, price setting, investments, and savings. Decisions regarding savings and investments depend on long term interest rates, which are not directly affected by monetary policy. Therefore, for a regulator to conduct an effective monetary policy, it is crucial to anchor agents' expectations.

Announcing an inflation target helps to anchor economic agents' inflation expectations. This lowers unnecessary volatility in the markets, which otherwise could spread to the real economy. Inflation expectations aligned with a CB target

[1] Before 1994, the FOMC did not disclose information on key interest rate. Now, voting results are revealed as well as individual projections for growth, unemployment, inflation and interest rates, and a press conference is held quarterly. The ECB does not provide the minutes of meetings, to prevent the decisions from becoming politicized.

stabilize aggregate demand and therefore serve as a prerequisite for achieving stable inflation - the ultimate goal in the inflation-targeting (IT) framework.

Apart from announcing their goals and strategies, CB communication takes the form of speeches, interviews, regular publications of reports, and press conferences. The use of various channels provides the opportunity to describe monetary policy decisions up-to-date and precludes from excessive attention to a specific means of communication (Weidmann 2018). CBs provide forward guidance by communicating their viewpoint on the future direction of the monetary policy, including the future path of key interest rates conditional on the economic setting. This puts additional pressure on the long-term interest rates and allows agents to predict further steps of the CB, adjust expectations, and improve the decision-making process (Svensson 2014).

The number of questions arises: how those expectations are formed, whether they are anchored and if yes, is their level consistent with the CB target? In order to assess the inflation expectations and efficiency in communication, CBs around the world employ surveys of different economic groups (Table). Among respondents are usually households (consumers), professional forecasters (experts, financial analysts), firms (from all sectors, only financial corporations, banks, non-financial corporations). The results of surveys might affect the choice of particular policy actions and optimal response to chocks.

The objective of my thesis is to investigate the properties of private-sector expectations in Ukraine. The National Bank of Ukraine adopted IT in 2015, and inflation gradually decreased from over 40 percent in 2015 to 4.1 in 2019. However, surveys of inflation expectations of households, firms, banks, and professional forecasters (financial analysts, experts) had been launched before. I estimate the accuracy and forecasting performance of those four groups. The research question

is whether those expectations are biased, that is if they consistently overshoot or undershoot future realized inflation, and if all available information is used efficiently in the process of their formation. The question I am also addressing is whether CB communications play a coordinating role for those expectations. To answer this, I use disaggregated data from the survey of financial experts in Ukraine.

First, I compare the accuracy of the aggregated series of inflation forecasts of all four groups using different measures. As expected, financial analysts are the most accurate in predicting future price development, while business slightly outperforms banks forecast in the period after March 2016. However, this conclusion would not be derived from all available timespan, as in the 2014-2015 Ukrainian economy was hit by external shocks.

Then, I run a formal test for unbiasedness of expectations and conclude that expectations of all surveyed groups are biased, as on average they are not equal to future realized inflation. However, after IT implementation realized inflation has higher predictive power for expectations, although the coefficient is still not equal to unity, so that forecast error in every period is not random.

The advantage of studying financial analysts' survey results is the assurance that respondents understand the question correctly and that they report expectations they actually have in their minds. Therefore, I use the forecast of financial analysts to estimate whether all available information has been used effectively. As the exchange rate has statistical power in predicting the forecast error, expectations do not fully account for this macroeconomic indicator.

One of the insights I got from disaggregated data is that answers vary in their precision of reported values. Thus, I split forecasts in every period into two groups,

with and without decimal points. I find that forecasts of the group with higher precision, outperform those with rounded values.

Finally, I estimate whether CB communication affects the disagreement of financial experts. According to my results, dispersion in individual forecasts decreases after press-briefings regarding monetary policy decisions. This suggests that CB signal has a coordinating role for agents.

The paper is organized as follows. In Chapter 2, I review the literature on factors that influence inflation expectations of different economic groups, and the role of CB communication in private-sector expectation formation. In Chapter 3, I present my methodology. In Chapter 4, the data and its limitations are discussed. Chapter 5 discuss the results and Chapter 6 concludes.

Chapter 2

LITERATURE REVIEW

2. 1 Factor influencing expectations of economic agents

In the literature, expectations of households are well-studies on the disaggregated level. According to Bruin et al. (2011), when households report their expectations about aggregate variables, they consider the prices of specific goods. Two studies conducted by researchers reveal that inflation expectations of those respondents who thought of definite prices were more biased, as items associated with more extreme prices are more likely to be remembered. Therefore, individuals tend to over-extrapolate from rare instances.

Researchers in this field emphasize the role of personal experiences in forming expectations about future inflation by consumers. For example, Malmendier and Nagel (2016) use 57 years of Michigan Survey of Consumers and find a substantial variation in the reaction of different cohorts of respondents to the same inflationary shocks. Individuals adapt forecasts to new data but overweight their lifetime inflation experiences, represented by the mean inflation rate and the persistence of inflation shocks.

A similar conclusion is made by D'Acunto et al. (2019), who collect data for a representative US sample. Researchers show that consumers' inflation expectations are influenced by household-specific grocery-price changes, especially of the goods that are frequently purchased or exhibit extreme changes in price. Authors find that frequency and size of price changes are more critical than the expenditure share.

According to D'Acunto et al. (2020), differences in inflation expectations between men and women can be explained by traditional gender roles, among which is a participation in grocery shopping. Authors employ data on the contributions of individuals to household grocery chores, exposure to prices, and expectations regarding future inflation rates. Reducing the gap in expectations would improve women's economic choices.

In Ukraine, evidence suggests that citizens closely link inflation to national currency devaluation. Gorodnichenko and Coibion (2015) found a strong correlation between households' expectations of the exchange rate and inflation over time. Households and firms disagree much more about inflation than professional forecasters, and disagreement rises with inflation.

2. 2 Role of CB in expectations formation

CB communication takes various forms: from speeches and interviews to reports, press releases, policy announcements, and publications of macroeconomic projections. Communication makes the decision-making process more transparent and also aims at anchoring private-sector expectations with the CB target.

If the CB states the future path of its instrument (for example, key policy rate), this is considered to be forward guidance. Campbell et al. (2012) defined two types of forward guidance: "Odyssean", which follows its announcement under any circumstances; and "Delphic", based on the assessment of the overall outlook for inflation so that deviations from its announced path are justifiable under certain conditions. The authors estimated how asset prices respond to forward guidance by FOMC and concluded that communication was successful as the private sector adjusts its forecast.

Committees make most policy decisions. Therefore, even if CB reveals that it does not want to undertake a certain step in its forward guidance, nothing prevents it from not doing so. With this taken into account, forward guidance could be considered as a cheap talk if credibility is not a priority for a monetary authority. King et al. (2008) study a situation when decision-makers could be of two types unobservable by private agents – either fully committed to its announcements (strong) or able to depart from the plan pursuing its interest (weak). Strong CB pursues low inflation in the long run but is also concerned about real activity. Because its agenda is not perfectly credible, it sizes the effect of policy movements on private-sector beliefs about actions that would be taken by a weak CB. Researchers find that in a static case with imperfect information, rational expectations approach and a signaling game produce the same result for both types of banks (separately). Authors also derived optimal expectations management for a case when dynamic is allowed, that is CB credibility changes because of announcements and undertaken actions.

Moscarini (2007) considers a precision of CB private signal as a measure of its competence that makes discretionary monetary policy credible and transparent. Motives for the policy action are explained by credible communication, so transparency is derived from the equilibrium message space represents. Credibility and ability to forecast CB actions move in the same direction with competence, while in opposite with an inflation bias. Thus, even if CB has some discretion, the public expects that it will be used to adjust policy for the circumstance to achieve a target and not stimulate output by surprising expectations.

Svenson (2014) compares the published interest-rate path with market expectations of future interest rates in Sweden, New Zealand, and the U.S. The author analyzes predictability and credibility of monetary policy, which is the extent to which the market expectations line up with the interest-rate path before and after CB

publication. A high disagreement of markets' anticipations and policy-rate path published by Riksbank arises from "leaning against the wind" when high policy rate had more weight than achieving inflation at long-run sustainable path - objective in New Zealand and the U.S.

Some authors consider forward guidance as the provision of not available before information to the private sector. In Angeletos and Lian (2018) private agents do not know strategic interaction in the environment, and this uncertainty harms their ability to forecast. Therefore, forward guidance is used for coordination, and for longer horizons, it is preferable that CB communicates the intended path for inflation and not a policy instrument. Basetto (2019) considers the environment in which agents are fully rational, so the CB communicates only about its own preferences and beliefs. The author considers cases with and without private information. In the first situation, communication increases the well-being of agents - because they get to know the preferences of policymakers, authority is able to provide some useful information supported by the credibility of the institution. In the latter case, equilibrium does not depend on CB announcements, so forward guidance as a commitment is unnecessary.

Introducing heterogeneity in agents brings more flexibility in the setup. Andrade et al. (2018) analyzed differences between professional forecasters and households in the perception of future monetary policy when the Fed introduced forward guidance. The authors assume that agents are not able to identify whether a specific announcement is a signal of a bad economic situation or of a more favorable regulator's policy, and thus divided agents into "pessimists" and "optimists". Researchers defined possible options of credibly signaling the type of CB policy by changing interest rates.

Lyziak and Paloviita (2017) find that Professional Forecasters who participate in European Survey are predominantly backward-looking, and their share is higher before 2008. According to results, experts do not considerably change their forecasts after ECB inflation projection, especially in the medium-term and in the pre-crisis period. The inflation expectations depend more on implicit targets than current rates, and the decrease of this implicit target below the official indicates de-anchoring of expectations.

For CB that pursues inflation targeting, the question of particular interest is how its adoption influences agents' expectations. Ukraine has IT in 2015, while the Bank of Japan - two years earlier. However, the BOJ started to publish economic forecasts much earlier — in 2000[2]. Moreover, while in other countries IT was mostly aiming at fighting with high inflation, inflation in Japan was below the new target. According to Hattori et al. (2016), the impact of the BOJ forecasts on the private sector is not because of higher accuracy but rather due to complementary of information, such as future actions of the CB. After controlling for other factors, the private sector forecasters still take into account BOJ forecasts, especially with the start of the IT regime. The influence is diminishing for current-year forecasts while increasing for next year's forecasts.

Some CB survey assess perceived credibility that the CB would meet its target. Pedersen (2015), using data from the Chilean Economic Expectations Survey, finds that CB's inflation forecasts influence those of the private sector. Forecasts for the next year are affected by changes in current year inflation projections, and more attention to the CB's short-term inflation forecast is devoted when it is lower than

[2] https://www.boj.or.jp/en/mopo/outlook/gor0010.htm/- Outlook and Risk Assessment of the Economy and Prices; October 31, 2000; Bank of Japan

those of the private sector. Interestingly, the assessment of the CB credibility does not have explanatory power for inflation expectations.

Kotlowski (2015) finds that the release of CPI projection by the Narodowy Bank Polski in 2006-2013 has affected neither disagreement nor the level of forecasts by professionals. However, disclosing GDP forecasts by NBP does reduce the cross-sectional dispersion in expectations. Therefore, CB plays a coordinating role by providing to the public its projection of future GDP growth. This result suggests that inflation forecasts are anchored to the numerical inflation target, while for GDP there is more uncertainty.

Chapter 3

METHODOLOGY

3. 1 Forecast accuracy and use of available information when forming expectations

From here I refer to the error of the forecast as a difference between expected and realized inflation in 12 months, so that if the forecast overshoots rise in prices, the error will be positive: $e_t = \pi_t^e - \pi_{t+12}$. The bias is an average error in the forecast: $bias = \frac{1}{N}\sum e_t$. Therefore, even not precise forecasts can achieve a low bias if positive errors offset negative. This issue is solved with other measures.

To assess whether the forecast is unbiased, I am following Friedman (1980)[3]. By definition, expectations of a particular variable are rational if they are identical to the mathematical expectation of this variable. Therefore, unbiased expectations are of the form: $\pi_{t+12} = \pi_t^e + u_t$, where u_t - disturbance term with zero-mean and finite-variance. Disturbances may be serially correlated according to an but are uncorrelated with π_t^e. To test for unbiasedness of expectations, I regress expectations on the actual realized inflation, where ϵ_t is a white-noise error:

$$\pi_t^e = \alpha_0 + \alpha_1 \pi_{t+12} + \epsilon_t \qquad (1)$$

If there is no bias, slope coefficient is equal to one and intercept – zero. The null hypothesis of unbiasedness $H_0: \alpha_0 = 0, \alpha_1 = 1$ is tested using F-statistics.

[3] This test is still widely used in recent works, for example Lyziak (2015).

Other measures of forecast accuracy that I use are MAE, MAPE, and RMSE. The Mean Absolute Error is the mean of the absolute error $MAE = \frac{1}{N}\sum |e_t|$. In order to scale this measure to the average level of inflation, it can be divided by the average rate: $MAE\ (\%) = \frac{\sum |e_t|}{\sum d_t}$. Low MAE is achieved by the median, which splits dataset equally: forecast is as many times higher than the realized as it is lower, being robust to outliers.

The Mean Absolute Percentage Error is the average of the percentage errors, calculated as a sum of the absolute errors individually divided by the realized value for each period: $MAPE = \frac{1}{N}\sum \frac{|e_t|}{\pi_{t+12}}$. High errors for low realized levels of inflation have a higher weight. Thus MAPE is not symmetric ($MAPE(\pi_t^e, \pi_{t+12}) \neq (MAPE(\pi_{t+12}, \pi_t^e))$.

The Root Mean Squared Error is defined as the square root of the average squared error: $RMSE = \sqrt{\frac{1}{N}\sum {e_t}^2}$. Low RMSE signals that prediction is correct on average, so it is unbiased but sensitive to outliers.

Expectations incorporate all available information efficiently if their errors are not predicted by other factors (Friedman 1980). To test whether all freely available information has been used when forming expectations, I estimate the following equation, where Z_t - a macroeconomic indicator available at the time of reporting forecast, and lagged term is included to account for autocorrelation in forecast errors:

$$e_t = \alpha_0 + \alpha_1 Z_t + \alpha_2 e_{t-1} + \epsilon_t \qquad (2)$$

Because various macroeconomic variables are strongly correlated, and due to a limited number of observations, this equation is estimated separately for every index. Among others, such approach is adopted in Lyziak (2015). If the coefficient on a macroeconomic index is statistically significant, this means that information on it would enhance forecast, but agents did not pay enough attention to it.

3. 2 Uncertainty and Central bank communication

To examine whether the information provided by CB influence disagreement in financial analysts' inflation expectations, I follow Kotlowski (2015). As a measure of dispersion, I use the standard deviation of individual forecasts in the particular month. Higher dispersion indicates more disagreement and higher uncertainty regarding future outcomes. To test the impact of the CB projection release on the disagreement between individual forecasts of professional forecasters, I use a binary variable which equals to one in months with press-briefings regarding monetary policy decision.

According to Capistran and Timmermann (2009) the dispersion across forecasters depends on the conditional variance of inflation. Therefore, I control for inflation volatility, which is calculated using GARCH(1,1) model of conditional variance:

$$\sigma_t^2 = \alpha_1 \sigma_{t-1}^2 + \alpha_2 e^2{}_{t-1} + \epsilon_t \qquad (3)$$

Also, I control for other factors[4] that affect the dispersion in expectations, such as:

[4] Mankiw et al. (2004), Gorodnichenko and Coibion (2015)

- Inflation level
- Exchange rate volatility
- A phase of the business cycle

The volatility of the exchange rate is calculated as the standard deviation of nominal exchange rate fluctuations.

Thus, the dispersion of inflation forecasts is modeled in the following way:

$$\text{St. d}_t = \alpha_0 + \alpha_1 \text{St. d}_{t-1} + \alpha_2 \text{St. d}_{t-2} + \alpha_3 \text{brief} + \sum_i \alpha_i contr_{it} + \epsilon_t \quad (4)$$

where two lags are added to account for the autocorrelation in dispersion, *brief* is a binary variable which equals one in the months when CB communication regarding inflation outlook takes place, and *contr* are macroeconomic indicators defined above.

Chapter 4

DATA OVERVIEW

4. 1 NBU inflation expectation surveys

For the first stage of the analysis, I use the aggregated series of firms, banks, households, and financial experts' inflation forecasts (Figure 1). The NBU carries out a quarterly survey of firm representatives regarding their business expectations since 2006. In the sample, there are about 700 non-financial sector enterprises of main economic activities selected by quota principle, proportional to the region's contribution and the contribution of activities to gross value added. Firm representatives are managers, employees responsible for economic analysis, and planning. They are surveyed in the second month of the quarter.

Since the 4th quarter of 2011, the NBU does a quarterly survey of bank representatives. Sample represents at least 90% of the assets of the banking system and consists of banks that are not insolvent, are not in the process of liquidation, and have not been assigned by the interim administration. The survey is conducted in the period between the last decade of the last month of the quarter and the first decade of the first month of the next quarter.

At the request of the NBU since July 2014, a sociological company GfK Ukraine carries out a monthly household survey. The sample consists of 1000 households, selected with quotas by region, age, gender, respondent's welfare.

Banks, firms, and households are asked about how they think the level of prices of consumer goods and services in Ukraine will change in the next 12 months. Respondents are provided with the current level of inflation, computed by the SSSU compared to the corresponding period of the previous year prices increased.

They choose answers from the listed intervals. According to Klaauw et al. (2008), because of differences in a way how inflation is referred to - "prices in general" or "rate of inflation" - answers reflect different concepts, such as gasoline or food prices versus prices that citizens pay in general. In the first case, both reported inflation and disagreement among respondents will be larger. The results are calculated as the sum of the proportion of respondents who chose the interval, multiplied by the average of the interval. As Easaw et al. (2013) showed for Italian data, the aggregate approach does not adequately capture how households update their inflation expectations. For example, most households overreact and rarely revise their expectations.

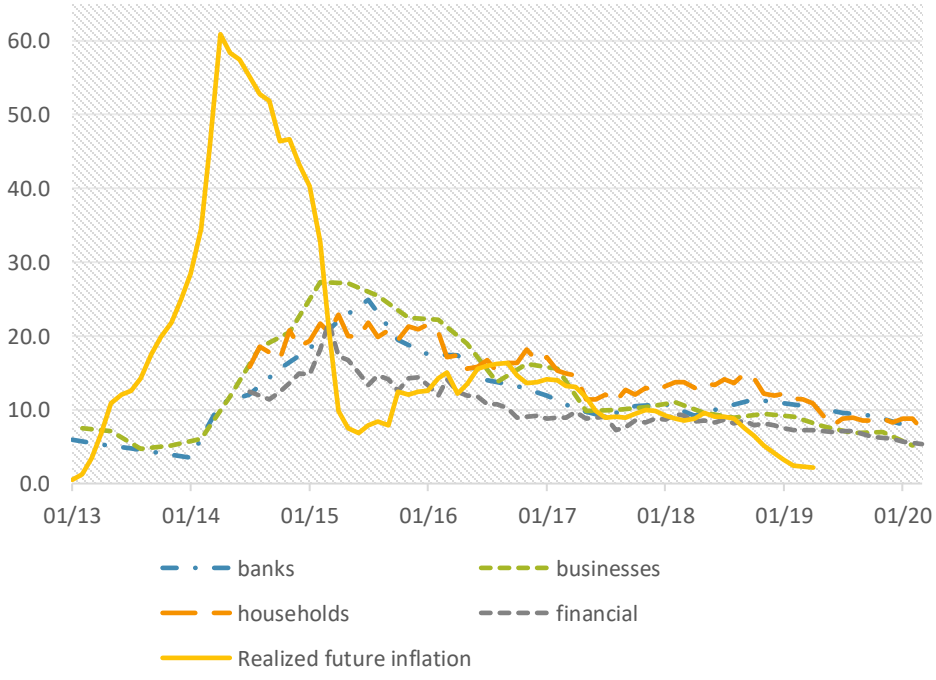

Figure 1. Inflation expectations of banks, business, households, and financial analysts in Ukraine and realized inflation in 12 months, %

The survey of financial experts is conducted by the NBU monthly, from July 2014 until September 2019, and after November 2019 - 6 times per year. Professional forecasters do not pick from defined intervals but provide point estimates, which decreases noise. If respondents also assign probabilities to several bins of possible inflation realizations, this would allow assessing the uncertainty that agents face and whether their expectations are anchored (Gorodnichenko and Coibion 2015). In this case, to large variations in inflation will be assigned low probabilities.

Figure 1 clearly documents a spike of CPI in 2014-2015. Ukrainian economy was hit by the military conflict in the Donbas region and Russia's illegal annexation of Crimea in 2014. Panic in the foreign exchange market in the first quarter of 2015 put additional upward pressure on inflation. To combat the catastrophic financial situation in the gas sector caused by subsidized gas prices[5] and corrupt schemes, an increase in tariffs for the population was adopted in April 2015. All those were external shocks that could not be anticipated. Therefore, I exclude a period before March 2016 from further analysis.

For the second stage of my analysis, I use disaggregated data on financial experts' inflation expectations. The number of participants varies from 5 to 11 in every round of the survey (Figure 12). Financial experts report how, in their opinion, will CPI in Ukraine change over different horizons: in current and next year, in 3 months, 12 months, two years, and three years. Expectations for longer horizons can be used to assess the credibility of CB. The current economic situation should have small predictive power for future inflation. Figure 2 displays three series of average forecasts and Table 1 reports their selected statistical properties.

[5] Subsidies for the population increased opportunity costs of energy saving-mechanisms.

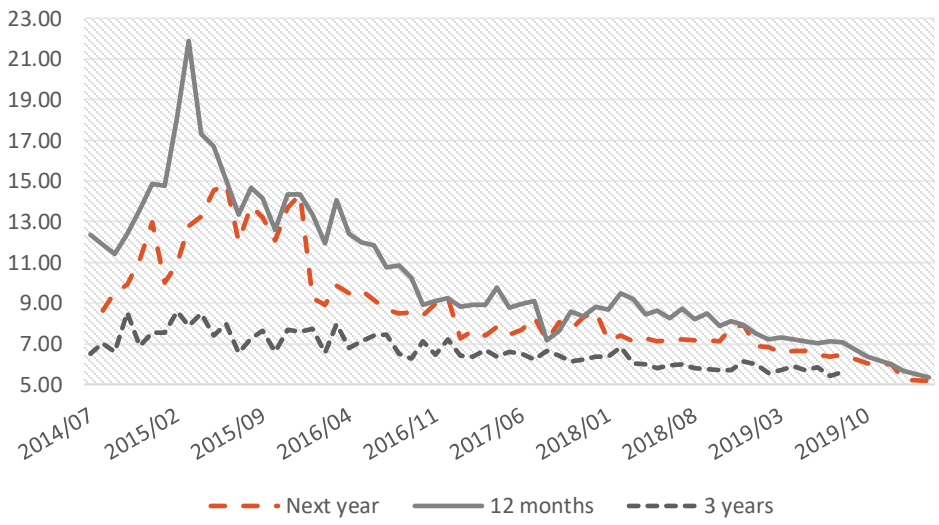

Figure 2. Average forecasts of financial analysts for different horizons: in the next year, in 12 months, in three years, %

Table 1. Selected statistics of inflation expectations of financial experts for different time horizons

Expectation horizon	*Average*	*Standard dev. (p.p.)*	*Coefficient of variation (%)*	*Sample*
current year	9.17	12.4	135%	August 2014-March 2020
next year	8.81	2.4	27%	August 2014-March 2020
12 months	10.38	3.3	32%	July 2014 – March 2020
2 months	5.23	0.1	3%	May 2015 – March 2020
3 years	6.67	0.8	12%	July 2014 – August 2019
3 months	2.52	1.3	51%	October 2019 - August 2019

From here, I refer to 12 months expectations of financial experts. Expectations are above realized inflation from March 2015 till January 2016. Correlation between the mean value of forecast for the whole period and current CPI is 0.795, while

between realized inflation 0.379. The NBU moved de facto to IT early in 2016, and for this subperiod corresponding coefficients are 0.565 and 0.683, respectively. The decrease is a magnitude of coefficients partly represents that economy went out of the crisis and that high inflation till March 2016 fed inflation expectations. However, it is also a sign of anchored expectations, as the forecast is less dependable on the current situation. The average difference between expected and realized inflation is -1.19 percentage point.

The standard deviation of individual responses captures disagreement among experts. It follows the dynamic of mean forecast and current inflation (Figures 3). Corresponding coefficients of correlations are 0.9 and 0.8, respectively. This is in line with Gorodnichenko and Coibion (2015), and Mankiw et al. (2004).

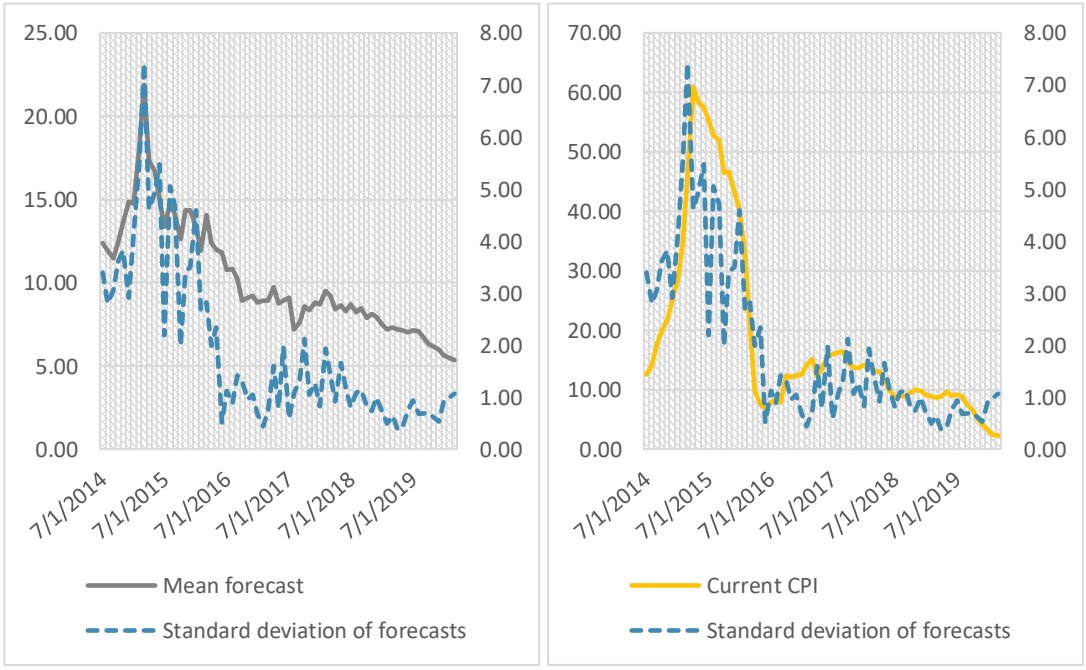

Figure 3. Current inflation level, standard deviation (right axis) and mean of expectations of financial analysts

Series of standard deviations in each round of financial analysts' survey is used for accessing role of CB communication. Figure 4 reports a series of standard deviation for different time horizons.

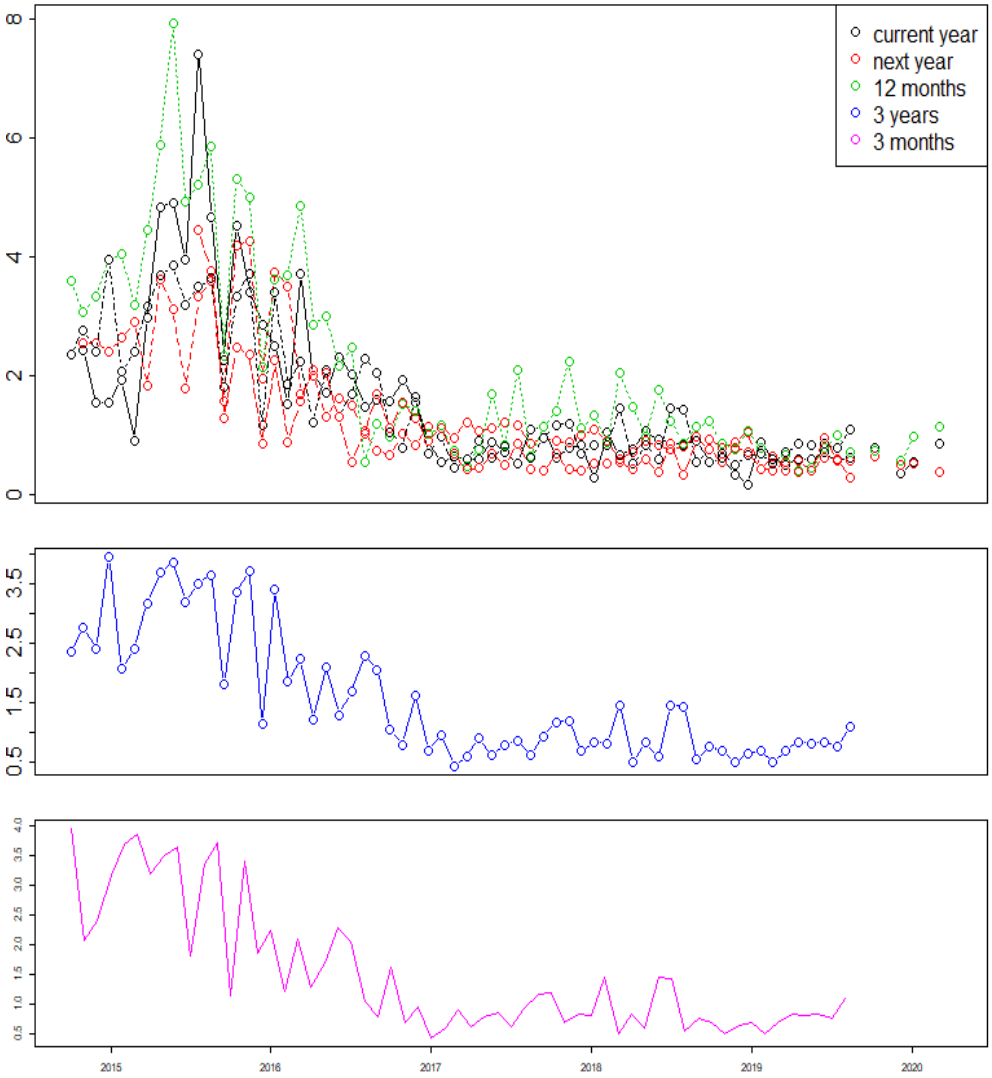

Figure 4. Standard deviation of expectations for different time horizons

Gorodnichenko and Coibion (2015) report a strong connection between inflation and exchange rate expectations for consumers, firms, and professional forecasters in Ukraine. Figure 5 displays financial analysts' expectations on inflation (right axis) and exchange rate (left axis). Despite the existence of the exchange rate pass-through effect, after the first quarter of 2015, there is no clear relationship between two series of expectations - the coefficient of correlation is -0.48. This can be explained by an understanding of market participants that the exchange rate does not provide a fully represent the state of the economy. In Ukraine, the exchange rate regime is floating, and foreign exchange interventions are only auxiliary instrument of the NBU, which is used to accumulate international reserves, smooth excessive exchange rate fluctuations, and support the transmission mechanism of the key policy rate.

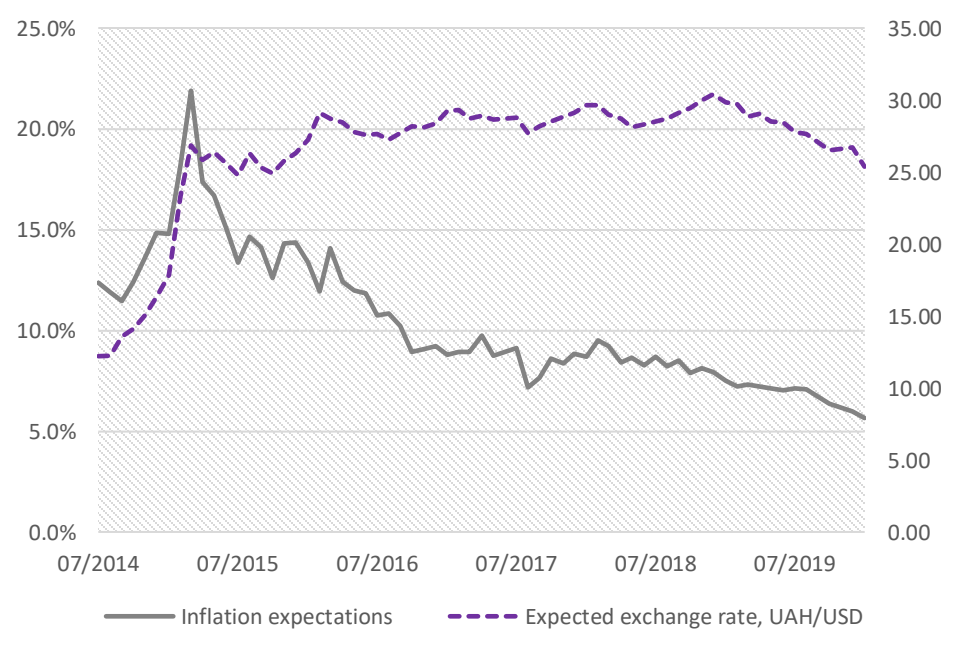

Figure 5. Inflation expectations, %, and exchange rate expectations, UAH/USD

4. 2 Macroeconomic indicators and NBU communications

To test whether all available information has been employed when forming forecasts, I use macroeconomic indicators that are mentioned in literature and are available for free to all market participants (Figures 6):

- Policy rate of the NBU
- Exchange rate UAH/USD
- Industrial output index calculated by the NBU
- CPI inflation

Industrial output index is a consolidated index of economic activity, which covers agriculture, mining, manufacturing, a supply of electricity and gas, construction, wholesale and retail trade, and transport (both freight and passenger). The index covers more than 50% of the economy's sectors used in the calculation of GDP by production method.

While the first two series are available in real-time, I need to make adjustments for the last two indicators. I assume that when reporting expectations, forecasters can access CPI in the previous month, but the industrial output index is available only with two months lag.

These indicators are also used as control variables when estimating CB communication's impact on a disagreement between individual forecasts.

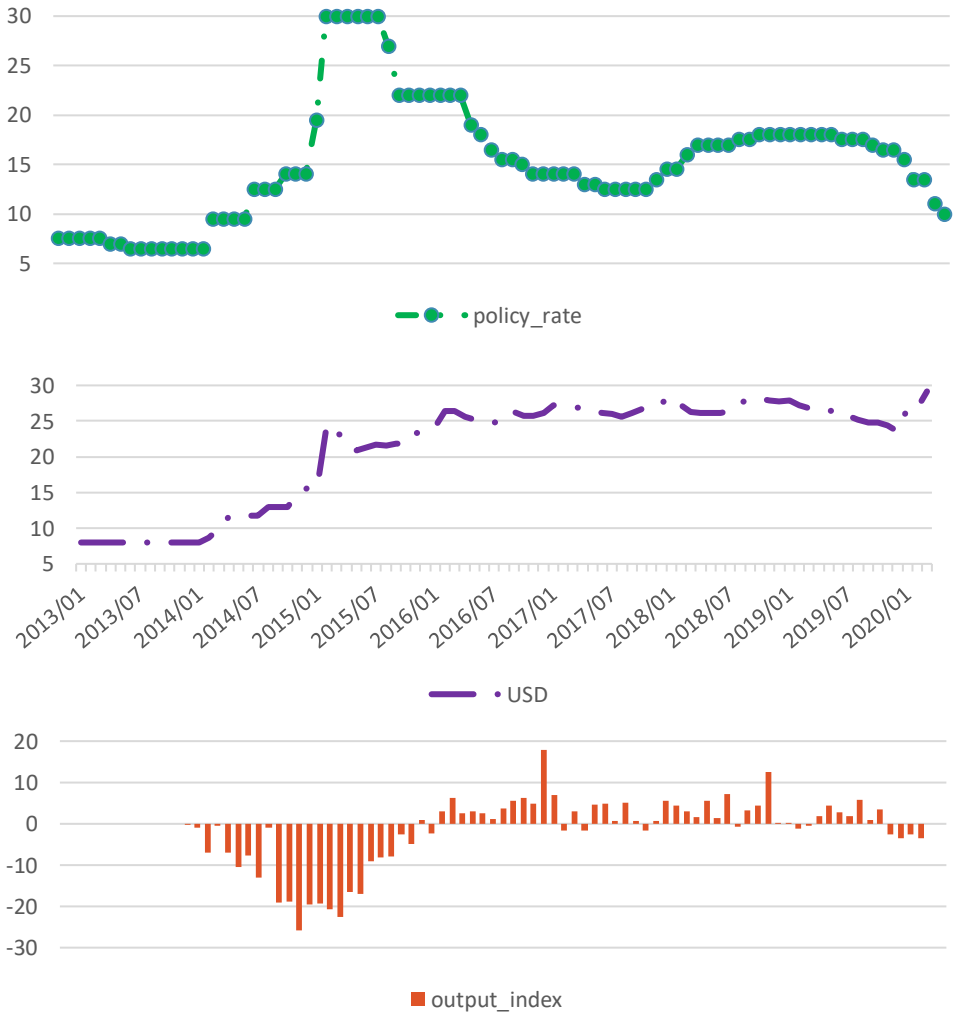

Figure 6. Macroeconomic indicators: policy rate, %; exchange rate, UAH/USD; industrial output index, %

I construct a dataset of events of the NBU communication regarding monetary policy and inflation outlook (Table 14). The Monetary Policy Committee (MPC) is an NBU advisory body that shares opinions on monetary policy implementation to achieve price stability. MPC reviews and approves the updated macroeconomic

outlook, which is then presented in the Inflation Report. One day after the MPC meeting, the NBU Board decide on key policy rate and other monetary policy issues. Inflation Report reflects the opinion of the NBU regarding the current and future economic state of Ukraine and includes inflation projections.

As press-briefings about monetary policy decision-making before the publication of a quarterly inflation report already discloses forecast, I consider it as an event of communication that could affect private-sector expectations. Thus, if there was at least one press-briefing before 15th of a particular month, I assign a binary variable equals 1 in this month, and if communication takes place after 15th – I treat it as it was in the next month. In such a way, I end up with 42 occurrences of NBU communication regarding monetary policy decisions from July 2014 to March 2020.

Chapter 5

RESULTS

5. 1 Accuracy of inflation forecasts and the use of available information

Calculated measures of forecast accuracy for different groups of economic agents for the period after March 2016 are presented in Tables 2. As a benchmark, I consider the case when the expected level of the future inflation rate is equal to the current one. The forecast of financial analysts is the most precise across different measures, with households' being the least accurate. All the groups, and in particular households, tend to overestimate future inflation[6]. Therefore, if we consider the whole period, we would erroneously conclude that households forecast outperforms others in terms of RMSE, as positive bias would capture spike in CPI in 2014-2015 caused by external shocks (Table 10). Inflation expectations of firms display lower mean absolute error compare to banks and are close to those of financial experts.

Table 2. Forecast accuracy in 12 months of different groups of economic agents for the period starting from March 2016

Measure	*Bias*	*MAE*	*MAPE*	*RMSE*
Banks	1.69	2.98	0.66	3.95
Businesses	1.68	2.38	0.42	3.11
Households	3.86	3.94	0.75	4.75
Financial analysts	-1.05	2.64	0.40	3.29
Benchmark	-0.96	16.04	1.26	22.83

[6] This result is consistent with literature (Bruin et al. 2011, D'Acunto et al. 2019, Klaauw 2008, Easaw 2013)

Table 3 reports forecasting performance for five horizons of financial experts' expectations. Expectations in the short term exhibit negative bias, while in medium term (3 years) – small and positive. Interestingly, the bias in expectations regarding CPI change in annual terms in current and next year is much smaller in absolute terms than those of 12 months. Percentage errors (MAPE) are higher for the shortest and longest available horizons.

Table 3. Forecast accuracy of financial experts for different time horizons for CPI change in annual terms

Measure	*Bias*	*MAE*	*MAPE*	*RMSE*
3 months	-9.24	9.24	0.80	9.73
Current year	-0.09	1.80	0.27	2.39
12 months	-1.05	2.64	0.40	3.29
Next year	-0.16	2.98	0.47	3.18
3 years	0.46	2.27	0.61	2.61

Estimates for the formal test of bias in expectations (eq. 1) are presented in Table 4. Here I treat March 2016 as a structural break. Therefore, I add a binary variable for subperiod starting from March 2016 to account for the decrease in constant term. I also add interaction between this binary control and level of realized inflation to account for a change in slope. For every group of economic agents, a constant term is significant, indicating systematic errors. Results for experts' forecast on different horizons are qualitatively the same (Table 11).

The slope before the creak is economically insignificant. Though future inflation is statistically significant in the post-break subperiod, the F-test statistic rejects the joint hypothesis that intercept equals zero and slope equals one. Because of

quarterly frequency for firms and banks, there are not enough observations for two separate subperiods. Thus, I perform F-test for the whole period as well (Table 5). On average, expectations are not equal to realized inflation concerning which they are formed. However, a decrease in F-statistics indicates that constant term and slope for expectations of households and experts are closer to zero and one.

Table 4. Unbiasedness of 12 months forecast of different groups

	Dependent variable:			
	banks	businesses	households	financial
	(1)	(2)	(3)	(4)
Realized inflation	-0.005	-0.001	-0.066***	-0.042*
	(0.082)	(0.107)	(0.016)	(0.021)
After break	-3.786	-10.323	-11.562***	-9.147***
	(4.870)	(6.691)	(0.765)	(0.981)
after break * realized inflation	0.260	0.624	0.456***	0.309***
	(0.401)	(0.549)	(0.056)	(0.071)
Constant	12.767***	15.856***	21.596***	15.502***
	(2.538)	(3.233)	(0.503)	(0.644)
Observations	26	25	58	58
R^2	0.031	0.137	0.864	0.742
Note:				**p<0.1; **p<0.05; ***p<0.01*

Table 5. F-statistic for subperiods

F Statistic	*banks*	*businesses*	*households*	*financial*
Whole period	109.76***	51.327***	393.37***	523.47***
Before break	101.31**	53.39**	2302.2***	1650.3***
After break	2.3685	0.5925	231.63**	65.468**

Table 6 reports estimates of the effect from macroeconomic indicators on the forecast error (eq.2). The coefficient on the exchange rate is statistically significant. This suggests that available information was not efficiently processed when expectations were formed. According to estimates, forecasters seem to account for the policy rate, output index., but information on the exchange rate is not fully used.

Table 6. Effects of macroeconomic indicators on the 12 months forecast error of financial experts

	Dependent variable: forecast error			
	(1)	(2)	(3)	(4)
Policy rate	-0.046			
	(0.086)			
Exchange rate		0.603***		
		(0.167)		
Output index			-0.021	
			(0.044)	
Lagged CPI				0.079
				(0.053)
Lagged error	1.025***	0.934***	0.999***	1.015***
	(0.067)	(0.052)	(0.058)	(0.055)
Observations	37	37	37	37
Adjusted R^2	0.899	0.926	0.898	0.904
Note:				*$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$*

As errors in the forecast are not orthogonal to the exchange rate, information on it is not fully used. It is optimal to acquire information if the marginal benefit exceeds marginal costs. Information on the exchange rate is available at no cost, and it would increase forecast performance.

5. 2 Uncertainty and Central bank communication

For modeling CPI volatility, I use monthly CPI from January 2007 to March 2020. I perform a seasonal adjustment to this series. For volatility analysis, I use differenced series to get rid of the trend. This series is centered around its mean, but the variance is not constant over time. I use Harrison-McCabe test statistic and Goldfeld-Quandt test to confirm the presence of heteroskedasticity.

I proceed with ARMA (2,1) specification for the mean. Correlogram and partial correlogram are presented in Figure 13. To account for volatility clusters, I use GARCH (1,1) model (eq.3). Series of seasonal adjusted CPI, first difference, and estimated volatility are depicted in Figure 7.

To check the correctness of estimates, I calculate the squared standardized residuals. There is no autocorrelation in them (Figure 9), so I use estimated volatility in further analysis.

I calculate monthly exchange rate volatility as a standard deviation from the daily series of UAH/USD (Figure 9). The coefficient of correlation between estimated CPI volatility and calculated exchange rate volatility is 0.17, so there is no multicollinearity problem from including both variables in the same model.

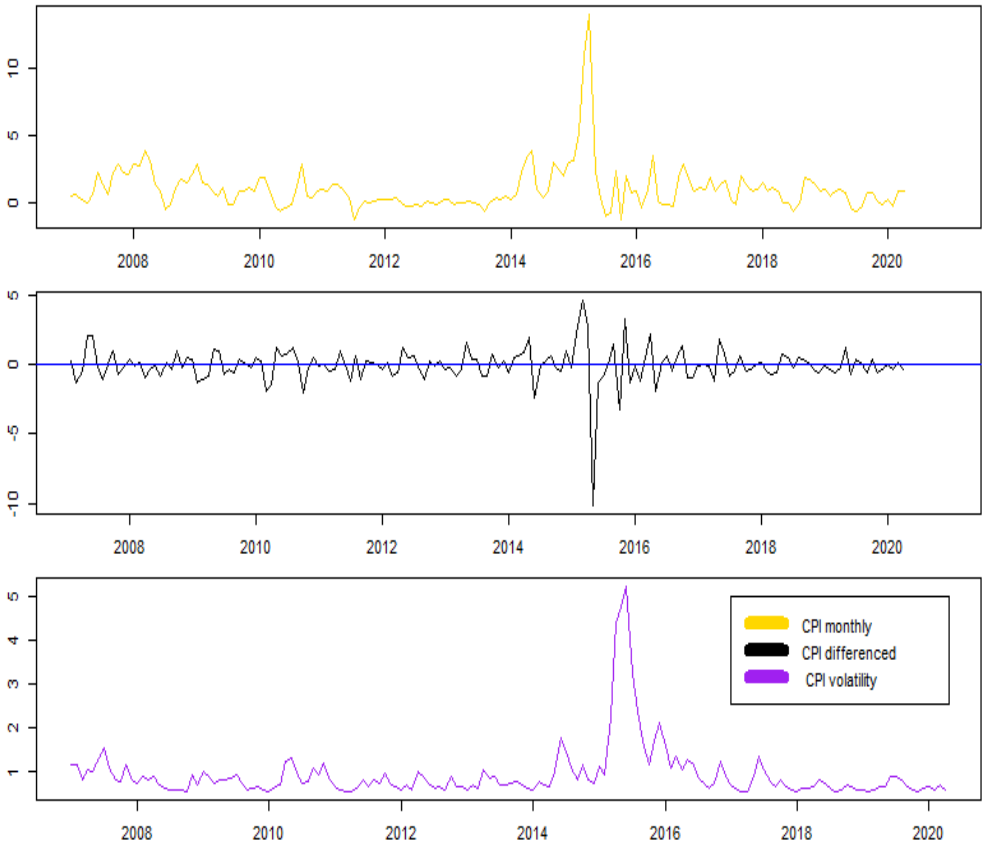

Figure 7. Monthly CPI series, differenced series of and estimated CPI volatility

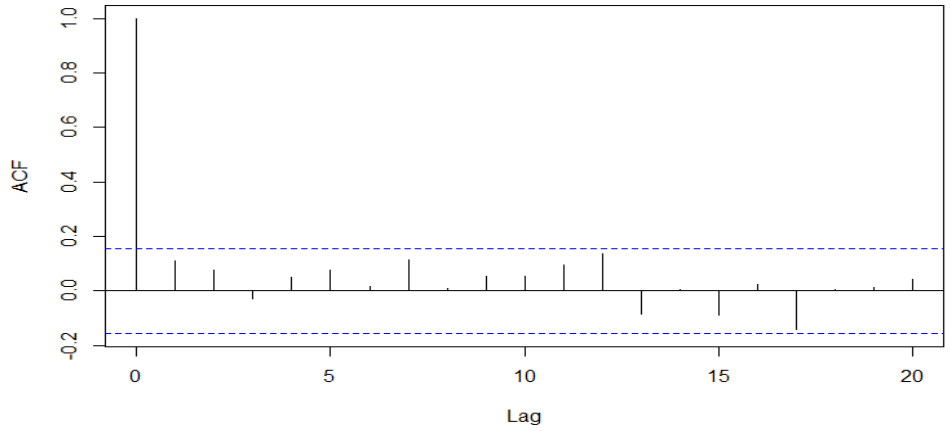

Figure 8. Autocorrelation in squared standardized residuals

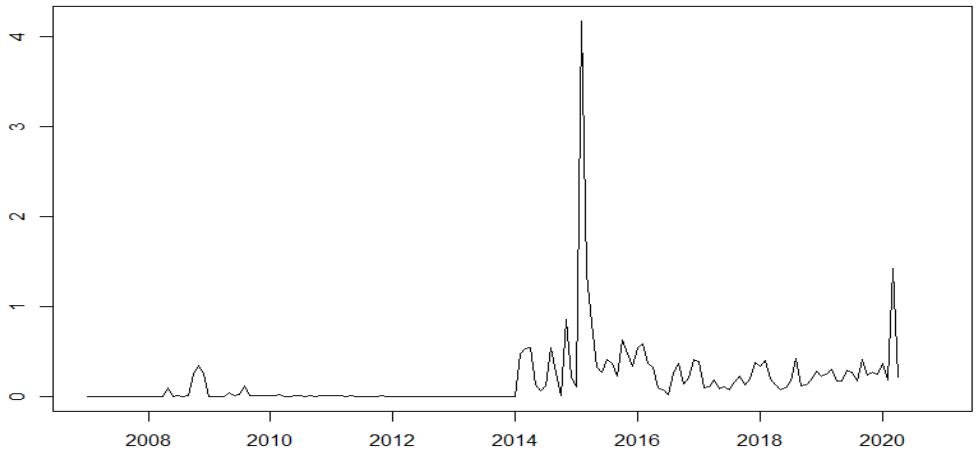

Figure 9. Exchange rate volatility, monthly

I use the 15th day of a month as a cut-off value to accounting whether press-briefing regarding monetary policy decisions has happened in this or next month. For the robustness check, I consider two other values: 10th and 20th days. The average value of disagreement (standard deviation) in individual forecasts of financial experts is higher in months without CB communication (Figure 10).

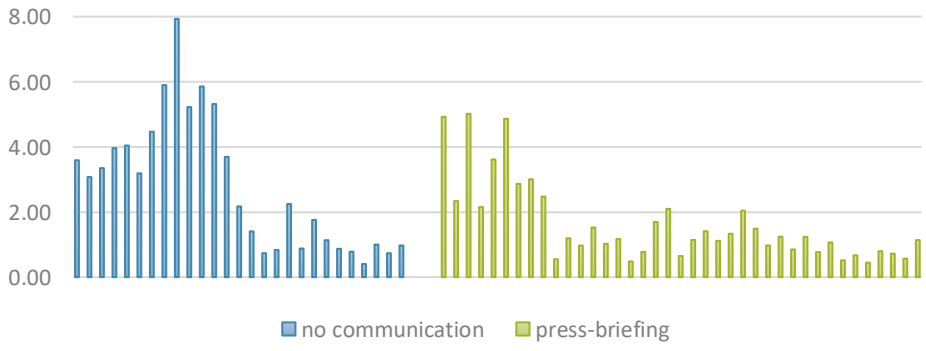

Figure 10. Standard deviations of individual forecasts of financial experts for months with and without CB communications

The estimated effect of CB communication (eq.4) for five different time horizons are presented in Table 7. All coefficients have anticipated signs. The forecast's dispersion is persistent, as captured by positive coefficients on first and second lag of standard deviation. However, those are statistically significant only for 12 months and three years forecasting horizons.

The coefficient on CPI is positive and significant for three short-term horizons for expectations: in the current year, next year, and 12 months, but it does not predict inflation in the longest and shortest horizons available from the survey. This is in line with inflation anchoring. One percentage point increase in CPI results on average 0.031 increase in dispersion for the current year, 0.043 – for next, and 0.025 in 12 months. Dispersion of forecasts in the current year also increases with CPI volatility, one percentage point increase in implied volatility results in half percentage point increase in forecast disagreement. It is worth noting that the average value of the estimated CPI volatility is 0.9.

Exchange rate volatility increases disagreement among forecasters for the same three horizons, as CPI does – by 0.7, 0.3 and 0.7 percentage points respectively. Although statistically significant, coefficients on exchange rate volatility are not economically significant, as a mean of exchange rate volatility is 0.17.

According to results, the coefficient on a binary variable for press-briefing always has anticipated negative signs. It is significant for current year forecasts, next year, and 12 months - standard deviation of individual forecasts decreases by 0.34, 0.4, and 0.63 respectively, while the average dispersion for those horizons is 1.5, 1.4, and 2.1. This indicates that financial analysts indeed extract additional information from CB communications.

Table 7. Estimated effects on the dispersion of individual forecasts

	Dependent variable:				
	Standard Deviation of individual forecasts				
	Current	Next	12 months	3 years	3 months
	(1)	(2)	(3)	(4)	(5)
First lag	0.081	0.168	0.269**	0.184	0.058
	(0.136)	(0.119)	(0.124)	(0.131)	(0.142)
Second lag	0.030	0.028	0.255**	0.443***	0.129
	(0.126)	(0.126)	(0.127)	(0.126)	(0.139)
Press-briefing	-0.341*	-0.396***	-0.630***	-0.283	0.088
	(0.185)	(0.145)	(0.223)	(0.175)	(0.142)
CPI	0.031**	0.043***	0.025*	0.001	0.015
	(0.012)	(0.012)	(0.015)	(0.010)	(0.010)
CPI volatility	0.535***	-0.095	0.078	0.180	0.039
	(0.190)	(0.122)	(0.195)	(0.142)	(0.294)
Exchange rate	0.712***	0.291**	0.678***	0.235	0.428
volatility	(0.176)	(0.133)	(0.216)	(0.167)	(0.635)
Constant	0.124	0.514***	0.518**	0.400*	0.234
	(0.200)	(0.171)	(0.243)	(0.206)	(0.215)
Observations	63	63	64	60	50
Adjusted R^2	0.766	0.721	0.754	0.647	0.391
Note:					**p<0.1; **p<0.05; ***p<0.01*

One interesting observation that I got from disaggregated data is that while some experts report round numbers (for example, 6%, 12%), forecasts of others contain fractions (5,7%, 11.6%). It is hard to infer why it is the case. Still, one of the possible explanations of the precision after decimal points is that they have some

extra information and, therefore, are more confident in their forecast. I would refer to them as group A and group B. The number of respondents in those two groups are plotted in Figure 11. Over time more respondents belong to group B.

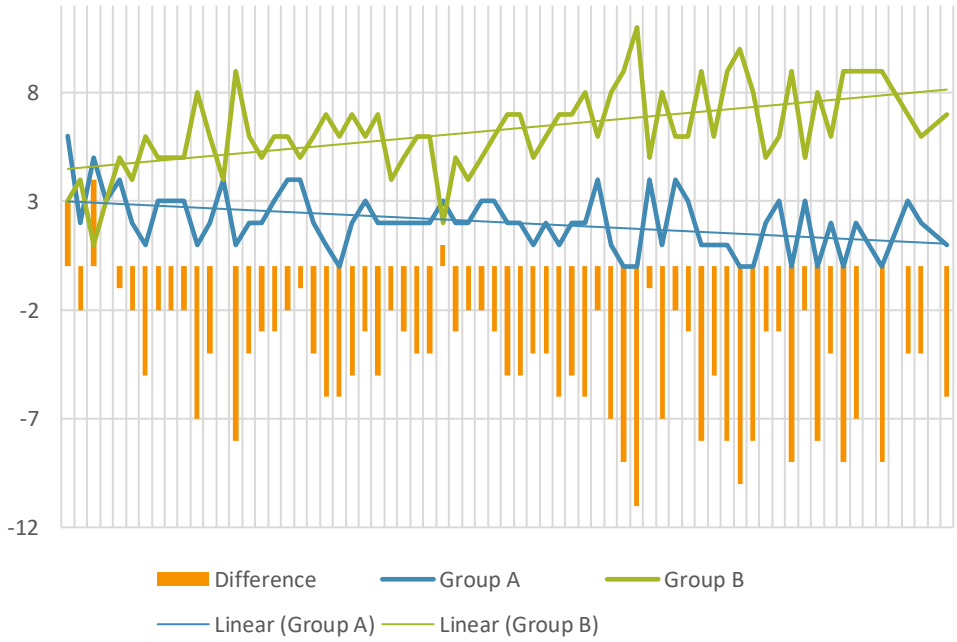

Figure 11. Number of forecasts with integer vs. real numbers

Therefore, I estimate the mean and median value for each group and assess their performance relative to the aggregate forecast (Table 8). After March 2016, mean forecast of group B outperforms not only the forecast of group B, but the aggregated forecast of all participants. The same is true for the median forecast. Though the differences between forecasts with and without decimal digits are only marginal, they exist across all four measures. It suggests that additional valuable information can be extracted from disaggregated series, as a more precise result is achieved by a subsample of forecasts.

Table 8. Forecast accuracy of financial analysts in group A and B

	Bias	*MAE*	*MAPE*	*RMSE*
Mean all	-1.22	2.57	0.35	3.22
Median all	-1.31	2.58	0.34	3.20
Mean A	-1.54	2.78	0.36	3.51
Mean B	-1.07	2.50	0.34	3.13
Median A	-1.55	2.76	0.35	3.49
Median B	**-1.19**	**2.52**	**0.34**	**3.12**

Chapter 6

CONCLUSIONS

In this thesis, I investigate the properties of private-sector inflation expectations in Ukraine, focusing on financial experts' expectations. I use aggregated data for households, firms, banks, and professional forecasters to compare the properties of their expectations across different measures. As expected, financial analysts are the most accurate in predicting future price development, while business slightly outperforms banks forecast in the period after March 2016. However, this conclusion would not be derived from all available timespan, as in the 2014-2015 economy was hit by external shocks.

Estimated results from aggregated series suggest that expectations of all four groups are biased; that is their forecasts for future inflation are not fully predicted by realized inflation in 12 months. However, after IT implementation, the weight on the future realized inflation has increased, which signals a decrease in bias.

According to estimation results for the forecast of financial analysts, not all available information has been used effectively in the process of their formation. As the exchange rate has statistical power in predicting the forecast error, expectations seem to not account for this macroeconomic indicator fully.

Analysis of disaggregated series reveals that for the analyzed period, CB communications plays a coordinating role for those expectations. Press-briefing regarding monetary policy decisions reduces disagreement in individual forecasts of financial experts.

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APPENDIX

Table 9. Inflation Surveys of different economic groups[7] in selected countries

Country	*Inflationary expectations of:*			*Inflation perception*	*Emerging economy*	*IT regime*
	Households	*Experts*	*Firms*			
Argentina		+	+[C]		+	
Brazil		+			+	+
Chile	+	+	+[C]		+	+
China	+		+ [D]		+	+
Colombia		+	+ [C, D]		+	+
Czech Republic	+	+	+[C,D]		+	+
England	+	+				
Hungary	+	+	+[D]		+	+
India	+	+	+[D]		+	+
Indonesia	+	+	+[C, D]		+	+
Israel	+	+	+		+	
Korea	+		+[C]		+	+
Malaysia	+	+	+[D]		+	
New Zealand	+	+	+	+		
Mexico		+	+[C, D]		+	+
Peru		+	+		+	+
Philippines	+				+	+
Poland	+	+	+[D]	+	+	+
Russia	+	+	+[D]		+	+
Singapore	+	+	+[C]		+	
South Africa	+	+	+[D]			
Thailand		+	+		+	+
Turkey	+	+	+[D]		+	+
US	+	+				

[A] – firms from all sectors, [B] - banks, [C] - financial corporations, [D]- non-financial.

[7] Based on CB websites

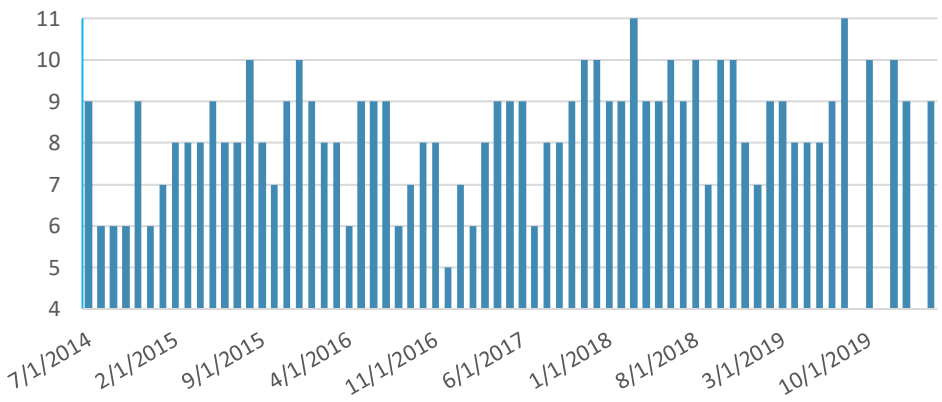

Figure 12. Number of participants in every round of financial analysts' survey

Table 10. Forecast accuracy in 12 months of different groups of economic agents for the whole available period

Measure	*Bias*	*MAE*	*MAPE*	*RMSE*
Banks	-4.91	10.84	1.12	16.98
Businesses	-3.58	10.43	0.85	15.83
Households	0.74	8.39	0.79	12.30
Financial analysts	-4.36	7.09	0.46	13.00
Benchmark	-0.96	16.04	1.26	22.83

Table 11. Unbiasedness of expert's expectations on different time horizons

	Dependent variable: Expected level of CPI in				
	3 months	current year	12 months	next year	3 years
	(1)	(2)	(3)	(4)	(5)
CPI in 3 months	-0.039				
	(0.068)				
CPI in current year		0.439***			
		(0.051)			
CPI in 12 months			0.267***		
			(0.044)		
CPI in next year				0.214***	
				(0.021)	
CPI in 3 years					0.088*
					(0.042)
Constant	2.632***	5.542***	6.355***	5.931***	6.289***
	(0.799)	(0.541)	(0.477)	(0.185)	(0.292)
F Statistic (slope=1, int=0)	1372.8***	61.483***	157.27***	686.65***	244.16***
Observations	39	45	38	45	15
R^2	0.009	0.635	0.507	0.702	0.251

Note: *p<0.1; **p<0.05; ***p<0.01

Table 12. Predictive power of macroeconomic indicators on forecast error

	Dependent variable: forecast error				
	indicators:				
	policy rate	real interest	USD	output index	lagged CPI
	(1)	(2)	(3)	(4)	(5)
Indicator	0.245***	0.039	0.197	-0.151***	0.030
	(0.072)	(0.083)	(0.141)	(0.041)	(0.024)
lagged error	0.841***	0.878***	0.837***	0.938***	0.877***
	(0.031)	(0.035)	(0.046)	(0.031)	(0.031)
Observations	56	56	56	56	56
R^2	0.950	0.940	0.942	0.952	0.941
Adjusted R^2	0.949	0.938	0.940	0.950	0.939

**** p<0.001, ** p<0.01, * p<0.05, p < 0.1*

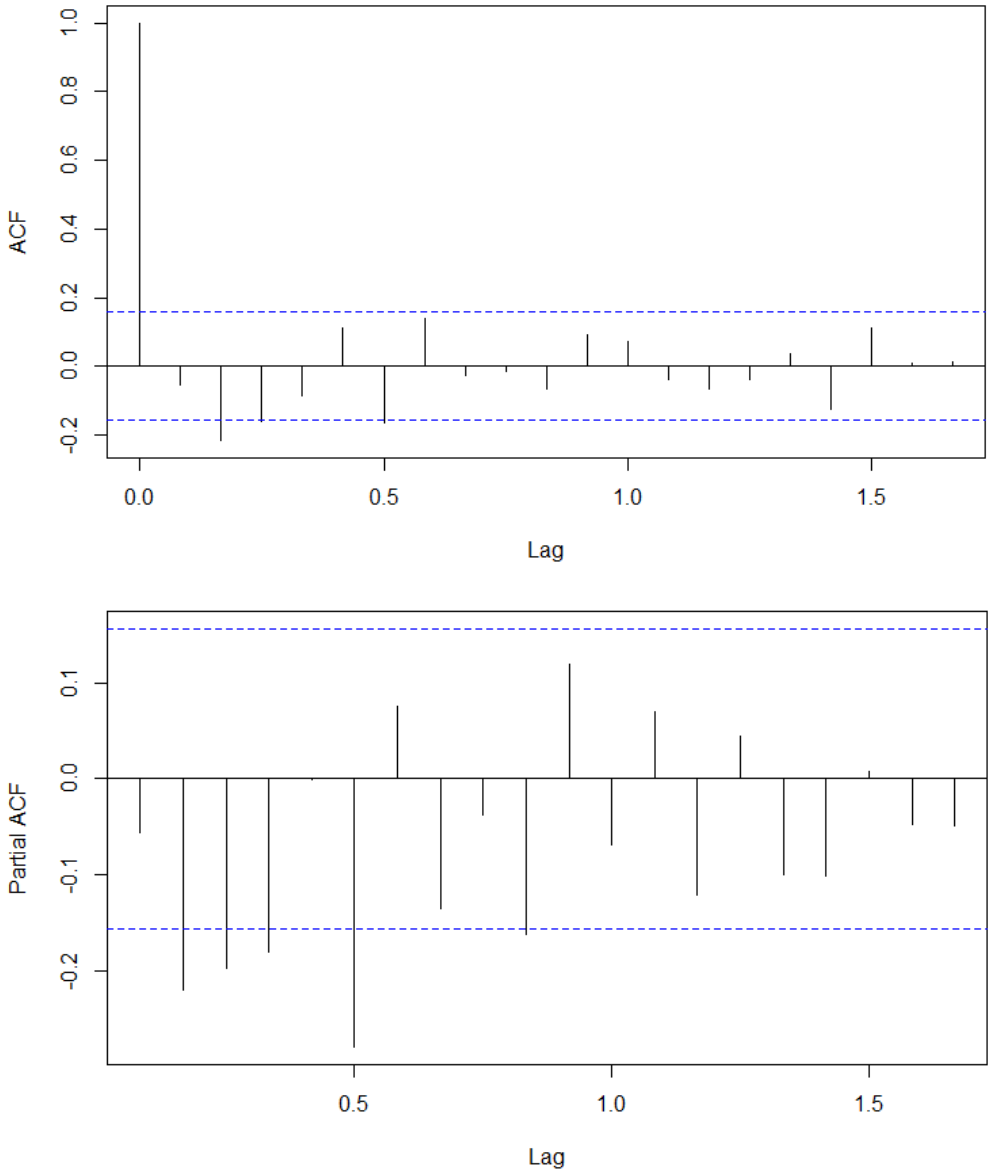

Figure 13. Autocorrelation and partial autocorrelation functions

Table 13. Forecast dispersion for 12 months horizon

	Dependent variable:								
	Standard deviation of individual forecasts								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
First lag	0.499***	0.476***	0.284**	0.284**	0.189	0.168	0.518***	0.275**	0.219*
	(0.119)	(0.113)	(0.129)	(0.128)	(0.125)	(0.124)	(0.105)	(0.118)	(0.117)
Second lag	0.376***	0.365***	0.197	0.222*	0.233*	0.179			
	(0.119)	(0.112)	(0.123)	(0.126)	(0.118)	(0.121)			
Press-briefing		**-0.668*** **	**-0.695*** **	**-0.705*** **	**-0.631*** **	**-0.507** **	**-0.595** **	**-0.662*** **	**-0.495** **
		(0.237)	(0.226)	(0.226)	(0.214)	(0.223)	(0.235)	(0.216)	(0.223)
CPI			0.041***	0.049***	0.044**	0.040**		0.054***	0.047***
			(0.015)	(0.017)	(0.016)	(0.016)		(0.015)	(0.015)
CPI volatility				-0.207	-0.059	-0.108	0.428**	0.012	-0.069
				(0.204)	(0.198)	(0.197)	(0.175)	(0.199)	(0.196)
Exchange rate volatility					0.608***	0.458*	0.675***	0.593**	0.411*
					(0.209)	(0.224)	(0.231)	(0.213)	(0.222)
Output index						-0.036*			-0.045**
						(0.021)			(0.021)
Constant	0.215	0.694***	0.671***	0.695***	0.542**	0.746***	0.620**	0.626**	0.854***
	(0.198)	(0.254)	(0.241)	(0.244)	(0.238)	(0.266)	(0.259)	(0.238)	(0.254)
Observations	64	64	64	63	63	63	64	64	64
Adjusted R^2	0.682	0.715	0.742	0.744	0.769	0.776	0.713	0.758	0.773

Note: *$^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$*

Table 14. Communication events

Date	*Event*	*Date*	*Event*
14 Apr 2014	Policy rate decision - Increase	01 Feb 2017	Inflation report
26 Jul 2014	Policy rate decision - Increase	02 Mar 2017	Policy rate decision - No change
12 Nov 2014	Policy rate decision - Increase	13 Apr 2017	Policy rate decision - Decrease
05 Feb 2015	Policy rate decision - Increase	29 Apr 2017	Inflation report
03 Mar 2015	Policy rate decision - Increase	25 May 2017	Policy rate decision - Decrease
30 Mar 2015	MPC recommendations	06 Jul 2017	Policy rate decision - No change
30 Mar 2015	Inflation report	25 Jul 2017	Inflation report
24 Apr 2015	MPC recommendations	03 Aug 2017	Policy rate decision - No change
28 May 2015	MPC recommendations	14 Sep 2017	Policy rate decision - No change
26 Jun 2015	MPC recommendations	26 Oct 2017	Policy rate decision - Increase
30 Jun 2015	Inflation report	29 Oct 2017	Inflation report
30 Jul 2015	Policy rate decision - No change	14 Dec 2017	Policy rate decision - Increase
27 Aug 2015	Policy rate decision - Decrease	24 Jan 2018	MPC recommendations
24 Sep 2015	Policy rate decision - Decrease	25 Jan 2018	Policy rate decision - Increase
30 Sep 2015	Inflation report	01 Feb 2018	Inflation report
29 Oct 2015	Policy rate decision - No change	05 Feb 2018	MPC anonymous discussion notes
17 Dec 2015	Policy rate decision - No change	28 Feb 2018	MPC recommendations
28 Jan 2016	Policy rate decision - No change	01 Mar 2018	Policy rate decision - Increase
04 Feb 2016	Inflation report	12 Mar 2018	MPC anonymous discussion notes
03 Mar 2016	Policy rate decision - No change	11 Apr 2018	MPC recommendations
21 Apr 2016	Policy rate decision - Decrease	12 Apr 2018	Policy rate decision - No change
25 Apr 2016	Inflation report	19 Apr 2018	Inflation report
26 May 2016	Policy rate decision - Decrease	23 Apr 2018	MPC anonymous discussion notes
23 Jun 2016	Policy rate decision - Decrease	23 May 2018	MPC recommendations
28 Jul 2016	Policy rate decision - Decrease	24 May 2018	Policy rate decision - No change
10 Aug 2016	Inflation report	04 Jun 2018	MPC anonymous discussion notes
15 Sep 2016	Policy rate decision - Decrease	10 Jul 2018	MPC recommendations
27 Oct 2016	Policy rate decision - Decrease	12 Jul 2018	Policy rate decision - Increase
03 Nov 2016	Inflation report	19 Jul 2018	Inflation report
08 Dec 2016	Policy rate decision - No change	23 Jul 2018	MPC anonymous discussion notes
26 Jan 2017	Policy rate decision - No change		

Table 14. Communication events - continued

Date	*Event*	*Date*	*Event*
05 Sep 2018	MPC recommendations	16 Jul 2019	MPC recommendations
06 Sep 2018	Policy rate decision - Increase	18 Jul 2019	Policy rate decision - Decrease
17 Sep 2018	MPC anonymous discussion notes	25 Jul 2019	Inflation report
24 Oct 2018	MPC recommendations	29 Jul 2019	MPC anonymous discussion notes
25 Oct 2018	Policy rate decision - No change	04 Sep 2019	MPC recommendations
01 Nov 2018	Inflation report	05 Sep 2019	Policy rate decision - Decrease
05 Nov 2018	MPC anonymous discussion notes	16 Sep 2019	MPC anonymous discussion notes
12 Dec 2018	MPC recommendations	22 Oct 2019	MPC recommendations
13 Dec 2018	Policy rate decision - No change	24 Oct 2019	Policy rate decision - Decrease
26 Dec 2018	MPC anonymous discussion notes	31 Oct 2019	Inflation report
30 Jan 2019	MPC recommendations	04 Nov 2019	MPC anonymous discussion notes
31 Jan 2019	Policy rate decision - No change	11 Dec 2019	MPC recommendations
07 Feb 2019	Inflation report	12 Dec 2019	Policy rate decision - Decrease
11 Feb 2019	MPC anonymous discussion notes	23 Dec 2019	MPC anonymous discussion notes
13 Mar 2019	MPC recommendations	28 Jan 2020	MPC recommendations
14 Mar 2019	Policy rate decision - No change	30 Jan 2020	Policy rate decision - Decrease
25 Mar 2019	MPC anonymous discussion notes	06 Feb 2020	Inflation report
23 Apr 2019	MPC recommendations	10 Feb 2020	MPC anonymous discussion notes
25 Apr 2019	Policy rate decision - Decrease	11 Mar 2020	MPC recommendations
03 May 2019	Inflation report	12 Mar 2020	Policy rate decision - Decrease
06 May 2019	MPC anonymous discussion notes	24 Mar 2020	MPC anonymous discussion notes
05 Jun 2019	MPC recommendations	21 Apr 2020	MPC recommendations
06 Jun 2019	Policy rate decision - No change	23 Apr 2020	Policy rate decision - Decrease
18 Jun 2019	MPC anonymous discussion notes	30 Apr 2020	Inflation report