Presenting Author: Florian Dost
(f.dost@lancaster.ac.uk)

Co−Authors: Erik Maier, Tammo Bijmolt

Interrelated Visits and Sales in an Omni-Channel System: An Empirical Dynamic Modelling Approach.

ISMS Marketing Science Conference 2018 14.06.2018

Lancaster University Management School

HHL LEIPZIG GRADUATE SCHOOL OF MANAGEMENT

university of groningen

Motivation

Research shopping

- ‘**research shopper**’ phenomenon.” (Verhoef et al., 2007)

Visits in one channel, purchases in another channel

Lack of offline tracking

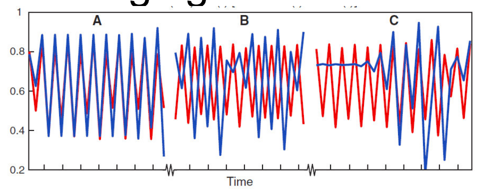
- **crossdevice** path to purchase data is necessary to get an accurate picture of the device attributions”
- The more pressing of an issue is **attributing the offline conversions**.” (Kannan et al., 2016)
- GDPR?

Integrate brick-and-mortar store with web and mobile

Omni-channel paradigm

- Compared to the multichannel phase, omni-channel thus involves **more channels**. An important additional change is that the different channels become blurred as the **natural borders** between channels begin to **disappear**.” (Verhoef et al., 2015)

Higher complexity
interrelated systems
changing correlations



From Channel Addition Challenges…

Brick & Mortar + **Online**		e.g., Pauwels et al., 2011; van Nierop et al., 2011
Catalog + **Online**		e.g., Ansari et al., 2008; Gensler et al., 2007
Brick & Mortar / **Catalog** + **Online**		e.g., Dholakhia et al., 2005; Avery et al., 2012; Pauwels and Neslin, 2015
Online + **Mobile**		e.g., Bang et al., 2013; Huang et al., 2015

…to Omni-Channel Challenges

Challenges for Omni-Channel Studies:

Visits and sales, online and offline	Aggregate time-series data from all channels
Interrelated channels, same-day effects	Endogeneous, co-varying effects
State-dependent effects	Dynamic model
Channel system embedded in larger system	Unobserved variables

A Short History of Empirical Dynamic Models (EDM)

late 20th century

Theoretical and methodological basis

- Chaotic dynamics in deterministic sytems:
  Lorenz 1963.
- Multivariate embeddings / attractor reconstruction:
  Packard et al. 1980
- Time-delay embedding theorem:
  Takens, 1981
- Detecting optimal embeddings and forecasting:
  Sugihara & May 1990
  Kantz & Schreiber 1997

2012 - 16

EDM methodology for ecosystems (e.g., predator – prey foodwebs)

- Causality-tests:
  Sugihara et al., 2012
  Ma, Aihara & Chen 2014
- Non-linear estimation:
  Deyle et al., 2013,
  Ye et al., 2015,
  Deyle et al., 2016a

2015 -

Applied to climate systems and retailing related settings

- Causal feedbacks in climate systems:
  van Nes et al.2015
- Global drivers of influenza:
  Deyle et al. 2016b
- Assessment of impact of e-commerce on energy consumption:
  Dost & Maier 2017

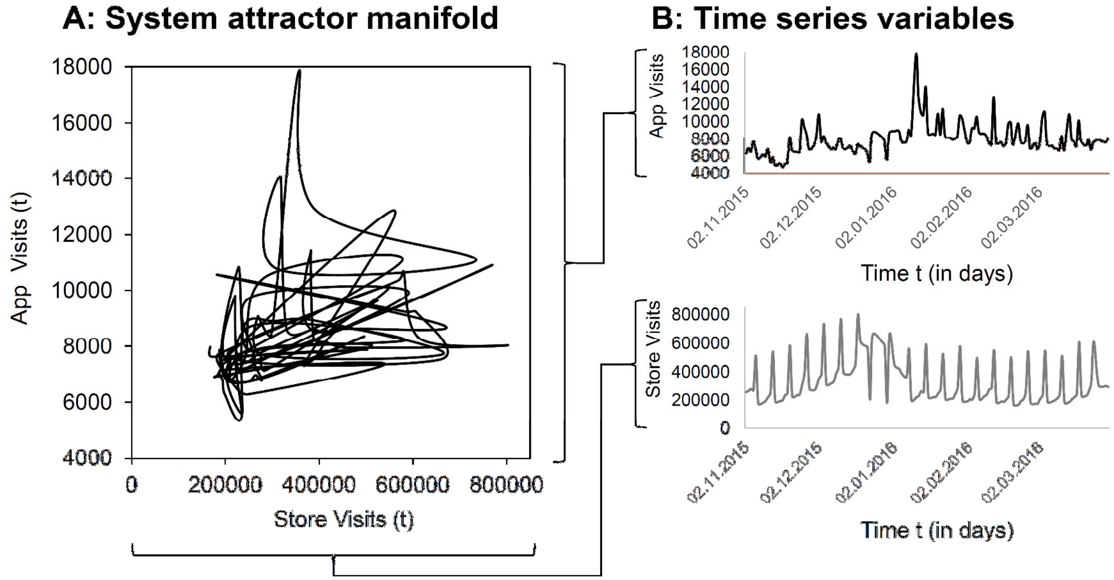
Lancaster University Management School

HHL LEIPZIG GRADUATE SCHOOL OF MANAGEMENT

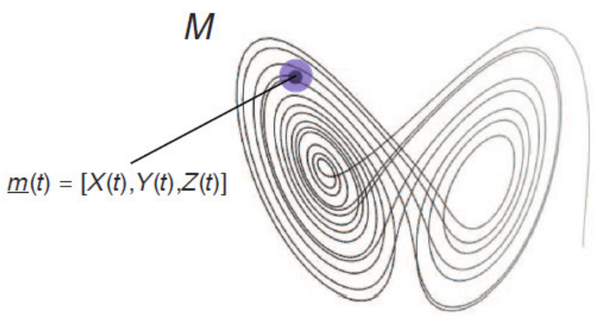
university of groningen

EDM Basics: Time Series as Attractor Manifolds

2D-example from our data:

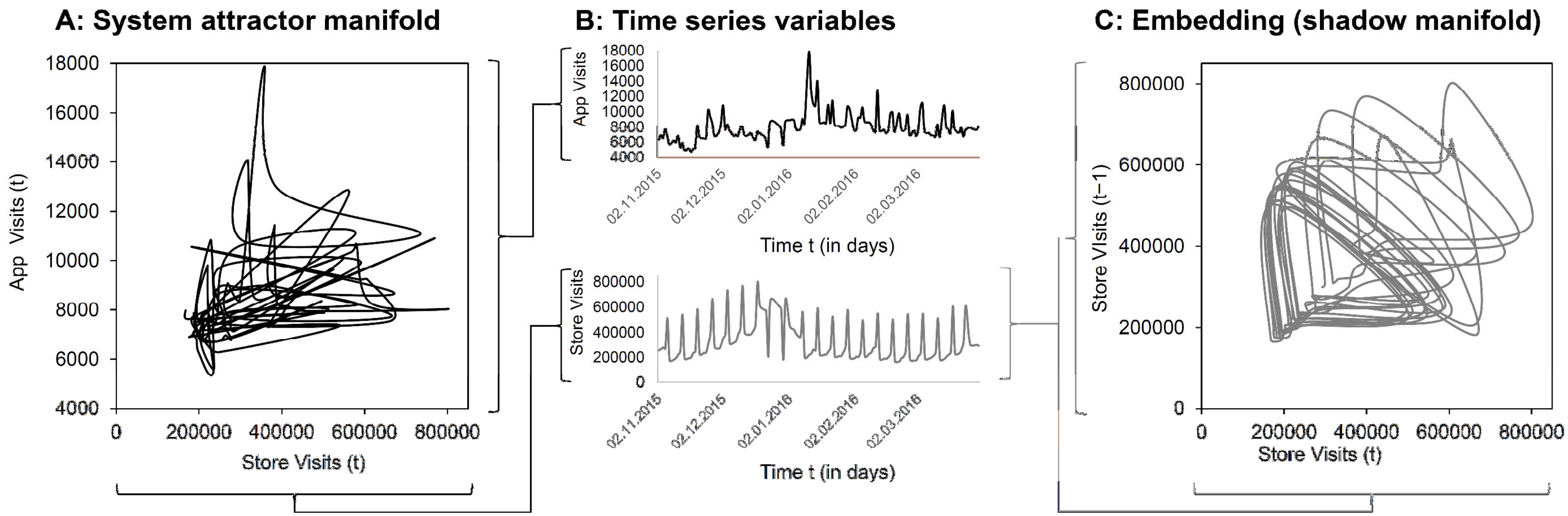


3D-example with Lorenz system (Sugihara et al 2012):

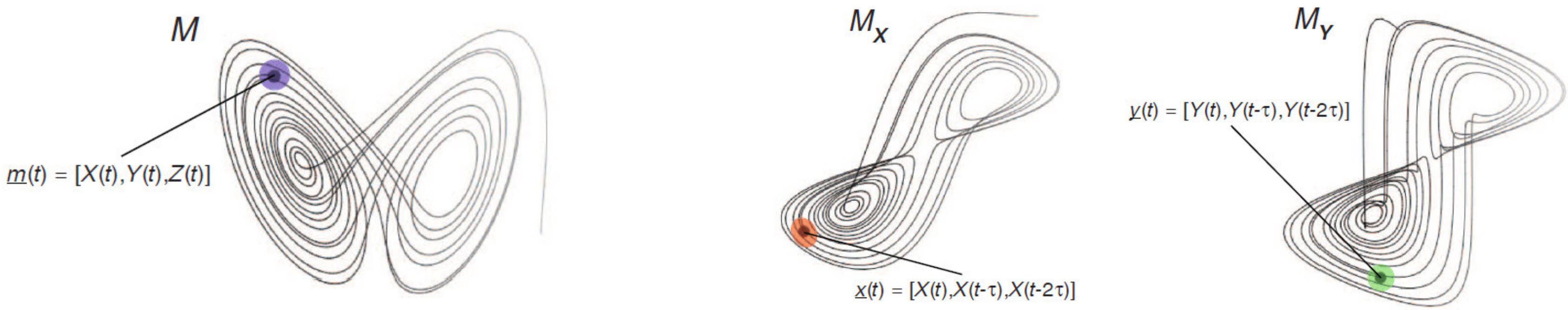


EDM Basics: Embeddings / Shadow Manifolds

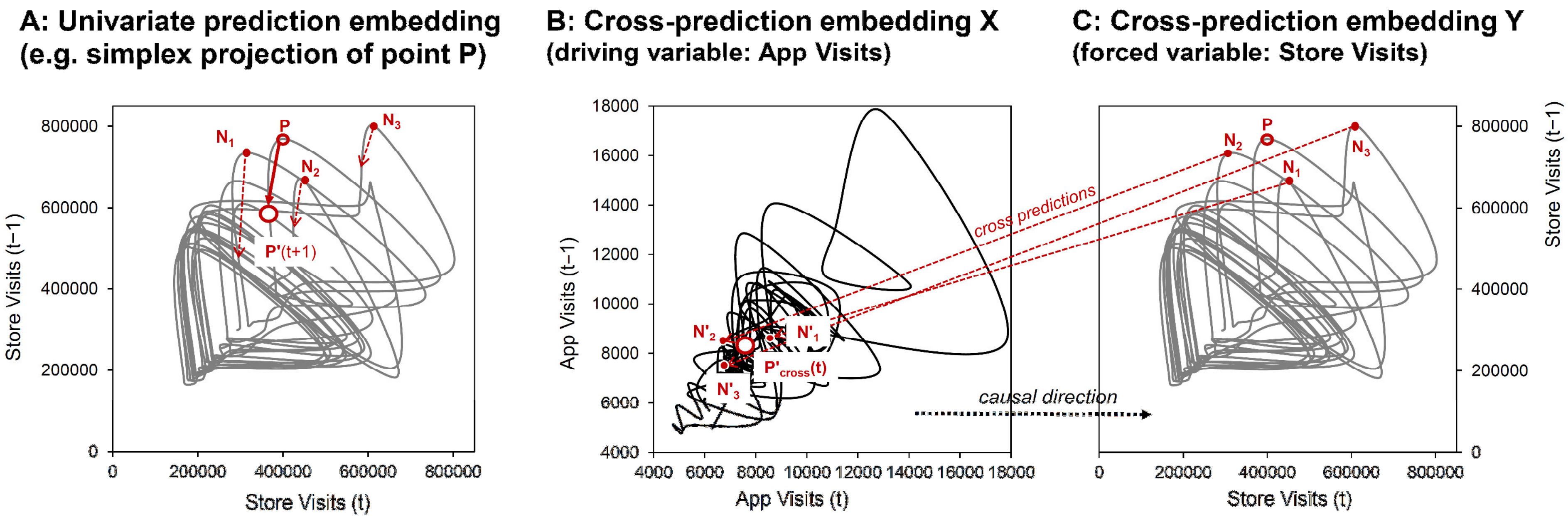
2D-example from our data:



3D-example with Lorenz system (Sugihara et al 2012):



Prediction and Cross-Prediction in EDM



Study with a Three-Channel System (B&M, Web, Mobile)

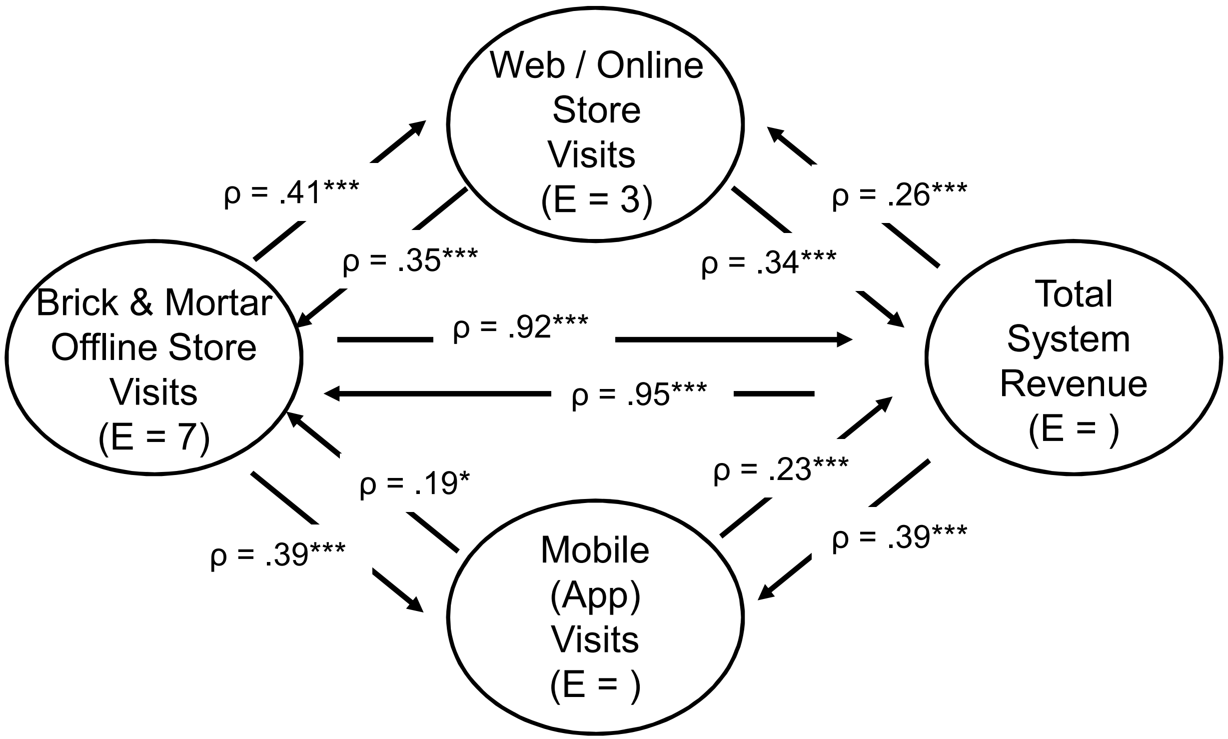
Modeling steps:

1) Establish embbedability for variables	Simplex projection (Sugihara and May 1990)
2) Derive and test interrelated (causal) network	Convergent Cross-Mapping (Sugihara et al. 2012
3) Build multivariate EDM model	S-Maps (Sugihara 1994)
4) Estimate marginal effects (Jacobian) at each state	Multivariate S-Maps (Deyle et al 2016a)

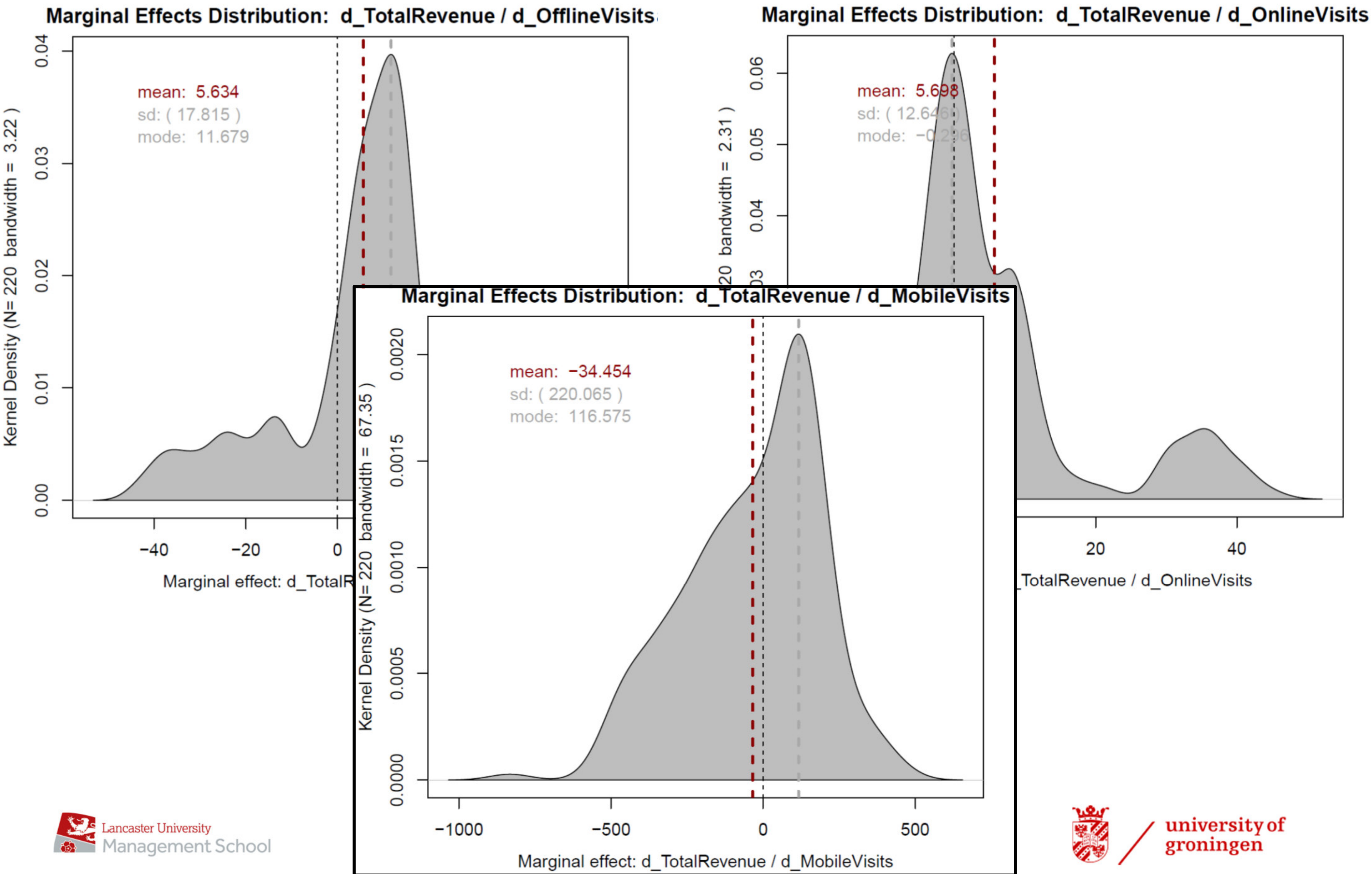
Data:

- **Visit and sales** time series from large European **fashion** retailer that operated **three channels**: brick-and-mortar stores as the dominant channel, an online store, and an app store
- Period **39 weeks of daily data**

Results: Embeddings and Omnichannel Consumer Flow Network



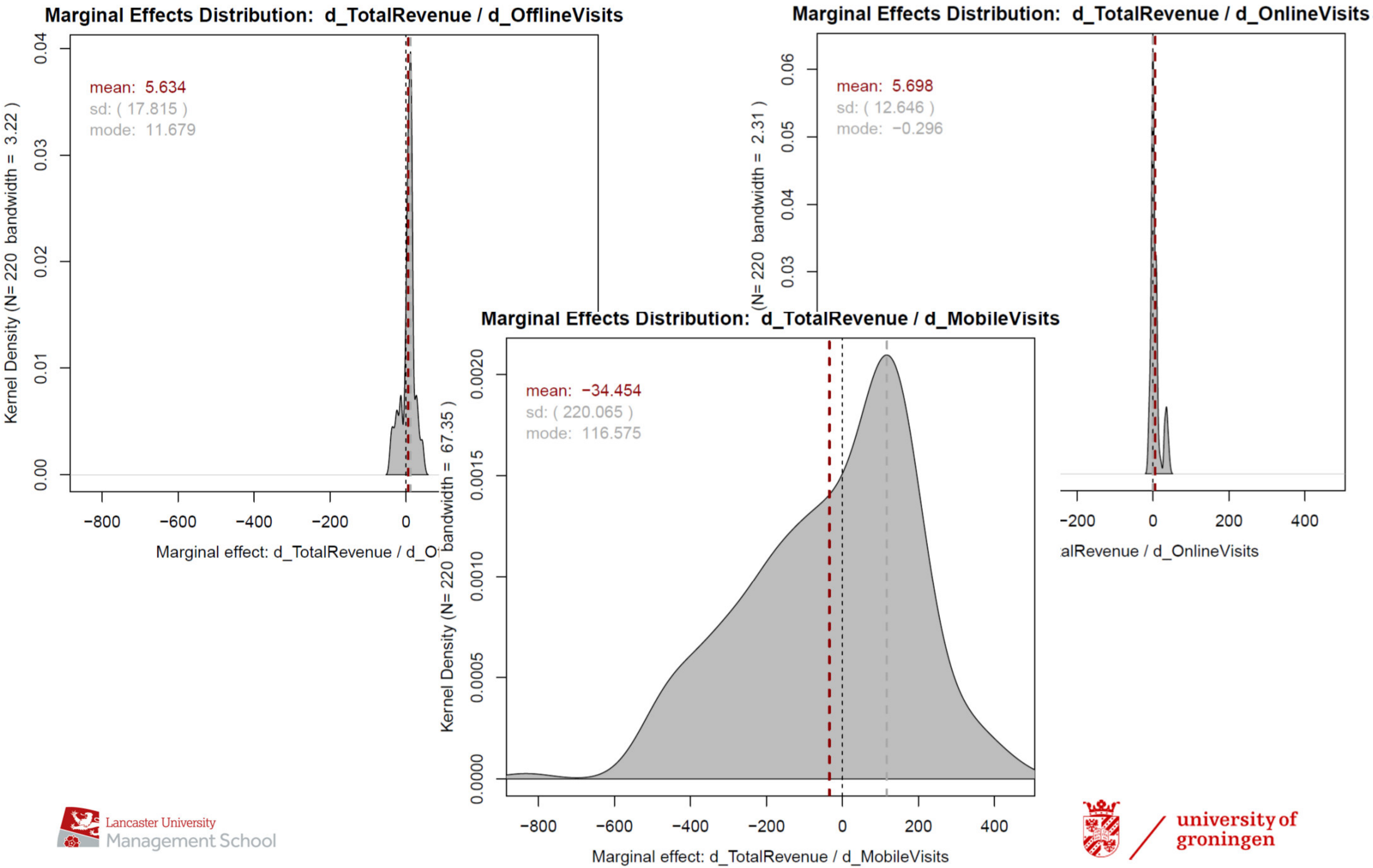
Results: Marginal Effects as Contributions to System Revenues



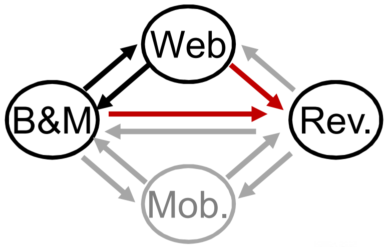
Lancaster University Management School

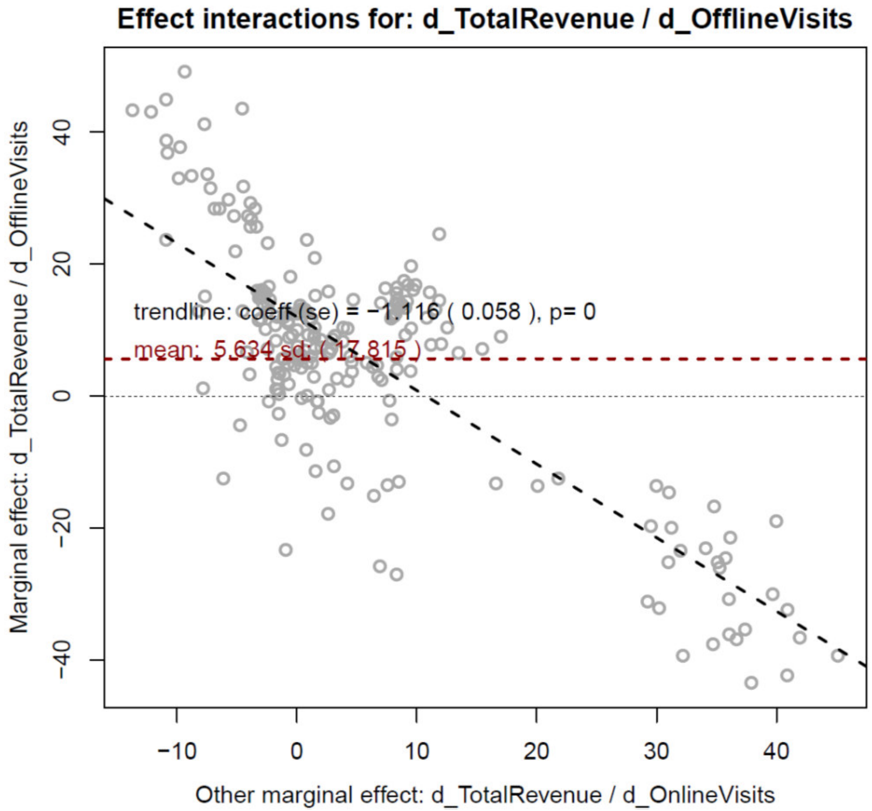
university of groningen

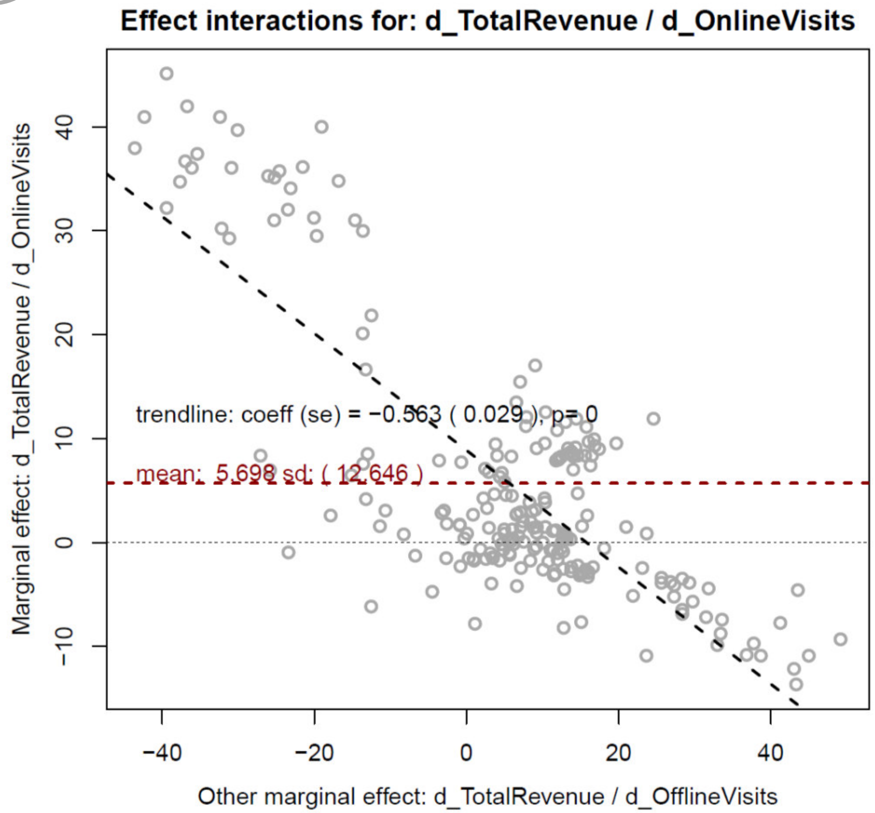
Results: Marginal Effects as Contributions to System Revenues – Higher Variance in Mobile Channel Effects



Results: Marginal Effect Interactions – Channel Conversion Tradeoffs





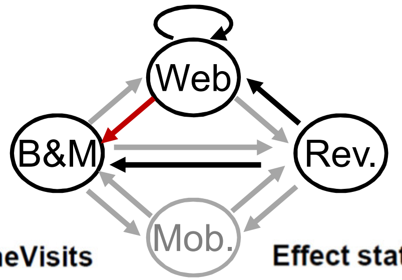


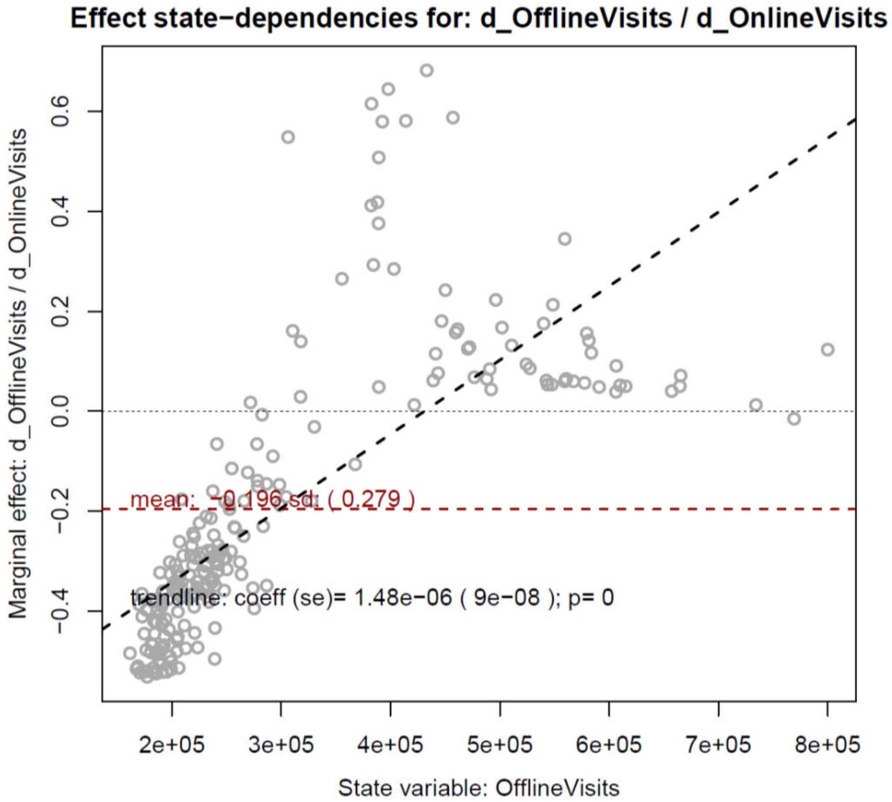
Lancaster University Management School

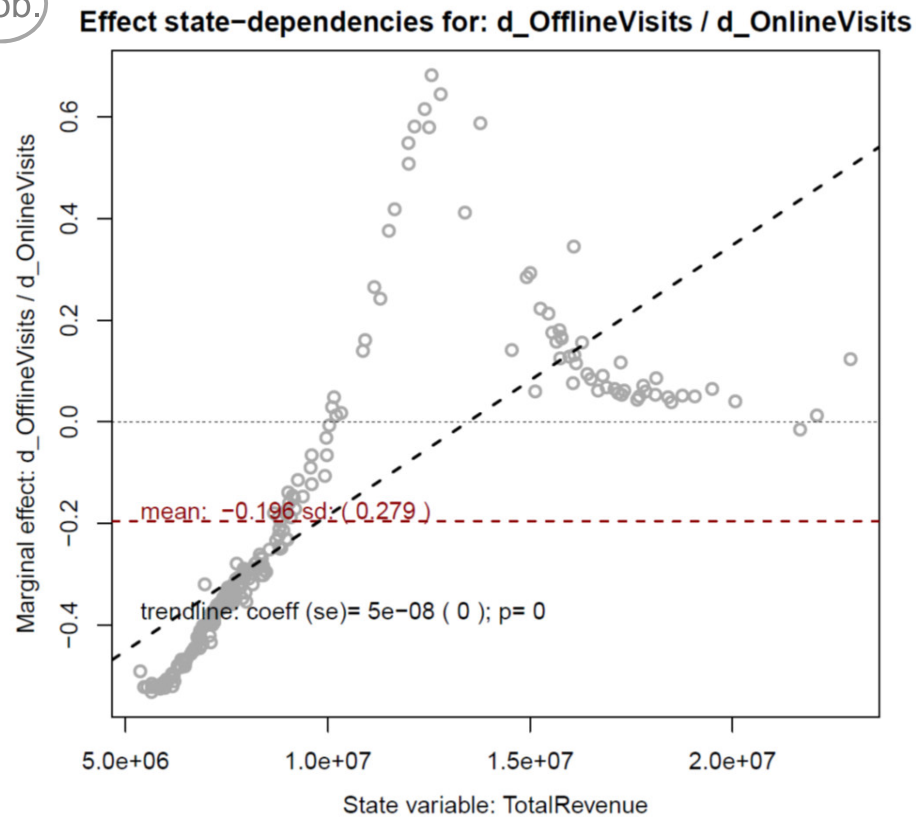
HHL LEIPZIG GRADUATE SCHOOL OF MANAGEMENT

university of groningen

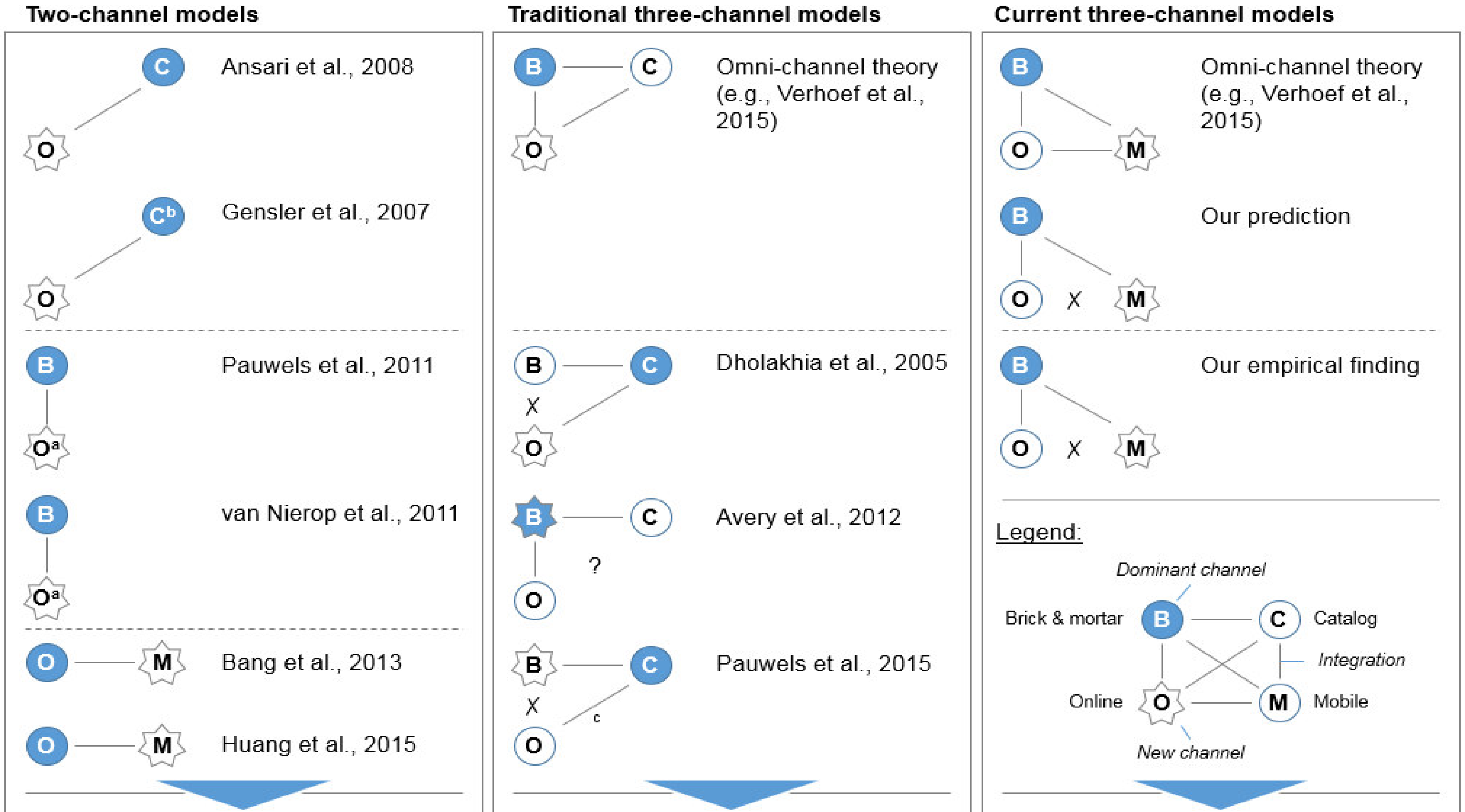
Results: State-dependencies –
From Increasingly Saturating to Strangely Nonlinear Webrooming







Speculation: Consumer Flows in Omnichannel Systems as Hub-and-Spoke System?



- **Channels always integrate**, irrespective of the channel combination

- Research finds that **some channels integrate**, but **others**—shown to integrate in 2-channel-models—**do not**
- Only dominant channel always integrated
- This contrasts with the **expected full channel integration** in the omni-channel paradigm

- Peripheral channels **always integrate with the dominant channel**, but not as strongly among themselves

Questions, please

Contact:

Florian Dost
(f.dost@lancaster.ac.uk)

Co−Authors: Erik Maier, Tammo Bijmolt

About:

Interrelated Visits and Sales in an Omni-Channel System: An Empirical Dynamic Modelling Approach

Lancaster University Management School

HHL Leipzig Graduate School of Management

university of groningen