

# *Empirical Analysis of Demand Patterns and Availability in Free-Floating Carsharing Systems*

Cornelius Hardt  
Institute for Intelligent Transportation Systems  
Bundeswehr University Munich  
Neubiberg, Germany  
cornelius.hardt@unibw.de

Klaus Bogenberger  
Institute for Intelligent Transportation Systems  
Bundeswehr University Munich  
Neubiberg, Germany  
klaus.bogenberger@unibw.de

**Abstract**—Carsharing (CS) services enable users not to have to depend on a privately owned vehicle by supplying cars for spontaneous rental. Optimized service, higher system availability and a more efficient urban transportation system can be obtained by analyzing a wide usage behavior and diurnal patterns within such a system. In order to gain a deeper understanding of the spatio-temporal behavior of such a service, it is vital to distinguish different demand patterns occurring within urban areas. We therefore analyze the demand for carsharing in the city of Munich, Germany. Based on data of a free-floating carsharing (FFCS) service provider we analyze rentals, drop-offs, and resulting availability of vehicles within different urban areas as well as develop diurnal demand patterns and cluster these by incorporating an incremental cross-correlation clustering. The compiled pattern clusters reveal notable distinctions in terms of demand, returns, and vehicle availability between the examined areas. By recognizing and analyzing these distinctions, FFCS will be able to adapt to new business areas, service operation, and pricing strategies in order to optimize their service.

**Keywords**—carsharing, demand patterns, usage behavior, spatial analysis

## I. INTRODUCTION

Over the years FFCS services have gained popularity most notably among urban dwellers in large cities [1]. The idea behind this success is the opportunity for users to choose the best means of transportation available for every single leg of a daily itinerary through a city solely depending on factors like location, destination, urgency, baggage, or traffic situation. This decision is independent of any regret leaving the own car somewhere in the city to be recollected later, since it was not utilized in the first place. However, this flexibility for users implies a big challenge for FFCS system operators. In order to operate such a system, it is vital to understand customers' demand and behavior to optimize the system in terms of spatial and temporal supply of vehicles. So far, research primarily focused on whole systems and analyzed demand rather as a holistic phenomenon occurring uniformly over the considered business area of a provider. In this work, a microscopic

analysis of selected areas was performed in order to find differences in demand, drop-offs, and availability, which facilitate local optimization approaches. By analyzing rental data of a German FFCS provider, diurnal patterns of demand, drop-offs, and availability for each of the selected areas were derived. Furthermore, compiled demand patterns were clustered by utilizing an incremental cross-correlation clustering, revealing two main types of demand patterns. Moreover, special areas with distinct patterns were found, not resembling those of revealed main clusters. Knowledge of such patterns and their distribution among areas can help to optimize the business area's shape, service operations, as well as the application of pricing strategies, enhancements in supplying vehicles to customers in demand, and a general understanding for other purposes like city planning or optimization of fleet operations with autonomous vehicles. This paper is structured as follows: an outline of current research within this topic is given. Then the current state of CS is characterized and the motivation on demand patterns and their applications is presented. Subsequently, the incorporated data and the applied implementation are described. The resulting patterns are then presented and analyzed. In the final section, results are discussed as well as future opportunities.

## II. RELATED WORK

There have been various studies analyzing demand within sharing systems. An empirical analysis of FFCS data was conducted in [2]. By analyzing rental data from the cities of Berlin, Germany, and Munich, Germany, the development of CS in these cities could be characterized. The authors were able to show temporal variability in rentals as well as usage differences between particular weekdays by outlining an average weekday pattern that is consistent over two cities. Diurnal usage and specific differences in average patterns of both cities were revealed. Furthermore, spatial hotspots of usage based on the starting locations of the considered bookings were identified. After all, authors gave an insight of the usage of an FFCS system as a whole but do not analyze usage patterns on a more local level.

Focusing on a bike sharing (BS) system in Paris, France,

# Empirical Analytics Of Demand Systems

**Yousef Farhaoui**



## **Empirical Analytics Of Demand Systems:**

*Empirical Analytics of Demand Systems* Alan A. Powell, 1974      **World Consumption Economics** Dongling Chen, Kenneth W. Clements, 1999 This book extends research in consumption economics by identifying similarities and differences in consumption patterns in a large number of countries both developed and less developed Its approach is to carefully analyze a large body of data from a highly diverse group of countries to determine the extent to which a simple economic framework can be used to understand and explain consumer behavior It uses data from more than 40 countries which range from the most affluent to the poorest in the world The book pays particular attention to the consumption of food and to new simulation techniques applied to systems of demand equations      *Handbook of Research Methods in Tourism* Larry Dwyer, Alison Gill, Neelu Seetaram, 2012-01-01 This is an excellent book which significantly contributes to tourism research and education It takes a rigorous yet readable style to address twenty five of the most pertinent quantitative and qualitative techniques applied in tourism research the book will appeal to a wider readership of social scientists as well as to scholars of tourism as each chapter provides a thorough overview and explanation of the techniques irrespective of their tourism application Dimitrios Buhalis Bournemouth University UK This insightful book explores the most important established and emerging qualitative and quantitative research methods in tourism the authors provide a detailed overview of the nature of the research method its use in tourism the advantages and limitations and future directions for research Each chapter is structured to provide information on the nature of the technique and its evolution background and types of problems that the technique is designed to handle applications of the technique to tourism including discussion of studies that have used the technique and their findings advantages and limitations of the technique conceptually and for policy formulation and further developments and applications of the technique in tourism research *Handbook of Research Methods in Tourism* will appeal to social scientists students as well as researchers in tourism who use quantitative and qualitative research techniques      *A System-Wide Analysis of International Consumption Patterns* S. Selvanathan, 2012-12-06 The modern system wide approach to applied demand analysis emphasizes a unity between theory and applications Its firm foundations in economic theory make it one of the most impressive areas of applied econometrics This book presents a large number of applications of recent innovations in the area The database used consist of about 18 annual observations for 10 commodities in 18 OECO countries more than 3 100 data points Such a large body of data should provide convincing evidence one way or the other about the validity of consumption theory A PREVIEW OF THE BOOK The overall importance of the analysis presented in the book can be seen from the following table which shows the significant contribution of the OECO to the world economy As can be seen the 24 member countries account for about 50 percent of world GOP in 1975 In this book we present an extensive analysis of the consumption patterns of the OECO countries      [Manuals for Policy Analysis: Price and Market-intervention Policies](#) ,      **Handbook Of Tourism Economics: Analysis, New Applications And Case**

**Studies** Clement A Tisdell, 2013-03-08 Handbook of Tourism Economics Analysis New Applications and Case Studies provides an up to date concise and readable coverage of the most important topics in tourism economics It pays attention to relevant traditional topics in tourism economics as well as exciting emerging topics in this field topics which are expected to be of continuing importance In doing this it takes account of advances in economic thought analysis and applied methods Contributions provide applications of economic analysis to tourism policy and constructive assessment of contemporary thought about tourism economics The handbook includes several in depth case studies such as the contribution of tourism to economic development in selected countries including China India Japan and Australia Portugal and Fiji Coming from diverse countries both industrialised and developing and established in the field of tourism economics travel and management many of the contributors have been consultants to governments private organisations and international bodies including the UN World Tourism Organisation the OECD and UNEP Experts contributing to this volume include the President of the International Association of Tourism Economics as well as its Secretary General the Secretary General of the Tourism Research Centre Association of Tourism Research Institutes the Founder Fellow of the International Academy for the Study of Tourism and the former Director of the UK's Centre for Social and Economic Research on the Global Environment CSERGE

*Economic Development and Consumption Patterns in Asian Countries* Shashika D. Rathnayaka, Saroja Selvanathan, Eliyathamby A. Selvanathan, 2024-07-05 This book analyzes consumption patterns in Asian countries that are at different stages of economic development and highlights the similarities and disparities of consumption patterns across countries using a system wide framework In a departure from previous studies in the literature which mainly present only single country analysis this book aims to provide a comprehensive analysis of cross country consumption patterns considering several Asian countries using the most recent consumption expenditure data for aggregate commodity groups In comparing consumption patterns across countries the book uses unit free measurements such as budget shares and changes in logarithms of price and quantities thus avoiding problems associated with exchange rate conversions The book also analyses the dynamic behaviour in the consumption patterns of the Asian consumers The findings of this book will be invaluable to researchers in development economics as well as policymakers in the formulation of fiscal policy or other types of economic control

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as econometrics statistics demand analysis information theory economic policy analysis aggregation theory forecasting index numbers management science sociology operations research higher education and much more The collection is also intended to serve as a tribute to him on the occasion of his 67th birthday These three volumes also highlight some of Theil's contributions and service to the profession as a leader advisor administrator teacher and researcher Theil's contributions which encompass many disciplines have been extensively cited both in scientific and professional journals These citations often place Theil among the top 10 researchers ranked according to number of times cited in the world in various disciplines

**Market Interrelationships and Applied Demand Analysis** Michael K. Wohlgenant, 2021-06-28 This textbook addresses the core issues facing economists concerning price determination in commodity markets especially food and agricultural commodities This book hones in on the conceptual basis of the various relationships with special emphasis on market interrelationships both horizontally and vertically This book covers key concepts such as consumer demand theory quality heterogeneous goods and cross section demand derived demand marketing margins and relationship between output and raw material prices retail to farm demand linkages imperfect competition and short run price determination dynamic consumer demand and dynamic models of the firm What makes this textbook of particular use to students is its focus on bridging the gap between theory and empirical analysis Going from theory to empirics requires that we have data time series or cross section that match the theoretical constructs Often the data match is not perfect either by definition or how the data are computed In addition to problems of matching data with theoretical constructs students and researchers need to know how to specify estimate and interpret results within the context of imperfect and often incomplete data This textbook uses several data sets to illustrate how one might address problems in real world settings Furthermore with exercises at the end of each chapter students are able to test themselves on their ability to bring theory to life *FCC Record* United States.

Federal Communications Commission, 2003 **The Effect of Food Price and Income Changes on the Acquisition of Food by Low-income Households** Harold Alderman, 1986 [Taxation and Economic Behaviour: Introductory surveys in economics](#) John Creedy, 2001-01-01 This volume offers a number of broad introductory surveys in public economics and public finance Divided clearly into two parts measurement issues and taxation and economic behaviour the collection consists of published refereed papers and several unpublished pieces

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would have given up on the project. Most of the papers though not all included in this volume are based on presentations at CESG conferences. In some cases scholars were invited to contribute to this volume where their research complimented those presented at these conferences even though they were not conference participants. Since papers selected for presentation at the CESG conferences are generally the finished product of scholarly research and often under submission to refereed journals it was not possible to publish the conference proceedings in their entirety. Accordingly it was decided in consultation with the publisher to invite a select list of authors to submit significant extensions of the papers they presented at the CESG conferences for inclusion in this volume. The editor wishes to express gratitude to all those authors who submitted their papers for evaluation by anonymous referees and for making revisions to conform to our editorial process. **Money,**

**Wealth and Expenditure** Dorian Owen, 1986-07-31 The book develops and applies a modelling framework that enables consumers expenditure and portfolio behaviour to be analysed in an integrated manner. It extends and applies the Yale approach to financial model building associated with James Tobin. The basis of this approach is surveyed with particular emphasis on the empirical implementation of portfolio models in the UK, US and other countries, appropriate econometric estimation techniques and comparisons with other monetary modelling strategies. Empirical application of the model is particularly addressed to testing whether the composition of wealth holdings is important for expenditure and asset demands, whether concentration on money at the expense of other assets and liabilities is acceptable and whether the interrelationships stressed by Tobin's general equilibrium approach are statistically important. The results have important implications for the recent literature on wealth effects on consumption and the overemphasis on money at the expense of other financial assets and liabilities. *Advances in root and tuber crops technologies for sustainable food security, improved nutrition, wealth creation and environmental conservation in Africa: proceedings of the 9th ISTRC-AB symposium. Mombasa, Kenya, 1-5 Nov. 2004 ,*

Artificial Intelligence, Big Data, IOT and Block Chain in Healthcare: From Concepts to Applications Yousef Farhaoui, 2024-08-17 This book covers a wide range of topics related to the integration of Artificial Intelligence, Big Data, IoT and Blockchain. From Concepts to Applications. It begins by establishing a solid foundation and introducing the concepts and principles of each technology. The subsequent chapters delve into the various applications and use cases, providing readers with real world examples of how AI, IoT and Blockchain can be leveraged to address key challenges in Smart Environments. Data is becoming an increasingly decisive resource in modern societies, economies and governmental organizations. Data science, Artificial Intelligence and Smart Environments inspire novel techniques and theories drawn from mathematics, statistics, information theory, computer science and social science. This book reviews the state of the art of big data analysis, Artificial Intelligence and Smart Environments. It includes issues that pertain to signal processing, probability models, machine learning, data mining, databases, data engineering, pattern recognition, visualization, predictive analytics, data warehousing, data compression, computer programming, smart city etc. The papers in this book were

the outcome of research conducted in this field of study The latter makes use of applications and techniques related to data analysis in general and big data and smart cities in particular The authors hope that this book serves as a valuable resource and guide for readers empowering them to navigate the intricate landscape of Artificial Intelligence IoT and Blockchain in Smart Environments Let the authors embark on this transformative journey together as the authors explore the concepts and applications that hold the potential to shape the future of Smart Environments The book appeals to advanced undergraduate and graduate students post doctoral researchers lecturers and industrial researchers as well as anyone interested in big data analysis and Artificial Intelligence

*China's Grain Economy* Liming Wang, John Davis, 2019-06-03 This book was originally published in 2000 China is the largest developing country in the world and is still heavily based on agriculture Currently about 70 per cent of China's total of more than one billion people live in rural areas and about half of the total national labour force is involved in agricultural activities It is clear that agriculture is the foundation for the development of the Chinese national economy Within agriculture the grain economy is the most important sector indeed it has been recognised as a treasure in managing the country by all past Chinese dynasties Ensuring enough grain supply to meet the demands of such a huge population seems to be a long term goal for the Chinese government and this book explores whether China will be able to produce enough grain to keep pace with its population increases

Vertical Relationships and Coordination in the Food System Giovanni Galizzi, Luciano Venturini, 2012-12-06 New analysis and empirical evidence on several topics such as the determinants of shape and nature of the vertical relationships in the food system the determinants of vertical co ordination and competition types and mechanisms of co ordination as well as the consequences for competitiveness consumer welfare and policy implications are provided The focus is on vertical issues at different stages of the food chain with a particular emphasis on the increasing role played by retailers in shaping the vertical relationships in the food system through the development of food supply chain management

*China's Fiscal Policy* Gao Peiyong, 2018-05-16 Fiscal policy has always been a primary measure of macroeconomic control The fiscal revenue and expenditure can influence the operation of the whole economic and social activities by changing the existing GDP distribution pattern affecting the consumption and investment of enterprises and people etc Within the framework of macroeconomic analysis this book reviews the evolution of China's fiscal policy and the main changes China's economy has experienced since 1990s To begin with it makes an empirical research of China's national debts including their relationship with macroeconomic regulation and total social demand Besides it examines the economic effect mechanism of national debts issuance Then it focuses on the taxation issues elucidating the sources of tax revenue growth and the judgments on tax burden The issue of tax reduction is also covered especially its complexity in China Lastly it provides insights into China's fiscal tendency changes of macroeconomic policies and financial operation in the context of the New Normal Scholars and students in economics finance and Chinese economic studies will be attracted by this book Also it will appeal to readers interested in modern Chinese economic history

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