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THE EFFECT OF EXPECED EVENTS ON THE RESULTS OF THE FORECASTS IN ECONOMIC AND MATHEMATICAL MODELS

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Abstract. The influence of the past on the current values of economic variables and parameters of econometric models is taken into account by introducing lag variables in the model. The influence of future random events in econometrics is taken into account in the models of adaptive and rational expectations, partial adjustment, which are also reduced to models with lag variables. Econometric models with lag variables are widely used to predict the dynamics of economic processes. The influence of past values of economic variables on their current and future States is explained both by the inertia of economic processes themselves and by the inertia of thinking of economic entities. At the same time, expectations of future changes in the economic situation cannot but affect the results of forecasting. Past and future are equal in their influence on economic processes. Expectations of future changes are also reflected in the statistics, which serve as the basis for the construction of econometric forecast models. Assuming that the expectations of future changes in the economic situation will remain the same as they were when sampling the statistical data used for the specification of the econometric model, the so-called f-lag variables are introduced, which, unlike lag variables, are one or more time intervals ahead of the current variables. Taking these expectations into account on the basis of introduction of f-lag (future values) variables in the model, as shown by the results of econometric modeling on several examples, significantly improve the statistical significance of the model and reduce the prediction error.

Keywords: econometric models, expectations, forecasting, f-lag variables.

Forecasting the dynamics of economic processes is an important component of such science as econometrics. The importance of this task distinguishes econometrics among many Sciences, as it tries to look into the future and overcome uncertainty and chance, which are the fundamental properties of our world. However, despite the huge number of studies in this area, the use of increasingly complex mathematical models, big data and supercomputers, the methodological foundations of econometrics in recent decades have not undergone any significant changes. It is still based on classical (frequency) probability and mathematical statistics based on data from the past.

According to the classical definition, the probability of an event is equal to the ratio of the number of favorable outcomes to the total number of possible outcomes. However, in an economy it is impossible to determine the ratio of the number of favorable events that contribute to the emergence of any economic event, for example, an increase in the value of a financial instrument, to the total number of events. Therefore, the classical notion of probability of occurrence of economic events, so to speak, are not always applicable to the substantiation of economic-mathematical models. There are other concepts of probability than frequency, such as the subjective probability of Bayes, which is fully consistent with economic concepts. Nevertheless, it is the classical definition of probability that is mainly used in econometric modeling.

This fact, along with others, lead a number of researchers to the conclusion that econometrics without changing the basic paradigm, in principle, cannot solve the above problem. The most prominent and visionary economists have long criticized econometrics. The great American economist Keynes, well-known economists Warswick, Hendry, V. Leontiev, representatives of the Austrian

school of Economics criticized econometrics [1-4].

In his book "the Black Swan" N. N. Taleb [5] writes "Then I looked at all the scientific work and the dissertation which has managed to unearth. None of them has conclusive evidence that economists (as a community) are able to make predictions; and if they are sometimes able to, their predictions are only slightly better than random — serious decisions cannot be made on their basis."

However "if the stars are lit, it means that someone needs it", that is, despite all the difficulties and the lack of accurate knowledge, econometrics is in demand and has many useful achievements, as well as in something similar to it the science of meteorology. If we agree with Friedman's statement [6] that realism is not an end in itself in the economic model, the utility of the model is determined only by the degree of compliance of its conclusions with real observations. However, it cannot be denied that any economic process is subject to random events, so that simulation results always contain uncertainty and error.

Terminology and definitions of probability of occurrence of a random event, adopted in the theory of frequency probability, can be used in other, more adequate theories of probability of random events, including in the socio-economic sphere, but they need to give a different explanation and interpretation.

Various random events can also be combined into separate groups, such as expected random events and so-called "black swans".

The influence of "black swans", that is practically unpredictable future random events, on the results of mathematical modeling of economic processes, is not actually considered in economic theory and practice [5].

If we do not take into account the impact of natural random events on economic processes, perhaps with the exception of climate, the subjective probabilities of random events associated with human activity can be estimated within acceptable limits. This, in particular, is the basis of insurance activities. In this regard, a large role belongs to the expected random events, which from the point of view of economic entities can happen with one or another probability within certain limits. By anticipating changes in the economic situation in the light of their perceptions of the future, people are turning these expectations into a powerful factor influencing the course of events. Sometimes it comes to the fact that a different event occurs only because it is expected by the actors operating in the economy.

Some studies have identified three types of expectations: static, adaptive, and rational. The first are used mainly in Keynesian concepts, the second – in monetarist, the third – in neoclassical concepts [7,8,].

Static expectations mean that in the future economic actors are guided by the same parameters of the market that take place in the present.

Adaptive expectations correspond to the assumptions of economic entities about future changes in the parameters of the economic situation while maintaining its overall configuration, that is, the absence of its qualitative changes. Economic agents only adjust their behavior. Rational expectations assume that economic agents form their plans and build their behavior based on the analysis of all available information at the moment. Rational economic actors not only take into account the mistakes of past experience, but also look to the future. This allows them to anticipate future changes fairly accurately in the absence of unexpected shocks. For example, entities, when making their forecasts about the future price level in stock or commodity markets, do so in the same way as the market determines the actual prices.

Decisions about purchases or sales are made based on expectations of prices in the future, and these prices, in turn, depend on current decisions about purchases or sales. The situation is not so obvious when it comes to commodity markets, where supply is highly dependent on production and demand is dependent on consumption. But in the financial market the role of expectations is almost obvious.

Econometric models that meet these expectations are called partial adjustment, adaptive and rational expectations models. These models assume that the future values

of the variables are linearly related to the past and present values of the variables. Ultimately, these models are reduced to models of autoregression with lag variables [9].

Taking into account the impact of possible future expected events on the explained characteristics of socio-economic processes is an actual direction of the study. The problem of accounting and evaluation of the probability of occurrence of a random event in the insurance business is particularly relevant.

In physical experiments it is possible not to take into account influence of future expected events, but in models of economic processes it leads to incorrect conclusions. Suppose that economic agents expect a stable economic situation in the future that is no different from the present. That is, we consider the situation with static expectations.

As an example, consider the event "buying shares in the financial market". The price of a share at which an investor wants or can buy it changes under the influence of events external or internal to it. These events can occur now, be in the past or relate to the future. For example, an investor makes a decision based on a mental and then a formal model. Then these assumptions about the future situation affect the characteristics of the model. Since everything is interconnected in the world, the events of the past, present and future form a graphical probabilistic model. As an example, such a graphical network model, which presents the characteristics of the share price-Y (endogenous variable) and the events affecting it – Xi(explaining variables) is shown in Fig. 1.

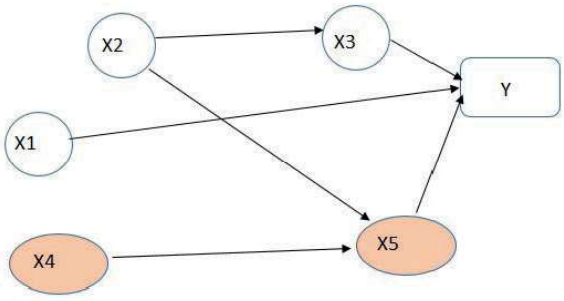

Fig. 1 Multiple events and their cause-and-effect relationships

Here:X1, X2, X3 – events that have already occurred; X3, X4 – events that are likely to occur; Y-the resulting event (endogenous variable).

In the above diagram, past and future events are completely equal in terms of their impact on the explained variable. This, by the way, was understood by Einstein, who said that "for us, convinced physicists, the difference between the past, the present and the future is no more than an illusion, although it is very stable" [10].

In this example, we can obtain only probabilistic estimates of the simulation results, which, in turn, depend on the probabilistic characteristics of samples of past events and the probabilities of future (expected) events. Statistical data on past events (changes in factors X1, X2, X3) are samples on the basis of which the model parameters are estimated in classical econometrics (for example, using the least squares method).

Forecasting of the future on the basis of classical econometric models is based on statistical processing of data of past observations of values of economic variables and the assumption that the state of economic space does not change fundamentally. Currently, however, comes the understanding that the future influences the present-day realities and take economic and political decisions. This means that the assumption of a person or society about the future began to predetermine their current behavior. This point is key, because in this case not only the past determines the present, but also the future affects the present. Thus, in the econometric model in its generalized form there should be both variables related to the past and variables related to the future. We will call such variables f-lag [11,12]. The use of f-lag variables suggests that expectations of the future imply a slight deviation from the past and this affects the present.

To confirm the hypothesis about the influence of the expected future random events, as an example, consider a time series describing monthly milk production in England for the period from January 1962 to may 1975, Changes of volume of milk production are random events. The corresponding graph is shown in Fig. 2.

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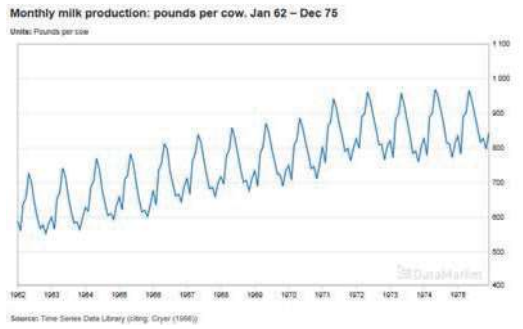

Fig. 2 Dynamics of milk production.
Source: Time Series Data Library (citing Cryer (1986))

We evaluate the quality of three econometric models describing this process:

1-linear: Yt = a0 + a1*t +et, excluding lag and f-lag variables

2-lag: Yt = a0 + a1*t + a2*Yt-1 with lag variable,

3-with the inclusion of the f-lag variable in the model

Yt = a0 + a1*t + a2*Yt-1 + a3* Yt+1

The latter model includes, in addition to the lag variable Yt-1, the variable Yt+1, which we call f-lag [12,13].

When evaluating the parameters of these models using the Regression function from the Excel data Analysis package, the following results are obtained (Table. 1).

Table 1

Parameter estimates of the three models

№ models	Coefficients	The Number of Fisher	Standart error	t-statistics
1.	611,68 1,69	306	60,7	t_1=64,9; t =17,5
2.	173,01 0,459 0,721	395	42,4	t_1=5,1; t_2=3,9 t_3= 13,2;
3.	8,83 -0,26 0,08 0,50	499	32,1	t_1=-0,3; t_2=3,9; t_3= 11,1; t_4= 11,2

From the data presented in the table, it is obvious that the best model is one that takes into account both lag and f-lag variables, both of which are actually equal: they have almost the same coefficients and student fractions. Similar studies have been carried out with other time series, in particular with the time series shown in Fig. 3 and Fig.4.

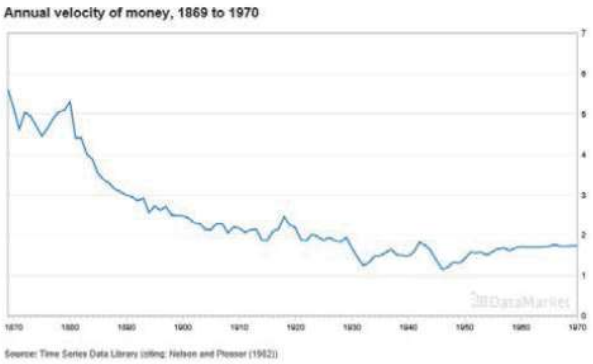

Fig.3 Dynamics of the rate of change of the money supply
Source: Time Series Data Library (citing:Cryer (1986))

Table 2

The model parameters with and without f-a lag variable

Without f-lag variable		With f-lag variable	
Multiple R^2	0,975	Multiple R^2	0,987
Standard error	0,173	Standard error	0,129
Observations	101	Observations	100

Table 3

The model parameters with and without f-a lag variable

Without f-lag variable		With f-lag variable	
Multiple R^2	0,938	Multiple R^2	0,984
Standard error	0,86	Standard error	0,63
Observations	51	Observations	50

Fig. 4 Dynamics of the closing price of the stock AT & T
Source: Time Series Data Library (citing: Cryer (1986)

SUMMARY

The presented results of comparison of time series models without f-lag variables and with them suggest that the use of f-lag variables in time series in some cases contributes to improving the quality of forecasting (standard error decreases). This fact also confirms the assumption that the economic and mathematical model takes into account the expectations of the future and improves its realism and quality.

Naturally, the assumption of the close identity of the past and the future, necessary to justify the use of the f-lag variable in the model, is a rather serious simplification of reality, but, nevertheless, in some cases it is useful.

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