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WHU
Otto Beisheim School of Management

LAST-MILE DELIVERY WORKSHOP 2022

WHU – OTTO BEISHEIM SCHOOL OF MANAGEMENT
27.-28. June 2022

Preface

It is my great pleasure to invite you all to this next iteration of the Last Mile Delivery Workshop. After some taxing years of pandemic-related disruptions, I am very much looking forward to meeting most of you in person again! Of course, I am likewise excited to welcome all online participants as this workshop is planned to run in hybrid mode!

The programme follows a similar schedule as previous in-person iterations of this workshop. On Monday evening, I would like to invite you for dinner at the "Altes Brauhaus Koblenz" in the city centre of Koblenz. It is not far away from the "Deutsche Eck" (where the rivers Mosel and Rhine merge) and other sights.

I am looking forward to two days of fascinating talks, discussions, and conversations!

Best wishes
Arne

General information

Location:
The workshop takes place at WHU Otto Beisheim School of Management - Vallendar. A map and directions are provided on the next page. The address is:

Building C, Room C-003
Burgplatz 2
56179 Vallendar

All sessions take place in the same lecture theatre.

Online platform: Zoom
We will use Zoom as our platform for the online workshop. You can download the app using this link: https://zoom.us/download, or simply use the links provided in the programme. We use two different 'Zoom sessions for each day. An invitation link will be sent to you in advance.

Presentations:
All presentations are scheduled for 30 minutes. The speakers are asked to prepare a talk in English of about 20 minutes, leaving 10 minutes for questions and discussion.

Dinner:
The conference dinner will take place on Monday evening in "Altes Brauhaus Koblenz" in the city centre of Koblenz (see map below). Taxis will transport you to Koblenz city centre. The organiser will cover the expenses for dinner and taxi. There are currently no COVID-19 restrictions; we will inform you at short notice if this should change.

Excellence in Management Education

WHU Otto Beisheim School of Management

Equipment inside the lecture theatre:

- Projector
- Blackboard incl. chalk
- VGA connection
- Speakers
- Flip chart
- HDMI connection
- Electronic screen (16:10)
- Slide advancer
- Power sockets at every seat

Wi-Fi details:

Network name: wl-whu
User: lastmile@guest
PW: lastmile-2022

Information about Covid-19 rules:

Please check our website for our Corona rules before arrival:
https://www.whu.edu/en/covid-19-guidelines-at-whu/

Covid test:

A rapid test center you can find inside building C (WHU) on the right side of the lecture Hall C-003.
Online registration: https://events.covidoo.de/IvCovid?tag=Vallendar

For the rapid test you can also scan a QR code on site and register on the same day.

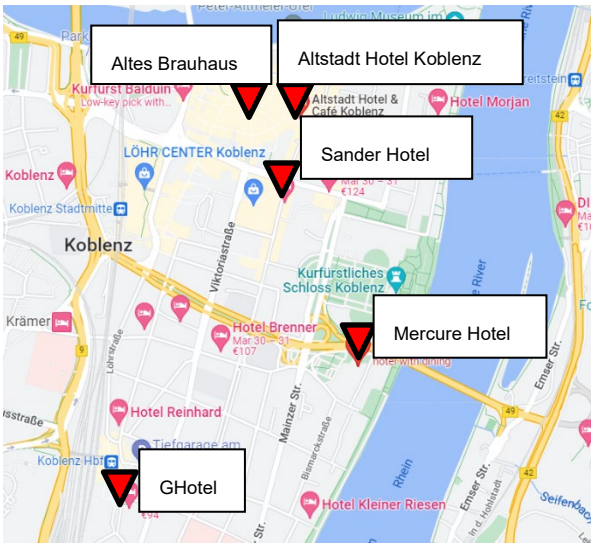
Hotel recommendations:

GHOTEL hotel & living Koblenz

3-star hotel

Neversstraße 15, 56068 Koblenz•0261 2002450

Close to the Koblenz railway station



Hotel Sander

3-star hotel

Casinostraße 17, 56068 Koblenz•0261 88968720

Centre of Koblenz

Altstadt Hotel & Café Koblenz

Jesuitenpl. 1, 56068 Koblenz•0261 201640

Old town Koblenz

Mercure Hotel Koblenz

4-star hotel

Julius Wegeler Straße 6, 56068 Koblenz•0261 1360

Taxi Hotlines Koblenz/Vallendar:

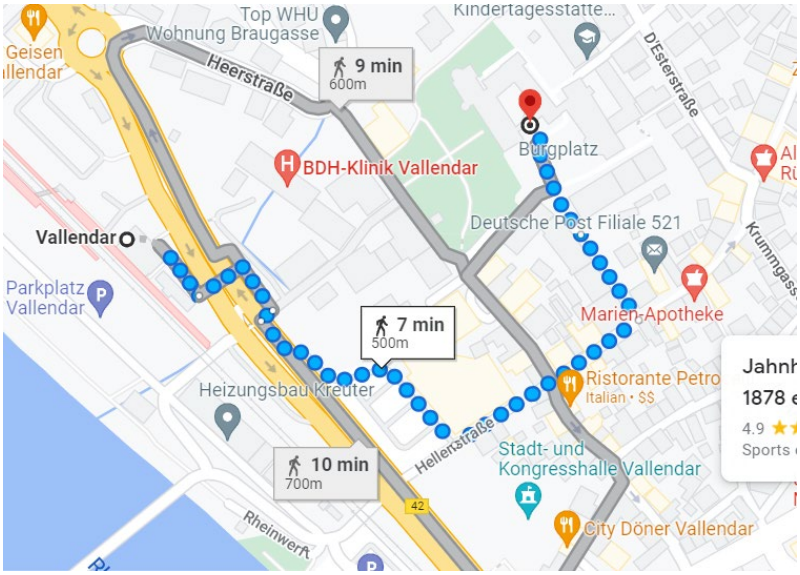
0049 261- 33055 / 0049 261-17934 / 0261 98880090
Taxi Koblenz E. G. / City Taxi 24 GmbH / Taxiruf Koblenz

Train and bus connections (e.g., to commute between Koblenz and Vallendar) can be found at https://www.bahn.com/en

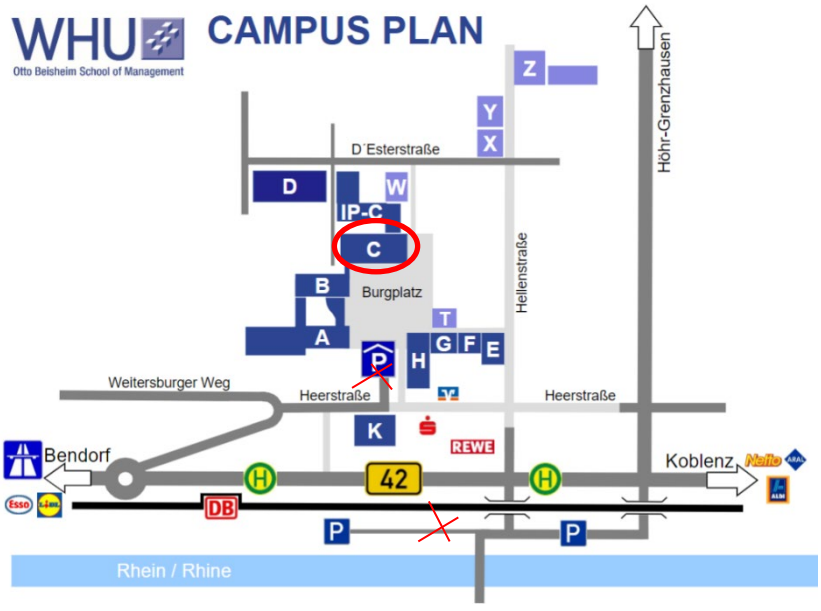
Directions

Arriving by train: Walking from Vallendar railway station to WHU

Head southeast
37 m
Take the pedestrian tunnel
61 m
↰
Turn right onto Wilhelm-Ross-Straße
9 m
↰
Turn left onto Rheinstraße/B42
150 m
↰
Turn left onto Hellenstraße
130 m
↰
Turn left onto Johannisbeergässje
60 m
↑
Continue onto Burgpl. 2 / Destination will be on the left



Arriving by car: There is an underground car park at WHU (Heerstraße – see red X on the map below). The upper level is available for visitors; note that you need to use the ticket machine there to obtain and then display a parking ticket, otherwise you are likely to get fined. Alternatively, you can park down by the river (also marked with a red X). Both options are easily reachable by foot.



Programme Schedule

Monday, June 27

From 12:30	**Arrival & Light Lunch**
13:20	**Welcome**
	Session 1
13:30 – 14:00	**Lena Hörsting** *(Christian-Albrechts-University Kiel)* Scheduling Shared Passenger and Freight Transport on a Fixed Infrastructure
14:00 – 14:30	**Steffen Elting** *(University of Vienna)* Collaborative Transportation Planning for Attended Home Deliveries
14:30 - 15:00	**Rico Kötschau** *(University of Vienna)* Mobile Parcel Lockers with Individual Customer Service
15:00 – 15:15	**Coffee Break**
	Session 2
15:15 – 15:45	**Sarah Powell** *(University of Iowa)* Crowdshipping in Urban Environments with Microhubs
15:45 – 16:15	**Liana van der Haagen** *(Rotterdam School of Management)* Effective Training of Machine Learning Models for Dynamic Time Slot Management
16:15 – 16:45	**Ehsan Aghamohammadzadeh** *(Rotterdam School of Management)* Time Slot Management with Customer Choice Profiles
16:45 – 17:15	**Ann Campbell** *(University of Iowa)* Does Parking Matter? The Impact of Search Time for Parking on Last-Mile Delivery Optimization
17:30	**Group picture**
17:45	**Departure:** taxis will transport you to Koblenz city centre (the organiser will cover the expenses)
20:00	**Dinner at "Altes Brauhaus Koblenz"**

Tuesday, June 28

Session 3

09:30 – 10:00 **David Fleckenstein** *(University of Augsburg)*
On the concept of opportunity cost in integrated demand management and vehicle routing

10:00 – 10:30 **Felix Spühler** *(University of Braunschweig)*
Modeling Rider Preferences in a Bicycle Courier Service

10:30 – 11:00 **Jonas Schwamberger** *(University of Mannheim)*
Getting the Best out of Online Deliveries: Proactive Customer Contacting in E-Fulfilment

11:00 – 11:30 **Katrin Waßmuth** *(University of Mannheim)*
Demand Management for Attended Home Delivery – A Literature Review

11:30 – 11:45 **Coffee Break**

Session 4

12:00 - 12:30 **Daniela Sailer** *(University of Augsburg)*
Dynamic Slot Management for Parcel Lockers

12:30 – 13:00 **Florentin Hildebrandt** *(University of Magdeburg)*
Fleet and Demand Control for Restaurant Meal Delivery

13:00 – 13:10 **Farewell**

Abstracts

Session 1

Lena Hörsting (*Christian-Albrechts-University Kiel*)

Scheduling Shared Passenger and Freight Transport on a Fixed Infrastructure

Traffic congestion and high greenhouse gas emission rates are frequent criticisms of conventional urban last-mile transport. The integration of freight deliveries with the existing public transport infrastructure, e.g., light rail, is a promising example of related future concepts. We propose a mixed-integer program that integrates the tactical scheduling of cargo and passenger vehicles and the allocation of cargo to vehicles. The optimisation prioritises the passenger service by minimizing the passengers waiting time first. As a secondary objective, it minimises the number of rejections and the delivery delay of cargo requests. However, that problem can be analytically optimised within acceptable runtimes only for small instances, which do not mirror real-world problem scenarios. To solve realistically large instances, we propose an adaptive large neighbourhood search heuristic.

Steffen Elting *(University of Vienna)*

Collaborative Transportation Planning for Attended Home Deliveries

Steffen Elting, Margaretha Gansterer, Jan Fabian Ehmke

Service providers for Attended Home Deliveries (AHD) face low profit margins, high customer expectations, and social and political pressure to operate with minimum emissions. AHD services are characterized by dynamic customer acceptance and narrow customer-specific delivery time windows. Their internal potential for optimization of delivery operations has been studied widely and is limited. Collaborative transportation planning is an external opportunity to further minimize costs and emissions by request reallocation of multiple collaborating carriers. This presentation focuses on the opportunities of request reallocation collaborations for AHD.
Before vehicles start their route, customers dynamically request a delivery from one of the carriers in the collaboration network. Upon request disclosure, the carrier offers a set of delivery time slots to the customer. Once a time window has been agreed upon, the order cannot be canceled in favor of another order that is requested later. After the order arrival phase, a two-sided combinatorial auction allows the carriers to buy and sell delivery orders. Based on spatial information, every carrier submits a fraction of its

accepted requests to a shared auction pool. A central auctioneer will generate a limited number of attractive request bundles from that pool using a Genetic Algorithm. All participating carriers solve a VRPTW to submit a bundle's marginal delivery cost as the bid price for each of these bundles. The solution to the Winner Determination Problem is the allocation of orders to carriers that minimizes the sum of bids.
We quantify the collaboration gain of this network by solving the underlying problems for dynamic customer acceptance, vehicle routing, and the combinatorial auction. We investigate the general impact of delivery time windows on network-wide travel durations. We will tailor specific parts of the auction mechanism to include time window information and deploy strategic procedures of dynamic customer acceptance to study the potential of request exchanges for AHD.

Rico Kötschau *(University of Vienna)*
Mobile Parcel Lockers with Individual Customer Service
Rico Kötschau,Ehmke, Jan Fabian

The ongoing growth of last-mile deliveries has led to a significant increase in transportation volumes. New technologies are continuously being investigated to provide these deliveries efficiently and in a customer-friendly manner. A common practice is to use fixed parcel lockers to make deliveries independent from the presence of the customer as is the case in attended home deliveries. Fixed parcel lockers are usually installed at key locations in cities, and customers can collect their package any time once it has been delivered at this particular location. Mobile parcel lockers represent a new idea: They can be parked for temporary collection at different locations, keeping the walking distance to the customer short and avoiding high infrastructure costs. However, customers need to collect their parcel within a restricted time window. This service is supposed to become especially efficient through autonomously operating vehicles that can move parcel lockers at low costs.
In this paper, we propose a mixed-integer program to evaluate different innovative delivery services - fixed parcel lockers, mobile parcel lockers, attended home deliveries and their combinations - within one framework. In our comparison, we consider that customers may have different expectations regarding their maximum walking distance as well as their temporal flexibility in accepting deliveries. A fixed fleet is applied to maximize the number of customers served, respecting individual customer preferences in terms of walking distances and time windows. We evaluate the different delivery services and possible combinations regarding managerial insights on service quality and efficiency. In the experiments, we evaluate the impact of structural demand differences and different fleet sizes, as well as the operational fleet utilization and the individual customer experience. Results show the potential to increase the number of customers served by about 10% through the use of mobile parcel lockers while considering individual customer preferences.

Session 2

Sarah Powell *(University of Iowa)*
Crowdshipping in Urban Environments with Microhubs
Sarah Powell, Ann Campbell, Iman Dayarian

Many companies offering home (or office) delivery of products ordered online are considering the use of crowdshipping. Crowdshipped delivery allows those who are not professional couriers to complete the last-mile delivery of goods by walking, biking, or providing their own vehicle for product delivery. Many studies on crowdshipping focus primarily on which packages to assign to which crowdshippers and/or professional drivers. The use of microhubs with crowdshipping has been introduced to serve as a point of pickup and/or as a point of dropoff in an urban environment to reduce the travel required by crowdshippers. We examine when it is costeffective to use crowdshipping in urban environments when traditional delivery options (trucks and drivers) are available, and microhubs are used. We determine the relative cost levels that make crowdshipped delivery desirable for different crowdshipper compensation models and truck mileage costs. Analytical and computational results yield a valuable set of managerial insights that can help businesses make important decisions about when and to what extent to use crowdshipping vs. traditional delivery models.

Liana van der Hagen *(Rotterdam School of Management)*
Effective Training of Machine Learning Models for Dynamic Time Slot Management

In attended grocery home delivery, it is common to let customers choose a delivery time slot to receive their groceries. To effectively manage the time slot offering, the e-grocer must evaluate the available capacity for each time slot as customer orders come in. This corresponds to finding a feasible solution to the Vehicle Routing Problem with Time Windows (VRPTW) for each new customer and time slot. Instead of checking this feasibility using routing methods, it is possible to use Machine Learning (ML) to predict the feasibility of offering a time slot in this context. The
performance of the ML model depends on the quality and quantity of the training data. However, obtaining labeled training data is computationally expensive, as it involves finding feasible solutions for VRPTW instances. In this talk, we focus on ways to interactively select informative training instances.

Ehsan Aghamohammadzadeh *(Rotterdam School of Management)*

Time Slot Management with Customer Choice Profiles

In this contribution, we focus on managing the bookings of time slots for attended home delivery services. Motivated by the collaboration with a company that offers technical services at home, we consider a setting in which there is information on the customer locations and probabilistic information on their time slot preferences. We present strategies to offer time slots to customers (simultaneous or sequential) as to minimize the total operating costs.

Ann Campbell *(University of Iowa)*

Does Parking Matter? The Impact of Search Time for Parking on Last-Mile Delivery Optimization

Ann Campbell, Sara Reed, Barry Thomas

Parking is a necessary component of traditional last-mile delivery practices, but finding parking can be difficult. Yet, the routing literature largely does not account for the need to find parking. In this paper, we address this challenge of finding parking through the Capacitated Delivery Problem with Parking (CDPP). Unlike other models in the literature, the CDPP accounts for the search time for parking in the objective and minimizes the completion time of the delivery tour. We determine when the search time for parking is large enough for the CDPP optimal solution to differ from the TSP solution. We identify model improvements that allow reasonably-sized instances of the CDPP to be solved exactly and propose a heuristic for larger instances. Computational experiments show that parking matters in last-mile delivery optimization. The CDPP outperforms industry practice and models in the literature showing the greatest advantage when the search time for parking is high.

Session 3

David Fleckenstein *(University of Augsburg)*

On the concept of opportunity cost in integrated demand management and vehicle routing

David Fleckenstein, Robert Klein, Vienna Klein, Claudius Steinhardt

Integrated demand management and vehicle routing problems are characterized by a stream of customer requests arriving dynamically over a booking horizon and requesting logistical services, which are fulfilled by a given fleet of vehicles during a service horizon. Prominent examples are attended home delivery and same-day delivery problems, where customer requests commonly have heterogeneous characteristics and differ in profitability. Thus, demand management methods are integrated to steer the booking process to maximize total profit.
In traditional demand management problems, this is typically done under consideration of opportunity cost as a measure for request profitability. The idea behind this is to only accept customer requests that have at least the contribution of all customer requests they displace. Consequently, the estimation of opportunity cost is an essential component of any demand management approach. In the context of integrated demand management and vehicle routing problems, such an estimation differs substantially from the estimation in traditional demand management applications. This is due to the routing component as it inhibits a clear quantification and attribution of cost, and of displacement of revenue, to certain requests.
Therefore, we formalize an opportunity cost definition specifically tailored for integrated demand management and vehicle routing problems. We define a model for one prototypical problem, based on which we then investigate and prove opportunity cost properties. Afterwards, we consider several generalizations of the prototypical problem and show that these properties also hold for more complex problems. Finally, we discuss implications for approximation approaches and managerial insights.

Felix Spühler *(University of Braunschweig)*

Modeling Rider Preferences in a Bicycle Courier Service

Felix Spühler, Dirk C. Mattfeld

Courier services have a long tradition in logistics, primarily in the delivery of valuable documents or medicines. In cities and on short-trips, bicycle couriers have major advantages as they are less affected by traffic volume and congestion, they do not block small streets while serving, and they can serve customers in car-free zones more easily. Since many courier service companies engage freelancing bike riders in a gig economy, they have to incorporate rider satisfaction into routing objectives to hold drivers in their

company. Satisfaction can be integrated by considering the individual preferences of each driver while assigning orders. Thereby, the riders may have different safety and comfort requirements with regard to the road network. This can lead to different routes between two points in the real-world network, especially with regard to length or satisfaction.
In this talk, we present a routing model that includes individual rider preferences. As the basic problem formulation for a courier service, we define a static pickup and delivery problem that is based on a multigraph. Considerations about fairness and satisfaction from the riders' perspective are then included in the model. In this process, we introduce a function that represents a rider's regret about having to travel an efficient route rather than the more comfortable route suggested by their individual preferences. Additionally, we present how satisfaction and efficiency may interact.

Jonas Schwamberger *(University of Mannheim)*

Getting the Best out of Online Deliveries: Proactive Customer Contacting in E-Fulfillment

Jonas Schwamberger, Moritz Fleischmann, Arne K. Strauss

During the Corona crisis, some e-grocers began to proactively reach out to certain customers, giving them priority access to order groceries online. In this project, we explore how this concept of proactively approaching customers can be implemented and leveraged in post-crisis times.

We propose to integrate the proactive customer contacting at the end of the classical booking process to generate additional, good fitting demand. We explore how much additional demand should be generated and which customers should be contacted. To this end, we propose a heuristic for the problem and conduct a numerical study using realistic data to evaluate the merit of our approach.

Katrin Waßmuth *(University of Mannheim)*

Demand Management for Attended Home Delivery – A Literature Review

Katrin Waßmuth, Charlotte Köhler, Niels Agatz, Moritz Fleischmann

Given the continuing e-commerce boom, home delivery services are becoming increasingly important. From a logistics perspective, attended home deliveries, which require the customer to be present when the purchased goods are delivered, are particularly challenging. To facilitate the delivery, the service provider and the customer typically agree on a specific time window. This step involves the customer directly in the service creation process. In designing the service offering, service providers thus face complex

trade-offs between customer preferences and the efficiency of service execution. To manage profitability, service providers have options available on both the supply and demand sides. While supply-oriented approaches to optimize attended home delivery have been studied for decades, demand management has only started to attract substantial attention in the research community more recently. In this talk, we report on a recent review of the corresponding literature. To structure the analysis, we develop a framework organized around different planning levels and demand management levers. We then report on our insights from reviewing corresponding available models in the academic literature. We conclude by pointing out research gaps and by discussing future research directions.

Session 4

Daniela Sailer *(University of Augsburg)*
Dynamic Slot Management for Parcel Lockers
Daniela Sailer, Robert Klein

Parcel lockers are emerging as a viable alternative to traditional home delivery. When ordering goods online, customers can specify a locker instead of their home as their desired delivery address. Because the lockers are fully automated, they enable customers to pick up their parcels at any time within a given number of days. Therefore, customers benefit from increased flexibility in receiving their parcels. From the logistics service provider's point of view, parcel lockers offer a huge cost reduction potential resulting from consolidation and fewer failed delivery attempts.
To fully exploit this potential and simultaneously ensure customer satisfaction, however, successful management of the locker's slots is crucial. Basically, this requires that an appropriately sized slot must be available for each customer's parcel from the time of delivery up until the customer collects their parcel from the locker. This is challenging because future delivery requests, the associated parcel sizes, and pickup times are stochastic from the provider's perspective.
In this talk, we show that slot management may act as a valuable tool to maximize the number of served customers and effectively utilize scarce locker capacity. Furthermore, we present the corresponding sequential decision problem and its main properties.

Florentin Hildebrandt *(University of Magdeburg)*
Fleet and Demand Control for Restaurant Meal Delivery

The demand for restaurant meal delivery has more than doubled in recent years. Yet, most delivery operations remain unprofitable. Service providers must scale efficiently with increasing demand to stay ahead in a competitive market. One important step towards efficient operational planning is fleet control, e.g., the anticipatory assignment

of orders to couriers. Another, mostly overlooked, control mechanism available to platforms is demand control: Platforms can influence customers in their restaurant choice, e.g., by dynamically configuring how restaurants are displayed to each customer. We propose a deep dueling Q-network with attention mechanism to learn both, the future value of assigning an order to a specific driver and the future value of a customer choosing a specific restaurant. On this basis, we derive an integrated anticipatory fleet and demand control policy. We test our method on a large-scale meal delivery operation in Iowa city, Iowa. We consider endogenous customer choices given by a behavior model with display location effects. The behavior model is fitted on recorded customer interactions with Slovenia's largest meal delivery platform. We demonstrate that our reinforcement learning policy strongly improves upon a policy commonly used in practice and derive valuable managerial insights.

Participants

University of Augsburg

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David Fleckenstein

Braunschweig University of Technology

Dirk Mattfeld

Felix Spühler

University of Magdeburg

Marlin Ulmer

Charlotte Ackva

Florentin Hildebrandt

European University Viadrina Frankfurt (Oder)

Charlotte Köhler

University of Iowa

Ann Melissa Campbell
(participating online)

Sarah Powell
(participating online)

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Liana van der Hagen

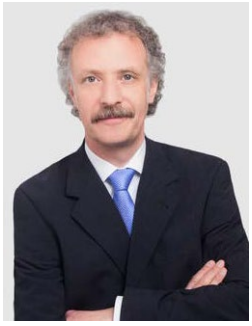
Econometric Institute
Erasmus University Rotterdam

Remy Spliet

Lancaster University

Alp Arslan
(participating online)

University of Mannheim



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