NBP Narodowy Bank Polski

Tomasz Łyziak / Economic Institute

Inflation expectations in Poland, 2001-2013 Measurement and macroeconomic testing

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2. Testing main features of inflation expectations in Poland:
   - the degree of forward-lookingness of inflation expectations (in particular the fulfillment of the rational expectations hypothesis);
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   - the relationship between inflation expectations of different groups of economic agents;
   - the usefulness of direct measures of inflation expectations in estimating the hybrid New Keynesian Phillips Curve.
3. Conclusions.

- Appendix: NBP business survey.

1.

Direct measures of inflation expectations applied

Data description

	Consumers	Producers	Financial sector analysts
Data source	GUS	NBP (*Quick Monitoring*)	Reuters
Data frequency	monthly	quarterly	monthly
Horizon	12 months	12 months	12 months

Direct measures of consumer inflation expectations

- Qualitative survey question:

  "Given what is currently happening, do you believe that over the next 12 months prices will: (1) increase more rapidly, (2) increase at the same rate, (3) increase at slower rate, (4) stay about the same, (5) go down, (6) I do not know".

- Applied measures of consumers' opinions on future inflation:
  - balance statistic (weights: 1, ½, 0, -½, -1);
  - 2 measures of inflation expectations quantified with the probability method (Batchelor and Orr 1988) assuming normal distribution of expected inflation and different scaling factors (i.e. measures of perceived inflation):
    - "objectified" measure – perceived inflation measured with the current CPI inflation;
    - "subjectified" measure – perceived inflation defined in terms of the Consumer Perceived Price Index (CPPI) (Hałka and Łyziak 2013).

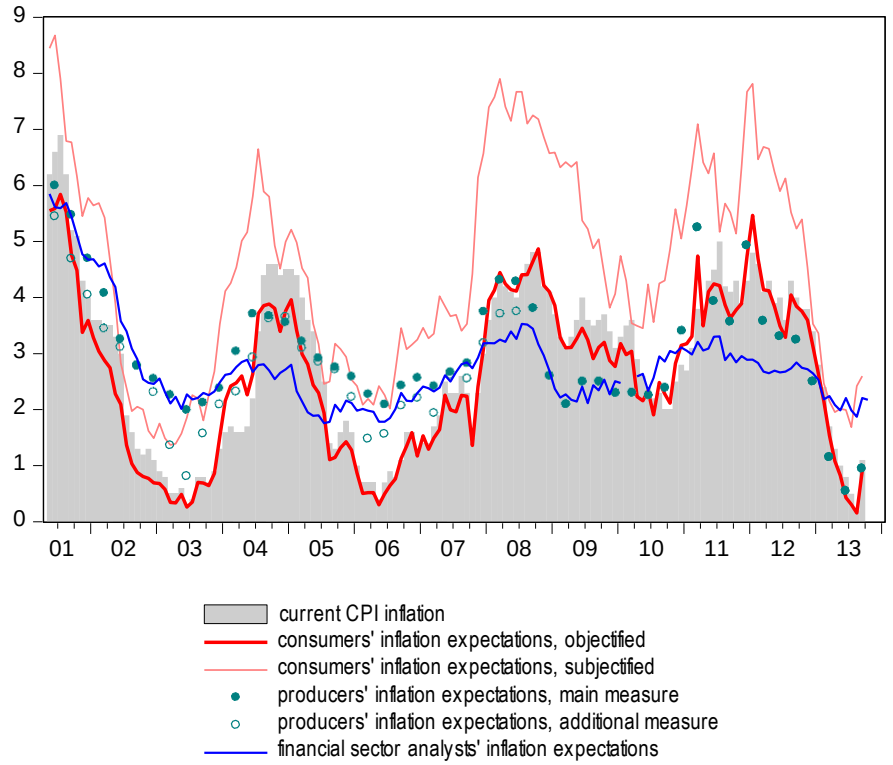
Direct measures of producer inflation expectations

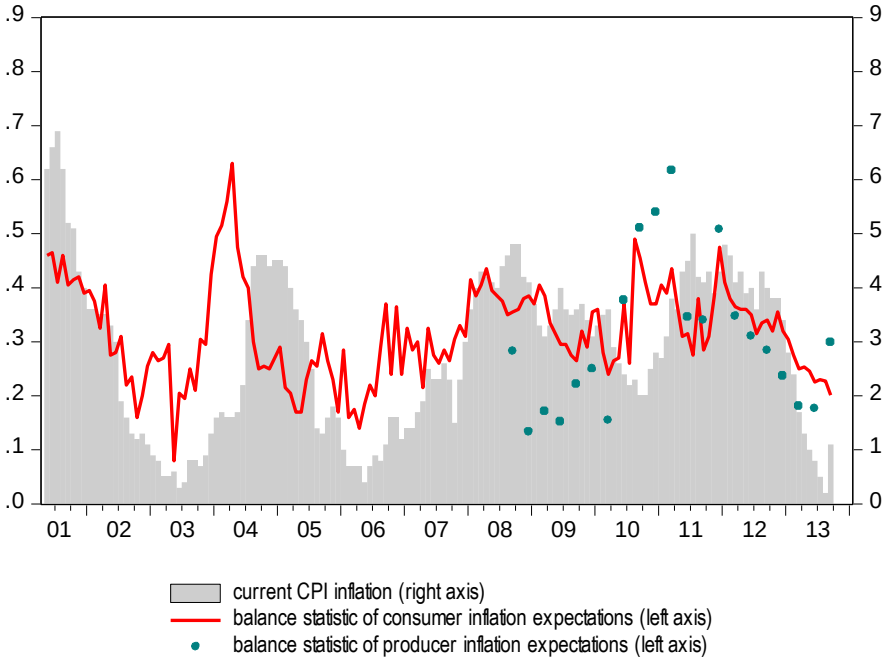
- Survey questions (NBP survey):
  - till 2008Q2: quantitative survey question;
  - since 2008Q3: qualitative survey question:

    „In … [here: the month with the most recent CPI index available] CPI inflation was …% in annual terms. In your opinion during next 12 months prices will: (1) rise faster than at present, (2) rise at the same rate, (3) rise more slowly, (4) stay at their present level, (5) go down, (6) difficult to say".

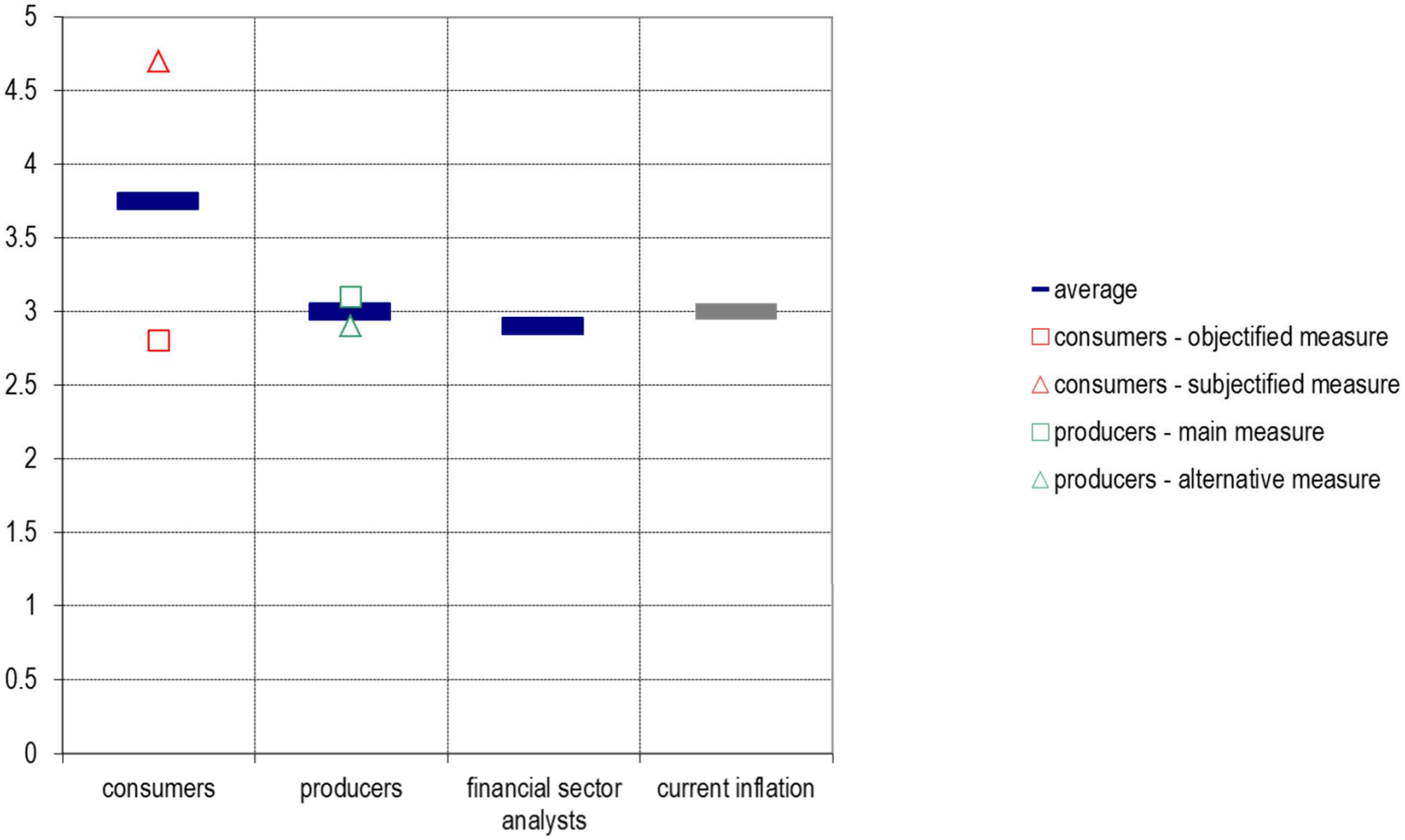
- Applied measures of producers' opinions on future inflation:
  - balance statistic (weights: 1, ½, 0, -½, -1);
  - 2 measures of inflation expectations:
    - main measure – till 2008Q2: average of individual quantitative expectations; since 2008Q3: expectations quantified with the probability method (Batchelor and Orr 1988) assuming normal distribution of expected inflation;
    - alternative measure – quantified with the probability method (Batchelor and Orr 1988) assuming normal distribution of expected inflation (till 2008Q2 we transform quantitative responses into qualitative ones and derive implied fractions of respondents selecting respective responses to the qualitative question).

Inflation expectations in Poland





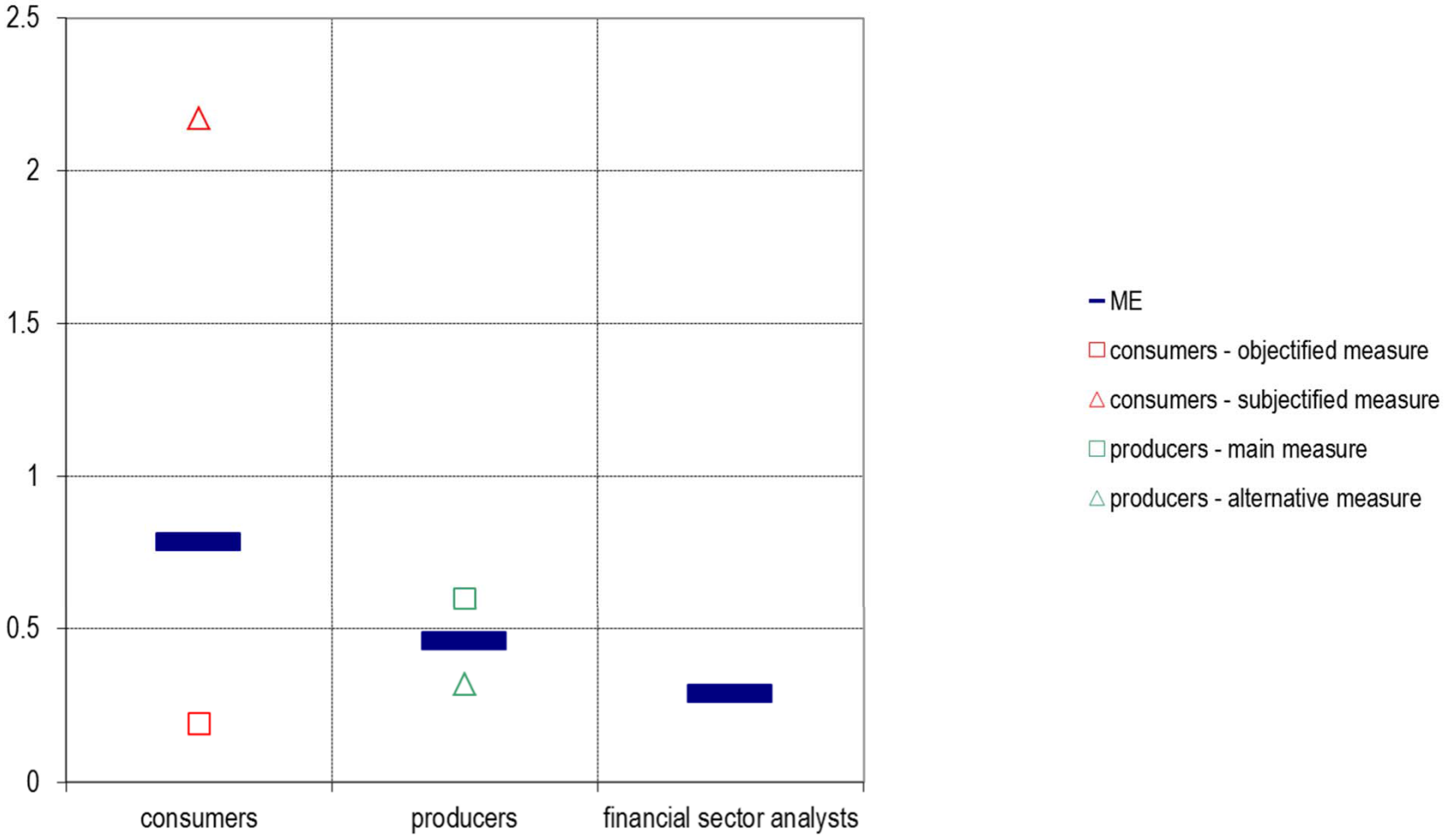
Inflation expectations in Poland



2.

Testing main features of inflation expectations in Poland

Expectational errors (ME)



Expectational errors – cross-check with balance statistics

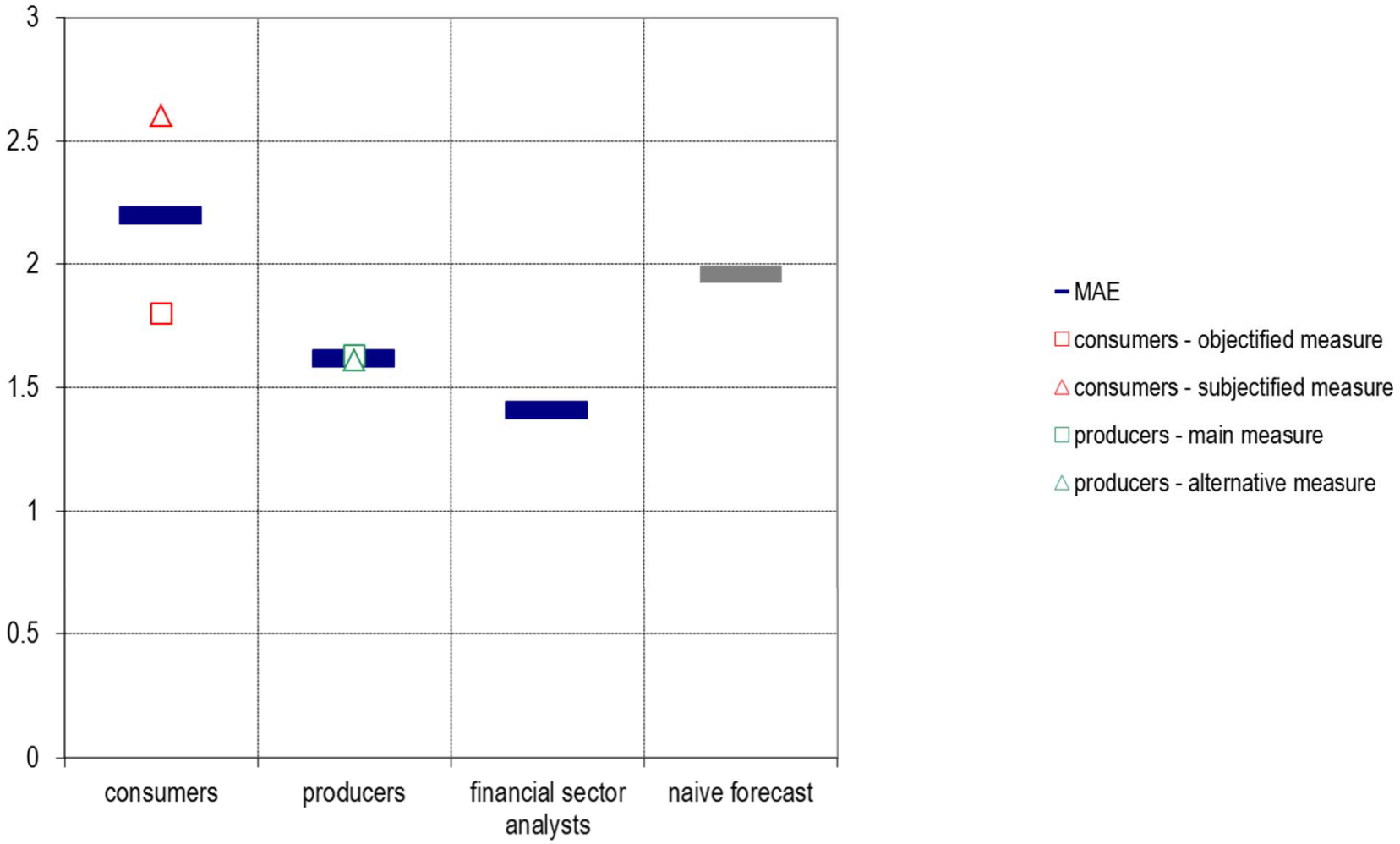
- Balance statistic of expected inflation applied in the paper attaches the following weights to subsequent fractions of respondents:
  - 1 – *„prices will increase more rapidly”*;
  - ½ – *„prices will increase at the same rate”*;
  - 0 – *„prices will increase at slower rate”*;
  - -½ – *„prices will stay about the same”*;
  - -1 – *„prices will fall”*.
- Inflation expressed in terms of the above balance statistic can be defined in the following way:

$$\pi_t^{BS} = \begin{cases} 1 & if \quad \pi > \pi_{t-12} \\ 0.5 & if \quad \pi_t = \pi_{t-12} \\ 0 & if \quad 0 < \pi_t < \pi_{t-12} \\ -0.5 & if \quad \pi_t = 0 \\ -1 & if \quad \pi_t < 0 \end{cases}$$

Expectational errors – cross-check with balance statistics

Agents	Data source, measure	Average inflation expectations	Average actual future inflation	Difference (in % of average actual future inflation)
Consumers(1)	GUS, balance statistic	0.37	0.44	-15.9
Enterprises(2)	NBP, balance statistic	0.49	0.49	1.3

Expectational errors (MAE)



Testing rational expectations hypothesis

- *Unbiasedness*: Expectations are unbiased if they differ from actual values by random residual:

$$\pi^{e}_{t|t-12} = \alpha + \beta \cdot \pi_t + \varepsilon_t \qquad REH \Rightarrow \alpha = 0, \beta = 1$$

- *Macroeconomic efficiency*: Expectations are efficient if information variables available while forming expectations are not statistically significant in explaining expectational errors:

$$e_t = \alpha_0 + \alpha_1 \cdot \Omega_t + \varepsilon_t \qquad REH \Rightarrow \quad \alpha_1 = 0$$

Testing unbiasedness of inflation expectations

Agents	Data source, measure	$R^2_{adj.}$	α	β	*F-prob* H_0: $(\alpha,\beta)=(0,1)$
Consumers	GUS, objectified	0.92	0.026 (0.006)	-0.084 (0.090)	*0.000*
	GUS, subjectified	0.92	0.045 (0.009)	-0.109 (0.123)	*0.000*
Enterprises	NBP, main	0.67	0.032 (0.005)	-0.079 (0.090)	*0.000*
	NBP, alternative	0.64	0.029 (0.003)	-0.078 (0.099)	*0.000*
Financial sector analysts	Reuters	0.97	0.031 (0.004)	-0.084 (0.113)	0.000

Testing macroeconomic efficiency of inflation expectations

Economic agents	Information variables							
	WIBOR1M	WIBOR3M	PLN/EUR	PLN/USD	Industrial output	Unemployment rate	Oil price	CPI inflation
Consumers	-	-	++	++	+	-	++	- -
Producers	-	-	++	++	++	+	++	++
Financial sector analysts	-	-	++	++	++	++	++	- -

„++" – a given variable used efficiently while forming inflation expectations
„+" – a given variable used rather efficiently while forming inflation expectations
„- -" – a given variable used inefficiently while forming inflation expectations
„-" – a given variable used rather efficiently while forming inflation expectations

Testing forward-lookingness and anchoring of expectations

- To test forward-lookingness of inflation expectations we estimate two hybrid models of expectations' formation:
  - a combination of rational and adaptive expectations (Gerberding 2001; Carlson and Valev 2002; Heineman and Ulrich 2006):

$$\pi^{e}_{t+12|t} = \alpha_1 + \alpha_2 \cdot \pi_{t+12} + (1-\alpha_2)\cdot\left[\pi^{e}_{t-2|t-14} + \alpha_3 \cdot \left(\pi^{e}_{t-2|t-14} - \pi_{t-2}\right) + \alpha_4 \cdot \left(\pi_{t-2} - \pi_{t-14}\right)\right] + \varepsilon_t$$

  - a combination of rational and static expectations:

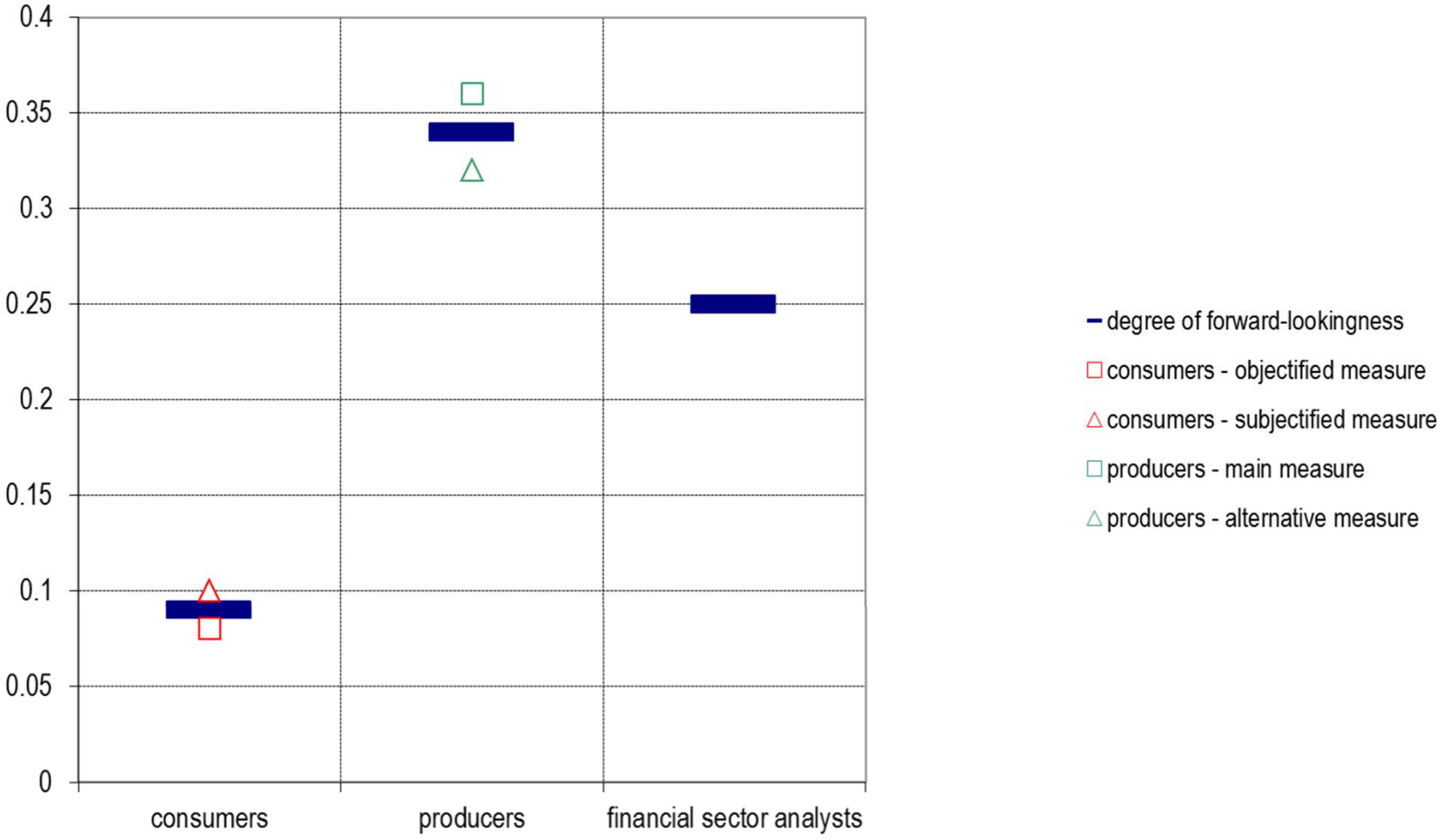
$$\pi^{e}_{t+12|t} = \alpha_1 + \alpha_2 \cdot \pi_{t+12} + (1-\alpha_2)\cdot \pi_{t-2} + v_t$$

  The degree of expectations' backward-lookingness is given by the weight (1- α_2), their forward-lookingness – by the weight α_2.

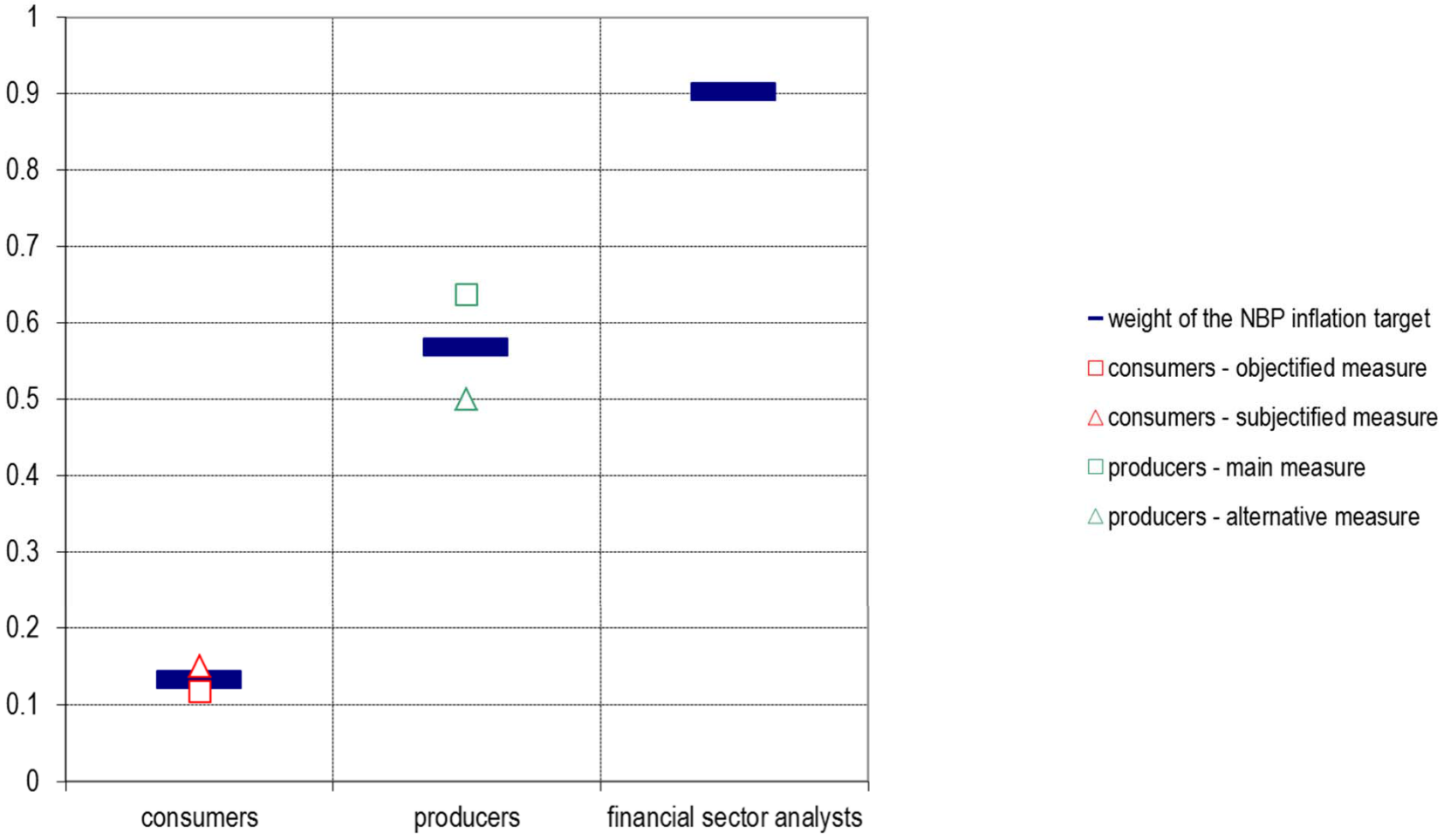
- To test anchoring of inflation expectations we estimate the weight of the central bank inflation target in the formation of inflation expectations (Bomfim and Rudebush 2000):

$$\pi^{e}_{t+12|t} = \lambda \cdot \pi^{tar}_{t+12} + (1-\lambda)\cdot \pi^{0}_{t} + \varepsilon_t$$

Degree of forward-lookingness of inflation expectations



Degree of anchoring of inflation expectations



Relationship between expectations of different agents

- Granger causality tests:
  - Financial sector analysts' and enterprises' inflation expectations are Granger causes of consumers' inflation expectations, while consumers' expectations do not influence expectations of the remaining groups.
  - There exists two-way causality between inflation expectations of financial sector analysts and enterprises, although there are slight differences in the assessment based on each of the measures of enterprise inflation expectations under consideration.
- Epidemiology models (Carroll 2003):

$$\pi^{e(i)}_{t+4/t} = \beta_0 + \beta_1 \pi^{e(i)}_{t+3/t-1} + \beta_2 \pi^{e(j)}_{t+4/t} + \varepsilon_t$$

- Estimation results confirm links between inflation expectations of economic agents identified with Granger causality tests.
  - Polish consumers update information on professional inflation forecasts every 12-14 months vs. 1 months in the US (Carroll 2006) and 18 months in large EU economies (Döepke et al. 2008).
  - Polish enterprises update information on professional inflation forecasts every 8-9 months.

Relationship between expectations of different agents

Measure of inflation expectations		β_1	β_2	R^2_{adj}	F-prob: $H_0: \beta_1 + \beta_2 = 1$	Frequency of updating (in months)
i	*j*					
INFE_C_OB	INFE_FSA	0.70 (0.10)	0.24 (0.12)	0.76	0.34	12.5
INFE_C_OB	INFE_P_M	0.60 (0.10)	0.32 (0.09)	0.81	0.10	9.4
INFE_C_SUB(+)	INFE_P_M	0.64 (0.12)	0.50 (0.18)	0.82	0.00	6.0
INFE_C_OB	INFE_P_A	0.53 (0.10)	0.42 (0.10)	0.84	0.26	7.1
INFE_P_M	INFE_FSA	0.61 (0.13)	0.40 (0.15)	0.66	0.91	7.5
INFE_FSA	INFE_P_M	0.64 (0.05)	0.31 (0.05)	0.90	0.00	9.7
INFE_P_A	INFE_FSA	0.63 (0.12)	0.34 (0.13)	0.64	0.38	8.8
INFE_FSA	INFE_P_A	0.71 (0.05)	0.26 (0.05)	0.88	0.05	11.5

INFE_C_OB – objectified measure of consumer inflation expectations,
INFE_C_SUB – subjectified measure of consumer inflation expectations,
INFE_P_M (INFE_P_A) – main (alternative) measure of enterprise inflation expectations,
INFE_FSA – financial sector analysts' inflation expectations.

Direct measures of inflation expectations in the hybrid NKPC

- Estimated hybrid New Keynesian Phillips Curve:

$$\pi_t^c = \alpha_0 + \alpha_1 \pi_{t+4/t}^e + \alpha_2 \pi_{t-4}^c + \alpha_3 x_{t-i} + \alpha_4 e_{t-j}^r + \varepsilon_t$$

π^c – core inflation (excluding either foodstuffs and fuels or foodstuffs and energy),
x – output gap,
e^r – real effective exchange rate gap.

- Inflation expectations of all groups of economic agents under consideration are statistically significant in the hybrid NKPC and their impact on core inflation in majority of cases is stronger than the impact of past inflation.

Direct measures of inflation expectations in the hybrid NKPC

- NKPC, core inflation measure excluding foodstuffs and fuels

Agents	Data source, measure, lags	α_1	α_2	α_3	α_4	$R^2_{adj.}$	*F-prob* $H_0: \alpha_1+\alpha_2=1$
Consumers	GUS, objectified, i=1, j=0	0.55 (0.08)	0.35 (0.07)	0.47 (0.13)	-0.05 (0.02)	0.79	*0.02*
	GUS, subjectified, i=2, j=0	0.33 (0.04)	0.32 (0.05)	0.42 (0.07)	-0.05 (0.02)	0.84	*0.00*
Enterprises	NBP, main, i=2, j=1	0.43 (0.08)	0.41 (0.07)	0.79 (0.14)	-0.05 (0.03)	0.81	*0.00*
	NBP, alternative, i=1, j=0	0.33 (0.11)	0.58 (0.08)	1.10 (0.20)	-0.11 (0.03)	0.71	*0.12*
Financial sector analysts	Reuters, i=1, j=0	0.61 (0.17)	0.33 (0.13)	0.80 (0.20)	-0.08 (0.05)	0.75	*0.31*

Direct measures of inflation expectations in the hybrid NKPC

- NKPC, core inflation measure excluding foodstuffs and energy

Agents	Data source, measure, lags	α_1	α_2	α_3	α_4	R^2_{adj}	*F-prob* $H_0: \alpha_1+\alpha_2=1$
Consumers	GUS, objectified, i=2, j=1	0.42 (0.05)	0.36 (0.04)	0.29 (0.09)	-0.03 (0.01)	0.89	*0.00*
	GUS, subjectified, i=2, j=1	0.21 (0.04)	0.42 (0.06)	0.60 (0.15)	-0.07 (0.04)	0.87	*0.00*
Enterprises	NBP, main, i=1, j=0	0.58 (0.29)	0.49 (0.15)	0.82 (0.22)	-0.15 (0.04)	0.62	*0.70*
	NBP, alternative, i=1, j=0	0.60 (0.17)	0.51 (0.08)	0.73 (0.13)	-0.11 (0.04)	0.72	*0.41*
Financial sector analysts	Reuters, i=2, j=1	0.43 (0.09)	0.32 (0.07)	0.58 (0.08)	-0.05 (0.02)	0.86	*0.00*

3.

Conclusions

Conclusions

- Survey data are extremely useful in analyzing inflation expectations. Results based on such measures should be checked for robustness by applying different measurement techniques.
- Formation of inflation expectations in Poland is diversified among analyzed agents:
  - There is a clear distinction between consumer inflation expectations on the one hand and inflation expectations of financial sector analysts and enterprises on the other hand.
  - But consumer and producer inflation expectations in Poland are influenced by financial sector analysts' forecasts.

Conclusions

- Features of inflation expectations of enterprises and financial sector analysts are similar to each other and the degree of forward-lookingness seems to be even higher in the case of producer inflation expectations.
- Possible explanations:
  - developed capacities of enterprises in observing and forecasting changes in the macroeconomic environment on their own,
  - enterprises monitor closely inflation expectations of professional forecasters and use them in setting their expectations,
  - overrepresentation of big firms in the sample of enterprises whose expectations are monitored.

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