EJ
Expert Journal of Economics (2014) 2, 69-79

ISSN 2359-7704
Economics.ExpertJournals.com

Partially Unforeseen Events. Corrections and Correcting Formulae for Forecasts

Alexander HARIN*

Modern University for the Humanities, Russia

A hypothesis of uncertain future was created and first applied in the field of utility and prospect theories. An extension of application of the hypothesis to the field of forecasting is considered in the article. The concept of inevitability of unforeseen events is a part of the hypothesis of uncertain future, namely of its first consequence. Partially unforeseen events and their role in forecasting are analyzed. Possible applications of the hypothesis in the field of forecasting are considered. Generally, preliminary preparations of forecast corrections are shown to be able, under specified conditions, to quicken the revisions of forecasts after partially unforeseen events have occurred. Particularly, correcting formulae for forecasts are proposed, including additive-multiplicative formulae. The hypothesis of uncertain future, its consequences and their possible applications are briefly reviewed.

Keywords: *forecast, uncertainty, risk, utility, Ellsberg paradox*

JEL Classification: *C53; D81*

1. Introduction

The article is devoted to partially unforeseen events, to their influence on forecasting and to correcting formulae for forecasts in the context of a hypothesis of uncertain future. A brief review the hypothesis of uncertain future, foundations, consequences and applications of the hypothesis are presented. The preliminary analysis of unforeseen and partially unforeseen events is introduced, corrections of forecasts and correcting formulae for forecasts are considered.

1.1. Literature Review

The hypothesis of uncertain future and the correcting formulae for forecasts are, in a sense, pioneering works. So, the main literature consists of the works of the author of this article. Nevertheless, there are a number of works of another authors those are concerned with the item.

A deal of works has been devoted to accuracy and errors of forecasts (see, e.g., Chang, 2011; Morlidge, 2013; McAleer et al., 2008).

Influences of unforeseen, unanticipated events are discussed in the book Hendry and Ericsson Eds., (2003), in the chapters of Clements and Hendry (2006), in articles (see, e.g., Bryan, 2009; Dincer and Kandil, 2011; Lu, 2012; Hackworth et al., 2013; Hendry and Mizon, 2014) and especially in working papers (see, e.g.,

* Corresponding Author:
Alexander Harin, Modern University for the Humanities, Moscow, Russia

Article History:
Received 18 July 2014 | Accepted 29 July 2014 | Available Online 04 August 2014

Cite Reference:
Harin, A., 2014. Partially Unforeseen Events. Corrections and Correcting Formulae for Forecasts. *Expert Journal of Economics*, 2(2), pp. 69-79

Gonzalez-Hermosillo et al., 2003; Goodhart, 2004; Lahiri et al., 2010; Miller and Ni, 2010; Arbatli and Vasishtha, 2012; Ikeda, 2012; Zeev and Khan, 2013).

The prehistory of hypothesis of uncertain future is presented in Heisenberg's (1927) seminal article about uncertainty principle and in subsequent works.

The article develops earlier reports Harin (2007, 2008, 2010) an article Harin (2012) and a recent report Harin (2014).

1.2. Research Premises. An Example of Hiroshima 1945

The importance of unforeseen events and of partially unforeseen events cannot be overestimated. The unforeseen events can crucially and, sometimes, dramatically change situations. The "black swans" are an example of them. This work serves to smooth down consequences of such events.

As an example, let us suppose that in 1930-35, an imaginary estimate of risk was needed with respect to bombing for an underground factory, government bomb-proof shelter, etc. for the year 1945. Suppose, in 1930-35 the ideal forecast was made. The forecast should be based firstly, e.g., on the forecast of the maximal power of an aircraft bomb for 1945. The forecast should be based secondly, e.g., on the maximal weight that bombing aircraft can lift.

To 1945, due to the most optimistic forecasts, a bombing aircraft could lift a bombing weight much less than 20 tons and even less when calculating in trinitrotoluene equivalent. In 1945 Hiroshima was bombed by the 4-tons atomic bomb. But it was equal to 20000 tons in trinitrotoluene equivalent. So, the initial estimate of risk was catastrophically wrong.

The prerequisite of an atomic bomb (the division of uranium) was discovered in 1938. Naturally, in 1930-35 it was an unforeseen event. So, in this case the relative error, caused by the unforeseen event, is more than 1000 (more than 100000%).

If in 1938 the risk estimate was revised, then the plans and/or the realization of construction of such a factory, shelter, etc. were corrected and then their safety was saved.

1.3. Research Methodology

A hypothesis of uncertain future (see, e.g., Harin, 2007) was created initially in the field of utility and prospect theories. The first purpose of the article is to extend applications of the hypothesis to other fields.

In the field of forecasting there are problems like "black swans" and abovementioned "Hiroshima 1945". The second purpose is to analyze and, if it is possible, partially solve particular problems of the forecasting.

The research objectives correspond to both of the interrelated purposes and are:

Objective 1: A draft of a procedure of application of the first consequence of the hypothesis for particular forecasting cases.

Objective 2: Consideration of general properties of possible formulae of application of the first consequence of the hypothesis for particular forecasting cases.

Objective 3: An attempt to outline a particular formula of application of the first consequence of the hypothesis for particular forecasting cases.

The purposes and objectives are new, so, at first stages of their study, the general methods of the research are mainly qualitative.

Due to the purposes, the used data should be independent and well-established and, so, they should be the experimental results obtained by other researchers and well-known facts. The techniques of analysis of data are mainly qualitative.

This article is a theoretical one. It presents an applied research which develops the basic research (see, e.g., Harin, 2007) of the hypothesis of uncertain future. Methods of this applied research can be attributed to mainly qualitative.

In accordance with the methods of the research, the conclusions are qualitative also.

2. A Hypothesis of Uncertain Future

A hypothesis of uncertain future was presented the first time as a principle of uncertain future in a plenary report Harin (2007) for the field of utility and prospect theories. Let us review it very briefly.

2.1. Formulation of the Hypothesis

A general hypothesis of uncertain future states:

"A future event contains an uncertainty."

A special hypothesis of uncertain future (referred to as simply the hypothesis of uncertain future) states:

"The estimated probability of a future event contains an uncertainty."

Or:

"At present, we cannot actually make an absolutely exact estimate of the probability of a future event" (except imaginary cases).

2.2. Consequences of the Hypothesis

The first (in the preceding works, see, e.g., Harin, 2007), it was denoted as the second) consequence of the hypothesis:

"The present probability system of a future situation is incomplete".

Or:

"Unforeseen events are an inalienable property of the (human) reality".

Or, more particular:

Suppose: After a non-zero interval of time from the present, there will be a future situation. One can calculate the present probability system of this situation. If there will be no unforeseen events, then the total probability of the present probability system of the situation can equal one. But future unforeseen events can emerge during this interval of time. These future unforeseen events can reduce the total probability of the present probability system of the situation by a non-zero value.

The first consequence states:

"The probability of the emergence of these future unforeseen events is non-zero."

The second (in the preceding works, see, e.g., Harin, 2007, it was denoted as the first) consequence of the hypothesis:

"The greater the data dispersion (uncertainty), the smaller the probability of a future event near the probability $p \sim 1$,* and the greater can be** the probability of a future event near the probability $p \sim 0$."

Or, more particular:

"At a non-zero data dispersion, the maximal probability of a future* event is less than one by a non-zero value. If the first consequence influence** is less than the dispersion influence, then the minimal probability of a future* event is also more than zero by another non-zero value"

* This consequence may be regarded as the rigorously proved mathematical statement of the existence theorem for non-zero restrictions on probability. It holds for both future and any other event.

** Because of the first consequence, the magnitude of the low probability is decreased, but because of the second consequence, it is increased. So as a result, it can be either increased or decreased or unchanged.

2.3. Foundations of the Hypothesis. Heisenberg Uncertainty Principle

The general hypothesis of uncertain future can be formally supported by the Heisenberg uncertainty principle.

The Heisenberg uncertainty principle is one of the most distinctive aspects of quantum mechanics. It was devised by Werner Heisenberg at the Niels Bohr Institute in Copenhagen and introduced in Heisenberg (1927).

The Heisenberg's uncertainty principle states that one cannot simultaneously measure both impulse and position better than with uncertainty

$$\Delta p \times \Delta x \geq \frac{\hbar}{2} \ ,$$

where:

Δp - impulse uncertainty;

Δx - position uncertainty;

$\hbar$ - Planck's constant divided by 2π.

The Heisenberg's uncertainty principle is true for every physical object involved in a situation, including future situations. So, it supports the general hypothesis of uncertain future.

2.4. Foundations of the Hypothesis. Existence Theorems for Restrictions

Purely mathematical theorems (see, e.g., Harin, 2010, 2012) prove the probability p cannot reach 1 at the condition of a non-zero dispersion of data. The theorems are presented in a form of a sequence of lemmas and theorems:

For a finite non-negative function on an interval $[0, 1]$, an analog of the dispersion D is proved to tend to 0, when the mean M of the function tends to any border of the interval. Hence, if D is not less than a non-zero value, then the non-zero restrictions exist on M. Namely, M cannot be closer to any border of the interval, e.g., to 1, than by another non-zero value.

As far as the probability estimation corresponds to such a function and a non-zero dispersion of data takes place, then the non-zero restrictions exist on the probability estimation.

As far as the probability is the limit of the probability estimation and a non-zero dispersion of data takes place, then the non-zero restrictions exist on the probability as well.

3. Partially Unforeseen Events and Corrections of Forecasts

3.1. Fully and Partially Unforeseen Events

There is a wealth of sorts of unforeseen events. According to Caporin and McAleer (2010) these events may be represented by univariate and multivariate models depending on the numbers of the events. We may divide them also into two types: fully unforeseen events and partially unforeseen events.

Rigorously speaking, in the presence of fully unforeseen events, we cannot make any reliable forecast. In other words, "If anything can happen, then nothing can be predicted."

Therefore the partially unforeseen events are considered in this article.

3.2. A Demand of Corrections of Forecasts

Suppose the following: There is a future partially unforeseen event which has at least one unknown characteristic, e.g., time, place, volume, intensity, etc. A forecast is prepared and it is based on a selected particular value of the characteristic. The partially unforeseen event takes place with the real value of the characteristic, which differs from the selected one. If there was a possibility to prepare forward corrections of a forecast, those depend on possible particular values of the characteristic, including the real value, then the forecast can be corrected much faster than in the case of preparing a new forecast.

The first consequence of the hypothesis of uncertain future states the possibility of unforeseen events is an inalienable property of the reality. Therefore, a following conclusion may be drawn:

When the preliminary preparing of corrections (those can be used or not used) is, on the average, more effective than the preparing a new forecast after the partially unforeseen event occurs, then this forward preparing of corrections should be done.

This conclusion is evident in the content of a hypothesis of uncertain future. But in the content of the accepted view it is not. So, it should be drawn and recorded.

Let us further consider some possible forms of such corrections of forecasts.

4. General Properties of Approximation Forecasting

4.1. About the Continuity and Differentiability of Approximations

When choosing an adequately detailed time scale, the vast majority of macro-world phenomena are characterized by continuity in time. The discontinuity, the discreteness in time is observed only in quantum phenomena, for example at the birth of elementary particles. Therefore, the description of the phenomena of the macro-world by means of continuous functions is lawful.

Changes in the macro-world phenomena, that is, the acceleration in a particular dimension, requires physical movements, changes of electromagnetic fields, etc. That is, they are also characterized by continuity in time. Therefore, the description of differentiable functions is lawful for the description of the macro-world phenomena.

4.2. On the Validity of the Approximation Forecasting

So far as for the macro-world phenomena the description by differentiable functions is lawful, then the forecasts of these phenomena in the form of approximations is lawful also. In this sense we can say that the future is a continuation of the present. And we can do calculations and estimates for the prediction of future events of macro-world on the basis of data about current status and about rate of change of these phenomena. Naturally, accurate calculations are possible only for sufficiently small time intervals for which this approximation is correct. But an approximation approach is possible for longer intervals of time, as the basis for assessing possible deviations.

Of course, except of the approximation approach, other approaches may be lawful also.

4.3. The Piecewise Smooth Representation for Univariate and Multivariate Models

Let us consider a pure mathematical case of infinitely differentiable analytical forecast functions. Consider a function $F(t) : F(t)$ is infinitely differentiable and analytic in a point t_{Base} of the timeline and on the semi-closed interval $[t_{Base}, t)$.

Let us denote the Taylor series of the forecast function $F(t)$ as $F(t_{Base}, t)$

$$F(t_{Base},t) = F(t_{Base}) + \sum_{n=1}^{\infty} \frac{F^{(n)}(t_{Base})}{n!}(t - t_{Base})^n \ ,$$

where $F^{(n)}(t_{Base})$ is the n-th derivative of $F(t)$ in the point t_{Base}.

Suppose there is a rupture of an n-th $: n \geq 1$, derivative of $F(t)$ in the point $t_{Corr,1} \equiv t_1 : t_{Base} < t_1 < t$, $(t_{Corr,0} \equiv t_0 \equiv t_{Base})$, but $F(t)$ is infinitely differentiable and analytic on $(t_{Corr,1}, t)$. Then, for univariate models, we obtain

$$F(t_{Corr,1},t) = F(t_{Corr,1}) + \sum_{n=1}^{\infty} \frac{F^{(n)}(t_{Corr,1})}{n!}(t - t_{Corr,1})^n \ ,$$

where $F^{(n)}(t_{Corr,1})$ is the right-side limit of the n-th derivative of $F(t)$ in $t_{Corr,1}$.

By means of the identical transformation we obtain for $F(t)$ at $t_{Corr,1} < t$

$$F(t) = F(t_{Corr,1},t) \equiv F(t_{Corr,1},t) + F(t_{Base},t) - F(t_{Base},t) =$$
$$F(t_{Base},t) + [F(t_{Corr,1},t) - F(t_{Base},t)] \equiv F(t_0,t) + [F(t_1,t) - F(t_0,t)] \ .$$

Denoting the modification of the function $\Delta F(t_{Corr,r-1}, t_{Corr,r}, t) \equiv [F(t_{Corr,r}, t) - F(t_{Corr,r-1}, t)]$, we have

$$F(t) = F(t_{Base},t) + \Delta F(t_{Base}, t_{Corr,1}, t) \ .$$

For $R : R < \infty$, rupture points $t_r : t_{Base} \equiv t_0,\ t_{r-1} < t_r < t : 1 \leq r \leq R$, (see also Castle et al, 2012) we obtain the general piecewise smooth representation for multivariate models

$$F(t) = F(t_0,t) + \sum_{r=1}^{R} \Delta F(t_{r-1}, t_r, t) \ .$$

Suppose a set of sub-functions $\{f_{1r}(t_{r-1}, t_r, t), \ldots, f_{sr}(t_{r-1}, t_r, t), \ldots, f_{Sr}(t_{r-1}, t_r, t)\} \equiv \{f_{sr}(t_{r-1}, t_r, t)\} : S < \infty$, $f_{sr}(t_{r-1}, t_r, t_r) = 0$, of the modification of $\Delta F(t_{r-1}, t_r, t)$ exists such as $\Delta F(t_{r-1}, t_r, t)$ may be represented as $\Delta F(t_{r-1}, t_r, t) = \Delta F(\{f_{sr}(t_{r-1}, t_r, t)\})$ and $\Delta F(\{f_{sr}(t_{r-1}, t_r, t)\})$ is infinitely differentiable with respect to any $f_{sr}(t_{r-1}, t_r, t)$ and analytic on $(\{f_{sr}(t_{r-1}, t_r, t_r)\}, \{f_{sr}(t_r, t_{r+1}, t)\})$. Let us denote a differential operator

$$T = f_{1r}(t_{r-1},t_r,t)\frac{\partial}{\partial f_{1r}(t_{r-1},t_r,t)} + \ldots + f_{Sr}(t_{r-1},t_r,t)\frac{\partial}{\partial f_{Sr}(t_{r-1},t_r,t)} \ ,$$

where the derivatives are the right-side limits in the point t_r. Then we have

$$\Delta F(t_{r-1},t_r,t) = \sum_{l=1}^{\infty} \frac{T^l \Delta F(\{f_{pr}(t_{r-1},t_r,t_r)\})}{l!} \ .$$

Denoting the modification of the function $\Delta F(t_{Corr,r-1}, t_{Corr,r}, t) \equiv [F(t_{Corr,r}, t) - F(t_{Corr,r-1}, t)]$, we have

So, by means of the formal identical transformations we obtain for multivariate models

$$F(t) = F(t_0) + \sum_{n=1}^{\infty} \frac{F^{(n)}(t_0)}{n!}(t - t_0)^n + \sum_{r=1}^{R}\sum_{l=1}^{\infty} \frac{T^l \Delta F(\{f_{pr}(t_{r-1},t_r,t_r)\})}{l!} \ .$$

5. Particular Formulae for Univariate Models

5.1. General Notes

Let us further consider the case of the only rupture point, of the point of correction $t_1 \equiv t_{Corr,1} \equiv t_{Corr}$

$$F(t) = F(t_{Base},t) + \Delta F(t_{Base}, t_{Corr}, t) \ .$$

Probably, the simplest sorts of partially unforeseen events are those having only unforeseen point of time or unforeseen magnitude and being represented by univariate models. Let us consider them further.

Let us suppose a partially unforeseen event with an unforeseen magnitude and/or an unforeseen point of time has taken place at some t_{Corr}.

If we know the unit value $\delta_1 F(t_{r-1}, t_r, t)$ of modification of the function, which corresponds to the unit magnitude of the event influence, and if, at $t > t_{Corr}$, we know the point of time t_{Corr} and we may determine the magnitude M of the influence, then we may denote $\Delta F(t_{r-1}, t_r, t) \equiv M * \delta_1 F(t_{r-1}, t_r, t)$.

If we have known the correction time point t_{Corr}, then we may express the modification of the function $F(t)$ also.

So, for the partially unforeseen events with the unforeseen magnitude and point of time, we may keep the form of the expression unchanged.

5.2. Low-Order Approximations by Sub-Functions

If a rupture of an n-th (where $n \geq 1$) derivative of $F^{(n)}(t)$ in a point t_{Corr} is caused by a foreseen event, then the series of the right-hand limits of the derivatives $F^{(n)}(t_{Corr})$ may be calculated in advance and the forecast may be corrected in advance also. If this rupture is caused by a partially unforeseen event, then sometimes the forecast correction should be performed extremely rapidly.

Let us consider a case of preliminary conditions:

1) The calculation of the right-hand limits of the derivatives $F^{(n)}(t_{Corr})$ (or the explicit calculation of $F(t)$) is very complicated and needs too long time to be admissible.

2) The function $F(t)$ may be represented by means of a finite set of sub-functions $f_s(t) : s = 1, 2, \ldots, S<\infty$ as

$$F(t) = F(\{f_1(t), \ldots, f_S(t)\}) \equiv F(\{f_s(t)\})$$

and the derivatives

$$\frac{\partial^n F(\{f_s(t)\})}{(\partial f_k(t))^n}$$

of ΔF or F may be calculated in advance.

Let us suppose, that after the partially unforeseen event have taken place, the following additional condition is true:

3. The derivatives

$$F(t) = F(\{f_1(t), \ldots, f_S(t)\}) \equiv F(\{f_s(t)\})$$

are happened to do not essentially depend on specific characteristics of this partially unforeseen event and the preliminarily calculated derivatives may be used (or they may be corrected during the admissible time).

Let us suppose, that the first few L terms give sufficient accuracy of approximation. Then

$$\frac{\partial^n F(\{f_s(t)\})}{(\partial f_k(t))^n} ,$$

where Δ_{Error} is the total error. Note, that Δ_{Error+} errors can essentially differ from Δ_{Error-}. The impact of negative shocks can differ from that of positive shocks (see, e.g., Caporin and McAleer 2011).

For the first order approximation, the general formula may be easily simplified to

$$F(t) \approx F(t_{Base}) + \sum_{n=1}^{\infty} \frac{F^{(n)}(t_{Base})}{n!}(t - t_{Base})^n + \sum_{k=1}^{S} \lim_{t_{Corr}+0 \leftarrow \tau} \left(\frac{\partial \Delta F(\{f_s(t_{Base}, t_{Corr}, \tau)\})}{\partial f_k(t_{Base}, t_{Corr}, \tau)}\right) f_k(t_{Base}, t_{Corr}, t_{Corr}) \pm \Delta_{Error} .$$

It may be expressed also as the derivative of a complex function

$$F(t) \approx F(t_{Base}) + \sum_{n=1}^{\infty} \frac{F^{(n)}(t_{Base})}{n!}(t - t_{Base})^n + \sum_{k=1}^{S} \lim_{t_{Corr} \leftarrow \tau} \left(\frac{\partial \Delta F(\{f_s(t_{Base}, t_{Corr}, \tau)\})}{\partial f_k(t_{Base}, t_{Corr}, \tau)} \times \frac{\partial f_k(t_{Base}, t_{Corr}, \tau)}{\partial \tau}\right)(t - t_{Corr}) \pm \Delta_{Error} .$$

5.3. Additive-Multiplicative Formulae

Let us suppose that the modification of the forecast function $\Delta F(t_{Base}, t_{Corr}\ t)$ of an object may be exactly or approximately expressed in the form of explicit functions. These functions may be internal (relative to the object), external (relative to the object), periodic, etc, to specialize, specify unified and standardized forecasts to special, specific forecasting objects and situations. Then the modification $\Delta F(t_{Base}, t_{Corr}\ t)$ may be written in a general form as, for example,

$$\Delta F_{Corr}(t_{Base}, t_{Corr}, t) \approx \Delta F_{Corr}(\{f_{Internal,i}(t_{Corr}, t,)\}, \{f_{External,k}(t_{Corr}, t,)\}, \{f_{Periodic,l}(t_{Corr}, t,)\}, \{f_{Special,m}(t_{Corr}, t,)\}, \Delta_{Error}) ,$$

where and further:

$\{f_{internal,i}\}$ - the set of internal (relative to the object) functions;

$\{f_{external,k}\}$ - the set of external (relative to the object) functions;
$\{f_{periodic,l}\}$ - the set of periodic functions;
$\{f_{special,m}\}$ - the set of specializing, specifying, adapting, concretizing functions to specialize, specify an unified and standardized forecast to special, specific forecasting objects and situations.

The operations of addition and multiplication are, probably, the most common and important ones as in practice so in the pure mathematics (see, e.g., van der Waerden, 1976).

Let us suppose that the partially unforeseen modification of the forecast function $\Delta F(t_{Base}, t_{Corr}\ t)$ may be exactly or approximately expressed by means of additive and multiplicative functions. Here, an additive function implies a function which additively contributes to the forecast. Here, a multiplicative function implies a function which multiplicatively contributes to the forecast.

Let us consider, as a heuristic hypothesis, the following formula

$$F(t_{Base}, t_{Corr}, t) \approx \left[F_{Base}(t_{Base}, t) \times \prod_{m=1}^{M} K_{Multiplica,m}(t_{Corr}, t) + \sum_{a=1}^{A} \Phi_{Addit,a}(t_{Corr}, t)\right] \times [1 \pm \Delta_{Error}] ,$$

or, omitting the variables and indices,

$$F \approx [F_{Base} \times \prod K_{Multiplica} + \sum \Phi_{Addit}] \times [1 \pm \Delta_{Error}] ,$$

where and further:

$F(t_{Base}, t_{Corr}, t)$ - the corrected forecast for the moment t;
$F_{Base}(t_{Base}, t)$ - the base forecast for the moment t;
$\prod K_{Multiplicat,m}$ - the product from 1 to M of the multiplicative (absolute) functions (coefficients) for partially unforeseen corrections;
$\sum \Phi_{Addit,a}$ - the sum from 1 to A of the additive (absolute) functions for partially unforeseen corrections;
Δ_{Error} - the total relative error.

For the cases when

$$F_{Base}(t_{Base}, t) \times \prod_{m=1}^{M} K_{Multiplica,m}(t_{Corr}, t) \neq 0 ,$$

(preferentially for $F \sim F_{base}$) this formula may be written as

$$F(t_{Base}, t_{Corr}, t) \approx F_{Base}(t_{Base}, t) \times \left[\prod_{m=1}^{M} (1 + k_{Multiplica,i}(t_{Corr}, t))\right] \times \left[1 + \sum_{a=1}^{A} \varphi_{Addit,a}(t_{Corr}, t)\right] \times [1 \pm \Delta_{Error}] ,$$

or, omitting the variables and indices,

$$F \approx F_{Base} \times [\prod (1 + k_{Multiplica})] \times [1 + \sum \varphi_{Addit}] \times [1 \pm \Delta_{Error}] ,$$

where and further:

$\prod(1+k_{Multiplicat,m})$ - the product from 1 to M of the multiplicative (relative) functions (coefficients) for partially unforeseen corrections;
$\sum \varphi_{Addit,a}$ - the sum from 1 to A of the additive (relative) functions (normalized on $F_{Base} \times \prod K_{Multiplicat,m}$) for partially unforeseen (absolute) corrections.

5.4. Transformations

We may easily obtain the transformations between the versions of the formula.

For the multiplicative functions

$$K_{Multiplica,m} = 1 + k_{Multiplica,m} .$$

For the additive functions

$$\Phi_{Addit,a} = \varphi_{Addit,a} \times F_{Base} \times [\prod_{m=1}^{M} (1 + k_{Multiplica,m})] \ .$$

5.5. Analytical and Non-Analytical Sub-Functions

It should be noted that a following possibility cannot be excluded:

When the above formulae were first proposed and considered, the analytical sub-functions were assumed. Nevertheless, the final formulae do not impose conditions of analyticity on the sub-functions. Therefore, a possibility of use of non-analytical, general-form sub-functions cannot be excluded. Such sub-functions can be presented, e.g., in graphical or table or computer calculated forms.

Such possibility can essentially expand feasible fields of applications of the proposed formulae.

6. Possible Applications of the Hypothesis

6.1. Applications of the First Consequence of the Hypothesis. Forecasting

Currently, high-quality forecasting is a rather expensive service. The reason is that such forecasting should take into account a large number of characteristics: from the individual characteristics of the customer to the global settings. Therefore, at present, only sufficiently large teams of specialists can develop high-quality forecasts. And high-quality forecasts can be ordered only by the government or sufficiently large and rich firms, corporations.

But in the case of unforeseen events, the forecast can largely lose its value. That is, the period of possible utilization of the forecast can be shortened by such events.

However, forecasting is an integral part of almost any management process. Therefore, forecasting is a service of mass demand, but its high price prevents its widespread dissemination.

The main advantages of the correcting formulae are:

1) a much lower cost of correction for a user, after a partially unforeseen event occurs, in the comparison with a cost of a new forecast;

2) a much shorter time of correction in the comparison with a time of preparing of a new forecast.

Due to these advantages, the correcting formulae can allow, for example:

The correcting formulae for forecasts can essentially increase the possibilities of application of forecasting for medium and small business.

Government orders for the municipal needs can be one of the most promising areas for application of the correcting formulae for forecasts. Here, the combination of a wide market of forecasts, high-quality development of basic forecasts and standardization is possible. It can be especially useful, e.g., in municipal city-planning programs.

In future, the formulae can allow available orders for the needs of the individual forecasts for individuals, that is, it will make available the individual forecasting.

The formulae will allow constructing and assemblage of forecasts from building forecasting blocks, adjustment of the standard forecasts for specific companies and their activities. Such works can be performed by not only large but also small groups of specialists.

6.2. Applications of the First Consequence of the Hypothesis. Ellsberg Paradox

The first consequence of the hypothesis was used initially for explaining of the Ellsberg paradox (see Ellsberg, 1961) and the problems of the incompleteness of systems of preferences and of ambiguity aversion.

The application of the hypothesis to the Ellsberg paradox and to the problems of the incompleteness of systems of preferences and of ambiguity aversion will be considered in an article in near future. The reports (see, e.g., Harin, 2007, Harin 2008) show the first consequence of the hypothesis of uncertain future explain the problems of the incompleteness of systems of preferences, of ambiguity aversion and of the Ellsberg paradox, at least partially.

6.3. Applications of the Second Consequence. Probability Weighting Problems

Kahneman and Thaler (2006) pointed out that the problems of the utility and prospect theories, including Allais (Allais, 1953) and Ellsberg (Ellsberg, 1961) paradoxes, have not been so far adequately solved. An essential part of the abovementioned problems of the utility and prospect theories consists in the problems, those are connected with a probability weighting (see, e.g., Tversky and Wakker, 1995). The probability weighting means that subjects treat the probability p by a function $W(p)$ which is not equal to p.

The second consequence of the hypothesis was applied to the probability weighting problems (in more detail see, e.g., Harin, 2012).

A practical applicability of the second consequence of the hypothesis and its ability to (at least partially) explain the abovementioned problems are supported by the well-established independent experimental data in independent fields (see, e.g., Harin, 2007, 2012, 2014). This is supported by the risk aversion, the risk premium, the underweighting of high and the overweighting of low probabilities, the opposite underweighting/overweighting of gains and losses, the Allais paradox, the "four-fold pattern" paradox, etc.

7. Conclusion

The hypothesis of uncertain future was created in Harin (2007) for the field of utility and prospect theories. The hypothesis states "At present, we cannot actually make an absolutely exact estimate of the probability of a future event".

The first consequence of the hypothesis includes the concept of unforeseen events. In the case of unforeseen events, their negative influence is that the forecast can largely lose its value. That is, the period of possible utilization of the forecast can be shortened by such events. The existence and influence of such events on forecasts is discussed in the literature (see, e.g., Hendry and Ericsson Eds., 2003, Bryan, 2009, Dincer and Kandil, 2011, Lu, 2012, Hackworth et al., 2013).

The first consequence states unforeseen events are an inalienable property of the human reality. So, the general conclusion and possible application of the hypothesis are: the unforeseen events should be explicitly taken into account in forecasting.

The negative influence of the unforeseen events can be lessened by the preliminary risk management in some cases of the partially unforeseen events. For example, if the influence of a partially unforeseen event could be and was preliminary estimated, then this estimate may be used just after such an event has occurred.

When the preliminary preparations of forecast corrections (those can be either used or not used) for a future partially unforeseen event are possible and more effective (on the average) than the preparing a new forecast or its new correction after the event will occur, then the forecast should include these preliminary corrections for this future partially unforeseen event.

Suppose, there is a future partially unforeseen event which has at least one unknown characteristic, e.g., time, place, volume, intensity, etc. If there was a possibility to prepare preliminary corrections of a forecast, those depend on possible particular values of the characteristic, including the real value, then the forecast can be corrected much faster than in the case of preparing a new forecast.

So, a draft of a procedure of application of the first consequence of the hypothesis has been made for particular forecasting cases.

A long-use forecast should contain correcting terms. These terms may have the form of a framework for forecasts – of correcting formulae for forecasts. These correcting formulae for forecasts may be used as a correcting tool for long-use forecasts and as an adapting tool in addition to unified forecasts to apply them to special situations.

The pure mathematical case of infinitely differentiable function $F(t)$ is considered as one of initial stages of consideration of influence of unforeseen events on forecasts. If there is a set of sub-functions $\{f_{pr}(t_{r-1}, t_r, t)\}$ of the modification of $\Delta F(t_{r-1}, t_r, t)$, such as $\Delta F(t_{r-1}, t_r, t) = \Delta F(\{f_{pr}(t_{r-1}, t_r, t)\})$, then, at the particular conditions, the function $F(t)$, which should be corrected after an unforeseen event, may be represented as a general formula in a form of the Taylor series. At the particular conditions, for the first-order approximation, the general formula may be simplified.

In particular, the modification $\Delta F(t_{Base}, t_{Corr}, t)$ of the forecast function may be exactly or approximately expressed in the form of sub-functions. The operations of addition and multiplication are, probably, the most common and important ones as in practice so in the pure mathematics (see, e.g., Waerden van der, 1976). If one supposes that the $\Delta F(t_{Base}, t_{Corr}, t)$ may be exactly or approximately expressed by means of additive and multiplicative sub-functions (those need not to be expressed in an explicit analytical form), then, omitting the variables and indices, the correcting formula may be written as

$$F \approx [F_{Base} \times \prod K_{Multiplica} + \sum \Phi_{Addit}] \times [1 \pm \Delta_{Error}] \ .$$

For the case of nonzero product of the first two terms (preferentially for $F \sim F_{base}$) it may be written, omitting the variables and indices, in the form of another correcting formula

$$F \approx F_{Base} \times [\prod (1 + k_{Multiplica})] \times [1 + \sum \varphi_{Addit}] \times [1 \pm \Delta_{Error}] \ .$$

So, the general properties of possible correcting formulae have been considered. The particular correcting additive-multiplicative formulae have been created. In general, the application of the first consequence of the hypothesis has been qualitatively extended to the new field and tested in it, the particular problems of the forecasting have been analyzed and their possible solutions have been considered.

8. References

Allais, M., 1953. Le comportement de l'homme rationnel devant le risque: Critique le postulats et axioms de L'École Américaine. *Econometrica*, 21, pp. 503-546.

Arbatli, E.C., and Vasishtha, G., 2012. Growth in Emerging Market Economies and the Commodity Boom of 2003–2008: Evidence from Growth Forecast Revisions. *Working Papers from Bank of Canada*.

Bryan, R.W., 2009. The Macroeconomic Impacts of the 9/11 Attack: Evidence from Real-Time Forecasting. *Peace Economics, Peace Science, and Public Policy*, 15, pp. 1-29.

Caporin, M., McAleer, M., 2010. A scientific classification of volatility models. *Journal of Economic Surveys*, 24, pp. 192-195.

Caporin, M., McAleer, M., 2011. Thresholds, news impact surfaces and dynamic asymmetric multivariate GARCH. *Statistica Neerlandica*, 65, pp. 125-163.

Castle, J., Doornik, J., and Hendry, D., 2012. Model selection when there are multiple breaks. *Journal of Econometrics*, 169, pp. 239-246.

Chang, C., Franses, P., and McAleer, M., 2011. How accurate are government forecasts of economic fundamentals? The case of Taiwan. *International Journal of Forecasting*, 27, pp. 1066-1075.

Clements, M., and Hendry, D., 2006. Forecasting with Breaks. in: Elliott, G., Granger, C. and Timmermann, A. (Eds.), *Handbook of Economic Forecasting*. Elsevier. 1, pp. 605-657.

Dincer, N., and Kandil, M, 2011. The effects of exchange rate fluctuations on exports: A sectoral analysis for Turkey. *The Journal of International Trade & Economic Development*, 20, pp. 809-837.

Ellsberg, L., 1961. Risk, Ambiguity, and the Savage Axioms. *The Quarterly Journal of Economics*, 75, pp. 643-669.

Gonzalez-Hermosillo, B., Martin, V.L., Dungey, M., and Fry-McKibbin, R.A., 2003. Characterizing Global Investors' Risk Appetite for Emerging Market Debt During Financial Crises. *IMF Working Papers from International Monetary Fund*, 03/251.

Goodhart, Ch., 2004. The interaction between the Bank of England's forecasts and policy, and the outturn. *LSE Research Online Documents on Economics from London School of Economics and Political Science*.

Hackworth, Ch., Radia, A., and Roberts, N., 2013. Understanding the MPC's forecast performance since mid-2010. *Bank of England Quarterly Bulletin*, 53, pp. 336-350.

Harin, A., 2007. Principle of uncertain future, examples of its application in economics, potentials of its applications in theories of complex systems, in set theory, probability theory and logic. *Seventh International Scientific School "Modelling and Analysis of Safety and Risk in Complex Systems", Saint-Petersbourg, Russia*, 7, 80-94.

Harin, A., 2008. To development of a general formula of forecasting, *Proceedings of the 51 scientific conference of MIPT "Modern problems of fundamental and applied sciences, Dolgoprudny, Moscow Region, Russia.*

Harin, A., 2010. Theorem of existence of ruptures in the probability scale. *9th International conference "Financial and Actuarial Mathematics and Eventoconverging Technologies", Krasnoyarsk, Russia*.

Harin, A., 2012. Data Dispersion in Economics(II)--- Inevitability and Consequences of Restrictions. *Review of Economics & Finance*, 2, pp. 24-36.

Heisenberg, W., 1927. Über den anschaulichen Inhalt der quantentheoretischen Kinematik und Mechanik. *Zeitschrift für Physik*, 43, pp. 172-198.

Hendry, D.F., and Mizon, G.E., 2014. Unpredictability in economic analysis, econometric modeling and forecasting. *Journal of Econometrics*, 182, pp. 186-195.

Hendry, D.F., and Ericsson, N.R., Ed., 2003. *Understanding Economic Forecasts*, MIT Press Books from The MIT Press, 1.

Ikeda, T., 2012. Three Essays on Robustness and Asymmetries in Central Bank Forecasting, *Discussion Papers from Graduate School of Economics, Kobe University*, 1216.

Kahneman, D., and Thaler, R. 2006. Anomalies: Utility Maximization and Experienced Utility. *Journal of Economic Perspectives*, 20, pp. 221-234.

Lahiri, K., Davies, A., and Sheng, X., 2010. Analyzing Three-Dimensional Panel Data of Forecasts. *Discussion Papers from University at Albany, SUNY, Department of Economics*.

Lu, Ch.-Ch.J., 2012. An adaptive system for predicting freeway travel times. *International Journal of Information Technology & Decision Making (IJITDM)*, 11, pp. 727-747.

McAleer, M., Medeiros, M., and Slottje, D., 2008. A neural network demand system with heteroskedastic errors. *Journal of Econometrics*, 147, pp. 359-371.

Miller, J.I., and Ni, S., 2010. Long-Term Oil Price Forecasts: A New Perspective on Oil and the Macroeconomy. *Working Papers from Department of Economics, University of Missouri*, No 1012.

Morlidge, S., 2013. How good is a "good" forecast?: Forecast errors and their avoidability. *Foresight: The International Journal of Applied Forecasting*, 30, pp. 5-11.

Tversky, A., and Wakker, P., 1995. Risk attitudes and decision weights. *Econometrica*, 63, pp. 1255-1280.

Waerden van der, B., 1976. *Algebra*, Moscow, Russia, pp. 1-648.

Zeev, N.B., and Khan, H.U., 2013. Investment-Specific News Shocks and U.S. Business Cycles. *Carleton Economic Papers from Carleton University, Department of Economics*, No 12-05.