OVERCOMING THE UNCERTAINTY IN THE DU-PONT GRAPH OF PROFITABILITY

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Abstract

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Financial analysis of a company requires a wealth of information. There is so much information available and so much of the analysis can be computerized, that the task of the analyst is to select the appropriate tools, gather the pertinent information, and interpret the information. Analysis is becoming more important following the recent scandals as investors and financial managers are learning to become more sceptical of accounting information and look more closely at trends in data, comparisons with other firms, the relation between management compensation and earnings, and footnote disclosures.
One of the best tools for predicting profit from financial analysis is the use of Du-Pont graph of profitability. It sees a connection between profit and turnover of operating assets. Each company has, however, individual curve of this dependence, therefore, the determination of turnover for the planned profit vague matter (values create the array of values). The aim of this paper is to propose a method to resolve uncertainty in planning for asset turnover target profit. Will be used polynomial interpolation theory and posterior information.
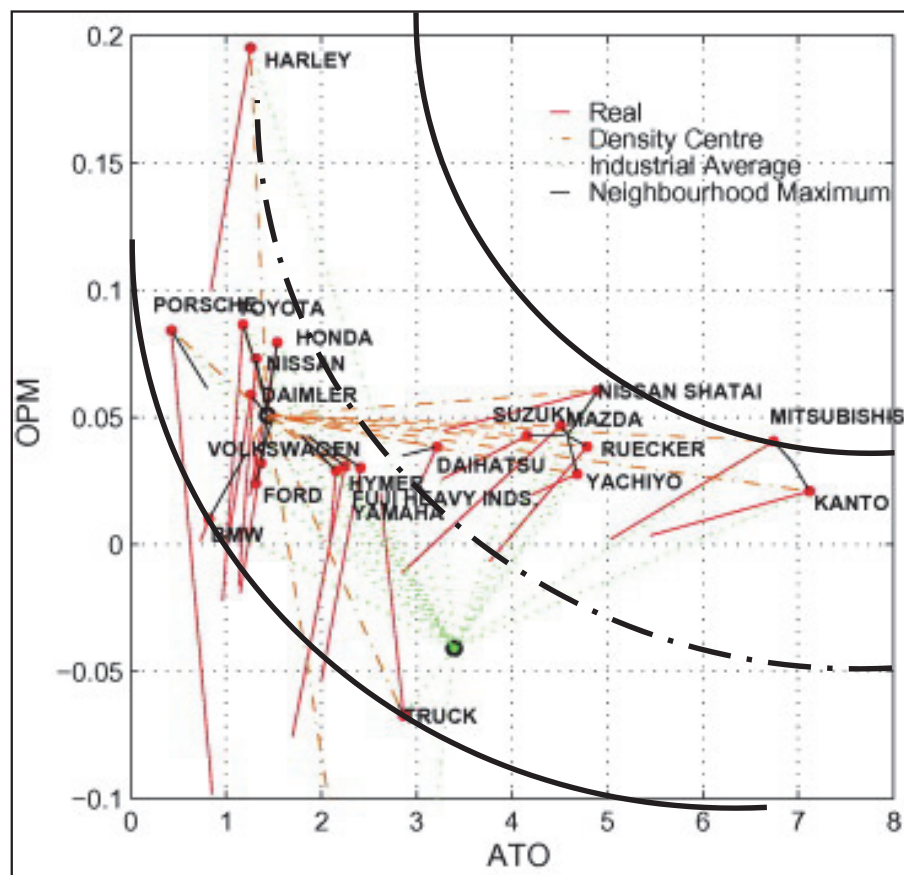
Keywords: Du-Pont Graph of profitability, asset turnover, polynomial interpolation, posterior information

INTRODUCTION

Understanding the principles of business profitability has been a longstanding domain of interest for researchers (see, e.g., Wu *et al.* (2010), Tecles (2010), and Thomas (2011)). Consumers expressed the degree of influence in their decision-making on satisfying their needs through selected key marketing factors such as price, brand, quality, habits and experience, advertising, recommendation from friends and relatives, packaging, discounts, new items, and so on Birčiaková *et al.* (2014). Research documents of the DuPont components of represent an incremental information source about the operating aspects of a firm. Du Pont analysis can be used as one of possible toll of corporate sustainability management (CSM), which appears to be an important issue for current management Vnoučková *et al.* (2014). It is also useful tool for market participants Soliman, (2008). Many textbooks of the financial statement analysis often argue decomposing profitability into profit margin because of their usefulness in company performance analysis (Stickney and Brown, 2006). Therefore financial performance has been widely accepted in practice since its development. The DuPont analysis can serve as input to expert discussion about the possible taxation of the financial sector, which has started in the European Union as a result of the financial crisis which has spread to the Europe from the United States in 2008 and consequently of the massive financial interventions by governments made in favour of the financial sector Solilová and Nerudová (2015).

In essence, DuPont analysis is an expression which separate return on equity (ROE) into three profitability factors: (1) operating efficiency – which

1: *Directions of German, USA and Japanese car manufacturers showing the borders of the set of values and the median ROA isoquant*

can be measured by profit margin (PM); (2) asset use efficiency – which is usually measured by asset turnover (ATO); and (3) financial leverage effect -which is usually measured by equity multiplier (EM), Nair (2003). PM and ATO are the components of return on assets (ROA). ROA measures how efficiently the company's assets are generating profits. In addition, ATO measures asset efficiency such as use of working capital. Whereas PM can be used as an indicator of the firm's profitability related to company's revenue. Disaggregating ROA into these components allows users (e.g. managers, market participants) to understand the sources of superior (or inferior) return within industry and across industries. Separating ROA into its component parts allows us reach better return within industry and across industries, Kahtryn (2014).

Our study of profitability limits itself to the three DuPont profitability ratios: profit margin, asset turnover and return of investment. Our study of profitability limits itself to the three DuPont profitability ratios: profit margin, asset turnover and return of investment. It can be useful to visualize these three profitability drivers in a two-dimensional area, with ATO on the X-axis, OPM on the Y-axis and the RNOA c levels (where OPM times ATO is equal to c) can then be illustrated as the Iso-Curves.

Related research are focused on the incremental benefit of looking at the decomposed profitability ratios OPM and ATO and their predicting future earnings. Fairfield and Yohn (2001) and study changes in profitability and look at the incremental profit of ATO and OPM specifically. They find that disaggregating the change in return on assets into the change in ATO and the change in OPM helps to better predict future profitability. Nair (2003) similarly finds the profitability measures to be informative for stock market prices.

Unlike them we have been trying to handle with these quantities in aggregated form. This brought the problem in the form: How to clearly determine the value of profit margin, with knowledge of the net asset turnover, operating (and a priori ignorance ROA)?

MATERIALS AND METHODS

In terms of methodology, first we measured extreme values defining a set of values (respectively OPM-ATO system). Using several reference points of the edges of OPM-ATO system, we made a polynomial interpolation. Based on this interpolation, we defined a set of values of ATO-OPM system. In next step, we calculated the mean value of isoquant of the ATO-OPM system and

I: *Values for calculation of the polynomial interpolations*

Variable	order of measured values			
Lower limit				
X: ATO	1	2	3	4
Y: OPM	−0.01	−0.05	−0.07	−0.09
Upper limit				
X: ATO	3	4	5	6
Y: OPM	0.18	0.10	0.06	0.05

also the maximum estimation error. After delivery posteriori information we could determine the real isoquant for the concerned producer. We used data published in the study "Profitability in the car industry", that had been published in the European Journal of Operational Research in 2013 (written by Hans van der Heijden), to verify the functionality of the new method, which we designed and presented in this paper.

RESULTS

There were 8 measured data in the chain and that is why the Tab. I contains 4 real points.

Polynomial interpolation is a method of estimating values between known data points (Schatzman (2002). When graphical data contains a gap, but data is available on either side of the gap or at a few specific points within the gap, an estimate of values within the gap can be made by interpolation. If a set of data contains n known points, then there exists exactly one polynomial of degree $n – 1$ or smaller that passes through all of those points. The polynomial's graph can be thought of as "filling in the curve" to account for data between the known points. A polynomial could be express as a mathematical expression comprising a sum of terms, each term including a variable or variables raised to a power and multiplied by a coefficient (Süli, 2003). This methodology, known as polynomial interpolation, often (but not always) provides more accurate results than regression model.

We have four values for lower polynomial construction, so we can interpolate these values using the third order polynomial in the following form:

$$f1(ATOi) = a_0 + a_1 \times ATO + a_2 \times ATO^2 + a_3 \times ATO^3. \quad (1)$$

By putting the data from the Tab. I into equations (1), we will get a homogeneous system of four linear equations with four unknowns:

$$-0.01 = a_0 + a_1 + a_2 + a_3, \quad (2)$$

$$-0.05 = a_0 + 2a_1 + 4a_2 + 8a_3, \quad (3)$$

$$-0.07 = a_0 + 3a_1 + 9a_2 + 27a_3, \quad (4)$$

$$-0.09 = a_0 + 4a_1 + 16a_2 + 64a_3. \quad (5)$$

By subtracting the vector of variables situated on the right hand side of the system, we will get a homogeneous system of four linear equations with four unknowns.

$$A \times P = 0. \quad (6)$$

Where A is the vector with a_1, a_2, a_3, a_4 states. P is a parametric matrix determined from the values in Tab. I. If we express the matrix product using the extended matrix of the system, we get:

$$\begin{pmatrix} a_0 & a_1 & a_2 & a_3 & | -0.01 \\ a_0 & 2a_1 & 4a_2 & 8a_3 & | -0.05 \\ a_0 & 3a_1 & 9a_2 & 27a_3 & | -0.07 \\ a_0 & 4a_1 & 16a_2 & 64a_3 & | -0.09 \end{pmatrix}. \quad (7)$$

According to the Frobenius theorem, the system of equations is solvable if and only if the rank of a matrix is equal to the rank of the augmented matrix of the system. In this case, the determinant of **P** matrix is nonzero. In order to verify that the augmented matrix (7) is solvable, we will compute the determinant of the polynomial parameters **P** (using the Saruss rule or by expansion according to row/column for determinants greater than '3 × 3').

$$Det(P) = det \begin{pmatrix} a_0 & a_1 & a_2 & a_3 \\ a_0 & 2a_1 & 4a_2 & 8a_3 \\ a_0 & 3a_1 & 9a_2 & 27a_3 \\ a_0 & 4a_1 & 16a_2 & 64a_3 \end{pmatrix} = 12. \quad (8)$$

As det P ≠ 0, the previous system has only one solution. The solution for the upper margin range of values provides the following parameter values:

$$a_0 = 0.07; a_1 = -0.1066; a_2 = 0.030; a_3 = -0.0033.$$

Polynomial interpolation for the lower margin of ATO-OPM system then has the following form:

$$f1(ATOi) = 0.07 - 0.1066x + 0.030x^2 - 0.0033x^3. \quad (9)$$

If we express the matrix for the upper margin of ATO-OPM system (using the extended matrix of the system), we get:

$$\begin{pmatrix} a_0 & 3a_1 & 9a_2 & 27a_3 & | 0.18 \\ a_0 & 4a_1 & 16a_2 & 64a_3 & | 0.10 \\ a_0 & 5a_1 & 25a_2 & 125a_3 & | 0.06 \\ a_0 & 6a_1 & 36a_2 & 216a_3 & | 0.05 \end{pmatrix}. \quad (10)$$

Polynomial interpolation for the upper margin of ATO-OPM system then has the following form:

$$f2(ATOi) = 0.76 - 0.2983x + 0.040x^2 - 0.2983x^3. \qquad (11)$$

Mean values expressed by the Central *p*olynomial of the PMO-ATO system is calculated by the following formula:

$$\overline{ATO} = \frac{1}{2} \times \left[Upper\ polynomial + Lower\ polynomial \right] \pm$$

$$\pm \frac{1}{4} \left[Upper\ polynomial - Lower\ polynomial \right]. (12)$$

After achieving calculated values of parameters we obtain the following prediction equation. On this basis, we can predict (estimate) ROA.

$$\overline{ATO} = 0.415 - 0.202x + 0.035x^2 - 0.0248x^3. \qquad (13)$$

To eliminate the variation of the ATO-OPM system is necessary to add a posteriori information. In our case, we can make a correction of estimated ROA by comparing the calculated and actual values using historical data from financial management. Deviation between actual and theoretical values of the RAO (calculated using polynomial) shows the right direction and also shift of the central polynomial.

DISCUSSION AND CONCLUSION

Although numerous techniques of financial statement analysis exist, there is a stream of literature in equity valuation examining how DuPont components can be used to improve forecasts of future profitability. In this paper we studied the estimation of the ROA in relation to the profit and turnover of operating assets.

Each company has, however, individual curve of this dependence, therefore, the determination of turnover for the planned profit vague matter (values create the array of values). The aim of this paper was to propose a new method to resolve uncertainty in prediction RAO using the ATO-OPM system. We have used polynomial interpolation theory and posterior information to achieve the objective. The main problem with polynomial interpolation arises from the fact that even when a certain polynomial function passes through all known data points, the resulting graph might not reflect the actual state of affairs. This problem most often arises when "spikes" or "dips" occur in a graph, reflecting unusual or unexpected events in a real-world situation. Such anomalies are not reflected in the simple polynomial function which, even though it might make perfect mathematical sense, cannot take into account the chaotic nature of events in the physical universe.

But we can say, that the use of this method is appropriate in terms of the lower cost of detecting of profit margin prediction as well as the speed of the detection response. The next phase of the research is to include more advanced methods such as the response surface methodology (RSM) by adding other variables such as a posteriori financial information from other companies of our industry. By adding other financial information, we can obtain the optimal response, namely the narrowest field of asset turnover values of different producers operating in our market.

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