Combining household survey data, key informant interviews, and hedonic modelling to understand housing demand in a dynamically shifting market

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DEVS Francophones, 1 May 2018, Corsica

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Social Sciences and Humanities Research Council of Canada | Conseil de recherches en sciences humaines du Canada | Canada

Why are land markets important?

- On the investment side, huge role in the financial system —look no farther than the 2009 housing crisis and Great Recession
- On the individual side:
  - Often the most significant asset/investment for home owners
  - "Lifestyle" contributions from house/neighbourhood strongly linked to identity
- On the market side, they influence:
  - Income and racial segregation
  - Tiebot sorting, public good provision (education), politics

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Land markets: Regional and global scale influences

- Housing market crash and global financial crisis
- Rising gas prices and fall of residential land values in low-accessibility areas
- Global trends towards urban migration and urbanization
- Biofuel initiatives, rising agricultural commodity prices, and agricultural land markets
- “Land Grabs”
- REDD (reducing emissions from deforetation and degradation) and emerging carbon markets

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Why are land markets different?

- Each property is a unique good—extreme case of monopolistic competition
- Few opportunities for repeat transaction -> limited opportunities for learning
- Information on prices is largely private (bids and transaction prices)
- Interaction between markets for a personal good (homeowner resident) and investment good
- Highly influenced by demographic shifts/migration
- Limitted competition/innovation in supply
- Highly regulated supply process

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Why are land market complex?

- Heterogeneity:
  - Differential resource and preferences
  - Differential risk
  - Differential knowledge and beliefs
- Interdependencies
  - Credit networks
  - Land markets
  - Transportation/proximity
  - Spatial spillovers (externalities)
- Learning and adaptation
- => Non-linearities, Analytical intractability,

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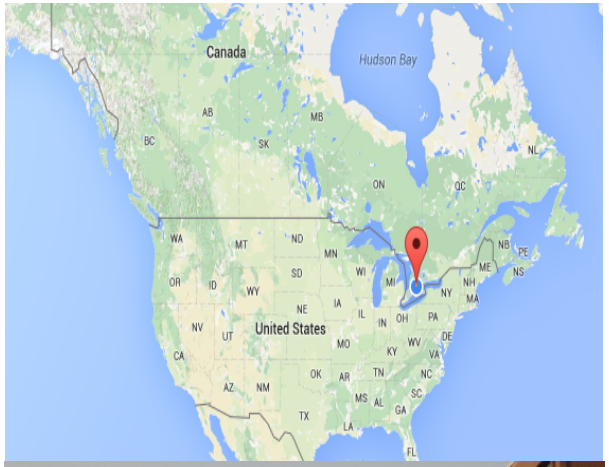

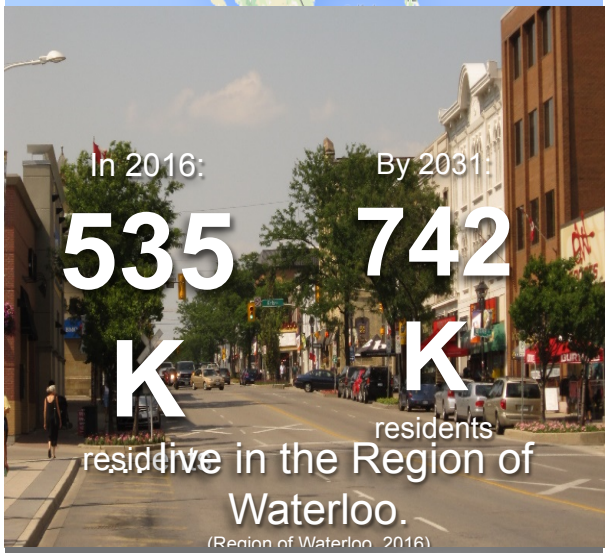

Why Kitchener-Waterloo Region?

- **Increasing people** and employment
- **High tech hub** with entrepreneurship and knowledge-intensive economy
- A new light rail transit system as a key strategy for urban revitalization and overall economic development strategy
- ***Housing boom (price volatility), but why?***

Toronto speculative buyers?

Foreign buyer tax?

Low interest rate?

Urban growth boundary?

Massive shortage?

Research Questions…

1. *How can we better interpret the housing market dynamics in Kitchener-Waterloo Region?*

2. *What are the housing demand or preferences among heterogeneous households during the boom?*

   - *How can we analyze the housing demand?*

   - *Specifically, how can we build a **theoretically-grounded, empirical model** to interpret **housing demand** in this Region?*

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Challenges in development of ABMs of land market

- Early models had endogenous prices, but no decentralized transactions
- Price formation processes mimicked Alonzo/Von Thuenen models—allocation parcel to highest profit use, or using numerical price adjustment mechanisms
- Filatova and Parker (various 2008-2010) first to our knowledge to implement decentralized price formation through bilateral transactions
- Challenges for building these models outlined in Parker and Filatova (2008)
- Achievements summarized in Huang et al. (2014)

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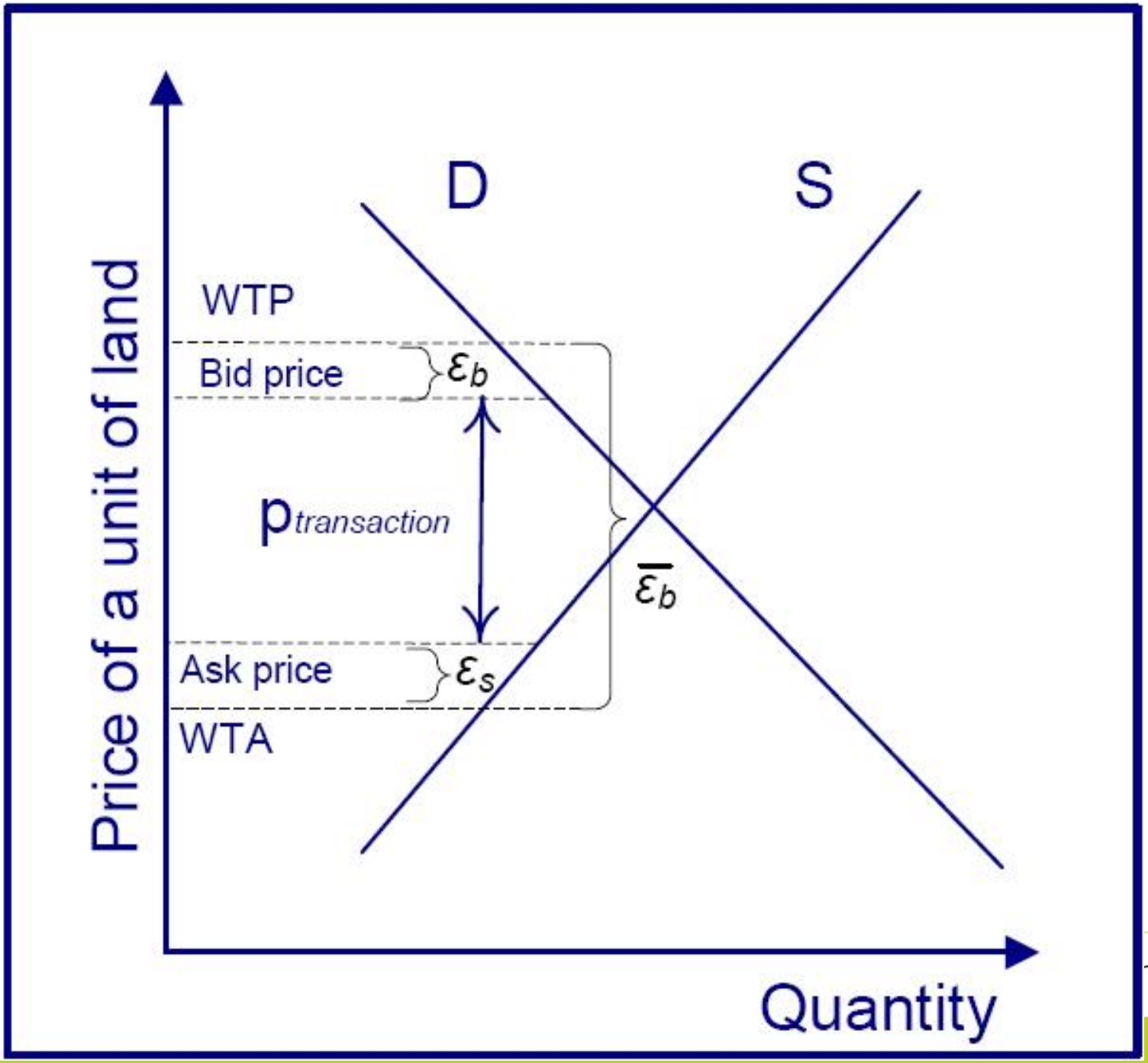
D
S
WTP
Bid price
ε_b
$p_{transaction}$
$\overline{\varepsilon_b}$
Ask price
ε_s
WTA
Price of a unit of land
Quantity

Major challenge: Empirical WTP/WTA estimation

- Spatial econometric models estimate transaction price only
- WTA/WTP depend on house-hold level factors
- Household information difficult to obtain
- Our theoretical ABMs used budget-constrained utility maximization—but that created a challenge of how to model price expectations
- Seemed to be no ground to empirically estimate utility function parameters

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Approach one:
Spatial hedonic regression models

Model Overview

- WAterloo Regional Model (WARM)
- Vector-based parcel landscape
  - Represents individual households and parcels
  - Practical given data constraints
  - Accurately represents transportation costs and accessibility
- Land market model
- Transportation model

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Hedonic Model (Babin)

- Statistical model to deconstruct property value
- Identifying relationship between intensification related environmental amenities (like open space and transit access) and property prices
  - controls for spatial and aspatial home characteristics

$$ln(Y_i) = \beta_0 + \beta_1 S_i + \beta_2 E_i + \beta_3 N_i + \varepsilon$$

Where:

$Y_i =$ Property value (preferably recorded sales price)

$S_i =$ Structural characteristics

$E_i =$ Environmental characteristics

$N_i =$ Neighbourhood characteristics

$\beta_0 =$ Intercept

$\beta_{1-3} =$ Estimated coefficients

$\varepsilon =$ Error

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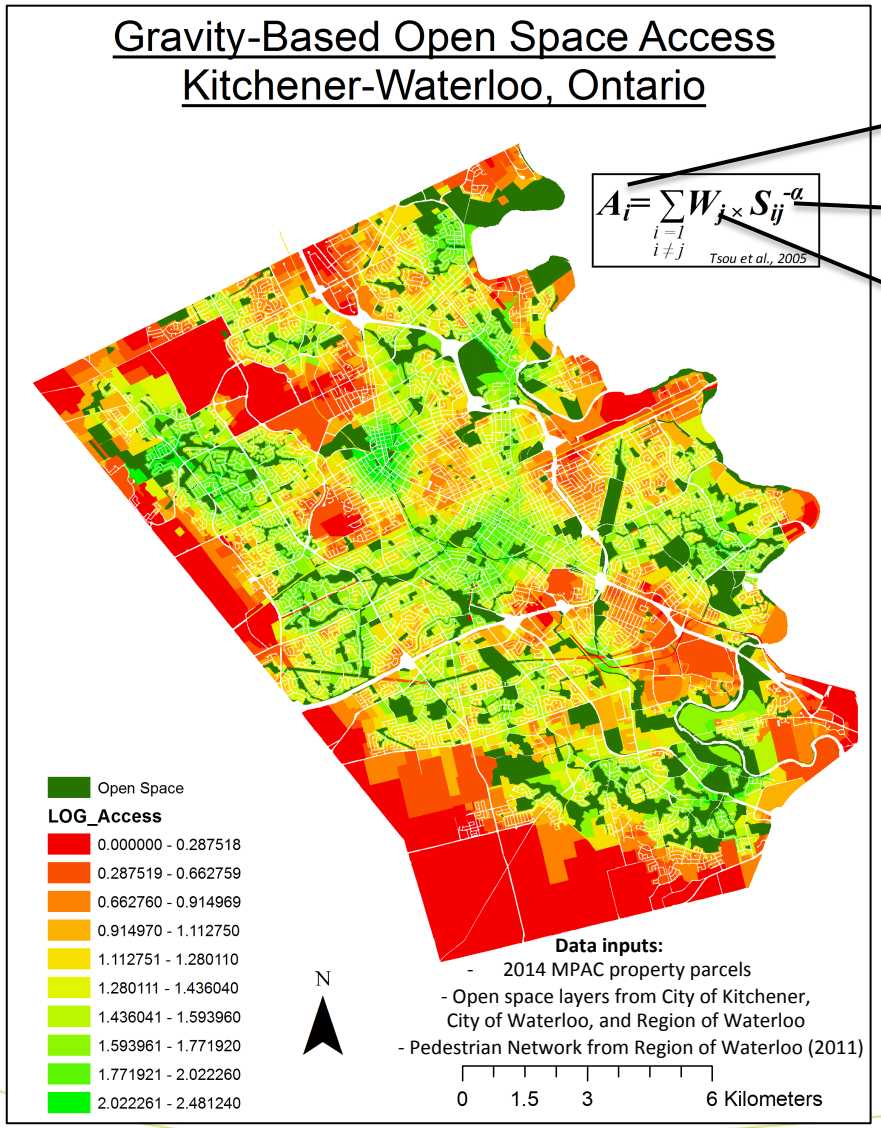
Modelling Access to Public Open Space

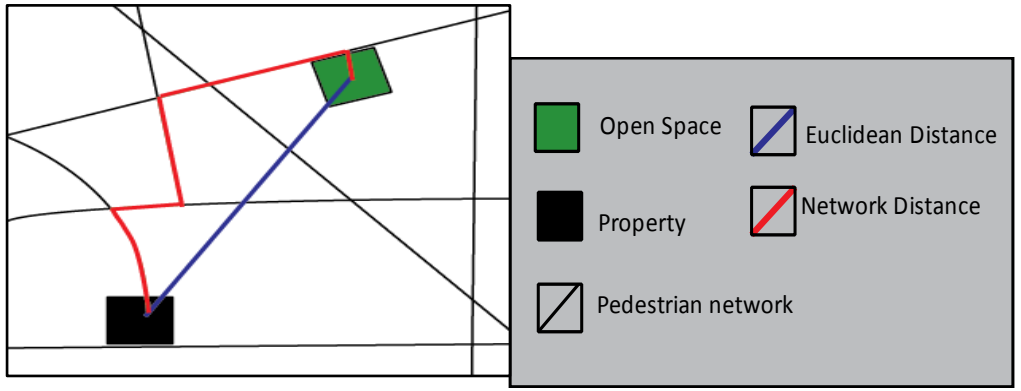


Access

Spatial Separation (distance)

Weight/Attractiveness
(size of open space)

Network (walking) Distance



Figures by Robert Babin

Hedonic model highlights

- Model run using data from 2005-2015, to establish pre-LRT baseline
- House characteristics (size, age, parcel size) strongly correlated with values, as expected.
- Neighbourhoods with higher appreciation rates showed higher values
- After 2011, houses inside the CTC sold for around 4.5% more than houses outside
- Walkability showed a premium; more so inside the CTC

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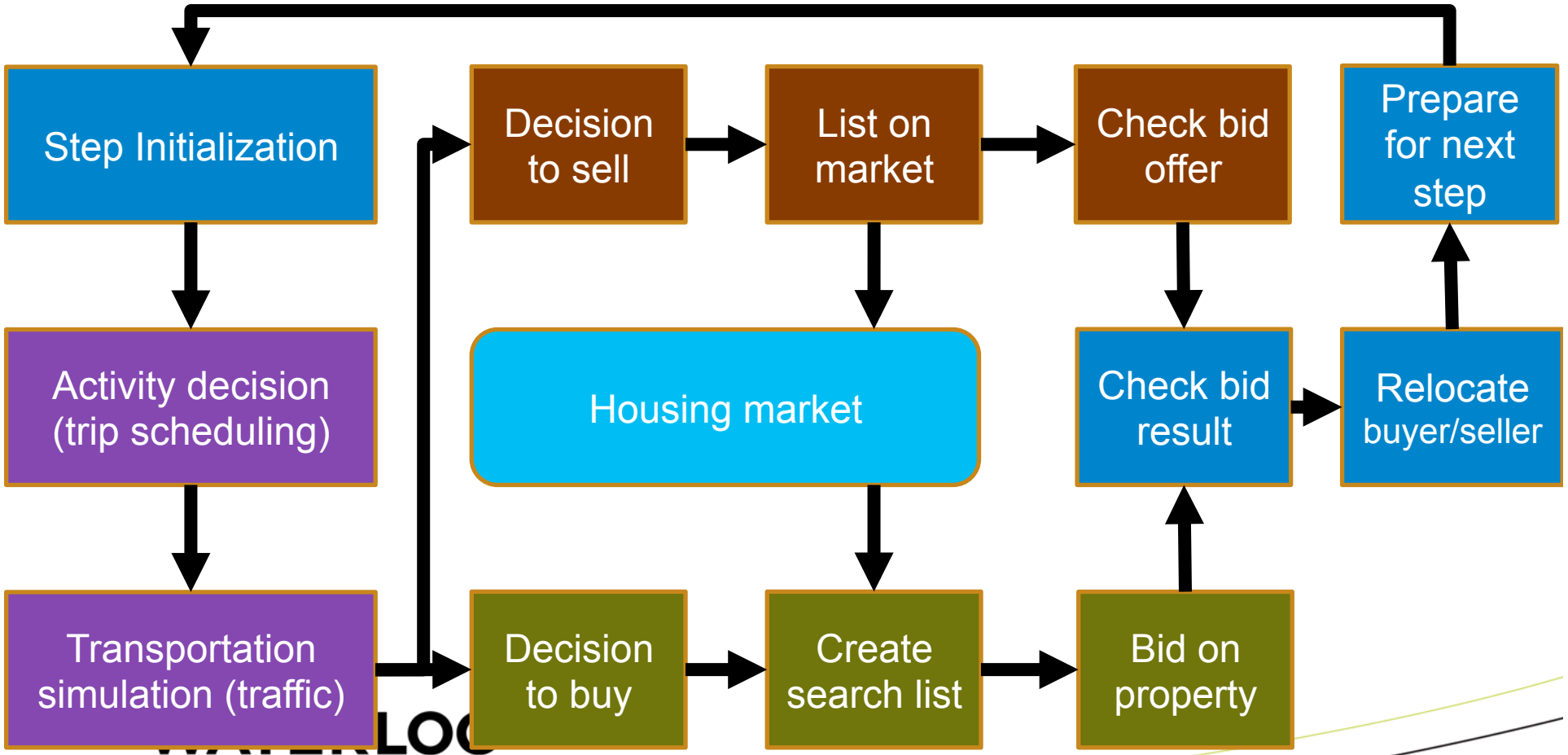
Agent-based Model process



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Land Market: WTA/WTP

- Seller's willingness to accept (WTA) assessment values
- Buyer's willingness to pay (WTP) – transaction values
- Both estimated via spatial econometric regression

$$ln(Y_i) = \rho W y_i + \beta_0 + \beta_1 \times S_i + \beta_2 \times N_i + \beta_3 \times E_i + u_i$$

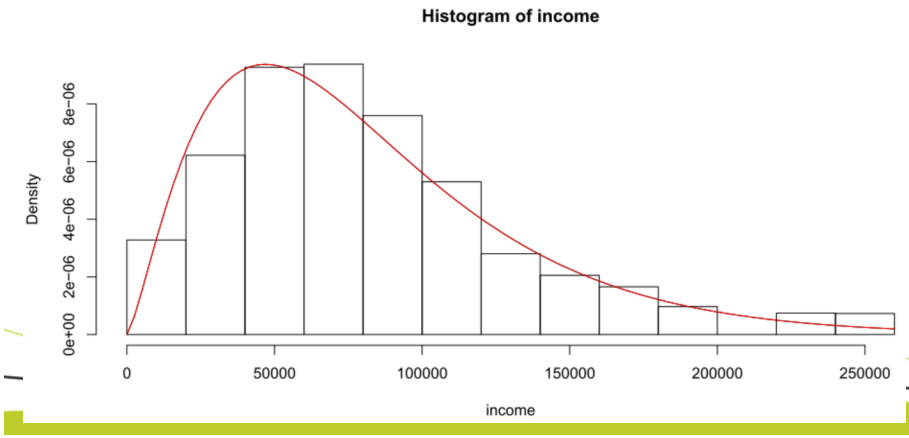
$$S_i = \begin{bmatrix} Living\ Area_i \\ Yard\ Size_i \\ Building\ Age_i \end{bmatrix}$$

$$N_i = \begin{bmatrix} In\ CTC_i \\ Rate\ of\ Appreciation_i \\ Education\ Rate_i \\ Population\ Density_i \\ Time\ Period_i \\ In\ CTC \times Time\ Period_i \end{bmatrix}$$

$$E_i = \begin{bmatrix} Open\ Space\ Access_i \\ Transit\ Access_i \\ Walkability_i \\ Open\ Space\ Adjacent_i \\ Regional\ Road\ Adjacent_i \\ Open\ Space\ Access \times Yard\ Size_i \\ In\ CTC \times Open\ Space\ Access_i \\ In\ CTC \times Transit\ Access_i \\ In\ CTC \times Walkability_i \\ Open\ Space\ Access_i \times Transit\ Access_i \\ Open\ Space\ Access_i \times Walkability_i \\ Walkability_i \times Transit\ Access_i \end{bmatrix}$$

Land Market: Budget Constraints

- Regulatory limit in Canada: about 32% of income
- higher-income households spend significantly less portion of their income on housing
  - Model settings: generated using normal distributions. Mean at 25% for households with income of 40k, and down to 8% for households with income of 250k.
- Income generated using a Gamma distribution based on census data



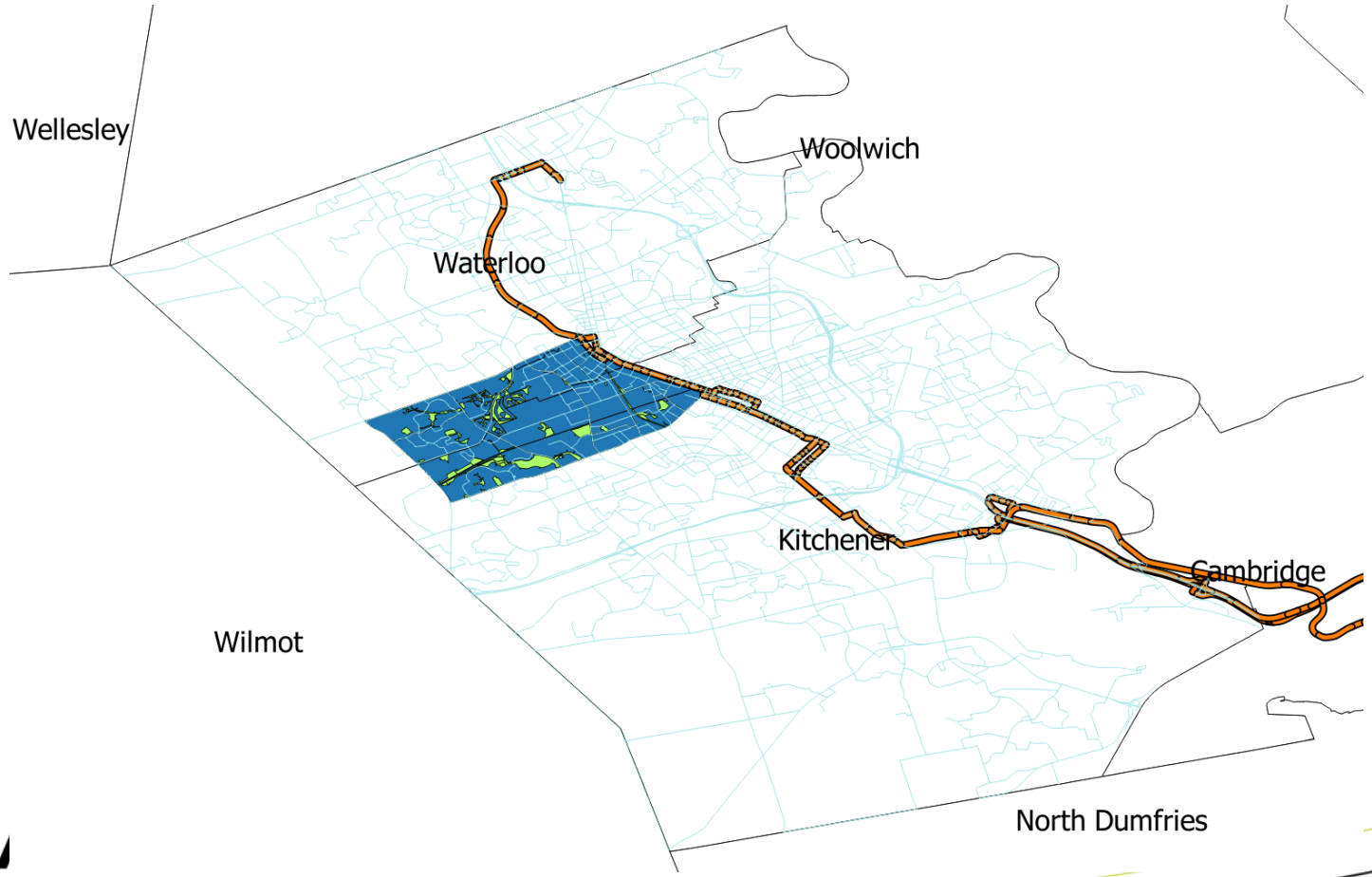
Land Market: Competitive Bidding

- Each buyer can bid on only 1 parcel each step
- Buyers bid on the parcel that provide the highest utility value (currently using WTP as proxy)
- Seller choose the highest bid that is above WTA

Transportation Simulation

- Uses Transportation Tomorrow Survey (TTS) trip diary data
- Supplemented by Original-Destination matrices from Region's transportation model
- Each household has its unique travel schedule, trip destinations, purposes and modes
- Internal shortest route calculation for car travel
- Utilizes OpenTripPlanner to calculate shortest transit route based on route and schedule data

Prototype modelling area



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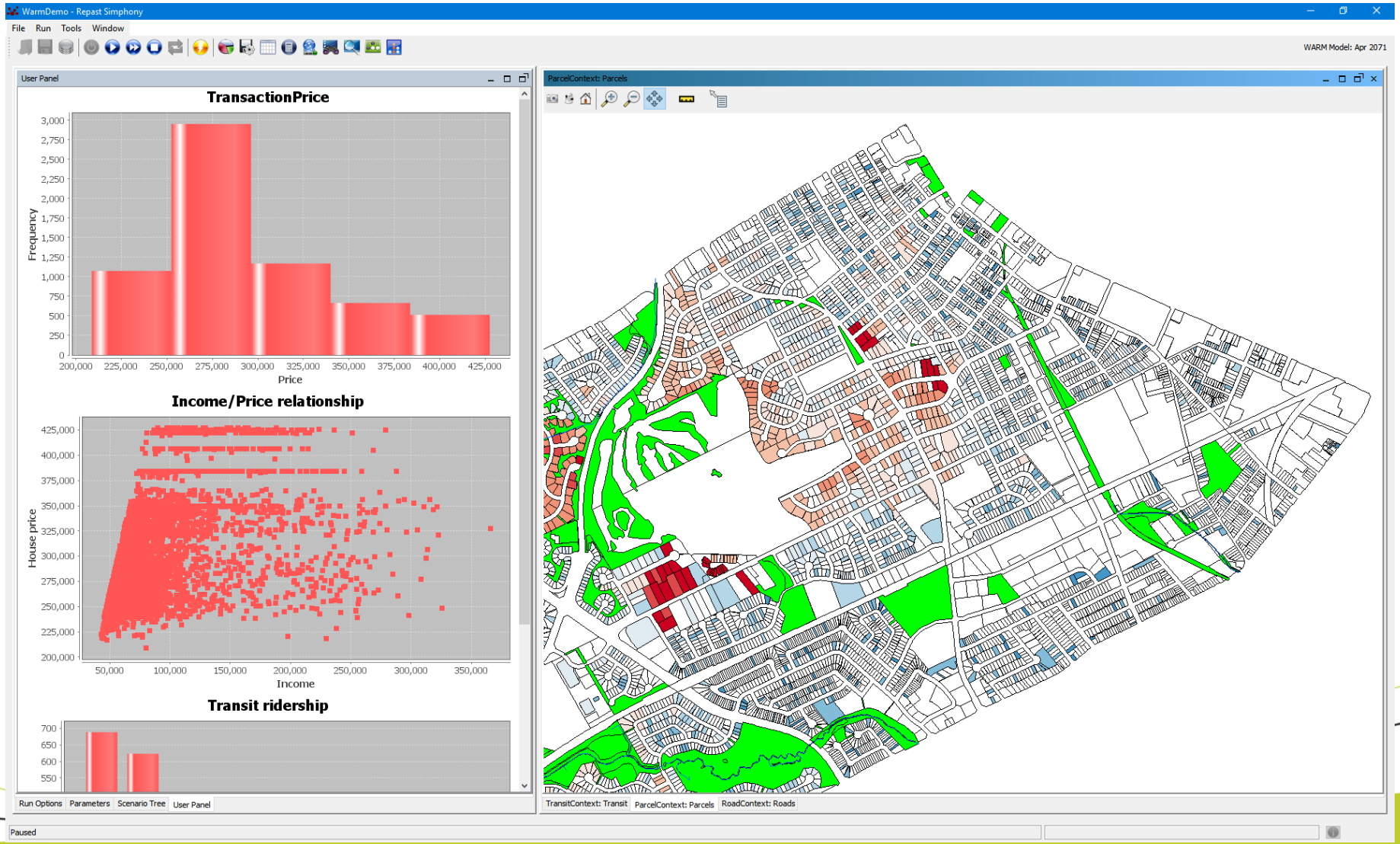
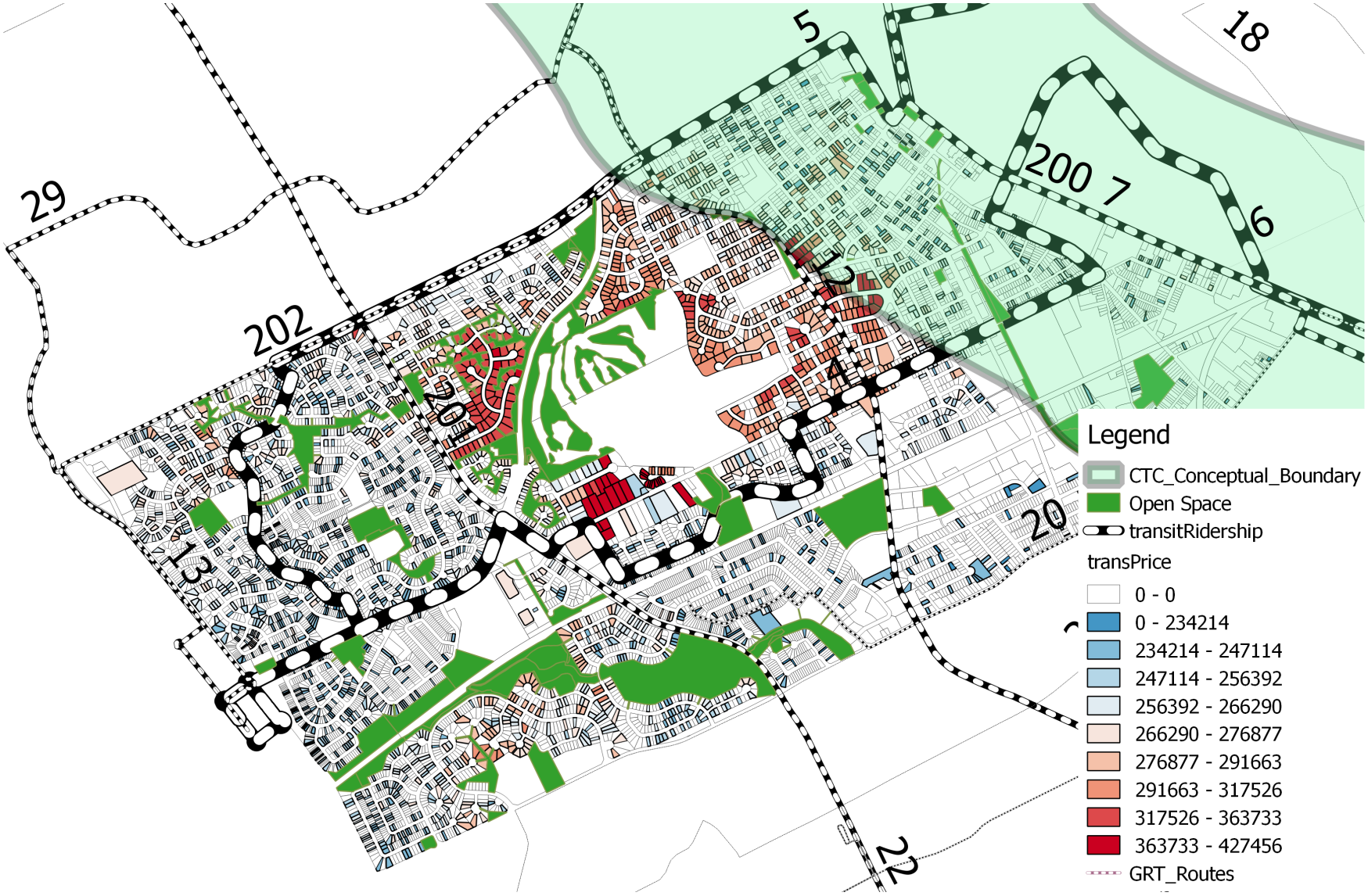
Prototype screenshot (enlarged)



Very preliminary results



Next steps—household surveys

✓ *Interpreting the Housing Market Dynamics in Kitchener-Waterloo from Individual Behaviours*

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Survey Research Questions (Xinyue Pi: rental, Yu Huang: buyer/seller)

- What is the relationship between different households' resources, values, structure and transportation needs, and urban residential patterns?

- How might light rail transit affect housing and rental markets?

Survey Structures

Homebuyers and sellers survey	Renters survey
I. Residential and neighbourhood characteristics	I. Residential and neighbourhood characteristics
II. Home selling/buying experience	II. Rental experience
III. Location choice preferences	III. Location choice preferences
IV. Preferences towards LRT	IV. Preferences towards LRT
V. Household characteristics and travel behaviour	V. Household characteristics and travel behaviour

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Approach 2: Incorporating household characteristics in regression

Rental hedonic Model Result (n=~150)
Household characteristics as ind. vars.

Category	Significant variables	Effect per unit increase	Level of significance
Household variables	Student household	10.34%	**
	Household with children	-9.12%	*
	One-person household	-8.53%	**
	Household income (per $1,000)	0.12%	***
Structural variables	Number of bathrooms	18.02%	***
	Number of bedrooms	15.02%	***
	High-rise apartment	7.83%	*
	Low-rise apartment	-8.39%	*
Neighbourhood variable	In CTC	7.48%	**
Behavioural variable	Renting a room	12.04%	*
R-squared	**0.85**		

Approach 3: Demand analysis (Two-stage regressions)

Situating demand analysis

1. **Alonso (1964)** proposed the bid-rent theory, and pointed out that housing prices and location choices are simultaneously determined by a **bidding process**

2. **Rosen (1974)**'s first-stage hedonic regression tells nothing about demand heterogeneity; **Second-stage** hedonic (basically demand analysis) has endogeneity problem

3. **Demand analysis matters for assessing policy/environmental changes, say the LRT implementation**

Housing Survey Summary

- ✓ ***Survey target:*** *Home Buyers and Sellers from 06/2015 - 04/2017*
- ✓ ***Survey mails out:*** *5000 addresses obtained from Canada Post*
- ✓ ***Survey responses:***

Responses		Total	
Buyers only	269	Total buyers	357
Sellers only	61	Total sellers	149
Both buyers and sellers	88	Response rate	10%

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2. Housing Demand Analysis - theoretical foundations

- Traditional location choice problem – budget constraint, utility maximization (Alonso, 1964)
- Suppose only two characteristics - ***house size (S_j)*** and ***proximity to CBD (d_j)*** compose the house *j*, the optimization problem can be formulated based on the theory.

Briefly, three estimation steps:

(Bajari & Kahn, 2005)	Step 1	Estimate implicit prices by hedonic (α)
	Step 2	Calculate expenditures on each characteristic (β)
	Step 3	Regress the expenditures (β) on demographics

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The optimization problem based on Alonso bid-rent theory:

Utility of house *j* provided to household *i*

Individual preferences for house size and proximity to CBD

$$max\ U_{ij} = \beta_i^S log(S_j) + \beta_i^d log(d_j) + c$$

$$s.t.\ \alpha^S S_j + \alpha^d d_j + c \leq M_i$$

A composite commodity

Household income

Implicit market prices for house size and proximity to CBD

Estimated from hedonic regression

$$P_j = \alpha^S S_j + \alpha^d d_j + \epsilon_j$$

(Bajari and Kahn, 2005)

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Solving the optimization problem, we derive,

$$\frac{\frac{\partial U_{ij}(S_j)}{\partial S_j}}{\frac{\partial U_{ij}(c)}{\partial c}} = \alpha^S$$

$$\beta_i^S = S_{j^*} \alpha^S$$

$$\frac{\frac{\partial U_{ij}(d_j)}{\partial d_j}}{\frac{\partial U_{ij}(c)}{\partial c}} = \alpha^d$$

$$\beta_i^d = d_{j^*} \alpha^d$$

- A way to "recover" *household-level preference* parameters in the utility function with a strong theoretical foundation

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Regress the expenditure on demographics to recover heterogeneous housing demand…

- Assume that households with similar demographic characteristics have similar preferences.

$$\beta_i^S = f(\boldsymbol{Dem}_i)^S + \eta_i^S$$
$$\beta_i^d = f(\boldsymbol{Dem}_i)^d + \eta_i^d$$

A vector of demographic characteristics collected from housing survey:

- Highest employment status
- Highest education level
- Household income
- Age of head

- Household type:
  - Couple with children
  - Couple without children
  - Lone parent
  - More persons
  - One person

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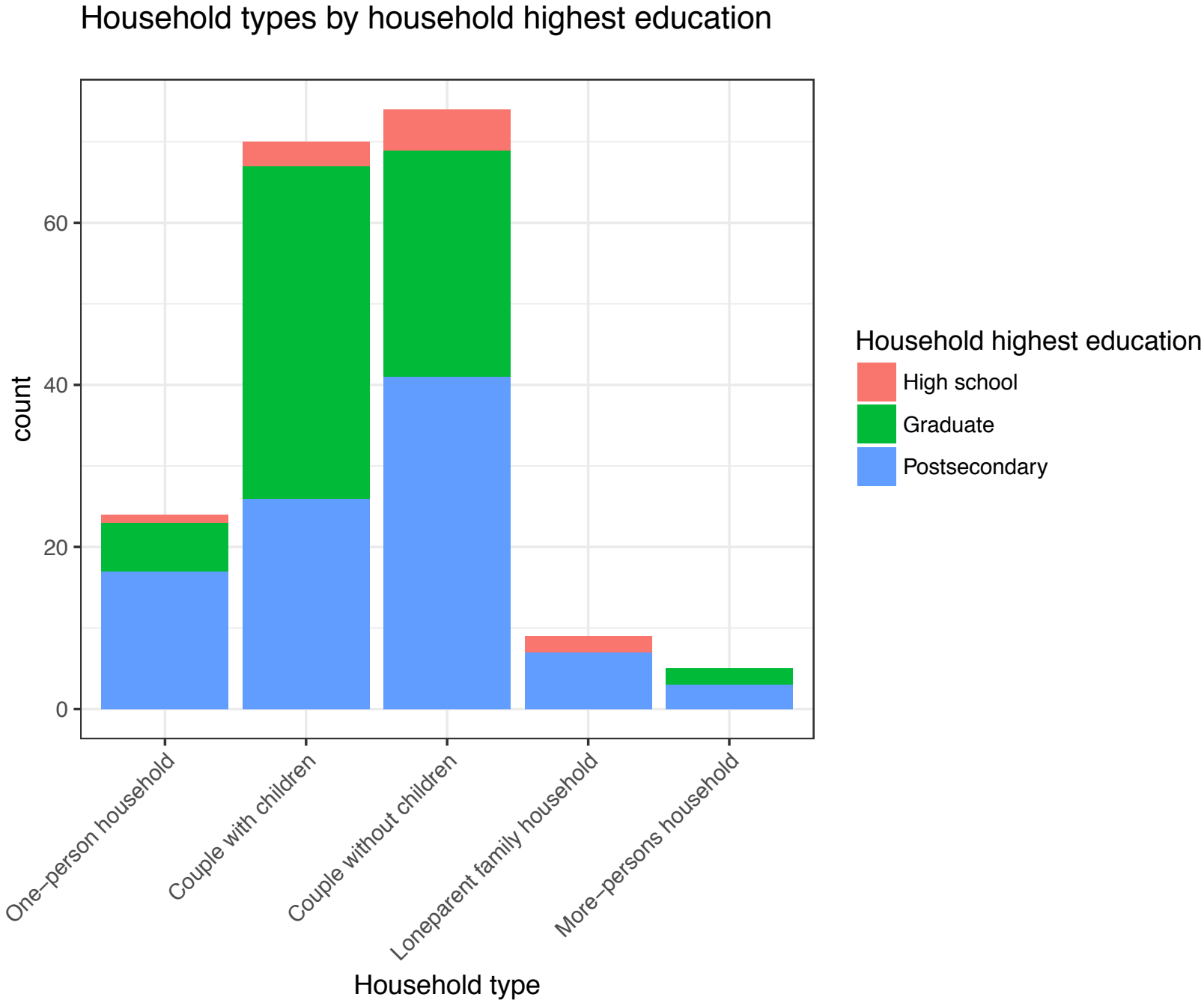
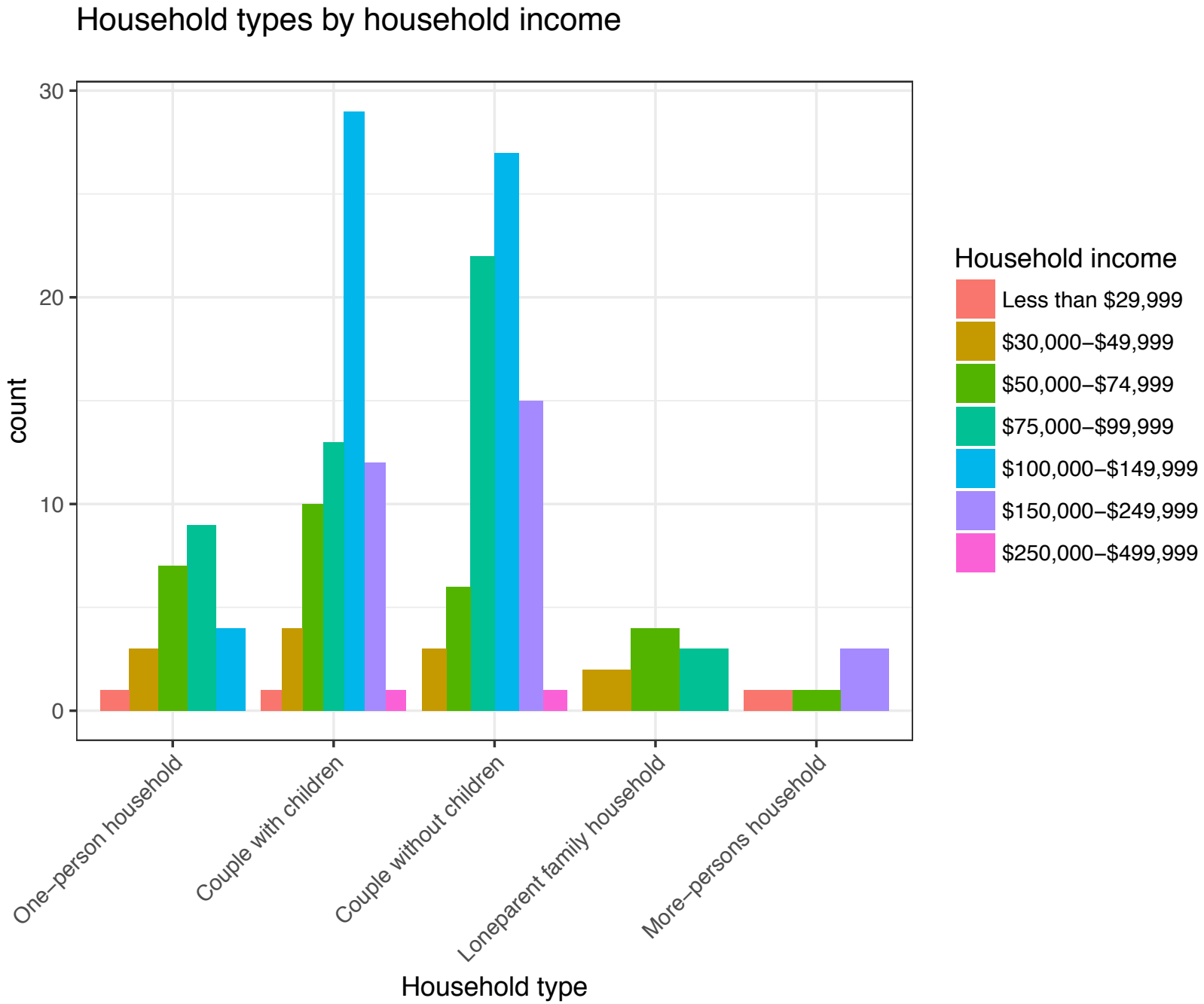
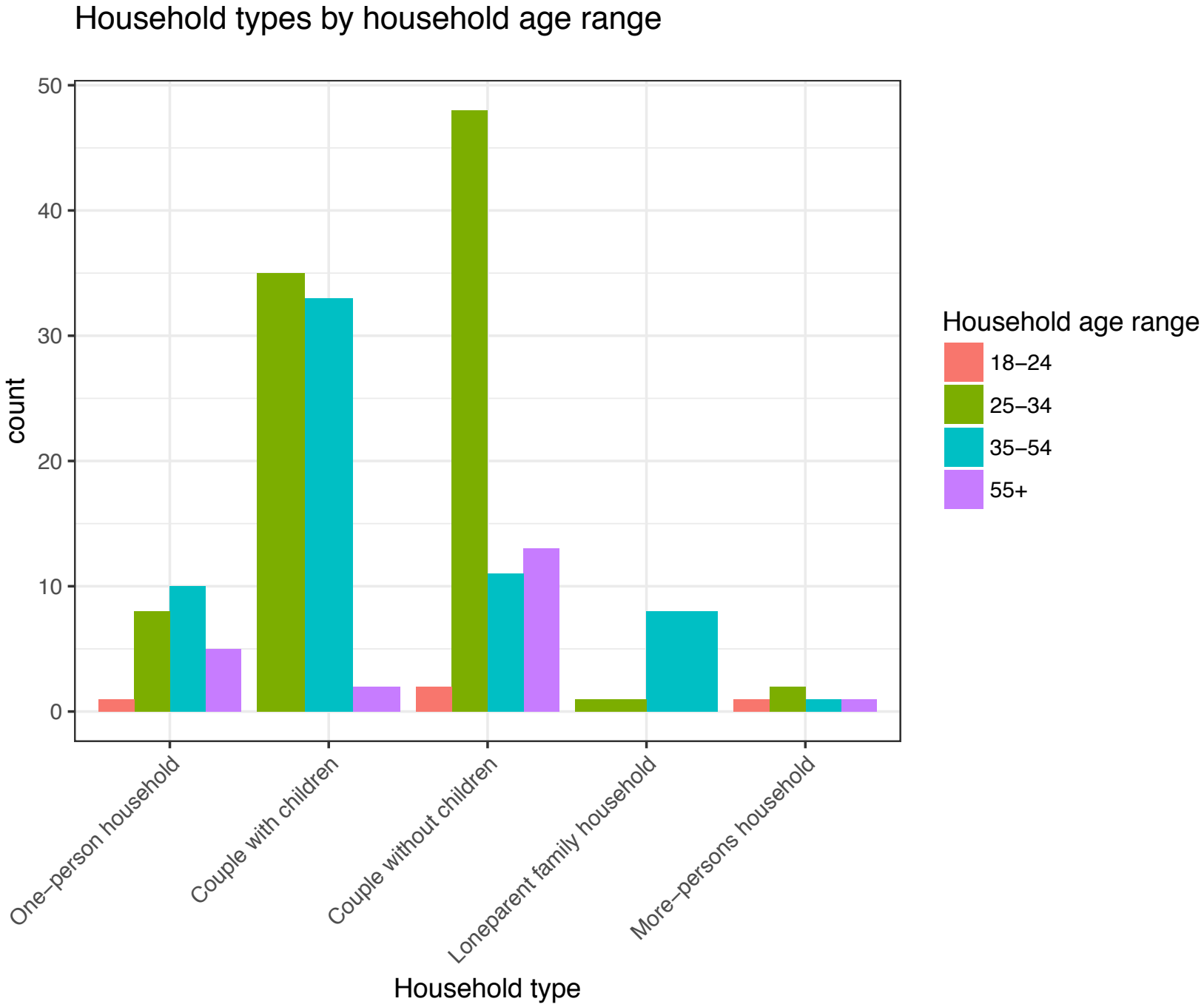
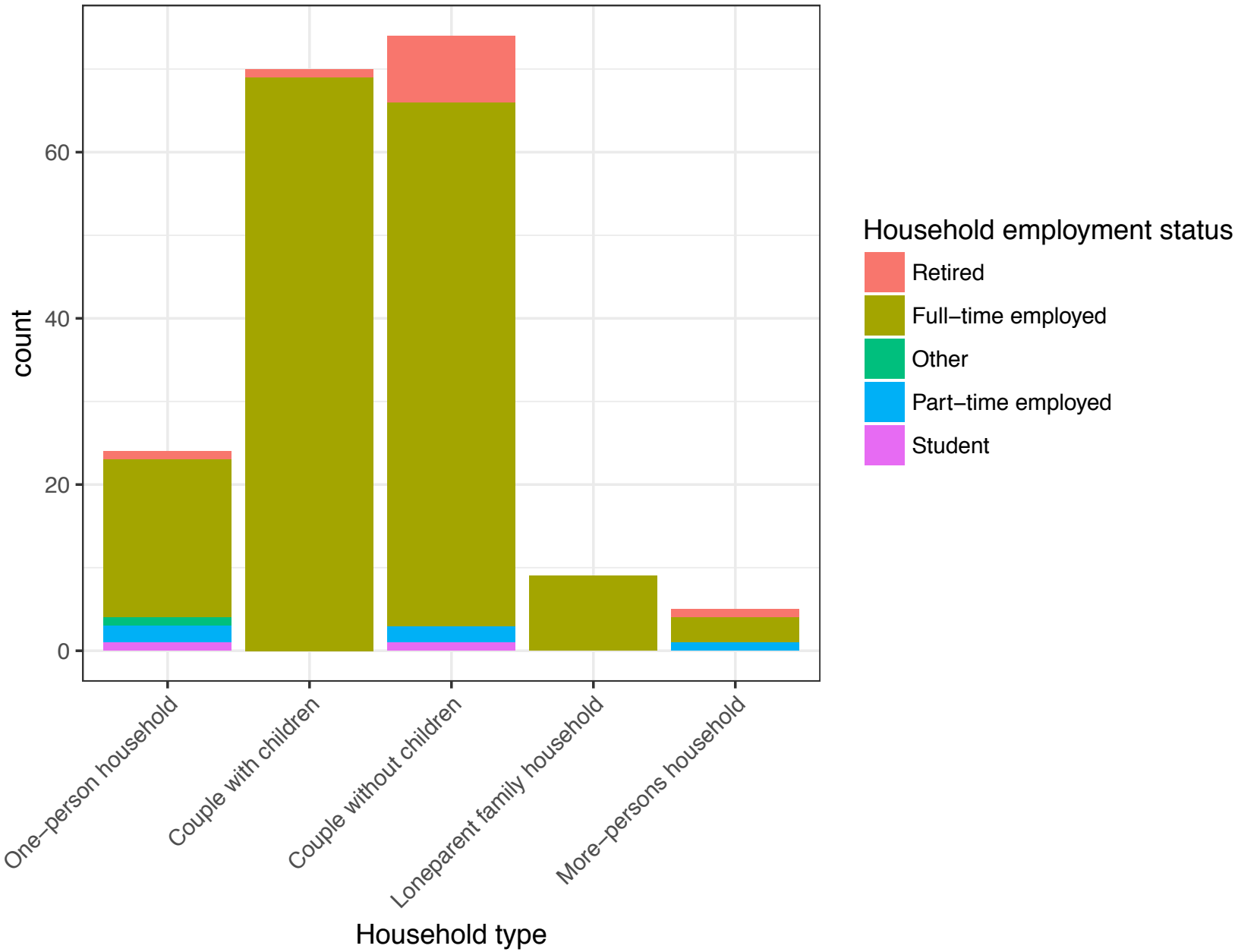

Household types by household highest education
count
60
40
20
0
One−person household
Couple with children
Couple without children
Loneparent family household
More−persons household
Household type
Household highest education
High school
Graduate
Postsecondary


Household types by household income
30
20
10
0
count
One−person household
Couple with children
Couple without children
Loneparent family household
More−persons household
Household type
Household income
Less than $29,999
$30,000–$49,999
$50,000–$74,999
$75,000–$99,999
$100,000–$149,999
$150,000–$249,999
$250,000–$499,999


Household types by household age range
count
50
40
30
20
10
0
One−person household
Couple with children
Couple without children
Loneparent family household
More−persons household
Household type
Household age range
18–24
25–34
35–54
55+

Household types by household highest employment status



First-stage hedonic regression results

	Dependent variable:
	log(P)
NOT-SINGLE HOUSE	0.094 (0.073)
SINGLE-DETACHED HOUSE	0.282*** (0.077)
BDMS	0.077*** (0.019)
FBTH	0.123*** (0.021)
HBTH	0.057** (0.023)
GRAG	0.095*** (0.023)
OPARK	0.009 (0.008)
BUL_AGE	-0.001 (0.001)
POP_DENS	-0.00000 (0.00001)
OS_ACES	0.0001 (0.001)
OS_ADJ	0.004 (0.034)
REG_RD_ADJ	-0.092** (0.046)
DIS_LRT	-0.00000 (0.00001)
DIS_BUS	0.0001** (0.00005)
POST_EDU	0.006*** (0.001)
EMPL_RATE	-0.004** (0.002)
Constant	11.864*** (0.164)
Observations	277
R^2	0.666
Adjusted R^2	0.646
Residual Std. Error	0.188 (df = 260)
F Statistic	32.473*** (df = 16; 260)
Note:	*p<0.1 **p<0.05 ***p<0.01

Key points from First-stage hedonic

- Proximity to LRT – amenity (not statistically significant)
- Proximity to bus stops – disamenity
- Adjacency to regional roads – disamenity
- Open space – amenity (not statistically significant)

- Neighbourhood post-secondary education rate – amenity
- Neighbourhood employment rate - disamenity

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Preference regression results

	Dependent variable:	
	Preference for bedroom	Preference for full bathroom
	OLS	*OLS*
	(1)	(2)
Couple with children	25,368.060***	17,754.490**
Lone-parent family	1,252.245	-28,910.870
More-persons household	-6,030.757	-26,173.180
One-person household	-9,142.029	-15,225.960
Less than 29,999	-32,895.700	-27,346.910
30,000-49,999	-24,198.010**	-22,281.470
50,000-74,999	-21,814.490**	-25,907.350**
75,000-99,999	-4,828.313	-6,993.440
150,000-249,999	18,065.060**	17,090.880*
250,000-499,999	105,039.100***	143,993.700***
Age	284.995	1,736.466***
Other employment	20,928.760	36,185.340*
Part-time employed	10,609.170	-2,084.516
Retired	-6,003.822	-35,255.460*
Graduate	7,102.596	7,067.105
High school	-17,961.080	-25,241.590*
Constant	81,174.910***	30,781.080**
Observations	279	279
R^2	0.325	0.392
Adjusted R^2	0.284	0.355
Residual Std. Error (df = 262)	46,221.790	53,386.050
F Statistic (df = 16; 262)	7.885***	10.573***
Note:		*p<0.1 **p<0.05 ***p<0.01

Key points from preference regression (1)

- Couple with children households prefer most for bedrooms, and full-baths
- Older households prefer more for full-bathrooms, but not for bedrooms
- Retired households prefer less for full-baths, compared to the full-time employed households
- Preferences for bedrooms and full-baths increase with household income

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Preference regression results

	Dependent variable:	
	Preference for half-bathroom	Preference for garage
	OLS	*OLS*
	(1)	(2)
Couple with children	7,657.316***	12,698.630***
Lone-parent family	10,449.630**	2,919.234
More-persons household	-3,283.114	-16,294.420
One-person household	-1,529.399	-6,109.171
Less than 29,999	2,402.076	-8,364.114
30,000-49,999	-6,939.626*	-20,382.580**
50,000-74,999	-7,320.011**	-18,635.680***
75,000-99,999	-1,580.410	-6,665.410
150,000-249,999	8,509.374***	15,892.420***
250,000-499,999	20,991.050***	65,047.020***
Age	-34.313	581.163**
Other employment	522.853	17,882.950
Part-time employed	3,793.232	-4,748.108
Retired	-2,476.225	-7,735.275
Graduate	827.396	6,542.320
High school	-4,143.095	-8,506.262
Constant	17,056.950***	20,814.630**
Observations	279	279
R^2	0.241	0.323
Adjusted R^2	0.194	0.282
Residual Std. Error (df = 262)	14,891.370	32,089.010
F Statistic (df = 16; 262)	5.194***	7.825***
Note:		*p<0.1 **p<0.05 ***p<0.01

Key points from preference regression (2)

- Households with children prefer more for half-baths
- Couple with children households prefer most for garage
- Older households prefer more for garages
- Preferences for half-baths and garages both increase with household income

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Preference regression results

	Dependent variable:	
	Preference for proximity to LRT stops	Preference for distance to bus stops
	OLS	*OLS*
	(1)	(2)
Couple with children	-258.236***	10,088.520***
Lone-parent family	-204.499	5,432.627
More-persons household	-21.677	134.948
One-person household	-57.885	3,697.882
Less than 29,999	219.750	-8,568.055
30,000-49,999	245.999*	-9,005.569**
50,000-74,999	270.978***	-8,500.903***
75,000-99,999	19.865	-4,486.113
150,000-249,999	-105.442	41.343
250,000-499,999	-1,037.744***	48,293.320***
Age	0.456	-102.882
Other employment	-136.897	-2,042.904
Part-time employed	53.786	3,372.380
Retired	61.092	5,224.278
Graduate	-165.495**	27.230
High school	120.344	-4,938.272
Constant	-701.146***	17,023.810***
Observations	279	279
R^2	0.287	0.317
Adjusted R^2	0.243	0.275
Residual Std. Error (df = 262)	484.955	16,895.200
F Statistic (df = 16; 262)	6.589***	7.606***
Note:		*p<0.1 **p<0.05 ***p<0.01

Key points from preference regression (3)

- Couple without children households prefer most for proximity to LRT stops, i.e., prefer living close to LRT stops
- Couple with children households prefer most for distance to bus stops, i.e., prefer living far from bus stops
- High income households prefer living far from LRT stops and bus stops
- Households with graduate degree prefer to live far from LRT stops

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Preference regression results

	Dependent variable:	
	Preference for neighbourhood post-secondary education rate	Preference for neighbourhood employment rate
	OLS	*OLS*
	(1)	(2)
Couple with children	27,007.750***	-17,348.310***
Lone-parent family	10,938.270	-9,950.384
More-persons household	-38,490.620	12,387.870
One-person household	-11,766.720	3,890.155
Less than 29,999	-28,647.960	24,675.380
30,000-49,999	-28,568.440*	16,589.090*
50,000-74,999	-41,262.140***	23,224.040***
75,000-99,999	-7,495.329	519.078
150,000-249,999	25,289.010**	-15,569.990**
250,000-499,999	185,973.900***	-101,294.300***
Age	1,230.977***	-268.462
Other employment	43,453.420**	-25,950.280**
Part-time employed	24,695.600	-16,894.930
Retired	-9,829.160	-1,891.157
Graduate	8,035.471	-5,838.001
High school	-38,440.200**	19,561.760**
Constant	105,677.500***	-88,175.710***
Observations	267	267
R^2	0.403	0.366
Adjusted R^2	0.365	0.326
Residual Std. Error (df = 250)	58,846.210	33,941.500
F Statistic (df = 16; 250)	10.569***	9.024***
Note:		*p<0.1 **p<0.05 ***p<0.01

Key points from preference regression (4)

- Couple with children households prefer most for neighbourhood education rate; Couple without children prefer more for neighbourhood employment rate
- Higher income and older households prefer more for neighbourhood education rate
- Lower income households prefer more for neighbourhood employment rate
- Households with high-school education prefer less for neighbourhood education rate, but prefer more for neighbourhood employment rate

WATERLOO ENVIRONMENT

Contributions of qualitative research
Jinny Tran (developers)
Justin Cook and Jennifer Dean (Realtors)

- Context
- Cross-validation
- Future directions

WATERLOO ENVIRONMENT

Factors that affect developers' decision making (Jinny Tran)

- **Physical** (e.g. land availability, environmental conditions)
- **Spatial** (e.g. proximity to transit, to employment centres, to commercial areas)
- **Socio-Economi**c (e.g. market demand, growth potential)
- **Planning** (e.g. approval costs, timing of approval)

- In theory, developers work to maximize profit, while minimizing risk and uncertainty

THE TANNERY DISTRICT
KITCHENER – MIXED USE CONVERSION (FORMER FACTORY)

Jinny Tran

Developer Survey Highlights

- Conducting surveys with 17 residential developers
- Fairly wide distribution of specializations and built form found; shift towards intensified and mixed use forms-but segmented target markets
- Few developers consider what others are doing when making plans
- Response to LRT generally positive, but more so for infill developers than the other two—some “wait and see” expressed

SEAGRAM LOFTS
WATERLOO – RESIDENTIAL CONVERSION

Jinny Tran

Realtor interviews/Focus Groups

Qualitative Approach

- Deeper understanding of why people are buying in the CTC
- Complementing quantitative research to draw stronger conclusions

Why Realtors?

- Key informants with specialized knowledge
- Emotional/cultural interpreters

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Key Discussion Points

Three broad themes emerged from discussions:

1. CTC development and investment
2. Resident perception of attractiveness of CTC
3. CTC creating connections within region and beyond

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Findings: 1. CTC Development and Investment

Encouraging Investment in Real Estate

- Understood as stimulating land value uplift
- Investors primarily from within the Region and GTA
- CTC Investment potential more desirable than long term residence

WATERLOO ENVIRONMENT

Findings: 1. CTC Development and Investment

“Tech Hub” Development

- Key piece of infrastructure supporting growth
- Connecting residents with emerging employment trends

WATERLOO ENVIRONMENT

Findings: 1. CTC Development and Investment

Regional Image

- Signifier of Region's status as "the Silicon Valley of the north"
- Symbol of the Region being "world class"
  - Allowed for comparison with many other international centers

WATERLOO ENVIRONMENT

Findings: 1. CTC Development and Investment

*"We're seeing investment, local people that are buying in uptown, or downtown **just for investment purposes**. I think the families, the 30 plus demographic, that are now looking for more investment opportunities, they realize [the CTC] is something they can grasp and they realize that's **an up and coming area**."*

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Findings: 2. Resident Perceptions

Lifestyle Choice

- More attractive to new residents than long term
- CTC is attractive for relative affordability of services and amenities
- Reflected the services and amenities available in other cities

WATERLOO ENVIRONMENT

Findings: 2. Resident Perceptions

Aging Populations

- View the CTC as desirable due to amenities
- Lack of affordable/appropriately sized options preventing downsizing

WATERLOO ENVIRONMENT

Findings: 2. Resident Perceptions

Long Term Residents

- Viewed more favourably as construction nears completion
- Few long-term residents show interest in using it
- Compared to Conestoga Parkway (freeway contrversial when built) as likely to be more appreciated/used over time

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Findings: 2. Resident Perceptions

*"Even some of the **older demographics**, I think they **are really looking forward to [the LRT]**. They are definitely buying to be close to it, not right on it but somewhat close to it, within a block or two. So it will be really good. I think it will impact [the Region] in a positive way."*

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Findings: 3. Creating Connections

Connecting the Region

- Bringing Kitchener and Waterloo together as a seamless urban environment
- Extension to Cambridge will bring the Region together as a unified whole

WATERLOO ENVIRONMENT

Findings: 3. Creating Connections

Connecting Southern Ontario

- Seen as a localized connection to Toronto and other near by municipalities
- Increased connectivity with GO/high-speed rail essential next step

WATERLOO ENVIRONMENT

Findings: 3. Creating Connections

*"In a real estate perspective, all the **condos**, the **Google** building… the **Zehr** group building; those are only there **because of the LRT**. They're looking at it as it's not just a north and south train, **it's connection** to Barrie, Hamilton, Niagara. All these places are going to have LRT that lead **to these fast trains** that all spine into Toronto. That's what [people are] investing on."*

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Implications for modelling

- Clear supply constraints
  - Lack of supply for families in the central transit corridor
  - Lack of strategic behaviour likely to lead again to oversuppy dynamics
  - Actual demand seems poorly understood/anticipated
- Clear evidence of market segmentation
  - “Urban lifestylers” create demand for core properties
  - Locals more likely to see suburban properties
  - Future regression/modelling will respond to this new information

WATERLOO ENVIRONMENT

Relative to other studies, this study …

- 1) builds on richer, more detailed data **through a comprehensive housing survey and realtor interview**
- 2) examines the housing market dynamics from **individual behaviours**
- 3) allows a strong direct connection between our implemented model and Alonzo's classic bid-rent theory models by
  - parameterising the utility function for empirical housing study with strong theoretical foundations
  - **recovering heterogeneous housing demand** by combining survey data and theoretical methods within 3-Steps
  - explaining varying preferences among heterogeneous households and thus provides more information than a traditional first-stage hedonic model

WATERLOO ENVIRONMENT

Future work …

- **1) Improve current model by**
  - using the stated preferences from survey to validate our proposed model
  - building a multi-level hedonic regression with potential more data source
  - using probit models to estimate heterogeneous demand for dichotomous characteristics, such as In CTC, or Large Yard, Single detached house.
- 2) Estimate **heterogeneous household *WTP*** for each house given their demographics
- 3) Simulate housing location choices in our **Agent-Based land market model**: by adding more theoretically-grounded and empirically-validated behaviour rules (especially, utility parameterization and *WTP* estimation from this study)
- 4) Model and better interpret the housing market dynamics

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		Estimation steps	Details
Our proposed demand estimation method	(Bajari & Kahn, 2005)	Step 1	Estimate implicit prices by hedonic (α)
		Step 2	Calculate expenditures on each characteristic (β)
		Step 3	Regress the expenditures (β) on demographics
	Step 4		Estimate the demand curve for each characteristic
	Step 5		Estimate *WTP* for each characteristic
	Step 6		Estimate the total *WTP* for each house

WTP estimation

Acknowledgements

- Team members:
  - Profs Dawn Parker, and Jennifer Dean, Jeff Casello,
  - Former post-doc Xiongbing Jin
  - Students: Andre Antanaitis, Robert Babin, Justin Cook, Pedram Fard, Yu Huang, Erica Ogden, Xinyue Pi, Veronica Sullivan, Filiz Tamer, Jinny Tran, Kevin Yeung, AJ Wray, Ginny Hang
- Funding Sources:
  - SSHRC Partnership Development Grant (SSHRC # 890-2013-0034) entitled "*LIGHT RAIL TRANSIT AND CORE-AREA INTENSIFICATION: Unpacking Causal Relationships*
  - SSHRC Insight Grant (SSHRC # 435-2012-1697) entitled "*Urban intensification vs. suburban flight: An integrated residential land-use and transportation model to evaluate residential land market form and function*
  - China scholarship programme (Yu Huang)

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Collaborating partners

- Region of Waterloo
- Cites of Waterloo and Kitchener
- Kitchener-Waterloo Association of Realtors,
- Coldwell Banker Peter Benninger Realty

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Student Theses Cited

- *Property size preferences and the value of private and public outdoor spaces amid a shift to high-density residential development: A case study of Kitchener-Waterloo, Ontario* (DeFields, 2013) http://hdl.handle.net/10012/7778
- *Understanding Accessibility, Analyzing Policy: New Approaches for a New Paradigm* (Neudorf, 2014) http://hdl.handle.net/10012/8759
- *Developing Up and not Out: Understanding the Barriers to and Opportunities for Reurbanization along Waterloo's Central Transit Corridor* (Antanaitis, 2014) http://hdl.handle.net/10012/9022
- *The Development of a Household Travel Resource Allocation Model for Kitchener – Waterloo* (Yeung, 2015) http://hdl.handle.net/10012/9705
- *Understanding Developer's Decision Making in the Region of Waterloo* (Tran, 2016) https://uwspace.uwaterloo.ca/handle/10012/11163
- *Estimating Homebuyer Preferences Under Intensification: Hedonic Modelling of Open Space and Multimodal Transit Amenities Preceding Light Rail in Kitchener-Waterloo* (Babin, 2016) http://hdl.handle.net/10012/10936
- *Exploring the Rental Housing Market in Kitchener-Waterloo, preceding Light Rail Transit* (Pi, in final revisions)

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References

- Parker, D., Filatova, T., Huang, Y., Huang, Q. and Jin, X., 2015. The implications of land-market representation for the interpretation of empirical land-use change models. Advancing Metropolitan Modeling. Anas, A. Riverside, CA.
- Sun, S., Parker, D. C., Huang, Q., Filatova, T., Robinson, D., Riolo, R., Hutchinson, M. and Brown, D., 2014. Market Impacts on Land-Use Change: An Agent-Based
- Experiment. Annals of the Association of American Geographers 104 (3), 460-84.
- Parker, D. C., 2014. An economic perspective on agent-based models of land-use and land-cover change. In: Duke, J. and Wu, J. (Eds.), Oxford Handbook of Land Economics, Oxford University Press pp. 402.
- Huang, Q., Parker, D., Filatova, T. and Sun, S., 2014. A Review of Urban Residential Choice Models Using Agent-based Modeling. Environment and Planning B 41 (4), 661 – 89.
- Huang, Q., Parker, D., Sun, S. and Filatova, T., 2013. Effects of agent heterogeneity in the presence of a land-market: a systematic test in an agent-based laboratory. Computers, Environment, and Urban Systems 41, 188-203

Reference, cont.

- Filatova, T., van der Veen, A. and Parker, D., 2011. The implications of skewed risk perception for a Dutch coastal land market: insights from an agent-based computational economics model Agricultural and Resource Economics Review 40 (3), 405–23.
- Filatova, T., van der Veen, A. and Parker, D., 2009. Land market interactions between heterogeneous agents in a heterogeneous landscape: Tracing the macro-scale effects of individual trade-offs between environmental amenities and disamenities. Canadian Journal of Agricultural Economics 57 (4).
- Filatova, T., Parker, D. and van der Veen, A., 2009. Agent-Based Urban Land Markets: Agent's Pricing Behavior, Land Prices and Urban Land Use Change. Journal of Artificial Societies and Social Simulation 12 (1), 3.
- Parker, D. and Filatova, T., 2008. A theoretical design for a bilateral agent-based land market with heterogeneous economic agents. Computers, Environment, and Urban Systems 32 (6), 454–63.

Current vs. Ideal Housing Types

- Most preferred rental housing type: **single-detached house**

Current	Count and % of total responses	Ideal matches Current	Ideal matches most popular other than current
Single-detached house	N=35, 12%	71% still prefer single	24% prefer apartment
Semi-detached house	N=10, 3%	40% still prefer semi	40% prefer single
Row house	N=28, 10%	38% still prefer row house	41% prefer single
Apartment(<5 storeys)	N=85, 30%	36% still prefer apartment(<5 storeys)	35% prefer single
Apartment(>=5 storeys)	N=114, 40%	56% still prefer apartment(>=5	19% prefer single

Descriptive Statistics of Selected Variables

Descriptive Statistics					
Statistic	N	Mean	St. Dev.	Min	Max
BDMS	339	**3.20**	0.80	1	8
FBTH	339	**1.87**	0.73	1	4
HBTH	340	0.78	0.57	0	3
GRAG	340	**1.14**	0.65	0	4
OPARK	340	1.80	1.59	0	10
BUL_AGE	297	**30.32**	22.05	0	118
POP_DENS	327	2,961.55	2,106.47	38.80	15,811.80
OS_ACES	340	42.76	17.84	8.66	103.77
OS_ADJ	340	0.16	0.37	0	1
REG_RD_ADJ	340	0.09	0.29	0	1
DIS_LRT	340	**3,605.16**	1,636.60	227.91	7,509.33
DIS_BUS	340	**347.84**	310.65	10.00	1,600.00
POST_EDU	327	62.35	9.52	34.75	87.70
EMPL_RATE	327	65.31	8.88	25.00	83.00
HP	327	404,046.40	143,633.20	135,000	975,000
LNHP	327	12.85	0.34	11.81	13.79

Correlation matrix