

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

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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,

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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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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.

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Catalog of Copyright Entries. Third Series Library of Congress. Copyright Office,1976 **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

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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

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Table of Contents Empirical Analytics Of Demand Systems

1. Understanding the eBook Empirical Analytics Of Demand Systems
 - The Rise of Digital Reading Empirical Analytics Of Demand Systems
 - Advantages of eBooks Over Traditional Books
2. Identifying Empirical Analytics Of Demand Systems
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Empirical Analytics Of Demand Systems
 - User-Friendly Interface
4. Exploring eBook Recommendations from Empirical Analytics Of Demand Systems

- Personalized Recommendations
- Empirical Analytics Of Demand Systems User Reviews and Ratings
- Empirical Analytics Of Demand Systems and Bestseller Lists
- 5. Accessing Empirical Analytics Of Demand Systems Free and Paid eBooks
 - Empirical Analytics Of Demand Systems Public Domain eBooks
 - Empirical Analytics Of Demand Systems eBook Subscription Services
 - Empirical Analytics Of Demand Systems Budget-Friendly Options
- 6. Navigating Empirical Analytics Of Demand Systems eBook Formats
 - ePub, PDF, MOBI, and More
 - Empirical Analytics Of Demand Systems Compatibility with Devices
 - Empirical Analytics Of Demand Systems Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Empirical Analytics Of Demand Systems
 - Highlighting and Note-Taking Empirical Analytics Of Demand Systems
 - Interactive Elements Empirical Analytics Of Demand Systems
- 8. Staying Engaged with Empirical Analytics Of Demand Systems
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Empirical Analytics Of Demand Systems
- 9. Balancing eBooks and Physical Books Empirical Analytics Of Demand Systems
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Empirical Analytics Of Demand Systems
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Empirical Analytics Of Demand Systems
 - Setting Reading Goals Empirical Analytics Of Demand Systems
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Empirical Analytics Of Demand Systems

- Fact-Checking eBook Content of Empirical Analytics Of Demand Systems
- Distinguishing Credible Sources

13. Promoting Lifelong Learning

- Utilizing eBooks for Skill Development
- Exploring Educational eBooks

14. Embracing eBook Trends

- Integration of Multimedia Elements
- Interactive and Gamified eBooks

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