

Raphael Mesaric

Masterarbeit FS 2020
Leitung: Prof. Dr. Kay W. Axhausen
Betreuung: Dr. Pieter Jacobus Fourie

Estimate of traffic generated by delivery services in Singapore and Zurich

Analysis based on surveys and measurement campaigns during the COVID-19 months

1 Introduction

Online delivery services have experienced rapid growth in recent years, affecting the traffic volume and resulting in congestion and the blocking of streets by delivery vehicles. Despite broad research to find potential solutions for these issues, little is known about the drivers of demand for online shopping, the actual traffic generated by delivery services and its spatial distribution across a city. This thesis wants to target these aspects with a regression analysis based on survey data from two cities.

2 Methods

To estimate the traffic generated by delivery services, various kinds of data must be acquired. In a first step, two surveys are conducted in Singapore and Zurich to collect socio-economic data and information about the online purchasing behavior. The survey sample in Zurich is further compared with the MOBIS survey to assess the feasibility of an extrapolation of the traffic estimates in Zurich to other cities in Switzerland.

The survey data is then used for an extensive regression analysis. In a first step, zero-inflated Poisson regression is applied to account for the special characteristics of count data and find the relevant explanatory variables for the number of deliveries. To obtain an insight into the spatial distribution of the deliveries, the study areas in the two cities are subdivided into smaller subareas for the regression, the planning areas in Singapore and the neighborhoods in Zurich.

In a second step, spatial regression methods are applied to the data in Singapore to account for spatial dependencies in the data. The degree of the dependency is calculated with the Moran's I .

The obtained data from the survey responses is then extrapolated to the entire city. This is done based on the subareas. For this reason, the extrapolation models take into consideration only variables from which their distribution for the individual subareas is known. In Singapore, this corresponds to age, gender and the type of inhabited building, while in Zurich only age and gender distributions of the subareas are available.

In a last step, the results of the extrapolation are compared with the results of the extensive measurement campaigns conducted in both cities. These provide information about the actual number of delivery vehicles which serve specific buildings / and or streets throughout a day. The datasets include 7 buildings and 14 measurement days for each city. The comparison of the extrapolation results with the measurements allows for a partial validation (or rejection) of the obtained models.

3 Results Singapore

In accordance with the descriptive analysis, the results of the zero-inflated Poisson regression indicate that the income level as well as the general shopping behavior (e.g. number of shopping trips) have the highest impact on the use of delivery services. Higher income is linked to a higher number of deliveries, while a lower income level increases the probability of not using delivery services in general (Fig. 1).

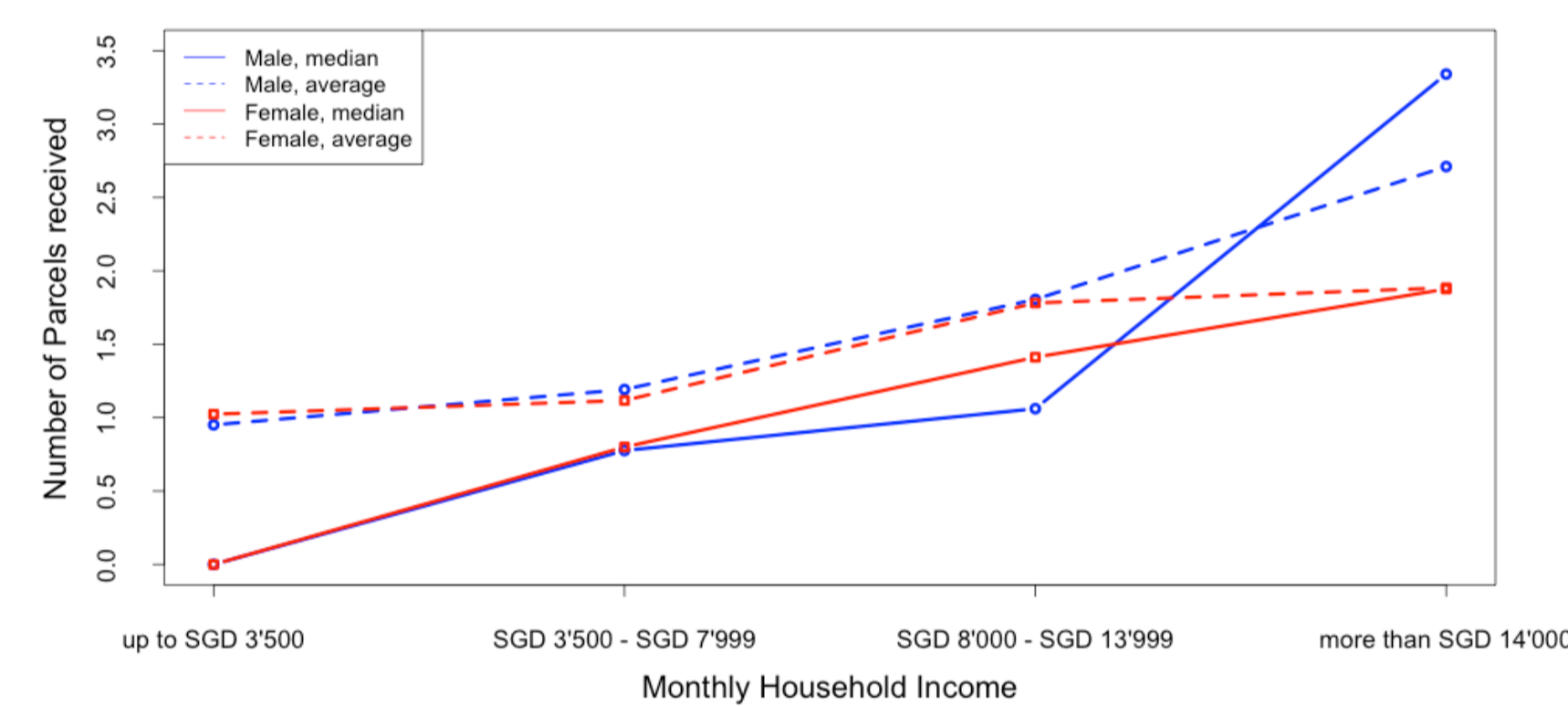


Fig. 1 Number of parcels received in the last week by gender and income

The models including variables representing points of interest exhibit spatial dependency, unlike the ones with dummy variables for the planning areas.

The measurement results show a generally higher number of deliveries on Tuesdays and Fridays. The second interesting observation is that people living in condos tend to place considerably more food orders than inhabitants of HDBs. This difference is less pronounced for parcel deliveries.

The comparison of the predicted number of deliveries for each planning area based on the extrapolation models with the measurement results yields an average of 10-29 deliveries per vehicle, which is relatively high. Most likely, the high traffic volume has led to the circumstance that not all delivery vehicles have been recognized as such.

5 Conclusion

The experiences in Singapore and Zurich have shown that a careful preparation and – in the case of the survey – the selection of the distribution method are key for successful measurement and survey campaigns. The comparison of the thesis survey in Zurich with the MOBIS/COVID-19 survey indicates that the samples are similar, with the MOBIS respondents using more individual and less public transport. Therefore, an extrapolation of the results from Zurich to other cities in Switzerland appears to be feasible.

The measurement results show that deliveries in Singapore and Zurich follow a similar weekly pattern. Zurich has a higher average of delivery vehicles per day and resident, most probably because of the smaller buildings. The regression models confirm the results of the descriptive analysis. In general, younger people tend to make use of delivery services more often. It can be observed that while the impact of age and gender varies, the income level is constantly the main driver of demand, i.e. higher income leads to a higher number of deliveries. The models also reveal that the general shopping behavior influences the use of online delivery services, confirming results from prior research. If points of interest are included in the model, spatial dependency can be observed whereas this is not the case for models with dummy variables for the subareas. The validation of the models with the measurement results shows that the predictions for Zurich are quite reasonable while the estimates for Singapore are relatively high. This might be the case because of the better measurement conditions in Zurich, i.e. in Zurich the vehicle count is expected to be more accurate.

The thesis succeeded in providing a first estimate of the traffic generated by delivery services. However, the concurrence of the studies with the COVID-19 pandemic asks for a second reference study after the situation has settled to assess the permanence of the impact of the safety measures on the number of deliveries.

4 Results Zurich

In accordance with the descriptive analysis, the results of the zero-inflated Poisson regression indicate that age and gender are important factors for the use of delivery services, while the effect of the income level is less clear. People older than 55 years tend to use delivery services less than people in younger age categories, while females have a higher probability of using them more often (Fig. 2).

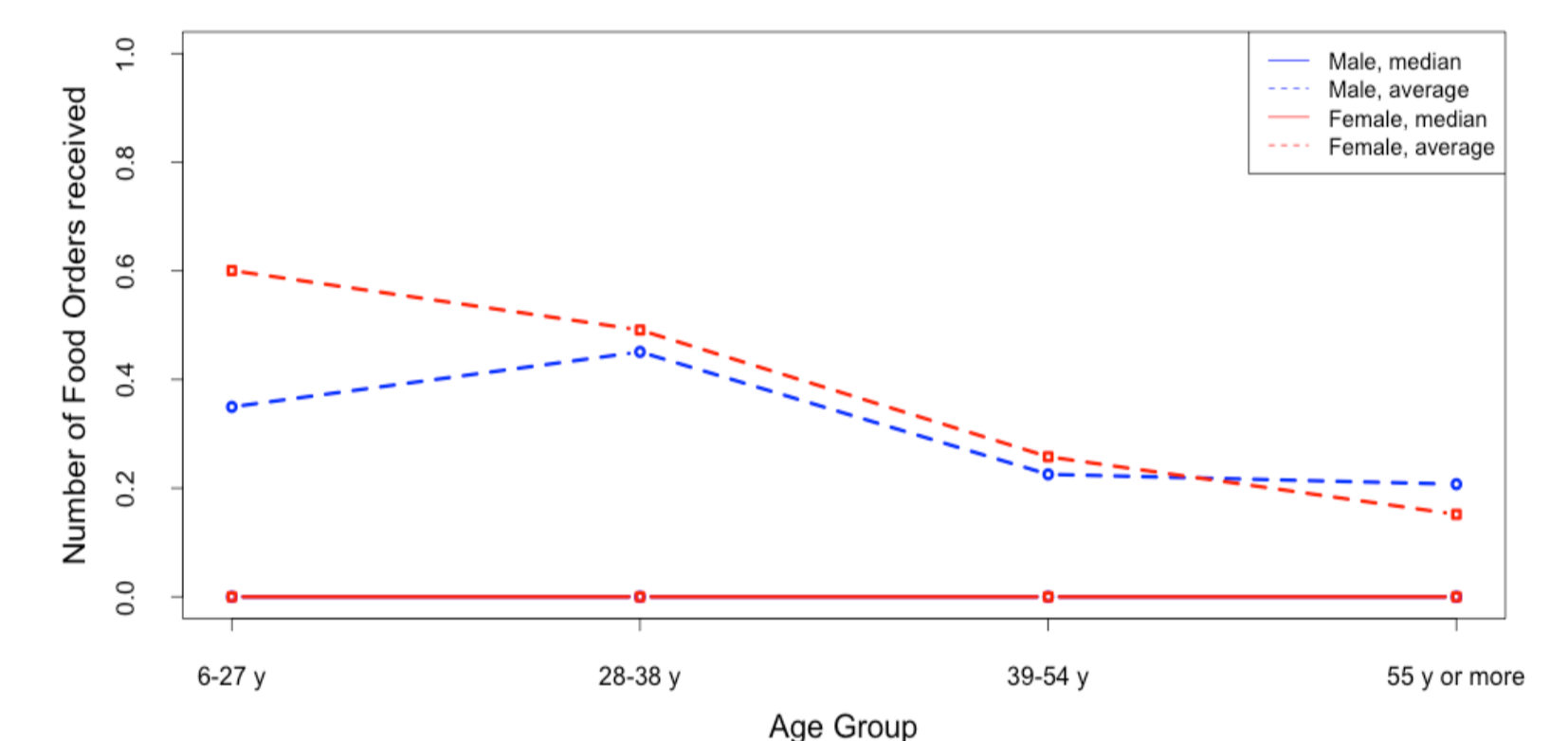


Fig. 2 Number of food orders received in the last week by gender and age

The effect described above is significantly stronger for food than for parcel deliveries where only a slight trend can be observed.

Similar to Singapore, the measurement results in Zurich exhibit peaks on Tuesdays and Fridays, mainly for parcels. On Sundays there is a clearly lower presence of delivery vehicles. The general income level of the neighborhoods does not appear to have a significant impact.

The comparison of the predicted number of deliveries for each neighborhood based on the extrapolation models with the measurement results yields for the majority an average of 2-5 deliveries which is realistic. Only two observation sites have a higher average between 12-18 deliveries and must be assessed critically.