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# FORECAST VALUE ADDED (*FVA*) ANALYSIS AS A MEANS TO IMPROVE THE EFFICIENCY OF A FORECASTING PROCESS

A praxeological approach has been proposed in order to improve a forecasting process through the employment of the forecast value added (*FVA*) analysis. This may be interpreted as a manifestation of lean management in forecasting. The author discusses the concepts of the effectiveness and efficiency of forecasting. The former, defined in the praxeology as the degree to which goals are achieved, refers to the accuracy of forecasts. The latter reflects the relation between the benefits accruing from the results of forecasting and the costs incurred in this process. Since measuring the benefits accruing from a forecasting is very difficult, a simplification according to which this benefit is a function of the forecast accuracy is proposed. This enables evaluating the efficiency of the forecasting process. Since improving this process may consist of either reducing forecast error or decreasing costs, *FVA* analysis, which expresses the concept of lean management, may be applied to reduce the waste accompanying forecasting.

**Keywords:** *forecasting, praxeology, efficiency, forecasting added value, FVA*

## 1. Introduction

Although forecasting is perceived mainly from the perspective of effectiveness, which means developing accurate forecasts, it is in fact a process consisting of many stages. The assessment or monitoring of accuracy is the last stage of this process. At its beginning, directly after the need for forecasting has been identified, data are gathered, analysed, an initial forecast is developed, which might be subsequently adjusted by an analyst or manager, or confirmed by other participants of the forecasting process. Afterwards, the forecast is employed in the decision-making process, and it can be evaluated in terms of its accuracy. Many activities may be carried out and many people may

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be involved before we get to know how accurate our forecast is. However, we do not predict simply in order to examine whether we are good at forecasting or have appropriate skills in it. We predict to reduce uncertainty when making decisions. Since the entire process, regardless of how complicated or developed it is, creates costs, the accuracy of forecasting cannot be the only criterion used to answer the question of whether forecasting is needed in an organization. The costs generated justify evaluating and improving the efficiency of the forecasting process. One of the management concepts which may be employed to improve forecasting efficiency is lean management. Forecasting value added (*FVA*) analysis is a tool which can help to find stages of the process or resources which do not improve the accuracy of a forecast or do this insignificantly in comparison to the costs they generate. The goal of this paper is to propose a praxeological approach to improve the efficiency of a forecasting process through the employment of the *FVA* analysis. This may be a manifestation of lean management in forecasting.

## 2. Effective and efficient forecasting processes

Effectiveness and efficiency are quite different concepts in the field of praxeology. According to Rotharb [13], *praxeology is a distinctive methodology of the Austrian School. The term was first applied to the Austrian method by Ludwig von Mises*. Mises [12] understands praxeology as a general theory of human action that evaluates this action not only in terms of achieving goals but also in terms of presenting satisfactory solutions to a problem, including economic calculations. Kotarbiński [9] understands praxeology as the theory of effective, efficient and beneficial acting. The term effective refers to the convergence or distance between the result and the goal (how close is the result to the goal?), efficient – to the relation between a measure of the benefits accruing from a result (output) and a measure of costs (input). Acting is beneficial if the benefit of the output is greater than the costs of inputs.

From a forecaster's point of view, forecasting is a process aimed at foreseeing the future and the main and final goal of this seems to be an accurate forecast. So, forecasting is effective if a forecast is accurate or the ex post error (e.g., percentage error *PE*, mean absolute percentage error MAPE) is acceptable to a manager or decision-maker – forecast user. However, the perspective of a forecast user is quite different in comparison to the perspective of a forecaster. Although both of them expect an accurate forecast, the accuracy of a given forecast is unknown at the time of the decision that is made on the basis of this forecast. This fact has a very important implication for a decision-maker – he or she is unable to take the accuracy into account before making a decision. Thus, the user – decision-maker only discovers whether a forecast is sufficiently accurate after making a decision. Therefore, the accuracy of a forecast should not be overstated as a goal of forecasting from the perspective of a decision-maker. Actually, for them, the main goal of forecasting is to use it to make a decision. This approach is also presented by Dittmann [5] in the definition of forecasting and by Cieślak [3], who understands the role of forecasting as supporting the process of decision making. Such decisions may be of different natures. Forecasting plays an important role in such areas as [11]:

• Scheduling (e.g., of production, transportation, cash, personnel) which supports the efficient use of resources. Forecasts of the demand for a product, material, labour, finance or services are an essential input to such scheduling.

• Acquiring resources such as materials, personnel, machinery, equipment for which the timeframe of the request varies from a few days to several years. To determine the requirements for future resources, an organization needs forecasts.

• Determining the requirements for resources is very important for any organization in the long-term. Any decision about this depends on market opportunities, environmental factors, internal development or financial, human, product, and technological resources. Assessing these factors requires good forecasts and managers who are able to interpret and use them when making decisions.

Using forecasts to make decisions is conditioned by the trust a manager has in the forecast and/or the forecaster. Generally, one can assume that the more accurate the forecast, the better the decision is. However, the accuracy of a forecast may only be assessed after making a decision. The approach to the effectiveness of forecasting described above means that effective forecasting results in trust in the forecast and brings benefits from the information considered when making a decision. The accuracy of past forecasts (produced previously for past moments/periods of time) may determine a manager's trust in the present forecast (produced for the next moment/period of time) and, therefore, may affect the decision as to whether such a forecast should be used in management. The accuracy of the present forecast does not play any role in this decision, since this accuracy "comes from the future". One can say that from the forecaster's point of view, a good forecast is an accurate one, whereas from the manager's point of view, a good forecast is one which is trustworthy and acceptable, and therefore, may be used in making a decision. Acceptability does not necessarily mean that a forecast is accurate.

The efficiency of the forecasting process is a quite different concept than effectiveness [2]. A forecast is produced to reduce uncertainty and therefore, to minimize the risk related to the decision made. The process of forecasting, regardless of its usefulness, needs many resources – people, data, software, knowledge, as well as processes. The following are the three main factors affecting the choice of a method of forecasting [1]:

• The need for data – methods requiring more data are more expensive, due to the costs of collection and processing.

• The complexity of a method – more complex methods require more highly trained analysts and more time for analysis.

• Implementation – both the forecaster and forecast user have to invest time and money in order to gain confidence in the forecasting procedure (or model).

Other costs of forecasting include maintenance costs (e.g., keeping data up to date) and operating costs (usually higher for judgmental methods, since formal models are of a repetitive nature – one estimates a model and then uses it many times to generate forecasts) [1].

These factors all create costs. A forecast and its use in decision-making are outputs of forecasting, whereas the cost of a forecasting process is an input. The relation $E$ between the benefits from outputs and the costs of inputs is a simple measure of the economic efficiency of forecasting:

$$E = f\,(\text{outputs, inputs}) \tag{1}$$

The costs of inputs seem to be relatively simple to measure, at least in comparison to the benefits of the output. To measure the costs of inputs, the process of forecasting has to be precisely defined and an appropriate accounting system and cost calculations have to be applied. Hence, costs may be attributed to the resources or processes used for forecasting. It is a real challenge to measure the benefits of the output. How can one estimate the impact a forecast has on an organization's performance (in terms of revenue, income, profit, etc.)? How does the difference between a forecast and an empirical observation affect performance? For instance, on the basis of a demand forecast (10 milion USD) for 2016, a given company acquired raw materials costing 2 milion USD. This was done to fulfil all the expected orders resulting from the demand forecast. However, it turned out that the real sales revenue amounted to 7 milion USD. Therefore, proportionally, the acquisition of raw materials costing 1.4 milion USD would have been sufficient. What is the loss resulting from the redundancy of materials? Many different costs should be taken into account: storage costs, opportunity costs, i.e. profits lost due to money not having been spent on other resources, etc. Thus, how can we evaluate the efficiency of forecasting in a simple way? Assume that the benefits of the output of the forecasting process, perceived as the profit obtained by an organization resulting from the implementation of a forecast in making a decision (a forecast's contribution to the success of a decision), are a function of the accuracy of this forecast (unknown when making the decision) and are maximized when the forecast error equals 0 (the benefits increase as the error declines). Then the efficiency of a forecasting process (in a given period of time) is a function of two factors: accuracy and the costs of the inputs. Such a cost-benefit approach to the evaluation of this efficiency enables monitoring this efficiency over time by analysing the following two measures:

$$\Delta FE = FE_t - FE_{t-1} \tag{2}$$

$$\Delta I = I_t - I_{t-1} \tag{3}$$

where $FE$ denotes the forecast error and $I$ – the costs of inputs to the forecasting process.

Both of the factors defining the efficiency of forecasting are of a the-lower-the-better nature. Therefore, a decrease in the forecast error, as well as in the costs of inputs, is desirable. Table 1 presents the impact that various combinations of the change in the forecast error and in the costs of inputs have on the efficiency of the forecasting process. Further analysis of these combinations is based only on changes in the costs of producing output (a decrease, no change, or an increase) and on changes in the forecast error (a decrease, no change, or an increase). No specific formula is recommended to evaluate the efficiency of forecasting, since it is really difficult to propose such a universal indicator. Efficiency is treated here as a function of the costs of input and the benefits of output, and in order to simplify the problem, the benefits of output are a function of the forecast accuracy. Nevertheless, it does not enable evaluating efficiency e.g., as the product of the costs of inputs and the forecast error (the-lower-the-better), since the impact of the forecast error on the output is unknown.

Table 1. Changes in the forecast error (*FE*)
and in the input (*I*) vs. forecasting efficiency (*E*)

<table>
<tr><th></th><th>$\Delta FE < 0$</th><th>$\Delta FE = 0$</th><th>$\Delta FE > 0$</th></tr>
<tr><td>$\Delta I < 0$</td><td rowspan="2">$\Delta E > 0$</td><td>$\Delta E > 0$</td><td>?</td></tr>
<tr><td>$\Delta I = 0$</td><td>$\Delta E = 0$</td><td rowspan="2">$\Delta E < 0$</td></tr>
<tr><td>$\Delta I > 0$</td><td>?</td><td>$\Delta E < 0$</td></tr>
</table>

Source: author's elaboration.

Although no synthetic formula of efficiency is used, an analysis of possible combinations of changes in the costs of inputs ($\Delta I$) and forecast error ($\Delta FE$) allows us to describe possible changes in the forecasting efficiency. Table 1 presents fully conclusive situations when decreasing forecast error is accompanied by decreasing or constant input costs, or decreasing input costs are accompanied by a constant forecast error. In such cases, forecasting efficiency improves. A clear conclusion may also be drawn in the case when an increase in input costs is accompanied by a constant or increasing forecast error, or if constant input costs are accompanied by an increasing error. In such cases, efficiency decreases. Efficiency is constant whenever both the input costs and the forecast error are constant. However, the two remaining cases require a more in-depth analysis to evaluate the effect on efficiency, since a simple comparison of the changes in the input costs and forecast error is inconclusive. The combination of $\Delta FE < 0$ and $\Delta I > 0$ requires evaluating the additional (marginal) improvement in accuracy caused by an additional unit of input (e.g., an additional dollar spent on the forecasting process). Although greater input costs result in a better forecast in this case, the question of whether this improvement is satisfactory remains. The same refers to the combination of $\Delta FE > 0$ and $\Delta I < 0$, since an increase in the forecast error may be accompanied by a significant (or insignificant) decrease in the input costs of the forecasting process. Thus, a manager may be willing to resign from an additional, but insignificant, improvement in accuracy when the resulting reduction in the input costs is significant.

## 3. The concept of lean forecasting

In the 1960s and 1970s, the common view among most economists and forecasters working for business was that econometric models would provide the most accurate macro- and microeconomic forecasts. However, in the next two decades, the results obtained were quite different and many other forecasting methods gained popularity. Statistical methods were applied that did not involve economic theory but were based on lagged variables and previous errors, consumer and business surveys, consensus forecasts and informed judgment. Several economists claimed that combining different methods may significantly improve forecast accuracy. However, today there is no general agreement as to which methods generate the most accurate forecasts [6]. So many questions remain: How complicated and developed should a forecasting process be? What is the added value generated by a more developed and complicated forecasting process? What is the added value generated by more sophisticated methods? We are unable to completely eliminate uncertainty in the decision making process, regardless of the sophistication or complexity of the forecasting procedure [4]. Moreover, *forecasting is a huge waste of management time* (…) *The amount of time, money, and human effort spent on forecasting is not commensurate with the amount of benefit achieved (the improvement in accuracy)* [7]. Therefore, managers should search for an optimal forecasting process based on the relation, understood in a wide sense, between the accuracy of forecasts and input costs in the forecasting process. Decreasing input costs increases the efficiency of the forecasting process. Thus, identifying and reducing extravagance is crucial to this efficiency. Therefore, the concept of lean management seems to be appropriate for improving the forecasting process in an organization.

Kahn and Mello [8] characterize how a lean approach to forecasting works. They notice that although lean management has found many applications in business today, it has not yet been discovered as a concept that can be employed in forecasting demand. The whole approach begins with the fundamentals of lean thinking, whose main premise is to reduce input resources for a given level of output. This is based on the rule that lean thinking minimizes the consumption of resources that do not add significant value to the output. Kahn and Mello identify 5 aspects of lean thinking that have to be applied in the forecasting process. These are [8]:

1. Specification of the value serving to focus the whole forecasting process on the consumer and his/her needs.

2. Identification of the value stream which aims at finding elements of the process that provide value to customers. Here, all the activities likely to be wasteful, e.g., excessive data collection, reporting, time consuming information gathering, over-analysis of data, redundant human resources involved in the forecasting process, and other expenditures, should be considered.

3. Creation of a flow that enables good synchronization of activities in the forecasting process. This is crucial for controlling and minimizing waste. To achieve the highest possible level of synchronization, an organization should focus on eliminating wait-times related to the creation of a baseline forecast, its adjustment and its final acceptance. This analysis enables identifying the critical path of the forecasting process.

4. Pull facilitation which refers to the idea of pull meaning replacing what has been used when there is a signal indicating increased demand for a product. To facilitate pull with reference to the forecasting process means to forecast what is needed and when it is needed.

5. Strive for perfection, which means permanent work on the forecasting process to make it more perfect, more efficient.

Magennis [10] understands lean forecasting as using simple models and historical data (when available) to forecast probable future outcomes. This concept is based on early and continual small experiments on the forecasting process that enable reducing the risk and initial pain of change. Early improvements have an important advantage – they bring benefits for a longer period of time. According to Gilliland [7], one objective of forecasting is the generation of a forecast which is as accurate and unbiased as anyone can reasonably expect, and to do this as efficiently as possible. However, he claims that we should not overestimate accuracy as a measure of success in forecasting, since we may have little control over this. If we are able to define the highest level of accuracy that is possible to achieve, we should focus on minimizing or eliminating waste in the forecasting process. This means applying lean management to forecasting. *FVA* analysis is a means to implement this concept.

## 4. How to find waste in a forecasting process? A numerical approach based on *FVA* analysis

The problem of improving the efficiency of forecasting is quite a new one and rather disregarded in the literature. Research on forecasting generally focuses on methods and less on processes. Although forecasting serves to make better decisions, not only at macro- but also at micro level (e.g., at the scale of an organization), discussion on forecasting is mainly an area of interest to econometricians and economists, less so to managers or even scholars specializing in management science.

To make a forecasting process lean, Gilliland [7] proposes the *FVA* analysis. He defines this method as *a metric for evaluating the performance of each step and each participant in the forecasting process*. The main idea is to compare the result of doing something with the result of having done nothing. The *FVA* analysis procedure is as follows [7]:

1. *Mapping the process.* This step serves to understand and map the overall forecasting process. This step is very important regardless of the complexity of the process. At this stage, all of the activities and human resources involved in forecasting have to be identified.

2. *Collecting data.* The raw data for *FVA* analysis include a forecast provided by each participant at each step of the process. This information should be very detailed and for each participant it consists of such elements as: level in the forecasting hierarchy (position and location in an organization), timeframe encompassed by the forecast (date), actual sales (or observations of a different variable to be predicted), the forecasts provided and the method used including: a benchmark or reference point (called a placebo by Gilliland), a statistical forecast or other forecast calculated using the model employed in the organization, and the final forecast after all the required adjustments or overrides have been made by analysts or managers. A placebo forecast is a benchmark which the forecast generated using the formal process is compared to. Therefore, in line with the rule of comparing the result of doing something with the result of having done nothing, this benchmark should be a simple forecast, produced, e.g., using a naive method. For a time series without any trend, this forecast could simply be the last observation. For a time series with a trend, a forecast could simply extrapolate the last increase/decrease in the level of the variable to be predicted. For a seasonal time series, the observation from the most recent moment/period of time with the same phase (in the same season) could be employed if there is no trend, or incremented by the difference between the values of the last two observations with the same phase (season) if there is a long-term trend in the time series. Alternatively, some method based on a moving average or a combination of simple methods (naive and moving average, for instance) may also be applied.

3. *Analysing the process*. This step aims to compare the forecast generated by the model or procedure applied in an organization with a placebo forecast. To do this, a popular measure of accuracy like MAPE (mean absolute percentage error), MSE (mean squared error) or other measures may be used.

4. *Reporting the results.* Many comparisons can be made here. Forecasts produced at different stages of the process may be compared to a placebo forecast or to each other. A statistical forecast may be compared to a placebo one, a forecast adjusted by managers or analysts may be compared to a statistical or placebo one, the final forecast may be compared to all the forecasts produced at earlier stages of the process. This allows us to find at which steps of the process and by which participants of the process added value, perceived as an improvement in the accuracy of a forecast, is created (or not created).

5. *Interpreting results.* The starting point is that *FVA* = 0 at each stage of the forecasting process and for each participant. This means that nothing and no one is able to beat the placebo forecast. An *FVA* analysis conducted for many periods enables identifying stages and persons who generate added value. For them, *FVA* > 0. If a given stage or a given person participating in the process deteriorates the accuracy, *FVA* < 0. No change in accuracy means no change in the *FVA*.

Singh, Raman and Wilson [14] propose a very similar role for *FVA* analysis in a forecasting process. The main question is: which, if any, of many stages of the forecasting process, including producing a statistical forecast and its further adjustments (introduced, e.g., by demand planners) improve the result. *FVA* analysis allows us not only to evaluate the contribution of each stage (connected with a given method of forecasting or adjustment procedure) but also to find an optimal combination of these methods and adjustments. The following hypothetical case study shows how the *FVA* analysis works. Additionally, it is more developed than e.g., the study conducted by Gilliland [7], since *FVA* is based not only on the MAPE but also includes the input analysis, as well as dynamic analysis of the absolute values of the *PE* in the whole period analysed.

## Hypothetical case study

Suppose a forecasting process in a given enterprise is as presented in Fig. 1. The sales forecasts for the years 2011–2015 produced at each stage of the process and the empirical observations, as well as the average input (yearly cost) at a given stage of the forecasting process are presented in Table 2. The naive-placebo forecast is supposed not to demand any input (cost generated = 0).

Table 2. Data from the study

| Year | Real sales | Estimate | | | | |
|---|---|---|---|---|---|---|
| | | Naive-placebo | Stage 1 | Stage 2 | Stage 3 | Stage 4 |
| 2011 | 105.0 | 106.0 | 104.0 | 104.0 | 102.0 | 103,0 |
| 2012 | 112.0 | 105.0 | 106.0 | 97.0 | 100.0 | 101,0 |
| 2013 | 107.0 | 112.0 | 108.0 | 100.0 | 102.0 | 103,0 |
| 2014 | 116.0 | 107.0 | 109.0 | 112.0 | 110.0 | 110,0 |
| 2015 | 122.0 | 116.0 | 111.0 | 119.0 | 118.0 | 116,0 |
| Input | | 0.0 | 0.5 | 0.1 | 0.3 | 0.5 |

Source: author's elaboration.

To evaluate the efficiency of the forecasting process, *FVA* analysis is employed. The percentage error (*PE*) of each forecast produced at each stage is calculated. Then, data for the overall period analysed are aggregated into a MAPE error. *FVA* based on MAPE is carried out for each stage of the forecasting process according to the following formula:

$$FVA_{i/k} = \left|\text{MAPE}_k\right| - \left|\text{MAPE}_i\right| \tag{4}$$

where: $FVA_{i/k}$ stands for the forecast value added at a given stage $i$ compared to a given preceding stage $k$ of the forecasting process, $\text{MAPE}_i$ stands for the mean absolute percentage error for the forecast produced at a given stage $i$ of the forecasting process, $\text{MAPE}_k$ stands for the mean absolute percentage error for the forecast produced at a given preceding stage $k$ of the forecasting process ($i > k$).

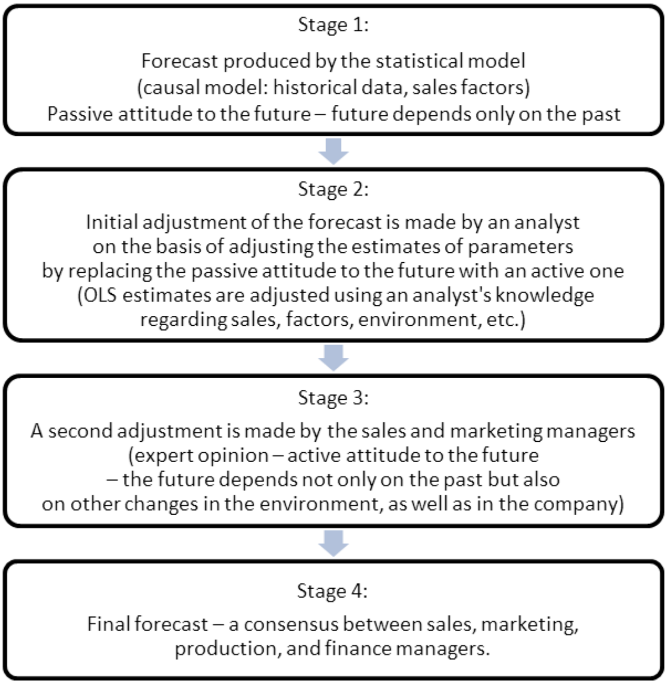


Fig. 1. The forecasting process in a given enterprise. Source: author's elaboration

Additionally, the absolute and comparative costs of inputs (stage vs. stage) are calculated. The results are presented in Tables 3 and 4.

Table 3. Calculations of $FVA_{i/k}$

| Stage | MAPE [%] | *FVA* compared to [pp] | | | |
|---|---|---|---|---|---|
| | | naive | stage 1 | stage 2 | stage 3 |
| Naive–placebo | 4.91 | – | – | – | – |
| Stage 1 | 4.46 | 0.45 | – | – | – |
| Stage 2 | 5.36 | –0.45 | –0.90 | – | – |
| Stage 3 | 4.13 | 0.78 | 0.33 | 1.23 | – |
| Stage 4 | 5.11 | –0.20 | –0.65 | 0.25 | –0.98 |

Source: author's calculations.

Table 4. Analysis of the absolute
and comparative costs of inputs (stage vs. stage)

| Stage | Inputs | Compared to | | | |
|---|---|---|---|---|---|
| | | naive | stage 1 | stage 2 | stage 3 |
| Naive-placebo | 0.0 | – | – | – | – |
| Stage 1 | 0.5 | 0.5 | – | – | – |
| Stage 2 | 0.1 | 0.1 | –0.4 | – | – |
| Stage 3 | 0.3 | 0.3 | –0.2 | 0.2 | – |
| Stage 4 | 0.5 | 0.5 | 0 | 0.4 | 0.2 |

Source: author's calculations.

Additionally, the process is analysed dynamically. To do this, the *FVA* measured according to the absolute value of percentage errors (*PE* absolute value) – components of MAPE – is calculated for each stage of the forecasting process (in comparison to the directly preceding stage). The following formula is used:

$$FVA_{i/t} = \left|PE_{i-1,\,t}\right| - \left|PE_{i,\,t}\right| \tag{5}$$

where: $FVA_{i,\,t}$ stands for the *FVA* at a given stage *i* of the forecasting process in period *t*, $PE_{i,\,t}$ stands for the percentage error of the forecast for period *t* produced at a given stage *i* of the forecasting process, $PE_{i-1,\,t}$ stands for the percentage error of the forecast for period *t* produced at the directly preceding stage ($i$ – 1) of the forecasting process.

$FVA_{i,\,t}$ allows us to assess whether or not a given stage improves the accuracy of the forecasts in comparison to the directly preceding stage. $FVA_{i,\,t} > 0$ ($FVA_{i,\,t} < 0$) means that a given stage of the forecasting process improves (worsens) the accuracy. When $FVA_{i,\,t}$ is increasing over time, the accuracy at a given stage improves compared to the previous one, whereas when $FVA_{i,\,t}$ is decreasing over time, the accuracy at a given stage is deteriorating compared to the previous one. Figures 2–5 present time series of $FVA_{i,\,t}$ created at each stage of the forecasting process. It is worth pointing out that such an analysis does not serve to identify any long-term trends in forecast errors (including the forecast bias, since calculations are based on the absolute values of percentage errors). This rather supports rationalising the forecasting process based on the signals "emitted" on how accuracy improves or deteriorates at a given stage of the forecasting process in comparison to the previous stage.

The results of calculations in Table 3 show that in the analysed period the forecasts developed at stages 2 and 4 have a worse accuracy than the benchmark – naive forecast. Additionally, stage 2 gives a much worse forecast than the one produced at stage 1 ($FVA_{2/1}$ = –0.90) and stage 4 gives a worse forecast than the one developed at stage 3 ($FVA_{4/3}$ = –0.98). This suggests that stages 2 and 4 could be removed from the process, since they do not create any added value. However, since the decision on removing a given stage or any other changes in the process should be made very carefully in order to preserve the effectiveness (accuracy) and efficiency, the inputs involved at stages 2 and 4 should also be analysed. The cost of stage 2 amounts to 0.1 (currency units), whereas the cost of stage 4 amounts to 0.5 (currency units). Additionally, the analysis of the dynamics of $FVA_{2,t}$ measured according to the absolute values of the *PE* shows a growth in accuracy in the case of comparing stage 2 to stage 1 and a positive value of $FVA_{2,t}$ in the last two years (Fig. 3).

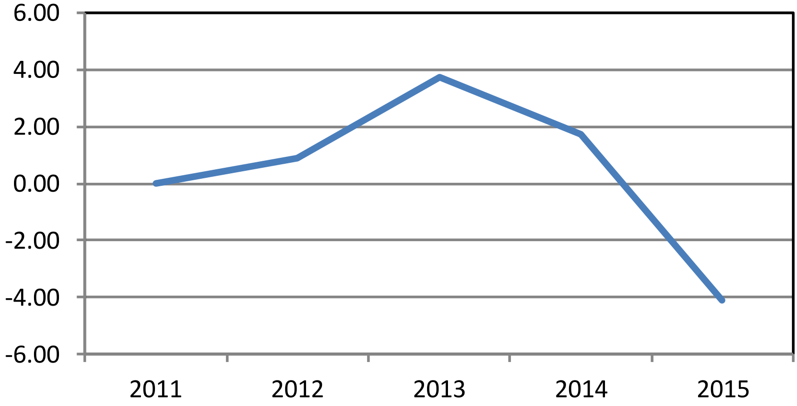


Fig. 2. $FVA_{1,t}$: stage 1 vs. naive-placebo. Source: author's elaboration

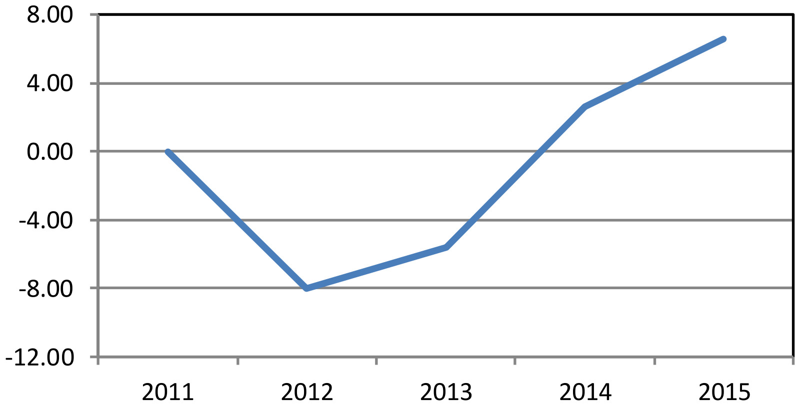


Fig. 3. $FVA_{2,t}$: stage 2 vs. stage 1. Source: author's elaboration

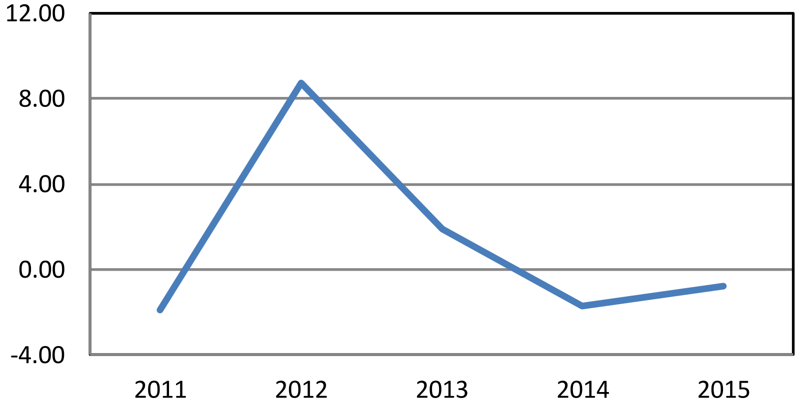


Fig. 4. $FVA_{3,\,t}$: stage 3 vs. stage 2. Source: author's elaboration

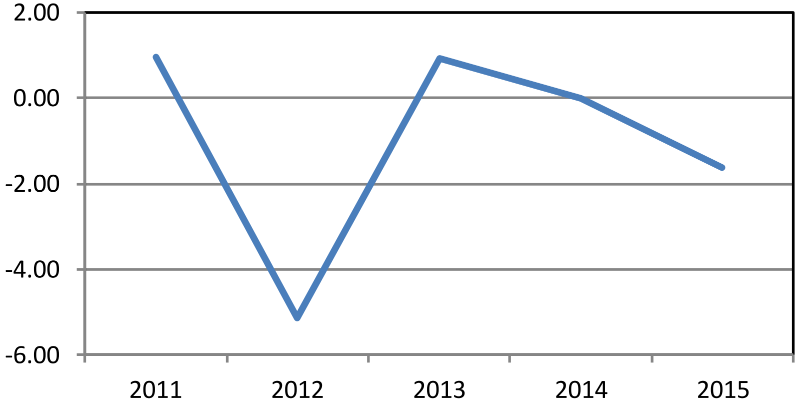


Fig. 5. $FVA_{4,\,t}$: stage 4 vs. stage 3. Source: author's elaboration

In the case of comparing stage 4 to stage 3, there is no tendency for $FVA_{4,\,t}$ to increase (Fig. 5). Taking $FVA_{4/3}$ (based on MAPE) for the overall period, the costs of inputs and the dynamics of $FVA_{4,\,t}$ (based on the absolute *PE* values) into account, stage 4 seems to be only creating negative value at relatively high cost. Therefore, any modification of the forecasting process should propose the removal of stage 4, at which a consensus forecast is developed by sales, marketing, finance, and production managers. The forecasts produced at stage 3 are much better in terms of accuracy and much cheaper (0.3 currency units compared to 0.5).

To summarize the results of the hypothetical case study, a more complete analysis, encompassing not only $FVA_{i/k}$ based on a measure of average accuracy for the overall period analysed (MAPE) but also changes in $FVA_{i,\,t}$ from year to year (*PE* absolute values) and input costs, enables a more in depth and detailed evaluation of the forecasting process. Therefore, the final conclusion is to firstly remove stage 4 and then observe and decide what to do with stage 2. For comparison, *FVA* analysis based only on MAPE would suggest rather to remove two stages – 2 and 4.

## 5. Conclusions

A praxeological approach to the forecasting process, although rarely addressed in the literature, seems to be justified and worth applying. Statistical methods are continuously being developed, becoming more and more complicated and the question as to what additional value is created by these methods is very important, since in general more complicated methods are more expensive. The overall process of forecasting in an organization creates additional costs regardless of the level of complexity of this process. Thus, searching for an optimum in terms of efficiency perceived as the ratio between the value of the output and input costs is very important. Not only does the management of a firm need to forecast, but forecasting needs to be well-managed as well. *FVA* is a tool that allows us to apply the concept of lean management to the forecasting process and reducing the waste accompanying it.

*FVA* analysis seems to be at the initial stage of its application in business. However, it has been applied, e.g., by Intel, AstraZeneca, Tempur-Pedic and Yokohama Tire Canada [7]. *FVA* has also been rarely addressed in the forecasting or management literature so far. Therefore, *FVA* analysis seems to be worth developing in the future. In this paper, a static approach to *FVA* based on the application of a single accuracy measure (MAPE) was developed by including input costs at each stage of the forecasting process, as well as dynamic analysis of *FVA* (based on absolute *PE* values) in the overall analysed period. This allows us to draw more meaningful, detailed and balanced conclusions on the process and make better decisions on its improvement. Further developments of *FVA* analysis should enable better measurement of the ratio between the value of the output and input costs in the forecasting process. Accuracy is not the only goal of forecasting and should not be treated as proof of the goodness of forecasting. The main goal is to support a decision-making process at the lowest possible cost. Therefore, efficient forecasting means producing trustworthy, useful forecasts employing only necessary resources. Thus, the development of an integral measure of the efficiency of a forecasting process, which seems to be a real challenge, would be very useful. It would enrich the evaluation of forecasting efficiency based only on combinations of the input costs and the accuracy analysed as separate measures.

Trust in forecasts is usually determined by their previous accuracy. However, previous accuracy does not guarantee accuracy in the future. The same refers to the *FVA* analysis, whose main limitations result from the data used. This method is based on past data that are not guaranteed to be reflected (or trends are not guaranteed to continue) in the future. The removal of a given stage of the forecasting process does not ensure an improvement. Nevertheless, this method gives us a chance to improve the process and provides a useful tool to make forecasting in an organization more efficient.

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