TECHNISCHE UNIVERSITÄT WIEN

25. Techno-Ökonomie-Kolloquium

24. Mai 2019

Business Cycle-Based Adaptive, Integrated Planning

Fakultät für Maschinenbau und Betriebswissenschaften
Institut für Managementwissenschaften
Bereich Finanzwirtschaft und Controlling

Doctoral Thesis - Konzeptpräsentation
Johannes Hunschofsky

Introduction

Hannes Hunschofsky

CEO of Engine Division

GE Energy

1980-1992 Austria

1993-1995 USA

Project and Application Engineer
R&D Engineer
Marketing Manager
Vice President Sales & Marketing
President & CEO Jenbacher USA

STORM

1995-1999 Germany

President & CEO

HOERBIGER

1999-2013 USA

2012-2019 Global

Chief Operations Officer HCA
President HARP & HCA
COO & Head of Production Division
CEO of Engine Division

Agenda

- Motivation
- Problem Statements
- Concept Review: ROC, BC Phase Changes
- Expected Results
- Research Methodology
- Literature

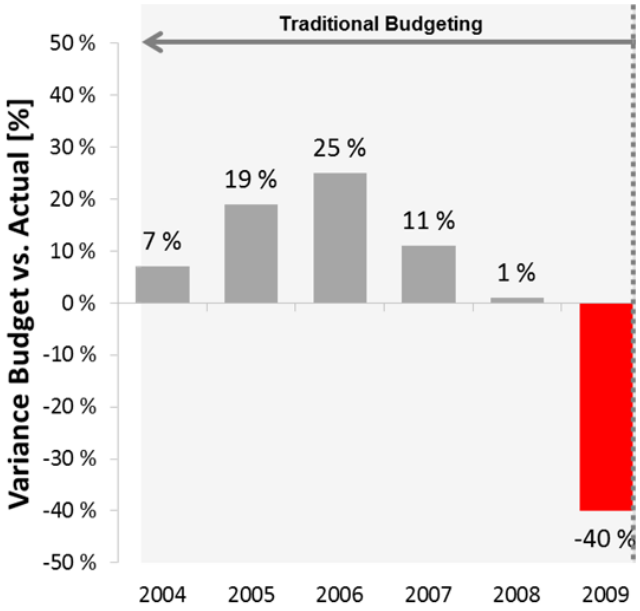
Motivation

ManufactureCo (ARC), US Corporation, Oil & Gas Business

> 120 M$ Revenue, > 350 Employees

Sales Time Series of 20 Years available

Results of classic sales planning model?



Avg. Variances
Actual vs. Budget since 2004:

17 %

Motivation

The lack of quality of sales forecasts, particularly during times of high volatility (business cycle phase changes), has a major impact on company performance.
(Bromiley, Navarro, & Sottile, 2008, p. 207) (Deleersnyder, et al., 2004, p. 373)
(Hewel, Neubäumer, 1998, p. 371)

The managerial planning (budgeting) process is missing objective (scientific) sales forecast information based on economic forecasts, enabling the improvement of the corporate plan.
(Weber, Zubler, & Krügerke, 2009, p. 51) (Joannidès de Lautour, 2018, p. 219)

Macroeconomic indicators can improve sales forecast quality, however they are generally lacking company specific correlation, long lead time and/or are not easy to forecast.
(Sagaert, et al., 2018, p. 566) (Allen & Fildes, 2002, p. 306)

There is a methodology missing, enabling management the use of company specific macroeconomic forecasting: an artifact that improves the quality of the sales forecast, is easy to use, cost sensitive to implement and therefore becomes part of an adaptive, integrated planning and decision making process.
(Bromiley, Navarro, & Sottile, 2008, p. 214) (Hope & Fraser, 2003, p. 113) (Magnet, Hunschofsky & Tschandl, 2013, p. 190)

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- Motivation
- **Problem Statements**
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Problem Statements

[1] Common Time Series Analysis Methodologies are not sufficiently designed to eliminate seasonality and outliers.

[2] Missing methodology to define multi variable causality of leading Macroeconomic Indicators and its integration into one company specific sales forecast.

[3] Contemporary management planning/budgeting processes do not consider impact of business cycle phase changes.

Problem Statements

[1] Common Time Series Analysis Methodologies are not sufficiently designed to eliminate seasonality and outliers.
Problem Solving Approach: Establish Methodology for Variables Transformation and Aggregation through monthly, quarterly and yearly Rate of Change (ROC) Analysis.

[2] Missing methodology to define multi variable causality of leading Macroeconomic Indicators and its integration into one company specific sales forecast.
Problem Solving Approach: Develop methodology (incl. artifact) to generate a set of correlating leading macro economic indicators and merge them into a single composite forecast indicator.

[3] Contemporary management planning/budgeting processes do not consider impact of business cycle phase changes.
Problem Solving Approach: Integrate business cycle-based forecast into managerial planning process to generate business cycle-based sales plan.

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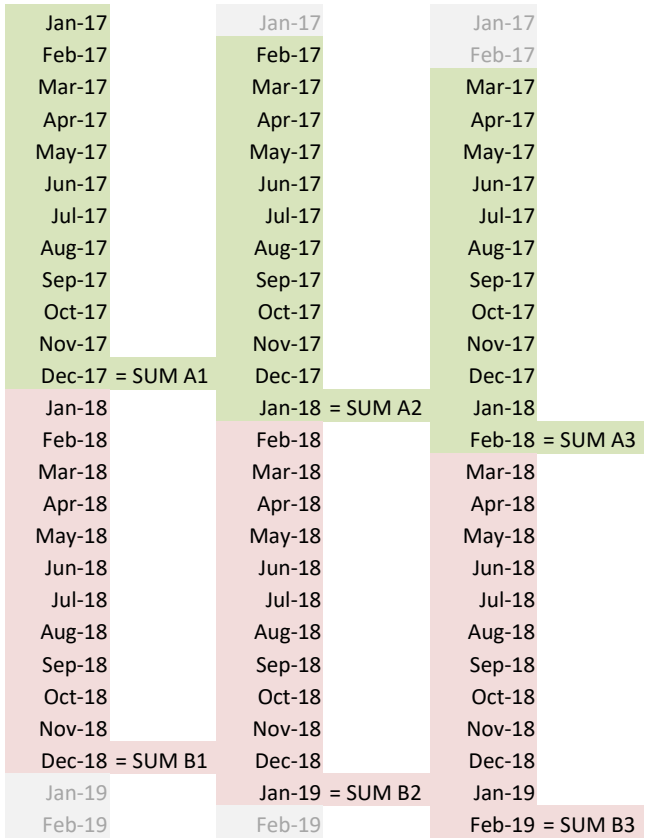
Rate of Change



ROC 12/12
Percentage change of the sum of the past twelve months versus the sum of the 12 months before.

ROC 3/12
Percentage change of the sum of the past three months versus the sum of the same three months one year ago.

ROC 1/12
Percentage change of the sum of the past month versus the same month one year ago.

Annual rate of change (ROC 12/12) December 2018 =

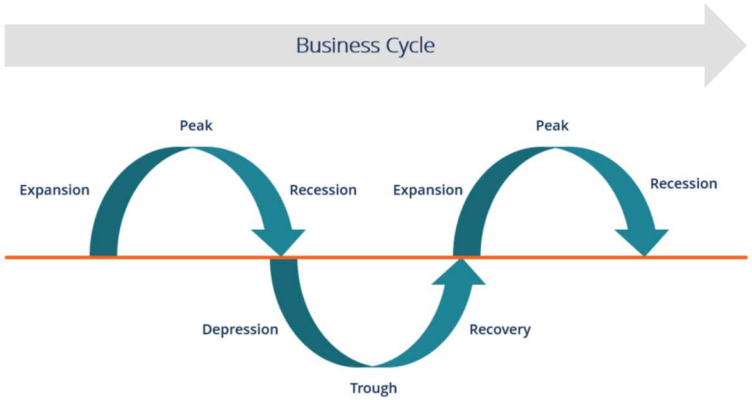
$$= \{ \left(\frac{\text{12 months total per Dec. 2018 = SUM B1}}{\text{12 months total per Dec. 2017 = SUM A1}} \right) \times 100 \} - 100$$

Example:
12 months total per December 2018 = SUM B1 = EUR 25 million
12 months total per December 2017 = SUM A1 = EUR 30 million

$$\text{Annual rate of change December 2018} = \{ \left(\frac{25}{30} \right) \times 100 \} - 100 = -16.6\ \%$$

Business Cycle Phase Changes

Business Cycle



Business Cycle Phase Changes

We define business cycle phase changes as the transition point in time, when the function of the business cycle transits from one quadrant into the next[1)].

Accelerating Growth (B): 12/12 is rising above 0, data trend is accelerating in its ascent and is above the year-ago level. This is the second positive phase of the business cycle.

Recovery (A): 12/12 is rising below 0 and the data trend is either heading toward a low or is in the early stages of recovery. This is the first positive phase of the business cycle.

Slowing Growth (C): 12/12 is declining but remains above 0, data trend ascent is slowing or has stopped its rise, but it is still above last year. This is the first negative phase of the business cycle.

Recession (D): 12/12 is below 0, data trend is below the year-ago level and the rate of decline is intensifying. This is the second and final negative phase of the business cycle.

1) Comment: Business cycle phases do not necessarily always follow a full loop business cycle. It can be observed for example, that slowing growth turns into accelerating growth again, which is also called a soft landing.

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Expected Results

- The proposed methodologies shall significantly improve sales forecasting accuracy over standard practice and established statistical benchmarks, allowing sales prognosis for 12-36 months ahead (“beyond forecasting”).
- The proposed methodologies shall create an “early warning system” for business-cycle phase changes one year ahead.
- The proposed methodologies shall provide economic insights to managers within an integrated, adaptive planning model process to improve accuracy of the sales plan.

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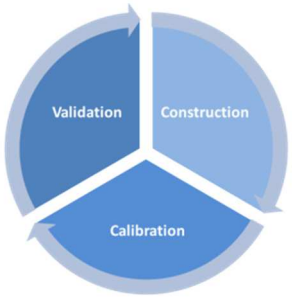
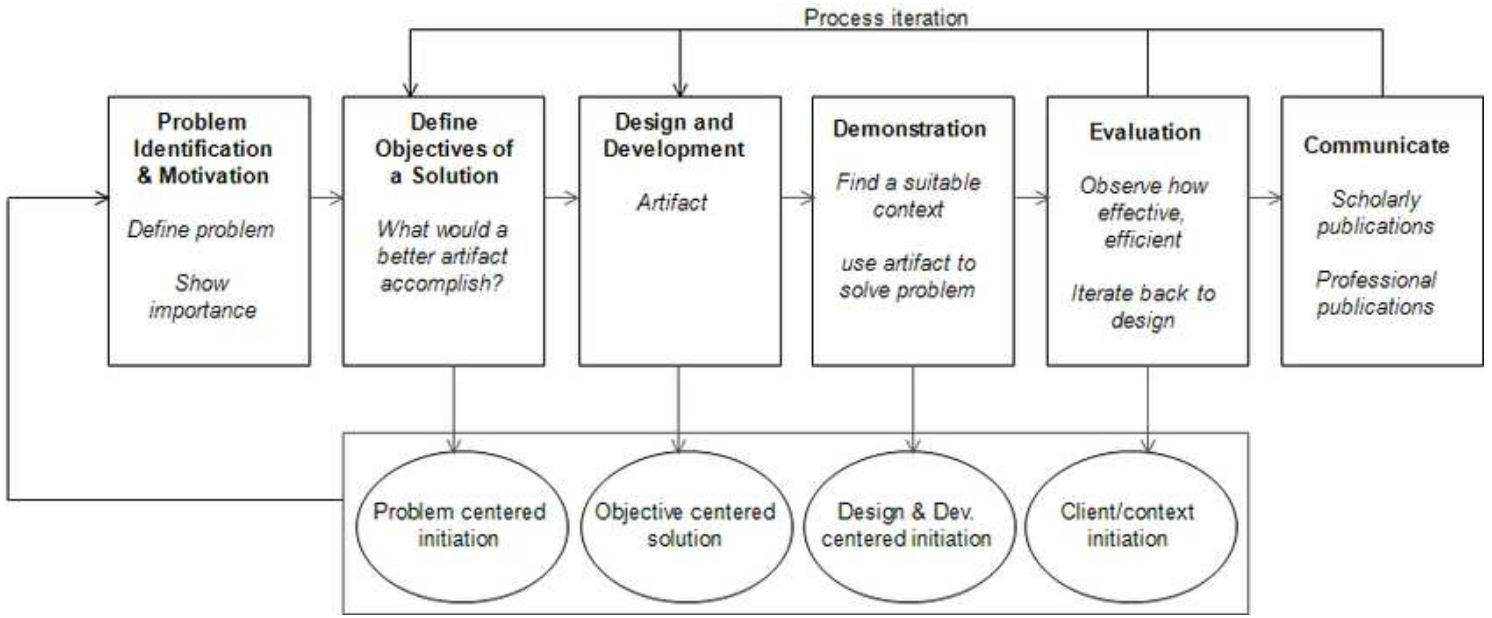
Research Methodology

Design Science Research Methodology (DSRM)

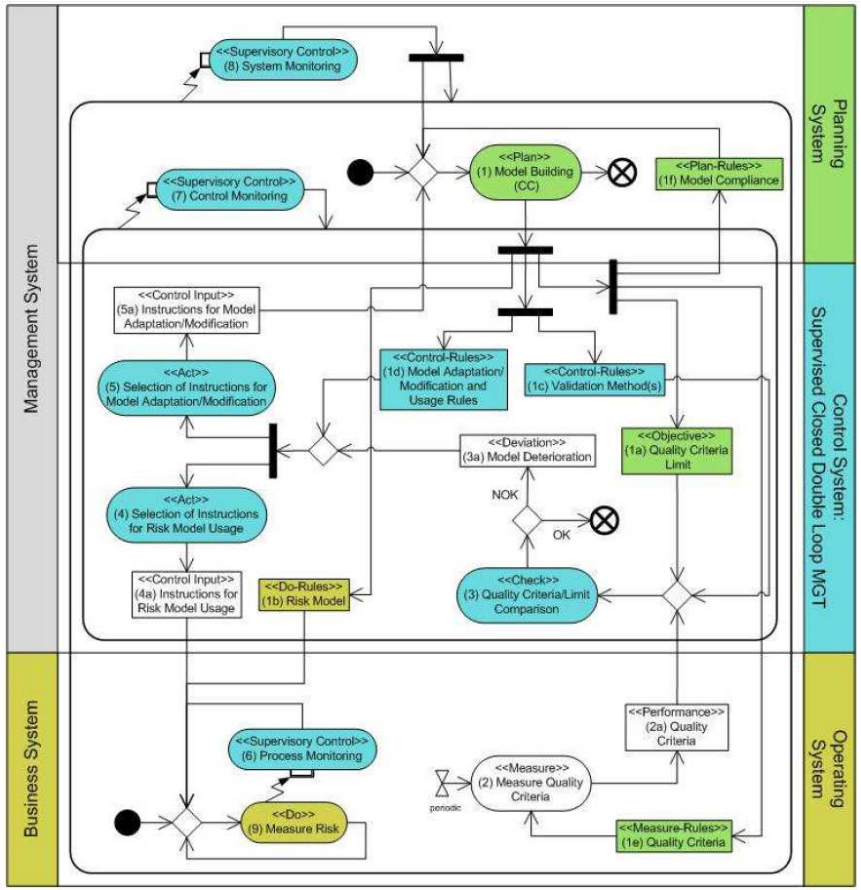


CCV-Process



Methodology

Cybernetic RMM Process



Lederer, T., 2010 Context-Specific Consideration of Credit Risk Model Validation (Dissertation TU Wien)

Risk Model Management

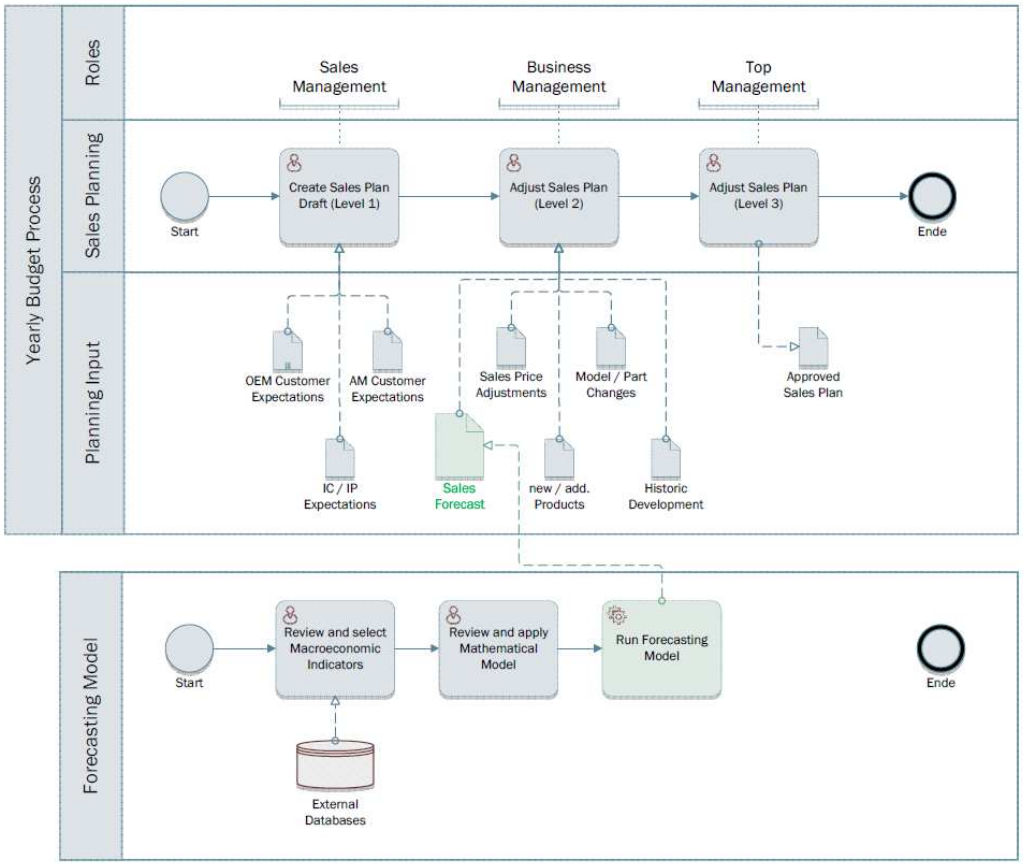
Using the management framework, Risk Model Management can be viewed as a control system in the form of a:

- Supervised,
- Closed loop,
- Double loop

Management Diagram.

Methodology

Development of a Cybernetic Forecasting and Planning Model Process



Following the approach of the Risk Model Management a **Cybernetic Forecasting and Planning Model** (CFPM) and Management Process shall be developed, that

- determines the Forecasting Model as integral input for the Sales Planning Process,
- allows for adjustments based on additional internal and external expert information and
- seamlessly integrates into the Management Decision Making Process.

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Literature

Allen, P. G., & Fildes, R. (2002). Econometric Forecasting. In J. S. Armstrong (Ed.), *Principles of Forecasting - A Handbook for Researchers and Practitioners* (pp. 303-362). Kluwer Academic Publishers.

Bromiley, P., Navarro, P., & Sottile, P. (2008). Strategic business cycle management and organizational performance: a great unexplored research stream. *Strategic Organization, 6*(2), pp. 207-219.

Deleersnyder, B., Dekimpe, M. G., Sarvary, M., & Parker, P. M. (2004). Weathering Tight Economic Times: The Sales Evolution of Consumer Durables Over the Business Cycle. *Quantitative Marketing and Economics, 2*(4), pp. 347-383.

Stock, J. H., & Watson, M. W. (1999). Business cycle fluctuations in US macroeconomic time series. In J. Taylor, & M. Woodford (Eds.), *Handbook of Macroeconomics* (pp. 3-64). Amsterdam: Elsevier.

Hewel/Neubäumer 1998: Hewel, Brigitte/Neubäumer, Renate: *Volkswirtschaftslehre: Grundlagen der Volkswirtschaftstheorie und Volkswirtschaftspolitik*, Gabler, Wiesbaden, 2. Auflage

Hope, J. & Fraser, R. (2003). *Who needs budgets?* Harvard Business Review 81(2) 2003 pp. 108-115

Magnet, C., Hunschofsky, J. & Tschandl, M. (2013) Erhöhte Planungsqualität durch makroökonomische Umsatzprognose, in: Controlling für Logistikdienstleister Hrsg. Christian Schneider DVZ Verlag Berlin June 2013 (Kapitel 10) Seite 184 – 202

Navarro, P., Bromiley, P., & Sottile, P. (2010). Business cycle management and firm performance: Tying the empirical knot. *Journal of Strategy and Management, 3*(1), pp. 50-71.

Phillips, C. J., Nikolopoulos, K. (2019) *Forecast quality improvement with Action Research: A success story at PharmaCo,* International Journal of Forecasting 35 (2019) pp. 129–143

Sagaert, Y. R., Aghezzaf, E.-H., Kourentzes, N., & Desmet, B. (2018). Tactical sales forecasting using a very large set of macroeconomic indicators. *European Journal of Operational Research, 264*, pp. 558-569.

Stock, J. H., & Watson, M. W. (1999). Business cycle fluctuations in US macroeconomic time series. In J. Taylor, & M. Woodford (Eds.), *Handbook of Macroeconomics* (pp. 3-64). Amsterdam: Elsevier.

Weber, J., Zubler, S., & Krügerke, C. (2009). Neueste Benchmarking-Ergebnisse für die Controllership im deutschsprachigen Raum. *Controlling & Management, 53*(1), pp. 50-56.

TECHNISCHE UNIVERSITÄT WIEN

Annex

Motivation

The lack of quality of sales forecasts, particularly during times of high volatility (business cycle changes), has a major impact on company performance.

"After more than five years of case work and empirical study in which we have identified and tested potential causal links between prescriptive Business Cycle Management and organizational performance, we find this lack of scholarly attention to Business Cycle Management both puzzling and exciting." (Bromiley, Navarro, & Sottile, 2008, p. 207)

"Business cycles can have a profound impact on many companies and industries. Still, not much prior research has systematically considered the extent and nature of cyclical sensitivity in marketing performance." (Deleersnyder, et al., 2004, p. 373)

"Alternatively, in the economics literature, quite some researchers have examined the relation between *aggregate* business cycles and various macro-economic indicators (see e.g. Mankiw, 1985; Stock and Watson, 1999). However, very few efforts have been made to explicitly consider the relationship at a more disaggregate micro-level that represents the immediate working domain for individual companies. Such a more disaggregate analysis is called for, as disaggregate relations may well differ from the aggregate ones." (Deleersnyder, et al., 2004, p. 348)

Motivation

The managerial planning (budgeting) process is missing objective (scientific) sales forecast information based on economic forecast, enabling the improvement of the corporate plan.

"The obvious weakness in traditional budgeting methods is that large future macroeconomic changes and their associated effects on the revenues of individual companies are not really taken into account." (Weber, Zubler, & Krügerke, 2009, p. 51)

"The first role assigned to budgets is that of being a synthesis of economic forecasts articulated by management. In sum, the budget is the formalising of how at a certain point in time managers perceive the future. Noticeably, it is never clear how these anticipations are forged." (Joannidès de Lautour, 2018, p. 219)

Motivation

Macroeconomic indicators can improve sales forecast quality, however they are generally lacking company specific correlation, long lead time and/or are easy to forecast.

"Tactical sales forecasts span typically up to 12 months ahead. In this time scale the changing characteristics of the economy can impact sales significantly." (Sagaert, et al., 2018, p. 566)

"In several sectors tactical forecasting that supports plans for raw materials, labor, machine resources and financial planning, has a horizon of 3 to 12 months ahead. In this context macroeconomic information is relevant. Often tactical level forecasts rely on univariate methods, which are unable to model changing conditions in a market." (Sagaert, et al., 2018, p. 558)

„For example, an equation that seems to explain how changes in a set of variables can cause a company's annual sales to decrease may help managers understand the forces in the economy that influence their business. But unless the causal variables can be controlled, have long leads, or are easy to forecast, they will be useless in a model intended for forecasting." (Allen & Fildes, 2002, p. 306)

Motivation

There is a methodology and a toolbox missing, enabling management the use of company specific macroeconomic forecasting: an artifact that improves the quality of the sales forecast, is easy to use, cost sensitive to implement and therefore becomes part of an adaptive, integrated planning and decision making process.

"Complicating matters further is that the deployment of forecasting resources can be an expensive endeavor which small- to mid-size firms may not want to shoulder. (Bromiley, Navarro, & Sottile, 2008, p. 214)

"Rolling forecasts differ from budgets in several ways. Most important, they are more accurate…they are constantly refreshed by the latest estimates of economic trends ..." (Hope & Fraser, 2003, p. 113)

"The starting point for the development of a macroeconomic trend and sales forecasting model in 2009 was the ideal concept of a planning process that includes future macroeconomic prospects, is company-specific and user-friendly, and can be integrated into an existing planning and budgeting architecture with minimum time and effort. (Magnet, Hunschofsky & Tschandl, 2013, p. 190)

State of the Art

Most Adjacent Papers

European Journal of Operational Research 264 (2018) 558–569

Contents lists available at ScienceDirect

European Journal of Operational Research

journal homepage: www.elsevier.com/locate/ejor

Production, Manufacturing and Logistics

Tactical sales forecasting using a very large set of macroeconomic indicators

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ARTICLE INFO

Article history:
Received 5 November 2015
Accepted 22 June 2017
Available online 29 June 2017

Keywords:
Forecasting
Tactical planning
Leading indicators
LASSO
Variable selection

ABSTRACT

Tactical forecasting in supply chain management supports planning for inventory, scheduling production, and raw material purchase, amongst other functions. It typically refers to forecasts up to 12 months ahead. Traditional forecasting models take into account univariate information extrapolating from the past, but cannot anticipate macroeconomic events, such as steep increases or declines in national economic activity. In practice this is countered by using managerial expert judgement, which is well known to suffer from various biases, is expensive and not scalable. This paper evaluates multiple approaches to improve tactical sales forecasting using macro-economic leading indicators. The proposed statistical forecast selects automatically both the type of leading indicators, as well as the order of the lead for each of the selected indicators. However as the future values of the leading indicators are unknown an additional uncertainty is introduced. This uncertainty is controlled in our methodology by restricting inputs to an unconditional forecasting setup. We compare this with the conditional setup, where future indicator values are assumed to be known and assess the theoretical loss of forecast accuracy. We also evaluate purely statistical model building against judgement aided models, where potential leading indicators are pre-filtered by experts, quantifying the accuracy-cost trade-off. The proposed framework improves on forecasting accuracy over established time series benchmarks, while providing useful insights about the key leading indicators. We evaluate the proposed approach on a real case study and find 18.8% accuracy gains over the current forecasting process.

International Journal of Forecasting 35 (2019) 129–143

Contents lists available at ScienceDirect

International Journal of Forecasting

journal homepage: www.elsevier.com/locate/ijforecast

Forecast quality improvement with Action Research: A success story at PharmaCo

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ARTICLE INFO

Keywords:
Action research
Forecast quality improvement
Supply chain forecasting
Forecasting practice
Information sharing

ABSTRACT

There is a gap in the forecasting research surrounding the theory of integrating and improving forecasting in practice. The number of academically affiliated consultancies and knowledge transfer projects that there are around, due to a need for improvements in forecast quality, would suggest that many interventions and actions are taking place. However, the problems that surround practitioner understanding, learning and usage are rarely documented. This article takes the first step toward trying to rectify this situation by using the specific case study of a fully engaged company. A successful action research intervention in the Production Planning and Control work unit improved the use and understanding of the forecast function, contributing to substantial savings, enhanced communication and improved working practices.

Sagaert, Y. R., Aghezzaf, E.-H., Kourentzes, N., & Desmet, B. (2018).
Tactical sales forecasting using a very large set of macroeconomic indicators.
European Journal of Operational Research, 264, pp. 558-569.

Phillips, C. J., Nikolopoulos, K. (2019)
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