

# Where to park your car at home?

## How district parking garages can complement existing parking options in dense urban neighborhoods

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# INTRODUCTION

## CHALLENGE

### On-street parking



Source: [Basler Zeitung](#)

- **Competition for other uses:** trees, cycling lanes, ...
- **Cheap:** in Swiss cities ~20-50 CHF/month
- **High demand**
- **Convenient, but not reliable**

### Private car park



Lange Gasse, Wien, July 2024

- **Expensive:** in Swiss cities ~150-300 CHF/month
- **Supply** usually mandated by law
- **High vacancy rates**
  - In (Swiss) cities and agglomerations ~ 5%-15%
  - Not nearly enough vacant lots to accommodate all on-street parking.
- **Fixed parking lots** → remain empty at certain times of the day
- Small garages are **not efficient in space utilisation**

1. **Increase fee for parking permit**
2. Support development of **district parking** →
3. Support **car sharing** as alternative to private car
4. Offer **incentives to give up car ownership**
5. ~~Mandate more private parking~~

- **Public car park**
- **No fixed parking spaces**
- **Long-term parking is restricted to residents**
- **High construction cost:** in Switzerland ~30 - 40k CHF per lot.
- **Monthly revenue of ~ 150 - 200 CHF required** to break even (2% interest, 2% depreciation and maintenance, 2% profit margin)

## INTRODUCTION

### RESEARCH QUESTIONS

1. How do urban residents decide where to park their car?
2. What is the willingness to pay for different types of parking?
3. How do factors such as parking pressure and car use intensity influence parking preference?
4. What are the implications of those preferences to parking provision and alternatives?

## INTRODUCTION

### LITERATURE

- Axhausen & Polak (1991) apply stated preference method to analyse parking behaviour
  - Most studies on parking behaviour focus on non-residential parking behaviour, e.g. Hilvert et al. (2012) Rodriguez et al. (2023)
  - Higher car usage with better residential parking availability (Weinberger, 2012; Guo 2013, Christiansen et al. 2017)
  - Ostermeijer et al. (2019) show for the Netherlands that
    - residence parking cost amount to 17% of ownership cost
    - parking cost influences car ownership with a price elasticity of -0.7
- ➔ To our knowledge, no studies available that quantify trade-offs with regards to residential parking options.

## EXPERIMENT METHODOLOGY

### Limitations of **revealed preference** data

- No variation of residents' parking permit within a city
- (Usually) no district parking options available

### Stated choice experiment

- Four choice alternatives
- No further decision attributes (eg. storage, charging availability) to keep it simple.
- Car owners in dense urban neighbourhoods in Zurich, Basel or Geneva

Imagine that **only the following options are available for parking** your Audi A2 at your place of residence.

Charging stations for electric cars are available everywhere

	On street parking	District parking garage	Private parking lot	Giving up the car
Cost per month	30 CHF (360 CHF per year)	100 CHF	250 CHF	-
Type of parking lot	-	Free choice	Outdoor	-
Walking distance to residence	5 - 8 min (400– 600 meter)	3 min (250 meter)	On the same plot	-
Nearest carsharing location	-	-	-	3 min (200 Meter) 2 shared cars
Your choice	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

# EXPERIMENT DESIGN

## Attribute levels

- **Cost** conditional on
  - City
  - Urban density
  - Type of parking

On-street: 25 – 110 CHF/m  
District P: 65 – 170 CHF/m  
Private: 90 – 285 CHF/m
- **Access** conditional on
  - Type of parking 0 to 12 minutes walking
- **Car sharing**
  - Distance 1-12 Minutes
  - Number of cars 1-4 cars

## Experiment design

- Random design for pretest (Zurich)
- D-efficient design with NGene for other cities)
- Softly formulated constraints to ensure trade-offs between district and private parking alternatives wrt cost and access distance
- 7 choice sets per respondent
- 25 blocks for each city and density class

## EXPERIMENT RECRUITING

- Randomly drawn addresses from car owners
- Recruiting letter with URL and QR-code.
- Only respondents who rent parking lot or pay for resident parking permit did the choice experiment.
- Prize draw (5x 100 CHF) as incentive
- Pretest in Zurich without any issues, subsequently no pretests in Basel and Geneva

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Muttenz, 22. November 2022

**Anfrage: Unterstützung bei der Rekrutierung für eine Online-Befragung im Rahmen eines Forschungsprojekts**

Sehr geehrter Herr Kyburz,

Im Auftrag des Bundesamts für Strassen führen wir an der Fachhochschule Nordwestschweiz ein Forschungsprojekt zum Thema «[Nachhaltige Ansätze der Parkraumplanung](#)» durch.

Im Forschungsprojekt soll, unter anderem, beantwortet werden, wie die Parkraumsituation für die Wohnbevölkerung in dicht besiedelten Stadtquartieren verbessert werden kann. Öffentliche Quartierparkings stellen eine städtebaulich verträgliche Lösung dar, um die in solchen Quartieren vorhandenen Angebotsengpässe anzugehen. Gleichzeitig ist derzeit schwierig abzuschätzen, ob und wie ein solches Angebot von Autobesitzenden aufgenommen würde.

Um besser zu verstehen, wie Kosten, Distanz zum Parkplatz und der Parkplatzdruck in der blauen Zone sowie persönliche Präferenzen und die Intensität der Autonutzung die Wahl der Autoparkierung am Wohnort beeinflussen, wird als Teil des Forschungsprojekts eine Befragung mit einem web-basierten Fragebogen durchgeführt. Die Zielgruppe dieser Befragung sind Personen, die in den Städten Zürich, Basel und Genf in einem dichten Stadtquartier wohnen und mindestens ein Auto besitzen.

Um belastbare Aussagen machen zu können, zielen wir darauf ab in jeder Stadt rund 250 Personen zu rekrutieren, die den Fragebogen vollständig ausfüllen. In der Stadt Zürich sind für uns Personen aus den Postleitzahlzonen 8003-8008 und 8037 von Interesse. Idealerweise möchten wir die Befragung bis Ende Januar durchgeführt haben.

Es wäre sehr hilfreich, wenn das Strassenverkehrsamt des Kantons Zürich uns bei der Rekrutierung der Befragten unterstützen könnte. Aufgrund der Datenschutzbestimmungen ist eine Weitergabe der Namen und Adressen aber wohl nicht möglich. Daher hat uns in die Motorfahrzeugkontrolle des Kantons Basel-Stadt angeboten, die Anschreiben mit einem Serienbrief zu

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## EXPERIMENT

### SAMPLE

#### Responses

- 875 responses
- 17% overall, of which 46% on-street; 49% private; 5% district parking
- Geneva: higher gross response rate (parking pressure?) but more drop-outs

#### Representativeness

Underrepresented:

- Lowest income groups
- Lower education levels
- Single households

Rewighting using “anesrake” for case study application

	Basel	Geneva	Zurich	Total
Letters sent	1152	2000	2000	5152
Questionnaire started	233	540	594	1367
Questionnaire completed	154	301	420	875
Gross response rate	20%	27%	30%	27%
Net response rate	13%	15%	21%	17%
Share of on-street parking users	44%	42%	50%	46%
Share of private parking user	56%	47%	47%	49%
Share of district parking	1%	12%	3%	5%

## EXPERIMENT

### MODELLING

#### Model development

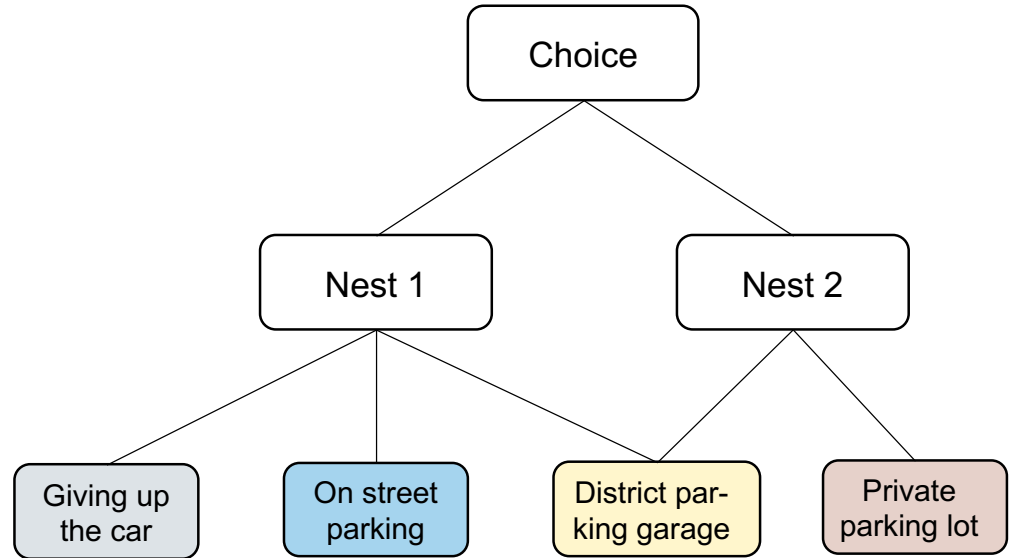
1. Linear combination of choice variables, plus inertia and control variables (car usage, assessment of on-street parking availability)
2. Cross-nested structure to better represent inertia effects
3. Introduction of interaction terms
  - Cost – income

$$f(c, y) = \beta_c \cdot \left(\frac{y}{\bar{y}}\right)^\lambda \cdot c$$

- Access distance – user groups

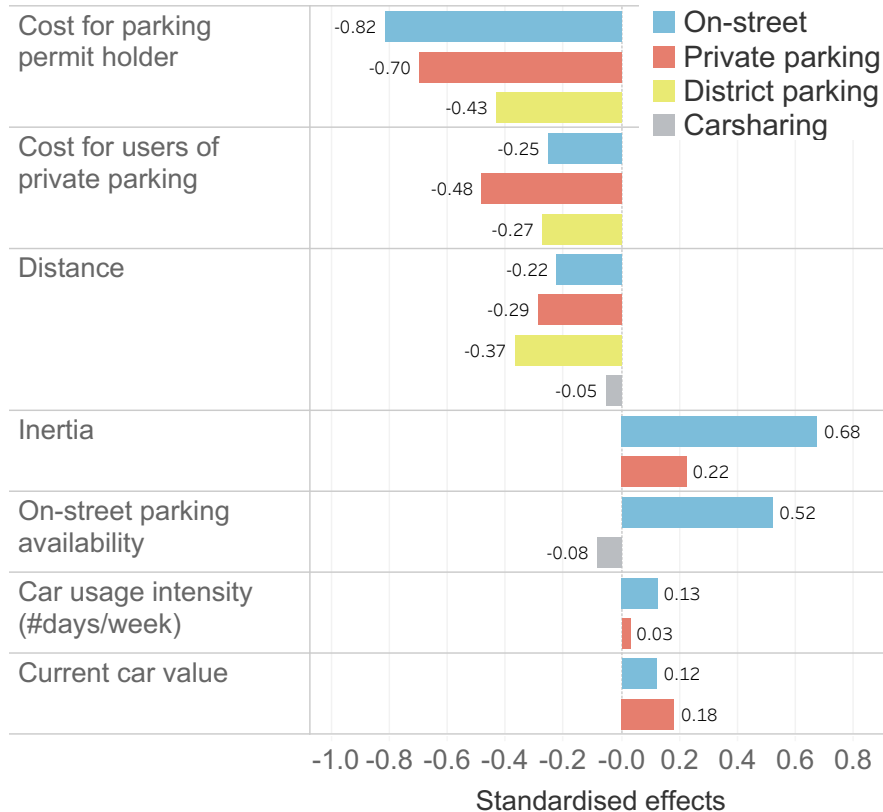
$$f(d, x) = \beta_d \cdot (1 + \beta_{d,x} \cdot x) \cdot d$$

4. Dummy variables to account for alternative specific preference of certain user groups



Models are estimated with Apollo in R.

# EXPERIMENT RESULTS



- Stronger cost perception among on-street parking users
  - 3.2x for private parking cost
  - 1.5x for district parking cost
  - Statistically significant, but low-income elasticity: highest income group perceives cost 6% less than average income
- Distance to district parking is perceived more
- Value of distance amounts to 17.4 CHF/month for 100m shorter access distance (private parking)
- Strong inertia effects, despite nesting.
- The better on-street parking availability, the higher its utility
- Utility of on-street alternative increases with more frequent car use
- The higher the (current) car value, the less are people inclined to use district parking or give up car ownership
- No systematic preference for district parking among different cities

## EXPERIMENT

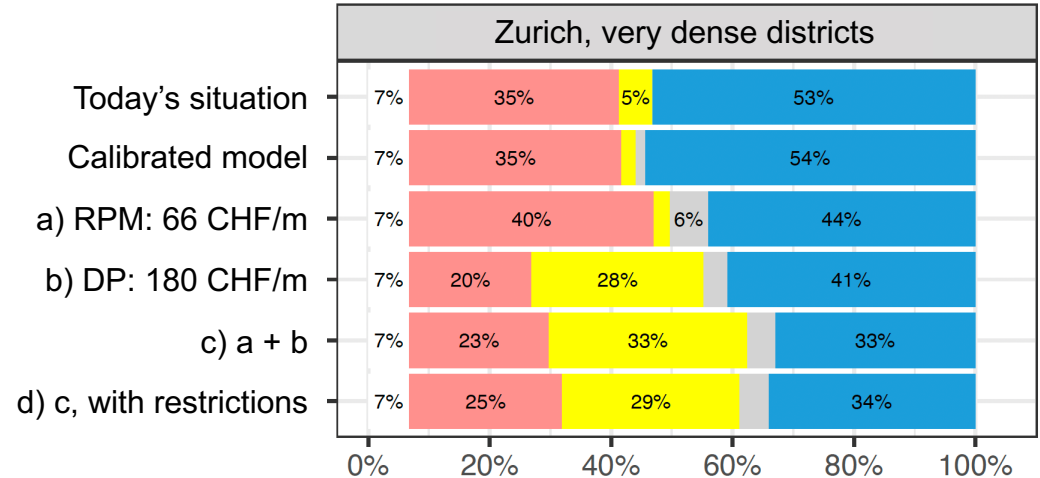
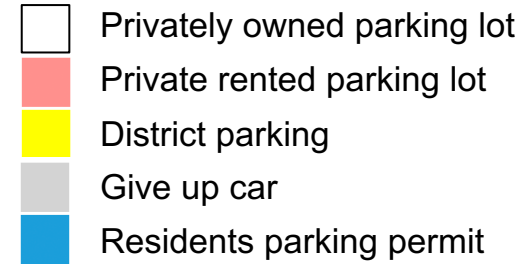
### MODEL APPLICATION

#### Scenarios

- Cost of residents' parking permit increased to 66 CHF/m instead of 25 CHF/m
- District parking available for 180 CHF/month
- Combination of a) and b)
- Like c), but district parking not allowed for persons who rent parking at place of residence

#### Results

- District parking serves primarily as alternative for private parking
- Tested restriction not sufficient to deviate effect to resident parking permit holders
- With district parking: about 20% less on street parking required
- Enough money will be raised from on-street parking revenue to subsidize district parking
- Access to district parking must be limited to residents' parking permit holders.



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## DISCUSSION

### Key insights

- Big heterogeneity with regards to a priori preference and cost perception
- Residents' parking permit user with highest cost sensitivity,
- More expensive residents' parking permits and better car sharing availability will make some people reconsider car ownership. But less so in dense urban neighbourhood
- Substantial reduction of on-street parking demand only feasible with district parking.
- Control measures are needed, e.g. max. one car per household or waiting list for people without private parking lot at their residence.

# WHERE TO PARK YOUR CAR AT HOME?

## DISCUSSION

### Conclusion

- Building district parking is challenging due to a lack of space and expensive
- Subsidies to make district parking economically viable can be raised from on-street parking
- Subsidies for low-income groups with a specific need for car ownership could address equity concerns

### Future research

- Test effectiveness of further incentives to give up car ownership, e.g. cash or free travel card
- Evaluate political acceptance
- Reproduce experiment in other cities with different starting situations.
- Implications of autonomous vehicles

# WHERE TO PARK YOUR CAR AT HOME? QUESTIONS AND CONTACT



**Project report**  
([available in German](#)  
with English summary)



## Contact



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<https://www.fhnw.ch/verkehr-und-mobilitaet>

## WHERE TO PARK YOUR CAR AT HOME

### LITERATURE

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# WHERE TO PARK YOUR CAR AT HOME

## ATTRIBUTE LEVELS

			On-street parking (cost per year)	Distric parking (cost per month)	Private parking lot (cost per month)	Giving up the car
Cost	Dense neighborhood	Basel (alle post codes)	300   480   780   1200	65 <sup>a</sup>   90 <sup>b</sup>   110 <sup>b</sup>   120 <sup>b</sup>   145 <sup>c</sup>	90 <sup>d</sup>   120 <sup>e</sup>   150 <sup>e</sup>   165 <sup>e</sup>   195 <sup>f</sup>	
		Genf (post codes 1203,1206,1227)	360   600   900   1320	80 <sup>a</sup>   105 <sup>b</sup>   130 <sup>b</sup>   140 <sup>b</sup>   170 <sup>c</sup>	120 <sup>d</sup>   160 <sup>e</sup>   200 <sup>e</sup>   220 <sup>e</sup>   260 <sup>f</sup>	
		Zürich (post codes 8006,8008,8037)	360   600   900   1320	65 <sup>a</sup>   90 <sup>b</sup>   110 <sup>b</sup>   120 <sup>b</sup>   140 <sup>c</sup>	110 <sup>d</sup>   145 <sup>e</sup>   180 <sup>e</sup>   200 <sup>e</sup>   235 <sup>f</sup>	
	Very dense neighborhood	Genf (post codes 1201,1205,1207)	360   600   900   1320	85 <sup>a</sup>   110 <sup>b</sup>   140 <sup>b</sup>   150 <sup>b</sup>   180 <sup>c</sup>	150 <sup>d</sup>   200 <sup>e</sup>   250 <sup>e</sup>   275 <sup>e</sup>   325 <sup>f</sup>	
		Zürich (post codes 8003,8004,8005)	360   600   900   1320	80 <sup>a</sup>   105 <sup>b</sup>   130 <sup>b</sup>   140 <sup>b</sup>   170 <sup>c</sup>	130 <sup>d</sup>   175 <sup>e</sup>   220 <sup>e</sup>   240 <sup>e</sup>   285 <sup>f</sup>	
	Type of parking lot		-		Free choice <sup>a,b</sup>   fixed parking lot <sup>b,c</sup>	outdoor <sup>d,e</sup>   in parking garage <sup>e,f</sup>   individual garage <sup>e,f</sup>
Walking duration between residence and parking lot (min)			1   2-3   3-5   5-8	3   6   9   12	0   2   5   8	
Number of vehicles stationed at car sharing location						1   2   4
Walking duration to the nearest car sharing location (min)						1   3   6   12

# EXPERIMENT

## MODEL RESULTS

Alternative	Parameter	Parameter	Rob. Std. error	Rob.t-value
All alternatives with parking option	Cost (1/CHF)	-0.008	0.00	-13.00
	Income elasticity $\lambda$	-0.100	0.03	-2.99
	Distance (1/100m)	-0.148	0.01	-11.87
On-street parking permit	Inertia (today's choice)	1.351	0.25	5.31
	Stronger cost perception for respondents who use on street parking today	3.223	0.31	7.16
	Assessment of the availability of on-street parking lots (per step)	0.497	0.07	7.49
	Numbers of days with car usage among the last seven days	0.052	0.01	3.57
	Residual car value (1/1000 CHF)	0.008	0.00	3.47
Private parking lot	Alternative specific constant	1.070	0.24	4.50
	Inertia (today's choice)	0.449	0.22	2.01
	Additional inertia for respondents from Geneva	0.109	0.05	2.02
	Stronger cost perception for respondents who use on street parking today	1.445	0.14	3.20
	Parking garage (as compared to outdoor parking)	0.304	0.06	4.68
	Individual parking garage (as compared to outdoor parking)	0.330	0.06	5.18
	Numbers of days with car usage among the last seven days	0.012	0.01	1.09
	male	0.142	0.05	2.81
	Residual car value (1/1000 CHF)	0.011	0.00	6.30

District parking	Alternative specific constant	1.843	0.11	16.08
	Stronger cost perception for respondents who use on street parking today	1.582	0.21	2.77
	Increased perception of distance	0.338	0.13	2.62
	Fixed parking lot (as compare to free choice)	0.124	0.05	2.40
Giving up the car	Alternative specific constant	-1.482	0.24	-6.12
	Respondents from Geneva	0.423	0.12	3.57
	Respondent who uses on street parking today	0.624	0.22	2.81
	Reduced perception of distance (to car sharing station)	-0.823	0.16	-4.99
	Number of car sharing vehicles at the station	0.090	0.04	2.20
	Assesment of the availability of on-street parking lots (per step)	-0.078	0.03	-2.86
	Income (linear)	-0.046	0.01	-3.41
	Existing car sharing membership	0.603	0.16	3.78
	Additional term for users of on-street parking in areas with low availability	-0.882	0.14	-6.28
	$\lambda$ -Parameter Nested Logit	Nest 1: district parking, on-street parking and giving up car	0.866	0.10
Nest 2: district parking and private parking lot		0.608	0.07	8.70
Affiliation of district parking: Nest 2		0.881	0.21	4.24
$\rho^2$				0.29
Log-Likelihood (0) / (final)				-8006 / -5667