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**FORECASTING FIXED ASSETS  
AND THEIR DEPRECIATION  
IN CONDITIONS OF VOLATILE DEMAND  
FOR PRODUCTION CAPABILITIES**

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**PROGNOZOWANIE AKTYWÓW TRWAŁYCH  
I ICH EKONOMICZNEGO ZUŻYCIA  
W WARUNKACH ZMIENNEGO ZAPOTRZEBOWANIA  
NA ZDOLNOŚCI PRODUKCYJNE**

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**Summary:** A significant element of managing corporate finance is forecasting the financial situation of an enterprise. Forecasting means drawing up simplified financial statements (pro-forma). One of the basic components of a financial situation forecast is estimating both: fixed asset levels, as well as their depreciation. In a volatile environment, the natural assumption is volatile demand for production capabilities, as a consequence of volatile economic conditions. Furthermore, eventual changes of the production capabilities being the consequence of purchasing and selling fixed assets are not smooth. Taking the above into account, the authors propose the concept of a financial model for forecasting fixed assets and their depreciation. The implementation of the model is also presented using a case study.

**Keywords:** financial modelling, forecasting, corporate finance, risk, Monte Carlo approach.

**Streszczenie:** Istotnym elementem procesu zarządzania finansami przedsiębiorstwa jest prognozowanie jego sytuacji finansowej. Polega ono na sporządzeniu sprawozdania pro-forma. Jednym z podstawowych ogniw prognozy sytuacji finansowej jest określenie poziomu aktywów trwałych i ich ekonomicznego zużycia. W zmiennym otoczeniu naturalnym jest założenie o zmiennym zapotrzebowaniu na zdolności produkcyjne jako konsekwencji zmiennej koniunktury gospodarczej. Ponadto ewentualne zmiany zdolności produkcyjnych na skutek nabywania i zbywania aktywów trwałych w celu ich dostosowania do zapotrzebowania mają w rzeczywistości skokowy – a nie płynny – charakter. W konsekwencji w opracowaniu zaproponowano koncepcję modelu finansowego służącego do prognozowania aktywów trwałych i ich ekonomicznego zużycia, które uwzględnia wskazane założenia. Funkcjonowanie modelu finansowego zostało zaprezentowane na przykładzie studium przypadku.

**Słowa kluczowe:** modelowanie finansowe, prognozowanie, finanse przedsiębiorstwa, ryzyko, metoda Monte Carlo.

## 1. Introduction

Forecasting the financial situation of an enterprise is an inseparable element of the financial management process. It is implemented using the financial model of a given enterprise. Solutions within financial modelling allow some simplifications, which not always appropriately correspond to the economic reality. These simplifications concern, among others, the direct reference of fixed assets and their depreciation to the forecasted sales and as a consequence assumption of smooth changes in fixed assets – as a result of changes in sales.

Moreover, the applied solutions do not correspond to the needs of the modern methods of forecasting the financial situation of an enterprise, taking into account the risk of economic activities based on the Monte Carlo approach. In particular, in a situation when one of the simulation assumptions is a changing economic situation resulting in subsequent periods of projections with alternating, random peaks and troughs in demand.

In the case of fixed assets, simplifications in the applied methods become particularly significant, as they do not reflect the nature of the volatile demand for production capabilities. Most of all, this refers to the phenomenon of abrupt changes of production capabilities. Therefore, the objective of this elaboration is to propose a universal financial model, which allows forecasting fixed assets and their depreciation in conditions of volatile demand for the production capability, assuming that changes in fixed assets can be abrupt and the enterprise, depending on the economic situation, increases or decreases the production capabilities, acquiring new or selling existing fixed assets, respectively.

## 2. Premises for forecasting fixed assets

Fixed assets constitute a particular type of property of an enterprise – a property that determines production capabilities. It should be noted that its possession requires significant financial outlays, and its excess results in freezing of the held capital. Therefore, correct forecasting of the level of fixed assets, necessary for the operational process, is very important for making financial decisions, while simultaneously taking into account that the held fixed assets systematically depreciate in subsequent operational cycles, which is reflected in the depreciation charges.

Depreciation is an important element of the financial surplus generated by an enterprise. It reflects the cost of use of fixed assets, while simultaneously not constituting a real expenditure of cash funds. In an enterprise which continues its activities, depreciation is a certain and stable source of financing fixed assets (acquiring new and replacing the used ones) [Ciupek 2004, p. 79], while depreciation, as a fixed cost (with a relatively high value), shapes the risk of operational activities of an enterprise [Kania 2014, p. 137]. The easier it is for an enterprise to adjust the level of fixed assets to the implemented sales (adjust the production capabilities to

the actual demand), the smaller the operational risk (perceived as a fluctuation of the results of the operational activities caused by changes in sales).

Methods of forecasting the financial situation of an enterprise include the budgeting method and the method of the percentage from sales. The method of the percentage from sales is a significantly simpler method of creating pro-forma financial statements. It is based on the division of items of the statement into values dependent and independent on sales. The dependent items may be determined based on the share of a given item in sales in the base period or an average share in several periods preceding the forecast, as well as by estimating the regression function [Dittmann et al. 2009, p. 245-247; Sengupta 2010, p. 273-274].

The preparation of the forecast of the enterprise's financial situation is due diligence required in the field of projecting fixed assets and their depreciation charges. Most frequently, the value of a depreciation charge is determined in the financial projection as the percentage of the initial value of net fixed assets, while capital expenditures for the purchase of fixed assets are calculated as the percentage from sales. In the long-term perspective, such a solution leads to a situation in which the level of the value of net fixed assets has a tendency to remain in a permanent proportion to sales [Rees 2008, p. 104; Klobucnik, Sievers 2013, p. 947-984; Doffou 2015, p. 165].

Another solution is determining net fixed assets as the percentage from sales and calculating depreciation based on the average level of fixed assets according to the acquisition cost (net fixed assets increased by cumulated depreciation) [Benninga 2008, p. 109]. Projection of net fixed assets can be brought to projection of the ratio: net fixed assets in the current period to sales, and the ratio: depreciation to net fixed assets in the previous period [Jennergren 2011, p. 11]. Depreciation can be calculated using the method of the percentage from sales or based on the depreciation plan – then the value of net fixed assets is calculated based on their initial value decreased by the cumulated depreciation charges [Sengupta 2010, p. 275]. However, the relationship between the sales and depreciation is indirect. Depreciation can be calculated for each subsequent year of projection individually – taking into account the level of capital expenditures from a given year [Tjia 2009, p. 337-338].

Solutions applying the past share of the percentage from sales or operational costs are found in the case of the valuation of enterprises using the method of discounted cash flows, and this approach should be treated with great carefulness [Panfil 2011, p. 301]. The assessment whether a given item is dependent or independent on the level of sales can be based on knowledge and intuition or application of dependence measures [Dittmann et al. 2011, p. 268].

An enterprise, which does not allow aging/depreciation of fixed assets by regular replacement investments and simultaneously does not change their economic activities (the structure of the offered products), will certainly be proof that the level of fixed assets and depreciation, determined using the method of the percentage from sales, will be confirmed in reality. However, later, it will be difficult to accept that

changes in fixed assets and depreciation determined in such a way constitute direct reflection of the changes in sales.

It should be stated that the level of fixed assets and their depreciation depends on the production capabilities maintained by an enterprise. The required demand for production capabilities can be subject to periodic fluctuations, depending on the economic situation. Changes in the production capabilities constitute a direct consequence of purchasing and selling fixed assets. It should be highlighted that changes in the production capabilities and fixed assets, and as a consequence changes in depreciation, will be abrupt and their growth will not be proportional to the changes in sales.

Furthermore, in a changing environment, an enterprise performing a risk assessment can – in the financial projection – assume successive increases and decreases (random) in sales as a result of changes in the economic situation, and therefore, in the demand for the offered products. In such a situation, a time-series model should be assumed, and then a simulation applying the Monte Carlo approach should be performed, considering the largest possible number of potential scenarios. Therefore, the model for forecasting fixed assets should not only take into account the abrupt nature of changes in fixed assets, but also be adjusted to the needs of the simulation methods and automatically react to changes in the forecast of demand, and simultaneously the maintained need for production capabilities.

### **3. The financial model for forecasting fixed assets**

The suggested financial model, which allows forecasting fixed assets in conditions of a changing economic situation (the changing need for production capabilities of an enterprise), assumes that:

- changes in demand result in changes in the need for production capabilities, which require changes of fixed assets;
- changes of fixed assets and therefore production capabilities do not occur smoothly (proportionally), but abruptly;
- it is possible to determine a minimum abrupt change in the production capabilities (therefore, it is necessary to recognise what is the smallest growth of production capabilities an enterprise can have, by acquiring new fixed assets);
- an enterprise acquires the necessary fixed assets when there are insufficient production capabilities in the market price (therefore, it is necessary to calculate the market value of the new fixed assets to the unit of production capabilities);
- an enterprise sells unnecessary fixed assets when there are excessive production capabilities according to the book value (therefore, it is necessary to calculate the book value of the existing fixed assets to the unit of production capabilities);
- an enterprise replaces fixed assets, which were subject to depreciation, which does not impact the available maximum production capabilities according to the assumed replacement rate.

In the suggested model, first of all, the maximum production capabilities in the current period of financial projection are determined. They constitute the total amount of maximum production capabilities from the previous period increased by a change in the maximum production capabilities in the current period. The change in the maximum production capabilities in the current projection period constitutes a multiplication of the minimum abrupt change of production capabilities. An increase of the production capabilities in the current period of the financial projection occurs when the demand forecasted in the current period in relation to production capabilities from the previous period is larger than 1. At the same time, a decrease of the production capabilities in the current period of financial projection occurs when the demand, forecasted in the current period in relation to production capabilities from the previous period, is equal to or smaller than 1.

$$Q_{max_t} = Q_{max_{t-1}} + Q_{chg_t}$$

$$Q_{chg_t} = Q_{minchg} \begin{cases} \left[ \frac{Q_t - Q_{max_{t-1}}}{Q_{minchg}} \right] \text{ dla } U_t > 1 \\ \left[ \frac{Q_t - Q_{max_{t-1}}}{Q_{minchg}} \right] \text{ dla } U_t \leq 1 \end{cases},$$

$$U_t = \frac{Q_t}{Q_{max_{t-1}}}$$

where:  $Q_{max_t}$  – maximum production capabilities in the current period of financial projection,  $Q_{max_{t-1}}$  – maximum production capabilities in the previous period of financial projection,  $Q_{chg_t}$  – change in the maximum production capabilities in the current period,  $Q_{minchg}$  – minimum abrupt change in production capabilities,  $U_t$  – using production capabilities in relation to the previous period,  $Q_t$  – production/demand in the current period.

Based on the change in the maximum production capabilities, a change in fixed assets is determined. The change in fixed assets in the case of the required growth of production capabilities constitutes a product of the unit purchase price (expressed as a production unit) of fixed assets at the end of the previous projection period and the change of maximum production capabilities in the current period. Whereas when a decrease in the maximum production capabilities is possible, the change in fixed assets resulting from the change in the maximum production capabilities is determined based on the unit sales price of fixed assets.

$$FA_{chg_t} = \begin{cases} Q_{chg_t} \cdot P_{new_{t-1}} \text{ dla } Q_{chg_t} > 0 \\ Q_{chg_t} \cdot P_{old_{t-1}} \text{ dla } Q_{chg_t} \leq 0 \end{cases},$$

where:  $FA_{chg_t}$  – change in fixed assets resulting from the change in maximum production capabilities in the current period,  $P_{new_{t-1}}$  – unit purchase price

of fixed assets in the previous period (expressed as a production unit),  $P_{old_{t-1}}$  – unit sales price of fixed assets in the previous period (expressed as a production unit).

The initial value of fixed assets (without taking depreciation into account) in the current period constitutes the total amount of the initial value of fixed assets from the previous period and the change in fixed assets resulting from the change in the production capabilities.

$$FA_{initval}_t = FA_{initval}_{t-1} + FA_{chg}_t,$$

where:  $FA_{initval}_t$  – initial value of fixed assets taking the change in production capabilities into account in the current period,  $FA_{initval}_{t-1}$  – initial value of fixed assets taking the change in production capabilities into account in the previous period.

The book value of fixed assets in the current period constitutes the book value of fixed assets from the previous period, adjusted for the change in fixed assets resulting from the change in the production capabilities, decreased by depreciation of fixed assets and increased by their replacement. The depreciation value is determined based on the average depreciation rate and the initial value of fixed assets in the current period applying the linear method. Replacement of fixed assets is determined similarly to depreciation, based on the average replacement rate.

$$FA_t = FA_{t-1} + FA_{chg}_t - D_t + R_t,$$

$$D_t = FA_{initval}_t \cdot d_t,$$

$$R_t = FA_{initval}_t \cdot r_t,$$

where:  $FA_t$  – book value of fixed assets in the current period,  $FA_{t-1}$  – book value of fixed assets in the previous period,  $R_t$  – replacement of fixed assets in the current period,  $r_t$  – average replacement rate,  $D_t$  – depreciation of fixed assets in the current period,  $d_t$  – average depreciation rate.

The book value of fixed assets is indicated in the forecasted enterprise's balance. Depreciation is taken into account first in the profit and loss account, and then – as an adjustment of net profit in cash flows from operational activities in the cash flow statement. Changes in fixed assets resulting from the production capabilities are indicated as flows from investment activities (capital inflows and expenditures), similarly to the assumed replacements of fixed assets (capital expenditures). Here, it should be noted that abrupt changes in the production capabilities will therefore determine the value of free cash flow for an enterprise (FCFF) and its owners (FCFE).

If the forecast of demand assumes successive increases and decreases, the suggested financial model reflects abrupt changes in fixed assets, depending on the value of the minimum change in the production capabilities. Abrupt changes in fixed

assets will occur with varying frequencies (the smaller the value of the minimum abrupt change in the production capabilities, the more frequent and smaller the abrupt changes in fixed assets).

#### **4. Application of the financial model for forecasting fixed assets – case study**

An enterprise running production activities has fixed assets the book value of which, at the moment of preparing the forecast ( $t_0$ ), is 280,000 PLN (initial value: 390,000 PLN). The average depreciation rate and the average replacement rate are 7.0% and 5.9%, respectively, per year in the entire projection period ( $t_0$ - $t_{10}$ ). The unit purchase price of fixed assets expressed as a production capability unit is 90 PLN/pcs. In the current reporting period ( $t_0$ ), being the forecast basis, the enterprise fully used the production capabilities in the amount of 5,000 pcs in a year. Assuming that the demand for the products manufactured by the enterprise will grow in the next 10 reporting periods ( $t_1$ - $t_{10}$ ) by a constant growth rate, which is 4.0% per year, and the minimum abrupt change of production capabilities is 750 pcs, a forecast of fixed assets can be prepared in accordance with the concept of the suggested financial model (Fig. 1). In the case being considered, fixed prices were assumed; however, the presented solution takes into account the possibility of assuming current prices.

Taking the result of the forecast (Fig. 1) into account, it will be necessary to increase the production capabilities every 3 reporting periods, starting from the first projection period ( $t_1$ ). The assumed scenario is related to stable cash flow from operational activities; however, definitely non-stable free cash flow for the enterprise (FCFF) (Fig. 2).

It should be noted that FCFF fluctuations can be reduced if the enterprise will be able to change their production capabilities more precisely (the enterprise will be able to decrease the minimum abrupt change in the production capabilities).

Assuming a decrease of the minimum abrupt change in the production capabilities in the considered case from 750 pcs. to 150 pcs. – with other forecast parameters remaining unchanged – it would be possible to significantly stabilise FCFF (Fig. 3). The minimum abrupt change in the production capabilities, which is possible to achieve by the enterprise, is therefore a source of risk in its economic activities.

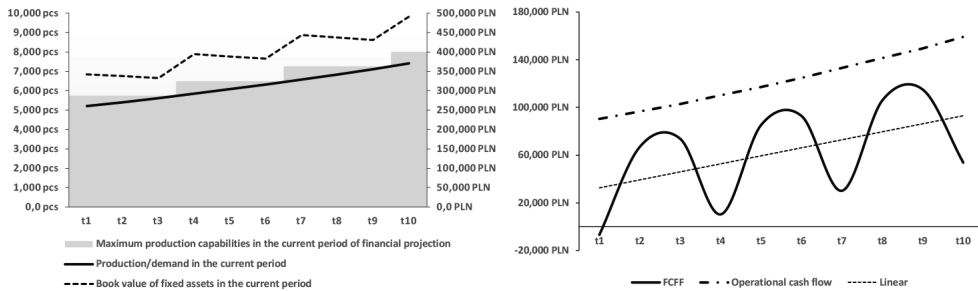
Assuming that the enterprise does not allow situations in which fixed assets age, the replacement rate should be levelled with the depreciation rate. The assumption is very rational; however, in principle, it will be associated with lower FCFF (compare Fig. 2 and Fig. 4).

While in the case of assuming decreases in demand by 4% y/y, the enterprise would report a decreasing need for production capabilities. An unbeneficial economic situation would mean the necessity to sell unused fixed assets and adequately decrease the production capabilities. Depending on the value of the minimum abrupt change in the production capabilities, the stability of cash flows would change (compare Fig. 5 and Fig. 6).



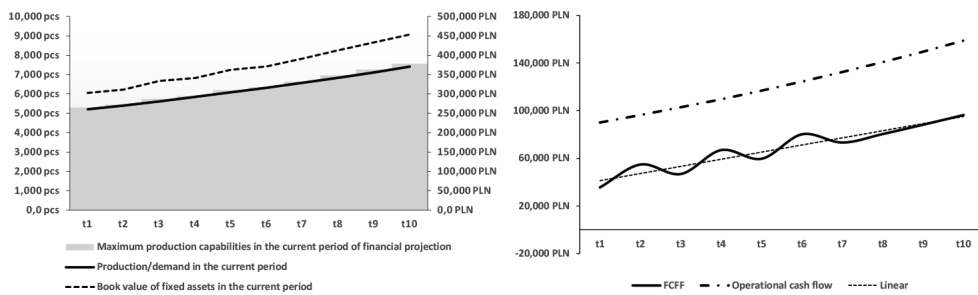






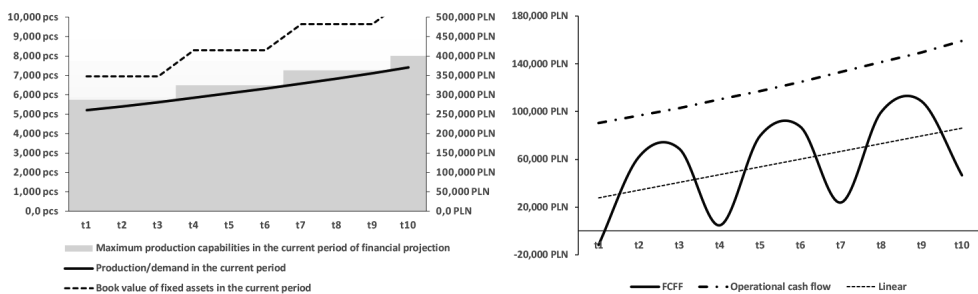
**Fig. 2.** Graphic representation of the scenario of the constant growth rate of demand (+4.0% y/y) and a relatively high minimum abrupt change in production capabilities (750 pcs.)

Source: own study.



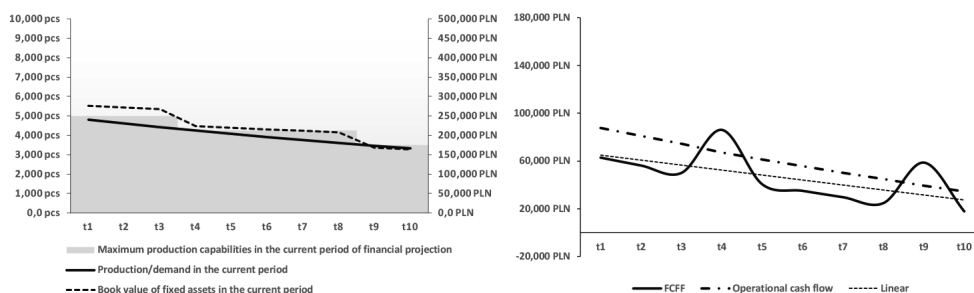
**Fig. 3.** Graphic representation of the scenario of the constant growth rate of demand (+4.0% y/y) and a relatively low minimum abrupt change in production capabilities (150 pcs.)

Source: own study.



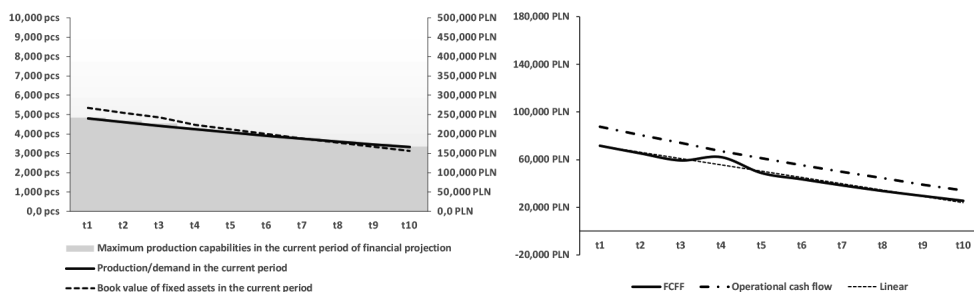
**Fig. 4.** Graphic representation of the scenario of levelling the replacement rate with the depreciation rate of fixed assets with a relatively high minimum abrupt change in production capabilities (750 pcs.)

Source: own study.



**Fig. 5.** Graphic representation of the scenario of the constant rate of decrease of demand ( $-4.0\%$  y/y) and a relatively high minimum abrupt change in production capabilities (750 pcs.)

Source: own study.

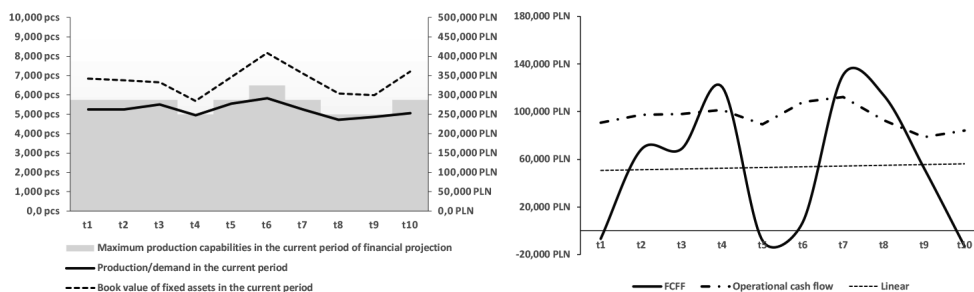


**Fig. 6.** Graphic representation of the scenario of the constant rate of decrease of demand ( $-4.0\%$  y/y) and a relatively low minimum abrupt change in production capabilities (150 pcs.)

Source: own study.

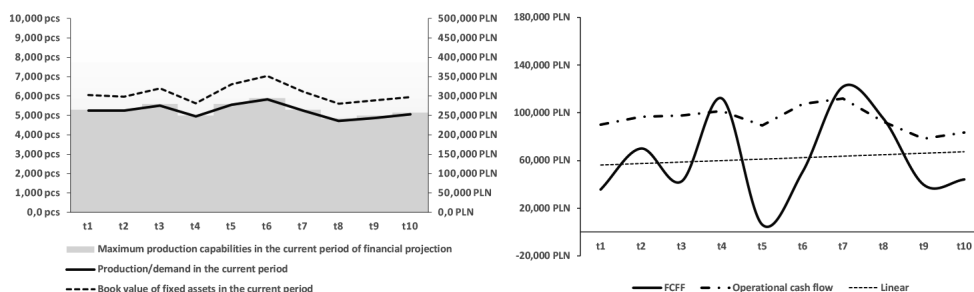
From the presented discussion, it can be concluded that the application of the suggested financial model for forecasting fixed assets allows precise reflection of the financial situation of the enterprise. The lower the minimum abrupt change in the production capabilities, the more stable the cash flows, taking into account the investment decisions of the enterprise.

The presented model takes on a special value if the forecast is associated with the assumption of successive increases and decreases of demand. A volatile economic situation may be associated for the enterprise with the necessity for periodic adjustment of production capabilities to volatile demand. The necessity for such adjustment will be more frequent, the lower the minimum abrupt change in production capabilities. It should be noted that, with assumptions in the considered case, a larger minimum abrupt change in production capabilities means periodically negative FCFE (compare Fig. 7 and Fig. 8).



**Fig. 7.** Graphic representation of the volatile demand and a relatively high minimum abrupt change in production capabilities (750 pcs.)

Source: own study.



**Fig. 8.** Graphic representation of the volatile demand and a relatively low minimum abrupt change in production capabilities (150 pcs.)

Source: own study.

Additionally, it should be highlighted that the presented model for forecasting fixed assets, assuming volatile demand for the production capabilities, takes on significance if the financial forecast is a basis for the assessment of the risk of economic activities of the enterprise. A particular advantage of the model is the possibility to take into account abrupt changes in the production capabilities in the risk forecast using the Monte Carlo methods.

## 5. Conclusion

The minimum abrupt change in the production capabilities possible to obtain by the enterprise has a significant impact on the stability of cash flows, taking into account changes in fixed assets, and as a consequence, on the level of risk of the economic activities of this enterprise. Solutions for forecasting fixed assets assuming direct transfer of the sales value to the level of fixed assets actually assume a situation in which the minimum abrupt change in the production capabilities is striving towards

zero, and therefore stability of cash flows taking into account changes in fixed assets is maintained in an unconditional manner. An advantage of the suggested financial model is the possibility to assume abrupt changes in the production capabilities. However, there is a problem in the form of the necessity to determine the value of such an abrupt change.

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