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Profitability in the car industry: New measures for estimating targets and target directions

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ABSTRACT

In this paper we study the profitability of car manufacturers in relation to industry-wide profitability targets such as industry averages. Specifically we are interested in whether firms adjust their profitability in the direction of these targets, whether it is possible to detect any such change, and, if so, what the precise nature is of these changes.

This paper introduces several novel methods to assess the trajectory of profitability over time. In doing so we make two contributions to the current body of knowledge regarding the dynamics of profitability. First, we develop a method to identify multiple profitability targets. We define these targets in addition to the commonly used industry average target. Second, we develop new methods to express movements in the profitability space from t to $t + j$, and define a notion of agreement between one movement and another.

We use empirical data from the car industry to study the extent to which actual movements are in alignment with these targets. Here we calculate the three targets that we have previously identified, and contrast them with the actual profitability movements using our new agreement measure. We find that firms tend to move more towards to the new targets we have identified than to the common industry average.

1. Introduction

Understanding the drivers of business profitability has been a longstanding domain of interest for operational researchers (see, e.g., Wu et al. (2010), Tecles and Tabak (2010), and So and Thomas (2011) for recent examples). In this paper we study the profitability of individual firms in relation to industry-wide profitability targets such as industry averages. Specifically we are interested in whether firms adjust their profitability in the direction of these targets, whether it is possible to detect any such change, and, if so, what the precise nature is of these changes.

Our study of profitability limits itself to the two DuPont profitability ratios: profit margin and asset turnover. The DuPont profitability ratios are disaggregated components of Return on Assets (ROAs). The ratios are well-documented in textbooks, and serve as the basic building blocks for profitability. Profit margin is defined as net income divided by sales. Asset turnover is defined as sales divided by total assets. In this paper we follow the approach advanced by Penman (2010) to focus on Return on Net Operating Assets (RNOAs), in order to neutralize the ways in which firms use financial leverage to increase profit. Financial leverage influences overall profitability by incorporating profits from financial assets, and because these profits can vary widely between companies in the same industry, it is difficult to compare operating profitability using ROA data. In line with this approach we study the disaggregated, multiplicative components of RNOA: Operating Profit Margin (OPM) and Net Operating Asset Turnover (ATO). For ease of reference, the study will often simply refer to these components as profit margin and asset turnover.

It is useful to visualize these two profitability drivers in a two-dimensional plane, with ATO on the *X*-axis and OPM on the *Y*-axis. The various RNOA c levels (where OPM $\times$ ATO = c) can then be depicted in the form of iso-curves. Soliman (2004) and Penman (2010) provide illustrations of such plots. The two-dimensional plane is an instance of a more general n-dimensional profitability space, in this case with $n = 2$. We are interested in describing how firms move year on year through this space (i.e., from one ATO-OPM point to another), and whether this movement is influenced by certain target points in the space.

This paper introduces several novel methods to assess the trajectory of profitability over time. In doing so we make two contributions to the current body of knowledge regarding the dynamics of profitability.

First, we develop a method to identify multiple profitability targets. We define these targets in addition to the commonly used industry average target. The derivation of our new targets is based

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on linear diffusion of kernel density estimation (KDE). KDE has the advantage that it does not estimate one global maximum (i.e., one "peak") but instead allows for the possibility of multiple local maxima. These local maxima manifest themselves as multiple, local "hills" in the profitability space. Using the KDE estimator we arrive at two new types of targets in addition to the industry average target.

Second, we develop new methods to express movements in the profitability space from t to $t + j$, and define a notion of agreement between one movement and another. The method is based on a comparison of the angles of movement, and a mapping of the difference in angles onto a linear $[-1,1]$ domain. The result is an agreement measure which enables us to express one profitability movement as a percentage of agreement with another movement.

The target level is often taken to be the profitability mean of the industry in which the firm operates. Previous research in this area has looked at whether the ratios are mean-reverting over time (see for example Freeman et al., 1982). Lev (1969) provides the first empirical evidence that firms do indeed adjust their ratios to such target levels. Lev also discusses the difficulty of adjustment (in the sense that some ratios are easier to manage than others) and the cost of not adjusting, for example, if banks insist on target levels and raise loan interest if the firm does not meet these levels.

Other than creditor pressure, theoretical reasons for firms moving their profitability towards target levels can be found in the competitive forces framework as outlined by Porter (1980) and Porter (1985). If the profitability of one firm is much higher than its peers, competing firms will attempt to imitate the distinctive resources available to the superior firm, or will move into the arena where the superior company enjoyed above-average profits. If the profitability of a firm drops below those of its peers, the firm will be much less profitable than the competition and it will face the risk of failure or takeover.

Fama and French (2000) use a version of the partial adjustment model which allows cross-sectional data to be combined with time series data, leading to a larger sample to draw conclusions from. They find strong evidence that profitability (return on assets) is indeed mean-reverting. They also show that firms with much higher profitability tend to revert faster. Soliman (2004), using a comprehensive empirical study, tests whether OPM and ATO indeed revert to their industry means rather than to the general economy-wide levels. The study finds increased predictive ability of RNOA when taking into account industry adjustments for OPM and ATO. Soliman concludes that it is worthwhile to study OPM and ATO at the industry level; this is precisely the approach adopted in this paper.

Related research has focused on the incremental benefit of looking at the disaggregated profitability ratios OPM and ATO and their informativeness for predicting future earnings. Fairfield and Yohn (2001) study changes in profitability and look at the incremental benefit 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. Soliman (2008) similarly finds the profitability measures to be informative for stock market prices.

We use empirical data from the car industry to study the extent to which actual movements are in alignment with these targets. The automobile sector has been subject of research on financial performance before (see, e.g., Saranga (2009) for an example in the component manufacturing industry). We focus on the 21 US, Japanese and German car manufacturers with a global presence. For each firm we calculate the three targets that we have previously identified, and contrast them with the actual profitability movements using our new agreement measure. We find that firms tend to move more towards the new targets we have identified than to the common industry average.

The remainder of the paper is as follows: We first present the new methods for profitability targets, profitability movements and directional agreements. We then document our sample and present the results of the calculations. Finally we present conclusions and directions for future research.

2. Method development

2.1. Movements and directional agreement

The first step in the development of our method is the standardization of the two profitability ratios. If left unstandardized, unit changes have differential effects on the two profitability ratios. For instance if the ATO range is 10 and the OPM range is 0.1 then without scaling (standardizing) them ATO has a 100 times larger impact, any OPM change would be negligible. It is therefore important to establish the relative weighting of ATO and OPM. Our assumption here is that they have equal weight.

We standardize every ratio by their yearly min–max range, such that unit changes carry the same impact for every ratio. The scaling is accomplished by dividing the ATO and OPM distances by their yearly ranges. The ATO range is $\max\{ATO_t\} - \min\{ATO_t\}$ and analogously for the OPM range. Here, these ranges will be called *scaling factors* and denoted by $s{:=}(s_{ATO},s_{OPM})$.

The actual profitability movement of a company c is its change of ATO and OPM from year t to year $t + j$, where j is the number of years forward.

The vector

$$\overrightarrow{r_{ct}} := (r_{c,t+j} - r_{c,t}) \div s \quad (1)$$

$$= (\mathrm{OPM}_{c,t+j} - \mathrm{OPM}_{c,t}, \mathrm{ATO}_{c,t+j} - \mathrm{ATO}_{c,t}) \div s \quad (2)$$

will be defined as the *actual direction* of profitability: from one position in year t to the following year $t + j$. The $\div$ operator indicates the element-by-element division by the scaling factor s. Given a current profitability position and a target position τ we can similarly define a target direction $\overrightarrow{\tau_{ct}}$.

We determine the level of agreement of the actual direction and target direction by considering the angles of the directions. Let φ_a be the angle of the actual direction $\overrightarrow{r_{ct}}$ and φ_τ be the angle of the target direction $\overrightarrow{\tau_{ct}}$. The absolute difference between these angles is the difference angle Δ_φ:

$$\Delta_\varphi = |\varphi_a - \varphi_\tau|. \quad (3)$$

To aid in our understanding of these difference angles, it is convenient to map them to an interval $[-1,1]$, where:

$$\Psi \in \begin{cases} (0,1], & \text{directional agreement;} \\ 0, & \text{orthogonal;} \\ [-1,0), & \text{directional disagreement.} \end{cases} \quad (4)$$

That means if actual and target direction are the same, then $\Psi = 1$, and there is 100% agreement. In case they are orthogonal, then $\Psi = 0$. If they point into opposite directions then the directional agreement is $\Psi = -1$, and the movements are in 100% disagreement.

This mapping is achieved by introducing the linear Ψ function, which we will call *directional agreement*:

$$\Psi := \begin{cases} 1 - \frac{2\Delta_\varphi}{\pi}, & \Delta_\varphi \leqslant \pi \\ \frac{2\Delta_\varphi}{\pi} - 3 & \Delta_\varphi > \pi \end{cases} \quad (5)$$

There are alternative mappings. For instance one could use the cosine function. However, the density shape of the cosine measure is biased towards one and minus one (see Fig. 1). The linear mapping is chosen specifically to neutralize such biases.

Fig. 2 presents a visual overview of these concepts. The Figure depicts one company (BMW), which moves in the profitability