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COMPARISON OF SURVEY EXPECTATIONS SERIES WITH NON-RESPONSE AND VARIOUS WEIGHTING SCHEMES

A b s t r a c t. Expectations concerning key economic variables certainly influence decisions undertaken by economic agents. Since assumption of rationality forms the basis of neoclassical economic theory, question of whether expectations of industrial enterprises are indeed formed rationally deserves careful attention. In this paper, we analyze two basic properties of expectations rational in sense introduced by J. F. Muth – that is, unbiasedness and orthogonality – taking into account issue of non-response and weighting schemes. We find that rationality of expectations of Polish industrial firms is not sensitive to these factors. Independently from non-response and weighting issues, expectations concerning relative changes in production remain unbiased but not efficient with respect to freely available information.

K e y w o r d s : expectations, rationality, tendency surveys, survey data, qualitative data, non-response, weighting.

1. INTRODUCTION

Economic agents are usually assumed to be rational; and while the term itself is variously defined, ranging from strict to bounded to imperfect rationality, the rationality assumption remains at the core of modern economics. Yet its accuracy and realism are often called into question, and tests of rationality constitute a major branch of modern economic research.

In this paper, we analyze properties of rational expectations, as introduced in 1961 by J. F. Muth, taking several weighting systems and non-response issues into consideration. Direct data on expectations are available mainly through business tendency surveys. Non-response problem is present in almost every

survey, and one of the most visible consequence of non-response is variable structure of the sample. Weighting systems used to control for size of respondents may also introduce bias into expectations data derived from business tendency surveys. Our previous work on influence of non-response on rationality (see Kowalczyk, Tomczyk, 2008) was based on contingency tables summarizing individual-level data; now we turn to classical rationality tests and in addition to non-response problem, we also consider several weighting systems employed to scale survey data.

2. RATIONAL EXPECTATIONS HYPOTHESIS AND ITS TESTING

Tests of rationality constitute major part of the economic research on expectations; popularity of this branch of analysis is well documented in both theoretical and empirical literature. Numerous of publications focus on the Rational Expectations Hypothesis (REH), introduced in 1961 by J. F. Muth. He defines expectations as rational if, being educated forecasts of future values of economic variables, they are equal to 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 timely and effective manner, and that they understand their environment well enough to correctly predict its future behavior. While many criticisms have been aimed at REH since its introduction, majority of them citing information asymmetries, information selection and processing costs, and influence of learning processes, its importance as an empirical hypothesis subject to empirical verification has not been questioned.

Muth's formulation of REH is very general. Several specific tests of rationality of expectations have been proposed for the purpose of its empirical verification, the most common being tests of unbiasedness and orthogonality.

Expectations are considered unbiased if they do not systematically overestimate or underestimate values of an economic variable. Let ${}_t x_{t+s}$ stand for relative change in variable x between t and $t+s$, as noted in official statistics, and ${}_t x_{t+s}^e$ – expected relative change in the same period. The standard unbiasedness test of expectations is defined by the hypothesis

$$H_0 : \alpha_0 = 0, \alpha_1 = 1, \quad (1)$$

where α_0 and α_1 are parameters of the regression equation

$${}_t x_{t+s} = \alpha_0 + \alpha_1 \cdot {}_t x_{t+s}^e + \xi_t, \quad (2)$$

and error term ξ_t is assumed to be a white noise process.

Property of orthogonality is defined through expectations error, that is, difference between observed and expected values of a variable. Expectations are termed orthogonal if expectations error is uncorrelated with information available at the moment that expectations were formed; that is, all relevant information has already been incorporated into the forecast. Test of orthogonality of expectations error in relation to information set Π is described by the hypothesis

$$H_0 : \alpha_i = 0, \quad i = s, s + 1, \dots, T, \quad (3)$$

where α_i are parameters of the regression equation

$$\left({}_t x_{t+s} - {}_t x_{t+s}^e \right) = \alpha_0 + \sum_{i=t+s}^T \alpha_i z_{t-i} + \xi_t, \quad (4)$$

$z_{t-i} \in \Pi$, and error term ξ_t is a white noise process. Orthogonality tests require that elements of information set faced by economic agents (that is, variables z_{t-i}) be specified. In empirical setting, they include arbitrarily selected set consisting of series that are likely to have been considered relevant by economic agents. If expectation errors are not orthogonal to freely available and relevant information, then forecasting process may be interpreted as inefficient because expectations could be improved by incorporating information provided by variables z_{t-i} .

Standard approach to evaluating REH is based on tests if observed expectations series fulfill conditions for unbiasedness (1) and orthogonality (3). Before tests of these properties can be undertaken, expectations series ${}_t x_{t+s}^e$ must be obtained – typically on the basis of survey data or, rarely, controlled experiments. Empirical analysis presented in this paper is based on data obtained through business tendency surveys by the Research Institute for Economic Development (RIED) at the Warsaw School of Economics.

In Poland, subject of rationality of economic agents emerged along with transformation of Polish economic system from centrally planned to market economy in the early 1990-ties. Tests of properties of REH carried out on Polish data on expectations provided results similar to those obtained from research conducted in the United States and Western Europe, that is, sensitive to several factors and not leading to unambiguous results (see Osińska, 2000; Łyziak, 2003; Tomczyk, 2004, 2008).

In this paper, we aim to re-address the issue and to contribute to the still relatively new field of tests of rationality for Polish economic agents. In addition to testing properties exhibited by expectations rational in the sense introduced by J. F. Muth, we consider two additional dimensions: problem of non-response in business tendency surveys that supply expectations data, and weighting systems employed to adjust the original data for differences in respondent size. Both issues are described in detail in our forthcoming paper (Tomczyk, Kowalczyk, 2009); here we present the summary of empirical results.

3. DESCRIPTION AND QUANTIFICATION OF RIED SURVEY DATA

Data on expectations of Polish industrial enterprises have been collected since 1986 by the Research Institute for Economic Development (RIED) at the Warsaw School of Economics through business tendency surveys. Launched for manufacturing industry, currently they also cover households, farming sector, exporters, construction industry, and banking sector. Empirical part of this paper is based on the monthly survey addressed to industrial enterprises. Each survey question asks respondents to evaluate both current situation (as compared to last month) and expectations for the next 3–4 months by assigning them to one of three categories: increase / improvement, no change, or decrease / decline (see Appendix 1). Aggregated survey results are regularly published and commented on in RIED bulletins along with balance statistics calculated as differences between percentage of ‘optimists’ (those who judge current situation favorably or predict improvement) and ‘pessimists’ (those who evaluate present situation unfavorably or predict decline). More formally, the unweighted balance statistics are defined for current situation evaluated by survey respondents as

$${}_t BA_{t+k} = {}_t A_{t+k}^1 - {}_t A_{t+k}^3 \quad (5)$$

and for expectations as

$${}_t BP_{t+k} = {}_t P_{t+k}^1 - {}_t P_{t+k}^3, \quad (6)$$

where

${}_t A_{t+k}^1$ – percentage of respondents reporting improvement between t and $t + k$,

${}_t A_{t+k}^3$ – percentage of respondents reporting decline between t and $t + k$,

${}_t P_{t+k}^1$ – percentage of respondents expecting improvement between t and $t + k$,

${}_t P_{t+k}^3$ – percentage of respondents expecting decline between t and $t + k$.¹

Empirical analysis focuses on question number 1, industrial production, for two reasons: first, production expectations influence numerous decisions of firms (among them, investment and employment levels); second, it has well-defined counterpart in official statistics which is necessary to employ quantification

¹ On the basis of previous analysis of the RIED data (see Tomczyk, 2004) we define expectations horizon as equal to three months ($k = 3$). When evaluating the current state, respondents are asked for comparison with previous month, hence for realizations $k = 1$. Percentages ${}_t A_{t+k}^2$ and ${}_t P_{t+k}^2$ refer to the “no change” category and are not used in this paper.

methods described below. Our dataset covers monthly data from January 2006 to January 2009 ($n = 37$).²

To describe expectations series analyzed, let us introduce the following notation:

A – no weighting (all respondents are weighted by 1),

B – RIED weighting (respondents are weighted by 1, 2, 3, 4 and 5 according to employment level),

C – weighting by lower limit of the employment interval (that is, by 1, 51, 251, 501 and 2001 respectively).

In addition, when consequences of non-response (specifically, its influence on variability of sample structure; see Tomczyk, Kowalczyk (2009)) are taken into account, the following alternatives are analyzed:

D – no weighting (all respondents are weighted by 1),

E – RIED weighting (respondents are weighted by 1, 2, and 3, respectively),

F – RIED weighting (respondents are weighted by 1, 2, and 4, respectively),

G – weighting by lower limit of the employment interval (that is, by 1, 51, 251, 501 and 2001 respectively).

Balance statistic employed by RIED (and in many other business surveys as well) is a very simple quantitative measure of qualitative expectations. More advanced options are offered by probabilistic and regressive quantification methods.³ In this paper, we use Anderson's model described by the following equation:

$${}_t x_{t+1} = \alpha \cdot {}_t A_{t+1}^1 + \beta \cdot {}_t A_{t+1}^3 + v_t, \quad (7)$$

where ${}_t x_{t+1}$ describes relative changes in value of variable x noted in official statistic between t and $t + 1$. Assuming that the same relationship holds true for expectations reported in surveys, and that error term in equation (7) meets standard OLS assumptions,⁴ parameters α and β are estimated, and quantitative measure of expectations is constructed on the basis of the following equation:

$${}_t \hat{x}_{t+1}^e = \hat{\alpha} \cdot {}_t P_{t+3}^1 + \hat{\beta} \cdot P_{t+3}^3, \quad (8)$$

where $\hat{\alpha}$ and $\hat{\beta}$ are OLS-estimators of (6.1) and reflect average change in variable ${}_t x_{t+1}$ for respondents expecting, respectively, increase and decrease of this variable.

² For analysis of weighting and non-response patterns, access to individual-level data was necessary. Authors wish to thank employees of the Research Institute for Economic Development (RIED) at the Warsaw School of Economics for data pre-processing to permit empirical analysis without compromising confidentiality of survey information.

³ For a concise review of basic quantification methods and their modifications see Pesaran (1989).

⁴ In practice, HAC standard errors are used to account for possible serial correlation and/or heteroskedasticity of the error term in (7).

Let us note that expectations balance statistic (6) is a special case of Anderson's expectations series (8) for $\hat{\alpha} = -\hat{\beta} = 1$.

Quantification procedure described above apply also in cases when weighted data are used and non-response taken into account.

4. EMPIRICAL RESULTS

Results of estimation of Anderson's model for series **A – G** are presented in Appendix 2. All quantification models are estimated by OLS with HAC standard errors to account for possible serial correlation of the error term (due to inertia often observed in expectations series) and heteroskedasticity (likely to result from learning patterns imbedded in expectations formation processes). Results prove to be very similar for all seven expectations series considered; neither weighting scheme nor non-response issues considered in this paper seem to influence results of quantification procedures. All explanatory variables exhibit correct signs and are statistically significant at the 5% significance level, and all models pass the RESET test of functional specification.

To verify if results of rationality tests depend on non-response or weighting schemes, all seven series **A – G** are submitted to unbiasedness test described by hypothesis (1). In each case, dependent variable $PP3_t$ is defined as currently observed relative change in industrial production as compared to three months ago; independent variable E_t represents expectations series calculated on the basis of expectations expressed three months earlier. All models are estimated by OLS with HAC standard errors; estimation results are presented in Appendix 3, Table 3. They provide evidence that all expectations series, independently from weighting systems and non-response issues considered, remain unbiased estimates of relative changes in production.

The final step in assessing whether results of rationality tests depend on abovementioned factors consists of orthogonality test defined by hypothesis (3). We define information set Π to include the following variables: $PP3$ (relative change in industrial production as compared to three months ago); AS (current state balance statistic) and PS (expectations balance statistic) because all three variables are available to industrial enterprises at no additional costs. All variables are lagged two and three months to account, on one hand, for delay in availability of the data, and on the other hand for relatively short attention span that may be expected from managers who are not professional forecasters. All models are estimated with HAC standard errors; detailed results are presented in Appendix 3, Table 4. They show that none of the expectations error series are orthogonal to the variables included in the information set, independently from weighting system

and non-response issues considered; specifically, variables $PP3_{t-3}$ and PS_{t-2} are significant in all cases. This result suggests that industrial enterprises do not efficiently use information included in these series, and incorporating them in firms' information set could improve quality of their forecasts.

5. CONCLUDING COMMENTS

We conclude that expectations concerning relative changes in industrial production expressed by Polish industrial enterprises in RIED business tendency surveys are unbiased but do not efficiently use all available information, namely, observed relative changes in production (lagged three months) and expectations balance (lagged two months). These results remain in line with previous research on the subject. Prior tests of rationality of production expectations in Poland have given mixed results, but generally exhibited unbiasedness and lack of orthogonality with respect to lagged expectations balance statistics and observed changes in production (see Tomczyk, 2004; 2008), as is confirmed in this paper.

We also found that rationality of expectations is not influenced by weighting schemes and two major problems introduced by non-response, namely, the fact that structure of the sample does not reflect the structure of the population, and that it changes in time. For every expectation series considered, results of standard rationality tests remain the same. This finding seems favorable from practical point of view because properties of expectations series analyzed in this paper appear to be insensitive to modifications of survey weighting schemes and sample structure, and therefore more reliable.

APPENDIX

Table 1. Monthly RIED questionnaire in industry

		Observed within last month	Expected for next 3–4 months
01	Level of production (value or physical units)	up unchanged down	will increase will remain unchanged will decrease
02	Level of orders	up normal down	will increase will remain normal will decrease
03	Level of export orders	up normal down not applicable	will increase will remain normal will decrease not applicable
04	Stocks of finished goods	up unchanged down	will increase will remain unchanged will decrease
05	Prices of goods produced	up unchanged down	will increase will remain unchanged will decrease
06	Level of employment	up unchanged down	will increase will remain unchanged will decrease
07	Financial standing	improved unchanged deteriorated	will improve will remain unchanged will deteriorate
08	General situation of the economy regardless of situation in your sector and enterprise	improved unchanged deteriorated	will improve will remain unchanged will deteriorate

Source: the RIED database.

Table 2. Anderson's quantification model: estimation results

	A	B	C	D	E	F	G
α	0,0014	0,0014	0,0016	0,0014	0,0015	0,0015	0,0014
β	-0,0016	-0,0016	-0,0019	-0,0015	-0,0015	-0,0015	-0,0016
centered R ²	0,1048	0,1160	0,1784	0,0977	0,0985	0,0988	0,1089
AIC	-85,2921	-85,7601	-88,4678	-85,0023	-85,0302	-85,0428	-85,4593
RESET p-value	0,894	0,598	0,171	0,861	0,873	0,877	0,679

Source: author's calculations.

Table 3. Unbiasedness test (1) with HAC standard errors

	A	B	C	D	E	F	G
H_0 p -value	0,6163	0,5367	0,5684	0,7323	0,7244	0,7226	0,5796
α_0	-0,0385	-0,0413	-0,0300	-0,0320	-0,0325	-0,0326	-0,0398
α_1	2,0340	2,1270	1,6424	1,8826	1,8894	1,8909	2,0873
adjusted R^2	0,0974	0,1206	0,1298	0,0653	0,0671	0,0676	0,1091
Akaike IC	-63,9821	-64,8619	-65,2207	-62,7897	-62,8553	-62,8741	-64,4227
RESET p -value	0,408	0,316	0,172	0,391	0,397	0,397	0,344

Source: author's calculations.

Values on grey background are not statistically different from zero at 5% significance level.

Table 4. Orthogonality test (3) with HAC standard errors

	A	B	C	D	E	F	G
H_0 p -value	0,000	0,000	0,000	0,000	0,000	0,000	0,000
adjusted R^2	0,6774	0,6681	0,5464	0,6454	0,6491	0,6495	0,6828
Akaike IC	-98,048	-97,571	-87,972	-94,095	-94,503	-94,555	-98,863
RESET p -value	0,224	0,127	0,288	0,546	0,526	0,526	0,165

Source: author's calculations.

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PORÓWNANIE ANKIETOWYCH SZEREGÓW OCZEKIWAŃ Z UWZGLĘDNIENIEM BRAKÓW ODPOWIEDZI I RÓŻNYCH SYSTEMÓW WAG

Streszczenie: Oczekiwania na temat kluczowych zmiennych ekonomicznych wywierają znaczący wpływ na decyzje podejmowane przez podmioty gospodarcze. Ponieważ założenia na temat racjonalności stanowią podstawę neoklasycznej teorii ekonomii, pytanie o stopień racjonalności cechujący polskie przedsiębiorstwa przemysłowe przedstawia interesujący empiryczny problem badawczy. W niniejszym artykule analizujemy dwie podstawowe własności oczekiwań racjonalnych w sensie zaproponowanym przez J. F. Mutha – to jest ich nieobciążoności i ortogonalności – z uwzględnieniem wpływu braków odpowiedzi na strukturę próby oraz różnych systemów wag. Wykazujemy, że własności oczekiwań polskich przedsiębiorstw przemysłowych nie są zależne od tych czynników; pozostają nieobciążone, ale nie są ortogonalne względem elementów zbioru informacyjnego (a zatem nie uwzględniają całej dostępnej informacji) niezależnie od występowania braków odpowiedzi i zastosowanego schematu wag.

Słowa kluczowe: oczekiwania, racjonalność, testy koniunktury, dane ankietowe, dane jakościowe, braki odpowiedzi, ważenie.