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# Why/when can scenarios be harmful for judgmental demand forecasts and the following production order decisions?

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# Overview

- The Study
- Background
- Research Design
- Summary of Main Findings
- Further Analysis
- Discussion

# The Study

- Continuation of the Study presented on **ISF2019, Thessaloniki**

- Investigated ***Judgmentally Forecasting*** demand by using ***Scenarios*** for making Production decisions
  - How many to produce from each of a ***portfolio of products*** under the constraint of ***total manufacturing capacity***

- In more detail, this study aimed to explore whether the availability of **best** and **worst-case scenarios** alongside **time series information** enhances or reduces the accuracy of **judgmental demand forecasts** ⇨ the **subsequent production decisions**

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# Background

- In judgmental demand forecasting, managers likely to 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 provide *colourful narratives* about possible futures
    (Godet, 1982; Goodwin and Wright, 2001)
  - Scenarios challenge managerial thinking and support strategic planning
    (Schnaars & Topol, 1987; Schoemaker, 1993; Önkal et al., 2013)

- The forecaster will have the task of ***integrating*** these two types of information to generate demand forecasts
  ⇒ production decisions

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# Background

- These forecasts are often inaccurate due to many *judgmental 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)

- **Scenarios** may help with problems due to these **judgmental biases**
  (Lawrence and Makridakis, 1989: Wright & Goodwin, 2009)

# Research Design

## 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*

$$y(t) = 125 + error(t) \qquad t = 0, 1, \ldots\ldots, 20$$

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

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# Research Design

- Participants were given these 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 ± 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)

  ⇨ (6 x 125 = 750)

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# Research Design

- Participants (68 in total) were *randomly* assigned to:
  - **Group 1 – No scenarios** (23 participants)
    - the time-series information only
  - **Group 2 – Both weak best-case and weak worst-case scenarios** (23 participants)
    - the time-series information,
    - weakly best-case and weakly worst-case scenarios (entitled as “Scenario A” and “Scenario B”)
  - **Group 3 – Both strong best-case and strong worst-case scenarios** (22 participants)
    - the time-series information
    - strongly best-case and strongly worst-case scenarios (entitled as “Scenario A” and “Scenario B”)

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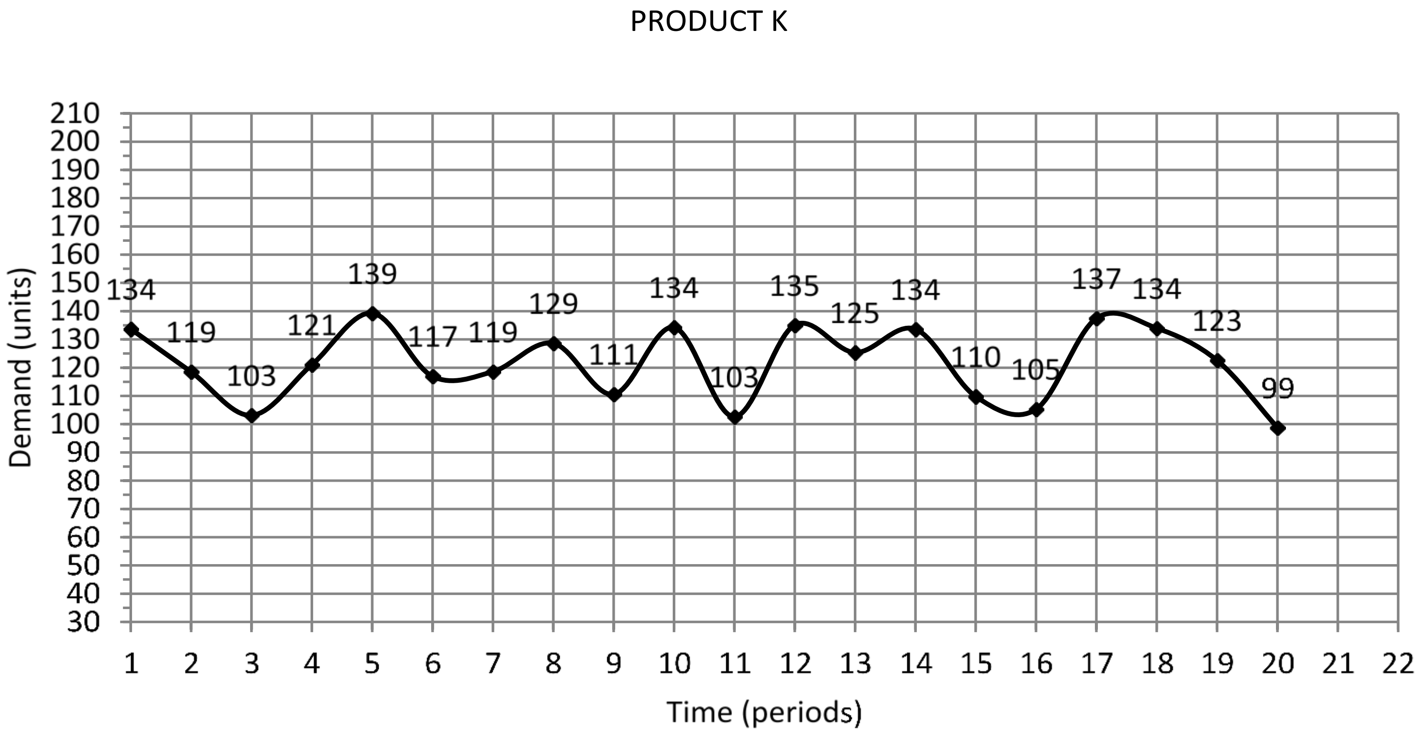


# Sample form Group 3

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 ± 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)

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# Summary of Main Findings

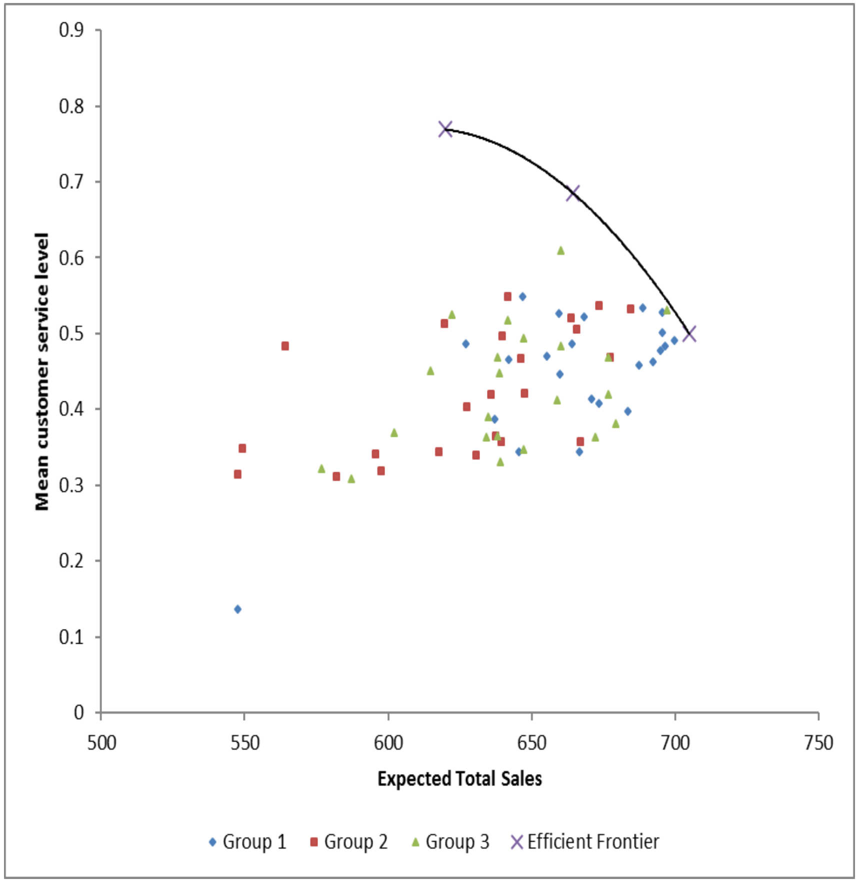
Forecast Accuracy

- *Judgmental point forecasts* of future demand (with or without scenarios) were **less accurate** than *software produced ones*
- Providing **scenarios** to judgmental forecasters **worsened** forecast accuracy.

# Summary of Main Findings

## Production Decision Quality

- Because **scenarios** led to **less accurate** *point forecasts*, in turn
  - The *production level decisions* were closer to the efficient frontier when there were **no scenarios**
  - Providing **scenarios** led the *production level decisions* to show a **greater deviation** from **optimality**

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# Further Analysis – Why?

- Why did *scenarios* lead to **inaccurate point forecasts**?

- Our data involved *repeated measures* (each participant made *six forecasts*) hence the method ***Generalized Estimating Equations (GEE)*** where

dependent variable:

*Point forecast – 125*

the *error* in estimating the signal multiplied by -1 for ease of interpretation

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# Further Analysis – Why?

- ***Generalized Estimating Equations (GEE)***

independent variables:

a) *the last observation - the mean of the series*

(Bolger & Harvey, 1993; Lawrence & O'Connor, 1992)

b) *whether scenarios were provided*

(as a dummy variable: 1= yes, 0 = no)

c) *whether the series had high noise*

(as a dummy variable: 1= yes, 0 = no)

d) *Two-way interactions* between a), b) and c).

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# Further Analysis – Why?

- ***Generalized Estimating Equations (GEE)***

| Variable | Parameter | Std error | Wald Chi-Square | p-value |
|---|---|---|---|---|
| Intercept | -2.28 | 2.02 | 1.27 | 0.259 |
| **Last obs - Series mean** | **1.06** | 0.07 | 256.06 | **<0.0005** |
| Scenarios provided | 3.27 | 2.72 | 1.44 | 0.230 |
| High noise | 2.00 | 2.44 | 0.67 | 0.410 |
| **(Last obs - Series mean) x Scenarios provided** | **0.46** | 0.13 | 12.02 | **0.001** |
| Scenarios provided x High Noise | -0.52 | 3.35 | 0.02 | 0.880 |
| **(Last obs - Series mean) x High noise** | **0.18** | 0.08 | 4.46 | **0.035** |

# Further Analysis – Why?

- ***Generalized Estimating Equations (GEE)***

- The most *recent observations* were **overweighted**.
- The latest observation **above(below)** the *series mean* tends to be associated with a point forecast that is **too high(low)**

- There is also a highly significant interaction between the *latest observation minus the series mean* and whether *scenarios* are provided.
- When *scenarios* were provided, this bias tended to be exaggerated.

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# Further Analysis – Why?

- ***Generalized Estimating Equations (GEE)***

- The scenarios were damaging point forecast accuracy by **increasing** the tendency of the forecasters to *overweight* the *most recent observations*.

- Group 2 and 3 saw both *worst-case* and *best-case scenarios* at the same time:
  - Attention paid to the scenario that was 'consistent' with the *latest movement*
- An **upward(downward)** sloping segment was perceived as being consistent with a **best-case(worst-case)** scenario.

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# Discussion

- The availability of a *best-case scenario* provided people with justification why an *upward movement* signalled better times
  ⇨ even **higher** point forecasts.
- Similarly, a *worst-case scenario* allowed people to have some explanation for a *fall* in the demand,
  ⇨ even **lower** forecast.
- And this was despite the additional presence of a *worst-case* and *best-case scenarios,* respectively.
- The scenario that was 'conflicting' with the *latest movement* in the graph was discounted.

- However, in the **exit questionnaire**, people expressed their fondness of receiving *both scenarios*

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# Discussion

| | Group 2 weak opt. & weak pess. | Group 3 strong opt. & strong pess. |
|---|---|---|
| *Scenarios enhanced future-focused thinking* | 4.24 | 4.20 |
| *Scenarios were useful for constructing forecasts* | 4.38 | 4.25 |
| *Scenarios were clear to understand* | 4.19 | 4.45 |
| *Scenarios were realistic* | 4.24 | 4.20 |
| *Scenarios provided important additional information* | 4.09 | 4.10 |

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# Discussion – What next?

- Specifically targeted research is needed to *systematically* explore the complex interaction between scenarios with the **time-series features** when generating judgmental forecasts.

- We need to understand the reasons behind the ***gap*** between perceived usefulness/merit of receiving scenarios *vs.* the 'real' use/merit.

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# THANK YOU

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