

Northumbria Research Link

Citation: Gonul, Sinan, Goodwin, Paul and Önköl, Dilek (2019) The effects of scenarios on judgmental demand forecasts and the subsequent production decisions. In: ISF 2019 - 39th International Symposium on Forecasting, 16th - 19th June 2019, Thessaloniki, Greece.

URL:

This version was downloaded from Northumbria Research Link:
<http://nrl.northumbria.ac.uk/40114/>

Northumbria University has developed Northumbria Research Link (NRL) to enable users to access the University's research output. Copyright © and moral rights for items on NRL are retained by the individual author(s) and/or other copyright owners. Single copies of full items can be reproduced, displayed or performed, and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided the authors, title and full bibliographic details are given, as well as a hyperlink and/or URL to the original metadata page. The content must not be changed in any way. Full items must not be sold commercially in any format or medium without formal permission of the copyright holder. The full policy is available online: <http://nrl.northumbria.ac.uk/policies.html>

This document may differ from the final, published version of the research and has been made available online in accordance with publisher policies. To read and/or cite from the published version of the research, please visit the publisher's website (a subscription may be required.)

www.northumbria.ac.uk/nrl





**Northumbria
University**
NEWCASTLE

Newcastle
Business School

The effects of scenarios on judgmental demand forecasts and the subsequent production decisions

M. Sinan Gönül

Newcastle Business School, Northumbria University

Paul Goodwin

School of Management, University of Bath

Dilek Önkal

Newcastle Business School, Northumbria University

©M.Sinan Gönül, 19 June 2019





**Northumbria
University**
NEWCASTLE

Overview

- Forecasts and Production Decisions
- Judgmental Forecasts and Cognitive Biases
- Research Focus
- Research Design
- Findings
- Discussion




Forecasts and Production Decisions

- Forecasts are designed to support decisions.
- Production decisions
 - How much to produce of each of a **number of products** when constrained by **manufacturing capacity**
- Forecasts for production decisions
 - Point forecasts  to predict the central tendency
 - Interval forecasts  to predict variability
- These forecasts allow
 - Setting **safety stocks** levels to prevent **stock-outs**
 - Achieving desired **customer service levels**



Forecasts and Production Decisions

- In production planning, managers likely access
 - time series information on **past demand**
 - contextual information relating to **demand**
(Fildes et al. 2009; Fildes et al. 2018)
- The contextual information may take the form of **scenarios**
 - Scenarios are *powerful tools* that suggest possible future events
(Godet, 1982; Goodwin and Wright, 2001)
 - Scenarios challenge managerial thinking and support strategic planning
(Schnaars & Topol, 1987; Schoemaker, 1993; Önköl et al., 2013)
- The forecaster will have the task of *integrating* these two types of information to generate forecasts  production decisions



Judgmental Forecasts and Cognitive Biases

- Such forecasts and the subsequent production decisions are often based on **management judgment**
(Sanders and Manrodt, 2003; Fildes and Goodwin, 2007)
 - These judgmental forecasts are often inaccurate due to many *cognitive biases* (Lawrence et al., 2006)
 - Most *recent* observations may be overweighted
(Bolger and Harvey, 1993; Lawrence and O'Connor, 1992)
 - *Judgmental intervals* tend to be too narrow, underestimating the variability
- Overconfidence** or **hyperprecision**
(Arkes, 2001; Soll and Klayman, 2004; Önkal et al., 2009; Moore et al., 2015)



Judgmental Forecasts and Cognitive Biases

- **Scenarios** may help with problems due to these **cognitive biases**, especially overconfidence
(Lawrence and Makridakis, 1989; Wright & Goodwin, 2009)
- Alternatively they *may not affect* overconfidence at all
 - *Middle ground scenarios* may divert attention from *extreme possibilities*
 - *Optimistic* scenarios may be preferred over *pessimistic*
(Schnaars and Topol, 1987; Newby-Clark et al., 2000)

Research Focus

- Scarcity of research

on the *interaction* between **scenarios** and **time series information** and its effects on

- **forecasts**

- in particular, the **production decisions** that follow

- This study aims to fill that research gap

whether the availability of **best and worst-case scenarios** alongside **time series information**

enhances or reduces the accuracy of

demand forecasts 

the **subsequent production decisions**



Research Design

- Participants (68 in total) were given time-series plots showing past demand over the previous 20 weeks for *six products*
- For *each* product, they were asked to
 - make a point forecast
 - give their confidence (probabilistic estimate) that the realized value would be within $\pm 5\%$ of their point forecast
 - make a production decision (i.e., decide on how many units they would order for production for a particular product)
- This represented an important decision that required them to *translate* their forecasts (and confidence in these forecasts) into actual action
given that the **total production capacity** was set to a **fixed value** (number of products x baseline demand)

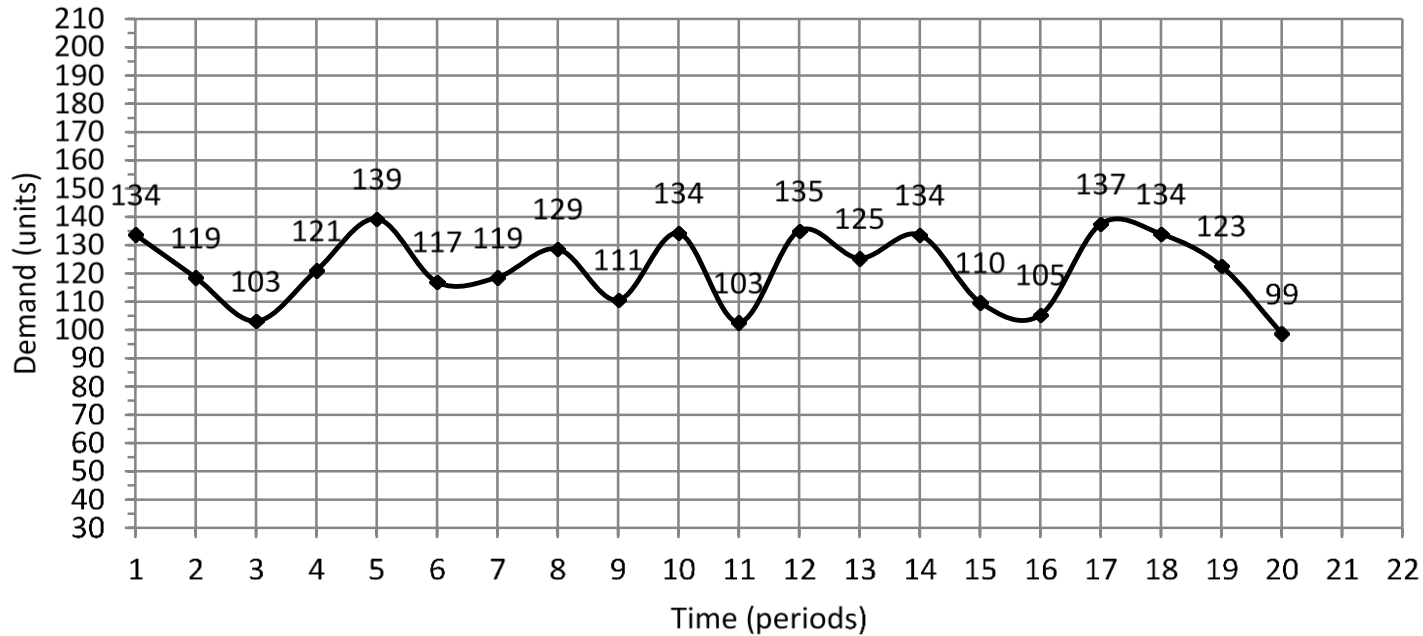


Research Design

- Participants were *randomly* assigned to:
 - **Group 1 – No scenarios**
(23 participants)
 - the time-series information only
 - **Group 2 – Both weak optimistic and weak pessimistic scenarios**
(23 participants)
 - the time-series information,
 - weakly optimistic and weakly pessimistic scenarios
(entitled as “Scenario A” and “Scenario B”)
 - **Group 3 – Both strong optimistic and strong pessimistic scenarios**
(22 participants)
 - the time-series information
 - strongly optimistic and strongly pessimistic scenarios
(entitled as “Scenario A” and “Scenario B”)



PRODUCT K



Sample form Group 3

Scenario A:

Product K, a mobile phone with multifaceted functionality, has extremely stable demand. It has got all that is necessary to compete very successfully in its target market. It is an attractively designed phone with full-fledged features, and comes with a nicely positioned price and exceptionally encouraging promotion package. It regularly receives exceedingly positive comments in the industry magazines/websites and first-class feedback from customers. Given the recent economic conditions, we strongly expect even higher demand for this product in the periods to come.

Scenario B:

This product has been serving its purpose and target market for a long time. Its customers seem to be satisfied with it and its sales performance is stable within a band. It could have continued like this for some time. However, our company has been experiencing vital problems with a major supplier, which happens to be the producer of a key part for this model. If this dispute cannot be solved shortly, we certainly will not be able to produce Product K until we find another supplier with equally good credentials. While it is very difficult to replace the existing one, it will certainly take some time until (a) we find such a supplier, and (b) it starts delivering the required parts. If customers learn about this problem, there is a very high possibility that we will be faced with significantly lower demand in the next period.



Sample form Group 3

YOUR FORECAST :

What is your point forecast for period 21 :

What is your confidence (probabilistic estimate) that

the realized value would be within $\pm 5\%$ of your point forecast: (between 0% and 100%)

YOUR PRODUCTION DECISION

How many units will you order for production? (between 0 and 750)

(Please note that *total production capacity* for period 21 is 750 units. Therefore your production orders for all six products should add up to a maximum of 750. Please keep in mind that there are different costs associated with over-production vs. under-production and make your decisions accordingly. Please use the checklist in the end for production plans)



Findings – The time-series for product demands

- Artificially created to control the levels of *uncertainty* and *trend* - similar to previous studies on judgmental forecasting (e.g. Gönül, Önkal & Lawrence, 2006; Önkal, Gönül & Lawrence, 2008; Önkal, Sayım & Gönül, 2013)
- Six untrended series, half with high noise and half with low noise

$$y(t) = 125 + error(t) \quad t = 0, 1, \dots, 20$$

- *error(t)* was *normally* distributed with zero mean and a standard deviation of
 - 10% (i.e., $0.1 \times 125 = 12.5$) for low noise
 - 20% (i.e., $0.2 \times 125 = 25$) for high noise



Findings – Accuracy of Point Forecasts

Group	No. of participants	MAE	SD
Group 1 - No scenarios	23	16.88	7.60
Group 2 - Weak scenarios	23	24.27	6.98
Group 3 - Strong scenarios	22	23.37	8.81

- Statistically produced forecasts (by *Forecast Pro*) on the series had **MAE = 10.67**
- So the software's forecasts were substantially **more accurate** than those produced by human judgment.

Findings – Calibration of Confidence Assessments

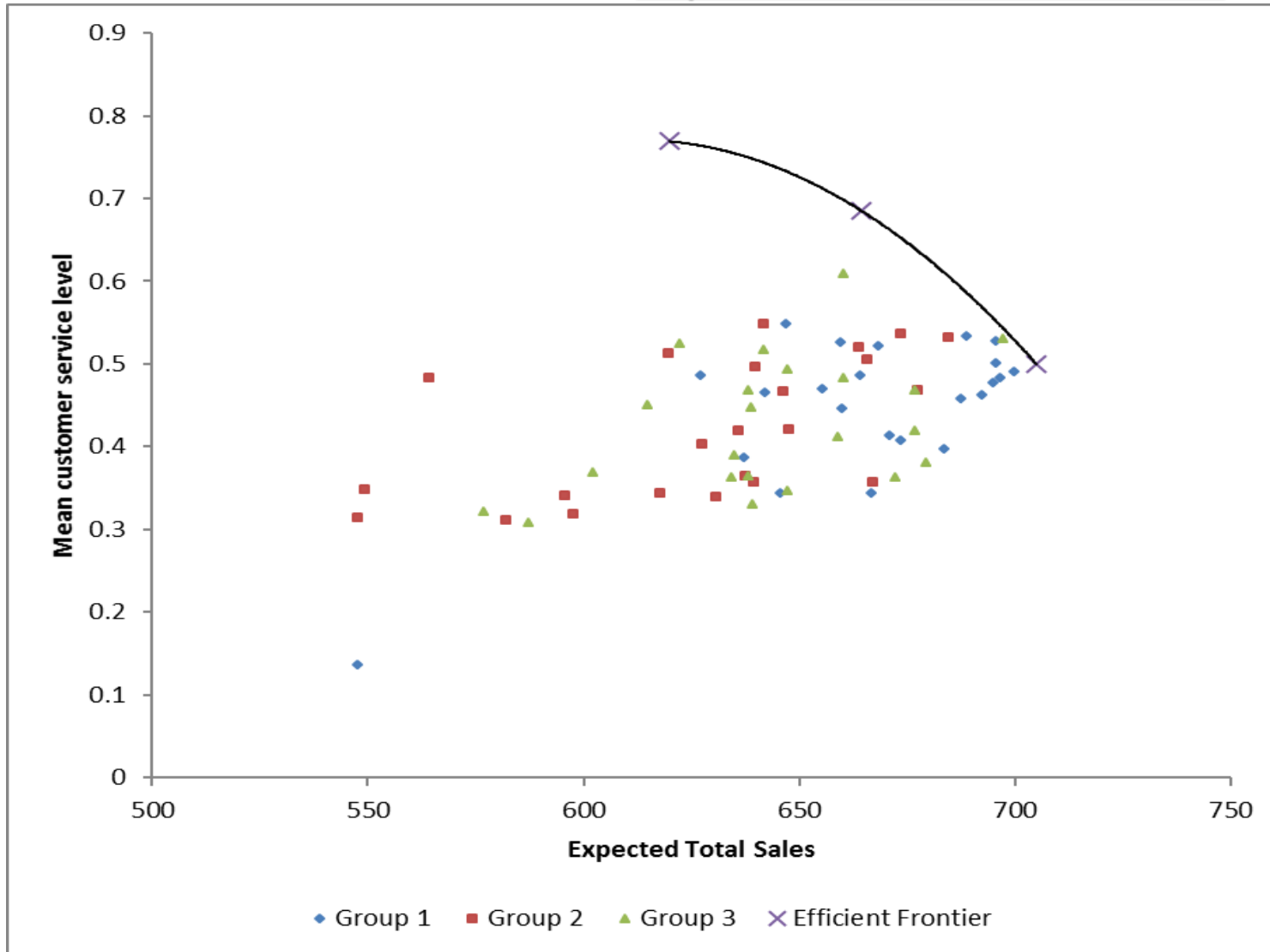
Bias = True SD – Implied estimate of SD (from Confidence assess.)

Group	Mean Bias (low noise)	SD	Mean Bias (high noise)	SD
Group 1 - No scenarios	7.66	1.40	19.60	1.43
Group 2 - Weak scenarios	6.96	3.43	18.66	4.24
Group 3 - Strong scenarios	7.11	2.00	19.66	1.77

- Almost all variability estimates were **too low** compared to true levels of variation – suggesting **overconfidence**.
- Statistically similar across all groups

Findings – Production Decision Quality

- Mean customer service levels (% of demand that could be fulfilled) across the products vs. the expected level of total sales in week 21.



Findings – Production Decision Quality

- Mean customer service levels (*% of demand that could be fulfilled*) across the products vs. the expected level of total sales that in week 21.

Group	Mean service level	Expected total sales (units)
Group 1 - No scenarios	44.90%	665.2
Group 2 - Weak scenarios	42.20%	628.4
Group 3 - Strong scenarios	42.60%	642.9



Discussion – Main Findings

- *Providing scenarios* to judgmental forecasters **worsened** forecast accuracy.
- *Judgmental point forecasts* of future demand (with or without scenarios) were **less accurate** than *software produced ones*
- Judgmental forecasters perceived *the demand variability* to be **much lower** than its true value – demonstrating **overconfidence**
- Scenarios **did not reduce** the tendency of forecasters to be *overconfident*.
- The *production level decisions* had a **greater deviation** from **optimality** when they also received *best-case and worst-case scenarios*.



Discussion – What Next?

- These findings raise two questions
 - Why were *many of the decisions so far from the efficient frontier?*
 - Was this due to **inaccurate point forecasts**?
 - Was this due to **underestimation** of the **variance** of the probability distribution of demand?
 - Was this due to an **inability to handle** the need to **allocate** the total units of production capacity?
 - Why did those who *did not receive scenarios* make *better* decisions?





**Northumbria
University**
NEWCASTLE

Newcastle
Business School

THANK YOU



**Northumbria
University**
NEWCASTLE