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RATIONALITY OF EXPECTATIONS AND DATA VINTAGE: EVIDENCE FROM BUSINESS TENDENCY SURVEYS

RACJONALNOŚĆ OCZEKIWAŃ A ROCZNIK DANYCH: WYNIKI Z TESTU KONIUNKTURY

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Summary: In this paper, the results of the quantification procedures and the properties of expectations series obtained for two data vintages are compared. The volume index of production sold in manufacturing is defined for end-of-sample and real time data, and evaluated against expectations expressed in business tendency surveys. Empirical analysis shows that (1) there are no statistically significant differences between the quantification results obtained on the basis of real time and end-of-sample data, and (2) the results of unbiasedness and orthogonality tests are not influenced by data vintage. Therefore, for the purposes of analyzing the properties of expectations expressed in the business tendency survey, researchers can use easily available end-of-sample data instead of custom-designed and individually compiled real time databases. Also, (3) expectations series are not unbiased or efficient forecasts of changes in production, regardless of data vintage.

Keywords: data revisions, survey data, quantification, expectations, rationality.

Streszczenie: W artykule przedstawione są wyniki procedur kwantyfikacyjnych i własności szeregów czasowych oczekiwań otrzymanych na podstawie dwóch roczników danych. Wskaźnik produkcji sprzedanej przemysłu jest zdefiniowany dla danych wstępnych i ostatecznych, a następnie porównany z oczekiwaniami wyrażonymi w ankietach testu koniunktury. Analiza empiryczna prowadzi do następujących wniosków: (1) wyniki procedur kwantyfikacyjnych dla różnych roczników danych nie różnią się w sposób statystycznie istotny; (2) wyniki testów nieobciążoności i ortogonalności nie są wrażliwe na rocznik danych. Na potrzeby analizy własności oczekiwań wyrażonych w teście koniunktury można zatem stosować łatwo dostępne dane ostateczne zamiast trudnych do skompilowania baz danych wstępnych; (3) szeregi czasowe oczekiwań nie stanowią nieobciążonej ani efektywnej informacyjnie prognozy zmian w poziomie produkcji, niezależnie od rocznika danych.

Słowa kluczowe: rewizje danych, dane ankietowe, kwantyfikacja, oczekiwania, racjonalność.

1. Introduction

Data revisions in economic time series introduce a relatively recent subfield in testing properties of expectations; systematic studies of the influence of data corrections on the behavior of expectations date back only to the 1990s. Data revision is usually defined as an adjustment introduced after the initial announcement had been published, and end-of-sample (EoS) – as data provided in the most recent announcement. Real time values (RTV) are initial numbers available to economic agents in real time and (frequently) subject to revisions. The date when a particular dataset was made available is termed the "vintage" of that data series.[1]

Data revisions in Polish statistical reporting are only rarely explicitly stated or consistently described; consequently, constructing and updating a vintage-specific database for all the economic variables of interest, in time for ongoing empirical research, becomes a time-consuming and tiresome task. In this paper, I continue analyses of the influence of data vintage on the properties of expectations [Tomczyk 2013; 2014] and test whether the properties of expectations time series are sensitive to data vintage. The main motivation of this paper is to assess whether compiling separate EoS and RTV data sets is necessary for the purpose of evaluating the rationality of economic expectations as measured by business tendency surveys.

The sensitivity of rationality tests to data vintage has already been noted in literature; Dean Croushore [2012, p. 1] points out that "(…) the results of bias tests are found to depend on the subsample in question, as well as what concept is used to measure the actual value of a macroeconomic variable". In this paper, actual values of macroeconomic variables are defined in terms of EoS and RTV values, and the unbiasedness and orthogonality (informational efficiency) of expectations are tested on the basis of quantified business tendency survey data. The following hypotheses are tested: (1) EoS data are better suited to quantifying expectations expressed in business tendency surveys because respondents aim to forecast final (revised) numbers and not preliminary data, and (2) the differences between expectations series derived from EoS and RTV data are not large or systematic enough to influence the results of rationality tests.

2. Measuring and testing expectations

Analyses of economic expectations – in particular, tests of rationality of expectations – have constituted a basic building block of modern economics since the 1960s. For the purposes of the direct testing of the rationality hypotheses, survey data is usually employed. In this paper, expectations and subjective assessments of changes

[1] For details on the definitions and classifications concerning data revisions, as well as a review of literature and databases related to economic data revisions and a comparison of quantification results for initial and revised data on production volume index in Poland, see Tomczyk [2013; 2014].

in production are taken from the Research Institute for Economic Development (RIED, Warsaw School of Economics) monthly business tendency surveys. Each questionnaire includes eight questions designed to obtain information on the current situation as compared to last month, as well as expectations for the next 3-4 months, grouped in three categories: increase/improvement, no change, or decrease/deterioration. On the basis of the individual questionnaires, by dividing the number of responses in each of the three categories by the total number of returned questionnaires, the following percentages are calculated:[2]

A_t^1 – percentage of respondents who observed an increase or improvement between $t - 1$ and t,

A_t^2 – percentage of respondents who observed no change between $t - 1$ and t,

A_t^3 – percentage of respondents who observed a decrease or deterioration between $t - 1$ and t,

P_t^1 – percentage of respondents who expect an increase or improvement between t and $t + 3$,

P_t^2 – percentage of respondents who expect no change between t and $t + 3$,

P_t^3 – percentage of respondents who expect a decrease or deterioration between t and $t + 3$.

In order to analyze the rationality of the aggregated expectations, the qualitative responses of the business tendency survey respondents have to be converted into a quantitative time series – that is, quantified. The simplest method of obtaining a quantitative time series from the qualitative responses of business tendency survey respondents is to derive balance statistics for the observed changes:

$$BA_t = A_t^1 - A_t^3 \tag{1}$$

and for expectations:

$$BP_t = P_t^1 - P_t^3. \tag{2}$$

More sophisticated quantification procedures are classified into probabilistic and regressive approaches (for a concise review of basic quantification methods and their modifications, see [Tomczyk 2011]; for a more detailed description, see [Pesaran 1989]). In Section 4, two versions of the regression method are used to quantify business survey data: Anderson's [1952] and Thomas' [1995] models.

Not all of the expectations series collected in the RIED business tendency survey can be subjected to an analysis of rationality; only those with well-defined counterparts in official statistical reporting can be submitted to quantification. Of the eight questions included in the monthly survey directed to industrial enterprises, four can be quantified on the basis of Central Statistical Office (CSO) data: level of

[2] Previous studies based on RIED survey data [Tomczyk 2008] show that expectations series defined for three and four-month forecast horizons are very similar; in this paper, the three-month horizon is used.

production, prices of produced goods, level of employment and general situation of the economy. For the remaining sections of the survey (that is questions pertaining to levels of orders and export orders, stocks of finished goods, and financial standing of an enterprise) the data needed for quantification procedures is not available in Polish official statistical reporting on a macroeconomic level.

Furthermore, to evaluate the sensitivity of rationality tests to data vintage, data revisions in the time series corresponding to the quantified time series have to be present. Of the four survey questions mentioned above, there are no revisions in CSO data on producers' price index (other than regular changes of the base) or levels of employment, and revisions in the volume index of industrial production sold as a measure of the general situation of the economy are small enough not to cause any difference between the quantified time series obtained on the basis of RTV and EOS data [Tomczyk 2015]. Therefore one variable of interest remains: the volume index of production sold as an equivalent of question number 1 in the RIED survey. This variable and its revisions are described in more detail in Section 3.

Rationality tests constitute a significant part of the economic research on expectations. The bulk of both theoretical and empirical literature centers on the Rational Expectations Hypothesis (REH), introduced in 1961 by J.F. Muth.[3] He defines expectations as rational if, being educated forecasts of future values of economic variables, they are equal to the expected values of these variables as reflected in predictions formed on the basis of the relevant economic theory. REH postulates that economic agents make use of all available (and pertinent) information in a timely and effective manner, and that they understand their environment well enough to correctly predict its future behavior.

Of the several properties that expectations should exhibit to be compatible with Muth's Rational Expectations Hypothesis, two have been regularly tested in empirical literature: the unbiasedness of expectations, and the orthogonality of expectations errors to information available at the moment the expectations were formed (usually abbreviated to "efficiency").

To test for unbiasedness, a procedure based on unit root tests of expectations and the corresponding observed time series has been used in empirical tests of the rationality of expectations. A preliminary condition for the expectations series being unbiased predictors of the observed series is that they are integrated on the same order [Maddala, Kim 1998]. If so, the second condition may be tested: whether the expectations and realized changes in production are cointegrated, and whether the cointegrating parameter is equal to one [Da Silva Lopes 1998].

In short samples, the so-called Mincer-Zarnowitz unbiasedness test [Mincer, Zarnowitz 1969] is employed, with the null hypothesis H_0: $\gamma = 0$, $\mu = 1$, tested on the basis of the following equation:

[3] A detailed description of REH, a discussion of its implications for policy, and the properties of rational expectations are presented in [Pesaran 1989].

$$y_t = \lambda + \mu \cdot y_t^E + \varepsilon_t \tag{3}$$

where y_t is observed and y_t^E – expectations time series.

Unbiasedness tests are considered to be very sensitive to measurement errors and are often supplemented with tests of orthogonality (sometimes also called informational efficiency) of expectations errors with respect to freely available information [Pesaran 1989; Da Silva Lopes 1998]. An orthogonality test consists in testing the null hypothesis H_0: $\kappa_1 = \kappa_2 = \ldots = \kappa_k = 0$ in the following equation:

$$y_t - y_t^E = \kappa_0 + \kappa_1 \cdot x_{1t} + \kappa_2 \cdot x_{2t} + \ldots + \kappa_k \cdot x_{kt} + \theta_t \tag{4}$$

where y_t stands for observed values, y_t^E – for expectations series, and x_{1t}, …, x_{kt} – for variables that belong to the respondents' information set. Tests of orthogonality are classified as weak when the information set includes only lagged values of variable being forecasted, or strong when the information set contains additional exogenous variables. In this paper a strong version of the hypothesis is tested with explanatory variables that can be reasonably identified as included by the survey respondents in the information set at the moment of expressing expectations.

3. Industrial production and data revisions

Analyses of industrial production are typically based on the volume index of production sold in manufacturing provided by the Central Statistical Office (CSO). In Poland, systematic data revisions in the past two decades were due to changes in the base period for the index in 2004, 2009 and 2013. In January 2013, the value of reference was set as the average monthly industrial production of 2010. To extend the sample, observations dating back to January 2005 were recalculated with the 2010 base.

Apart from revisions reflecting updates of the base period, there are frequent corrections of last month's value of production index. In the period of January 2005 – April 2015 (124 observations), there are 32 downward revisions (that is the initial value was larger than the final value), 52 upward revisions, and 40 cases of no revision. The corrections are small in absolute values (up to 0.5 percentage point) but frequent enough to pose the question whether they influence the results of the empirical analyses based on the original and revised data.

For the purpose of comparing data vintages, a dependent variable in quantification models (that is changes in the volume of industrial production) may be based on either RTV or EoS data. Previous research [Tomczyk 2014], shows that quantification models estimated with dependent variables defined with respect to the last month exhibit unsatisfactory statistical properties. It seems likely, however, that respondents evaluate current changes in production against recent averages, and one quarter appears a plausible observation horizon. Let P_t^{RTV} stand for initial (RTV)

data and P_t^{EoS} – for revised (EoS) data on the volume index of industrial production sold. To analyze changes in industrial production (in accordance with the questions presented to respondents in the RIED business tendency survey), let us define

$$P_t^{RTV-AV} = \frac{IP_t^{RTV}}{\frac{1}{3}\sum_{s=1}^{3} IP_{t-s}^{RTV}} - 1 \tag{5}$$

for real time data and

$$P_t^{EoS-AV} = \frac{IP_t^{EoS}}{\frac{1}{3}\sum_{s=1}^{3} IP_{t-s}^{EoS}} - 1 \tag{6}$$

for end-of-sample data. Formulas (5) and (6) reflect changes in the volume of industrial production sold as compared to the average calculated on the basis of the last three months, for real time and end-of-sample data.

4. Results of quantification procedures

The first hypothesis stated in the Introduction stipulates that EoS values should be better matched than RTV series in the quantification models as survey respondents intend to forecast final rather than preliminary data, subject to corrections. To verify this hypothesis, two quantification models, Anderson's and Thomas', are used in this paper.

In Anderson's [1952] model, the following equation is estimated:

$$_t x_{t+1} = \alpha \cdot A_t^1 + \beta \cdot A_t^3 + \nu_t , \tag{7}$$

where $_t x_{t+1}$ describes relative changes in the value of variable x noted in the official statistic between t and $t + 1$. Assuming that the same relationship holds true for the expectations reported in surveys, and that the error term in equation (7) meets standard OLS assumptions, parameters α and β are estimated, and the quantitative measure of expectations is constructed on the basis of the following equation:

$$_t \hat{x}_{t+1} = \hat{\alpha} \cdot A_t^1 + \hat{\beta} \cdot A_t^3 , \tag{8}$$

where $\hat{\alpha}$ and $\hat{\beta}$ are OLS-estimators of (7) and reflect the average change in variable $_t x_{t+1}$ for respondents expecting, respectively, an increase and decrease of dependent variable.

A modification of the general Anderson model was proposed by D.G. Thomas in 1995 to allow for a special case in which the normal or typical situation that respondents compare their current situation to includes a certain growth rate, making downward corrections more essential than upward:

$$_t x_{t+1} = \gamma + \delta \cdot A_t^3 + \xi_t, \tag{9}$$

where $\beta < 0$, and constant γ is interpreted as the typical growth rate. Thomas' quantitative measure of expectations is given by the formula

$$_t \hat{x}_{t+1} = \hat{\gamma} + \hat{\delta} \cdot P_t^3, \tag{10}$$

where $\hat{\gamma}$ and $\hat{\delta}$ are estimates obtained on the basis of equation (9). Thomas's model reflects the assumption that the behavior of economic agents depends on the growth rate of a variable (usually production or prices – hence the applicability for volume index of production) that the enterprise typically observes, and limits the degree of multicollinearity which often emerges in Anderson's model (7). Additionally, HAC standard errors are usually used to account for possible serial correlation and/or heteroskedasticity of the error term in equations (7) and (9).

Tables 1 and 2 present the results of the quantification procedures obtained for two data vintages: RTV and EoS with dependent variables defined by (5) and (6). All quantification models are estimated on the sample of January 2005 – April 2015 (124 observations) by OLS with HAC standard errors to account for possible serial correlation and unstable variance of the error term, due to inertia in processes describing the behavior of macroeconomic variables and probable learning patterns imbedded in the expectations formation processes.

Table 1. Anderson's quantification model (7): estimation results

Coefficient estimate / measure	Real time data	End-of-sample data
$\hat{\alpha}$	0.295	0.295
t-Student *p*-value	2.11e-09	2.28e-09
$\hat{\beta}$	−0.255	−0.255
t-Student *p*-value	2.60e-05	2.96e-05
centered R^2	0.272	0.271
AIC	804.500	804.731
RESET *p*-value	0.272	0.284

Source: own calculations.

The results presented in Tables 1 and 2 do not confirm the preliminary hypothesis that the final (EoS) dataset is more appropriate for quantifying expectations on changes in industrial production as the models estimated for the two data vintages are very similar. For both data vintages and both quantification models, all the estimated parameters exhibit correct signs and are different from zero at a 0.01 significance level. In all four cases, the RESET test does not lead to the rejection of the null hypothesis of correct specification, and the coefficients of determination

Table 2. Thomas' quantification model (9): estimation results

Coefficient estimate / measure	Real time data	End-of-sample data
$\widehat{\gamma}$	12.707	12.675
t-Student *p*-value	1.86e-07	2.13e-07
$\widehat{\delta}$	−0.447	−0.445
t-Student *p*-value	1.75e-05	2.03e-05
centered R^2	0.224	0.223
AIC	809.103	809.443
RESET *p*-value	0.603	0.626

Source: own calculations.

of the models are acceptable. To find a basis for selecting either Anderson's or Thomas' models for further analysis, let us note that the correlation coefficients between explanatory variables in Anderson's equations, both based on RTV and EoS data, are equal to approximately −0.87. While not high enough to introduce serious multicollinearity, in the face of the lack of other criteria, let us select Thomas' equations as more reliable.

To assess if minor differences in estimated parameters influence the results of rationality tests, expectation series for both data vintages have been constructed: E_t^{RTV} for real time data and E_t^{EoS} for end-of-sample data. In Sections 5 and 6, the analysis is continued with expectations series constructed on the basis of the two data vintages.

5. Unbiasedness of expectations

The results of the Augmented Dickey-Fuller test of nonstationarity of expectations series (E_t^{RTV}, E_t^{EoS}) and the observed changes in industrial production ($P_t^{RTV–AV}$, $P_t^{EoS–AV}$) are presented in Table 3. All test equations have been estimated with a constant and maximum lag set to 12 on the basis of the modified AIC criterion.

Table 3. Results of nonstationarity tests for expectations and observed production series

Variable	ADF *p*-value for levels	ADF *p*-value for first differences	Order of integration
Expectations series E_t^{RTV}	0.1208	0.2982	I(2) or higher
Observed variable $P_t^{RTV–AV}$	0.2212	4.90e-018	I(1)
Expectations series E_t^{EoS}	0.1208	0.2980	I(2) or higher
Observed variable $P_t^{EoS–AV}$	0.2260	2.83e-018	I(1)

Source: own calculations.

It is clear from Table 3 that the order of integration of the observed production series and their corresponding expectations do not coincide. The preliminary condition for expectations series being unbiased predictors of the observed series is therefore violated. Since the sample is not large, the standard unbiasedness is also performed; that is, hypotheses $\lambda_i = 0$, $\mu_i = 1$ for $i = 1, 2$ are tested in the following equations:

$$P_t^{RTV-AV} = \lambda_1 + \mu_1 \cdot E_{t-3}^{RTV} + \varepsilon_{1t} \tag{11}$$

and

$$P_t^{EoS-AV} = \lambda_2 + \mu_2 \cdot E_{t-3}^{EoS} + \varepsilon_{2t} \tag{12}$$

in which the explanatory variables have been lagged three months to account for the 3-month forecast horizon specified in RIED business tendency surveys. Models (11) and (12) have been estimated by OLS with HAC standard errors, and the results of the unbiasedness tests are reported in Table 4.

Table 4. Results of unbiasedness tests

Data vintage	*p*-value for restriction
Real time data	H_0: $\lambda_1 = 0$, $\mu_1 = 1$ in (11) $p = 0.000$
End-of-sample data	H_0: $\lambda_2 = 0$, $\mu_2 = 1$ in (12) $p = 0.000$

Source: own calculations.

In both cases, the null hypotheses of unbiasedness are rejected at any significance level. It follows that expectations concerning changes in volume of industrial production are biased, and therefore not rational, for both EoS and RTV data.

6. Efficiency of expectations

The efficiency hypothesis (more precisely, the hypothesis of orthogonality of expectation errors with respect to the information set available at the moment that expectations were formed) can only be tested conditionally on a selected information set. Initially the following elements of the information set have been considered, lagged one to three months on the basis of previous empirical results which suggest a three-month forecast horizon for the respondents of the RIED business tendency surveys [Tomczyk 2008; 2011]:

- changes in volume of industrial production P_t (that is, forecasted variable),
- price index of sold production of industry in manufacturing PPI_t, measured as compared to the corresponding period of the previous year = 100,
- average paid employment in the enterprise sector in manufacturing $EMPL_t$.

In cases when both RTV and EoS data are obtainable, real time values are used because they are available to business tendency survey respondents in real time, as they express their expectations. The initially assumed number of lags had to be limited, however, due to the multicollinearity of the explanatory variables, to 1 for the employment variable and 2 for the remaining two variables. After imposing these bounds, the maximum variance inflation factors, equal to 10.5, tie variables PPI_{t-1} and PPI_{t-2}; they are judged acceptable in the light of the economic importance of the lagged information on the prices of the industrial products for industrial production itself. Finally, for RTV data the following model is estimated:

$$P_t^{RTV-AV} - E_{t-3}^{RTV} = \kappa_0 + \kappa_1 \cdot P_{t-1}^{RTV-AV} + \kappa_2 \cdot P_{t-2}^{RTV-AV} + \kappa_3 \cdot PPI_{t-1} + \kappa_4 \cdot PPI_{t-2} + \\ + \kappa_5 \cdot EMPL_{t-1} + \theta_{1t} \tag{13}$$

and for end-of-sample data:[4]

$$P_t^{EoS-AV} - E_{t-3}^{EoS} = \varpi_0 + \varpi_1 \cdot P_{t-1}^{EoS-AV} + \varpi_2 \cdot P_{t-2}^{EoS-AV} + \varpi_3 \cdot PPI_{t-1} + \varpi_4 \cdot PPI_{t-2} + \\ + \varpi_5 \cdot EMPL_{t-1} + \theta_{2t}. \tag{14}$$

Equations (13) and (14) have been estimated by OLS with HAC standard errors. The results of the orthogonality tests are presented in Table 5.

Table 5. Results of orthogonality tests

Data vintage	*p*-value for restriction
Real time data	H_0: $\kappa_j = 0$ for $j = 1, \ldots, 5$ in (13) $p = 0.000$
End-of-sample data	H_0: $\omega_h = 0$ for $h = 1, \ldots, 5$ in (14) $p = 0.000$

Source: own calculations.

The results listed in Table 5 establish that the null hypothesis of insignificance of explanatory variables is rejected in both models. It follows that the RIED business tendency survey respondents do not efficiently make use of the available information, regardless of the data vintage, namely both lagged production variables and the employment variable prove statistically significant in equations (13) and (14). It seems that when forming their expectations pertaining to the volume of industrial production, the survey respondents do not take these variables into account even though this information is easily available. On the other hand, information on price index seems to be included in the expectations forming process.

[4] For clarity, the parameters in equation (14) are written as ω's rather than κ's to avoid being confused with equation (13).

7. Conclusions

In this paper, the sensitivity of the properties of the expectations time series was tested with respect to data vintage. Its main motivation was to evaluate the necessity of compiling separate EoS and RTV data sets for the purpose of testing the rationality of expectations as measured by business tendency surveys. The volume index of production sold in manufacturing, and the corresponding data obtained from business tendency surveys, were employed in the empirical part of the paper.

Of the two detailed hypotheses, one was rejected. There are no statistically significant differences between the quantification results obtained on the basis of RTV and EoS data even though the use of EoS data seems, at first glance, more reasonable. The second hypothesis was confirmed: the results of unbiasedness and orthogonality tests are not influenced by data vintage. What is more, neither of the expectations series constitutes a prediction of changes in production that is unbiased or employs available information efficiently. To summarize, for the purposes of analyzing properties of expectations expressed in the RIED business tendency survey, researchers can use easily available end-of-sample data. Time-consuming compilation of real time values will not change empirical results in either an economically meaningful or statistically significant way.

Empirical studies of the impact of data revisions on expectations promise to assist economists in drawing more general conclusions on behavior and properties of expectations series, including predictive quality, unbiasedness and the efficient use of available information. Analyses of the impact of data vintage on the properties of expectations should be continued with the following points suggested for further study:

- Are there revisions in the RIED business tendency survey data? Do they influence the results of expectations tests, and to what extent?
- Will more sophisticated quantification models point to discrepancies between the expectations time series constructed on the basis of EoS and RTV data?
- Will the results based on the volume index of industrial production be confirmed on a broader set of variables?

References

Anderson O., 1952, *The business test of the IFO-Institute for Economic Research, Munich, and its theoretical model*, Revue de l'Institut International de Statistique, 20, pp. 1-17.

Croushore D., 2012, *Forecast bias in two dimensions*, Federal Reserve Bank of Philadelphia Working Paper, no. 12-9.

Da Silva Lopes A.C.B., 1998, *On the 'restricted cointegration test' as a test of the rational expectations hypothesis*, Applied Economics, 30, pp. 269-278.

Maddala G.S., Kim I.-M., 1998, *Unit Roots, Cointegration, and Structural Change*, Cambridge University Press, Cambridge.

Mincer J.A., Zarnowitz V., 1969, *The Evaluation of Economic Forecasts*, [in:] Mincer J. (ed.) *Economic Forecasts and Expectations*, NBER, New York.

Muth J.F., 1961, *Rational expectations and the theory of price movement*, Econometrica, 29, pp. 315-335.

Pesaran M.H., 1989, *The Limits to Rational Expectations*, Basil Blackwell, Oxford.

Thomas D.G., 1995, *Output expectations within manufacturing industry*, Applied Economics, 27, pp. 403-408.

Tomczyk E., 2008, *Racjonalność oczekiwań polskich przedsiębiorców: reguła czy wyjątek? Wnioski z testu koniunktury IRG SGH*, [in:] Adamowicz E. (ed.), *Koniunktura gospodarcza – 20 lat doświadczeń Instytutu Rozwoju Gospodarczego SGH*, Prace i Materiały IRG SGH.

Tomczyk E., 2011, *Oczekiwania w ekonomii. Idea, pomiar, analiza*, Oficyna Wydawnicza SGH, Warszawa.

Tomczyk E., 2013, *End-of-sample vs. real Time Data: Perspectives for Analysis of Expectations*, [in:] Walczyk K. (ed.), *Expectations and Forecasting*, Prace i Materiały Instytutu Rozwoju Gospodarczego SGH no. 93, Warsaw School of Economics, pp. 45-69.

Tomczyk E., 2014, *Influence of data vintage on quantification of expectations*, Applied Econometrics Papers, no. 14-04.

Tomczyk E., 2015, *Quantification of expectations for general economic situation with data revisions*, paper presented at the CIRET/KOF/RIED SGH Workshop on Economic Cycles and Uncertainty, October 2015, Warsaw; accepted for publication in Prace i Materiały Instytutu Rozwoju Gospodarczego SGH, Warsaw School of Economics.