Understanding the effects of market volatility on profitability perceptions of housing market developers

Shahab Valaei Sharif[1], Dawn Cassandra Parker[1], Paul Waddell[2], and Ted Tsiakopoulos[3]

[1] School of Planning, University of Waterloo, 200 University Ave. W., Waterloo, ON N2L 3G1, Canada

[2] Department of City and Regional Planning, University of California, Berkeley, CA 94720, USA

[3] Canada Mortgage and Housing Corporation (CMHC), Toronto, ON M5J 1S9, Canada

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Introduction and background

- Affordability is a leading obstacle in Canada's housing crisis.
- The rapid price escalation has put homeownership out of reach for many residents, particularly first-time buyers.
- While condos were once seen as a more affordable option, they too have become less accessible due to price increases.

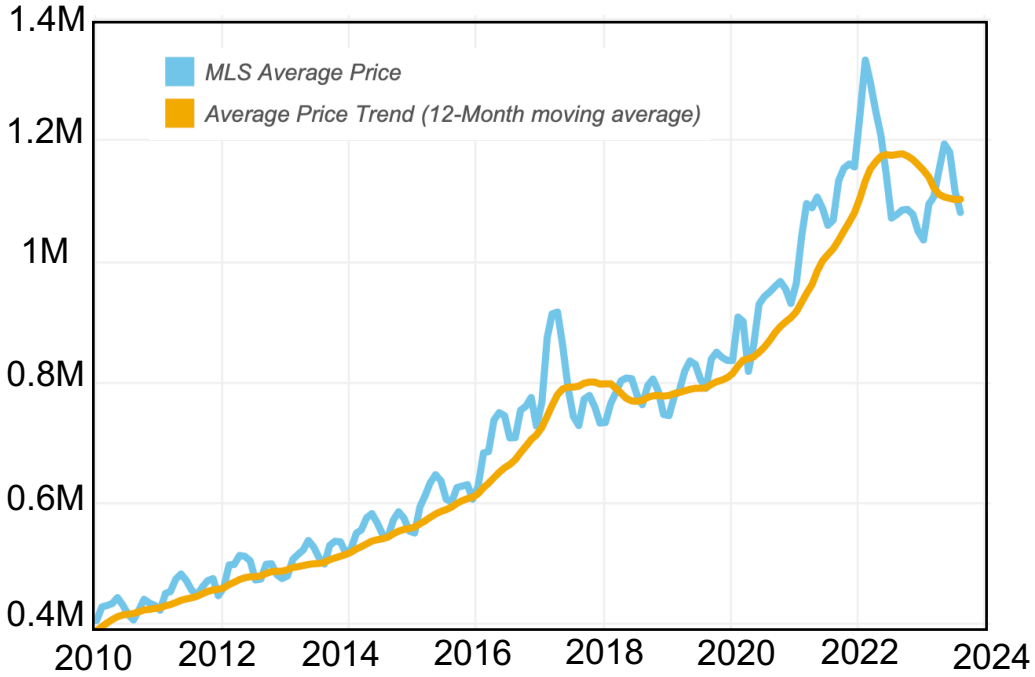

Figure 1. Average housing sales price in Toronto (Toronto Regional Real Estate Board, 2023).

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Introduction and background

- Canada is projected to build 2.3 million new homes by 2030.
- Condominium project starts have been rapidly increasing since 1990; however, housing supply is not seen as matching population growth.
- Canada needs an additional 3.5 million homes to restore housing affordability by 2030 (CMHC, 2023), with around 1.5 million additional homes needed in Ontario alone.

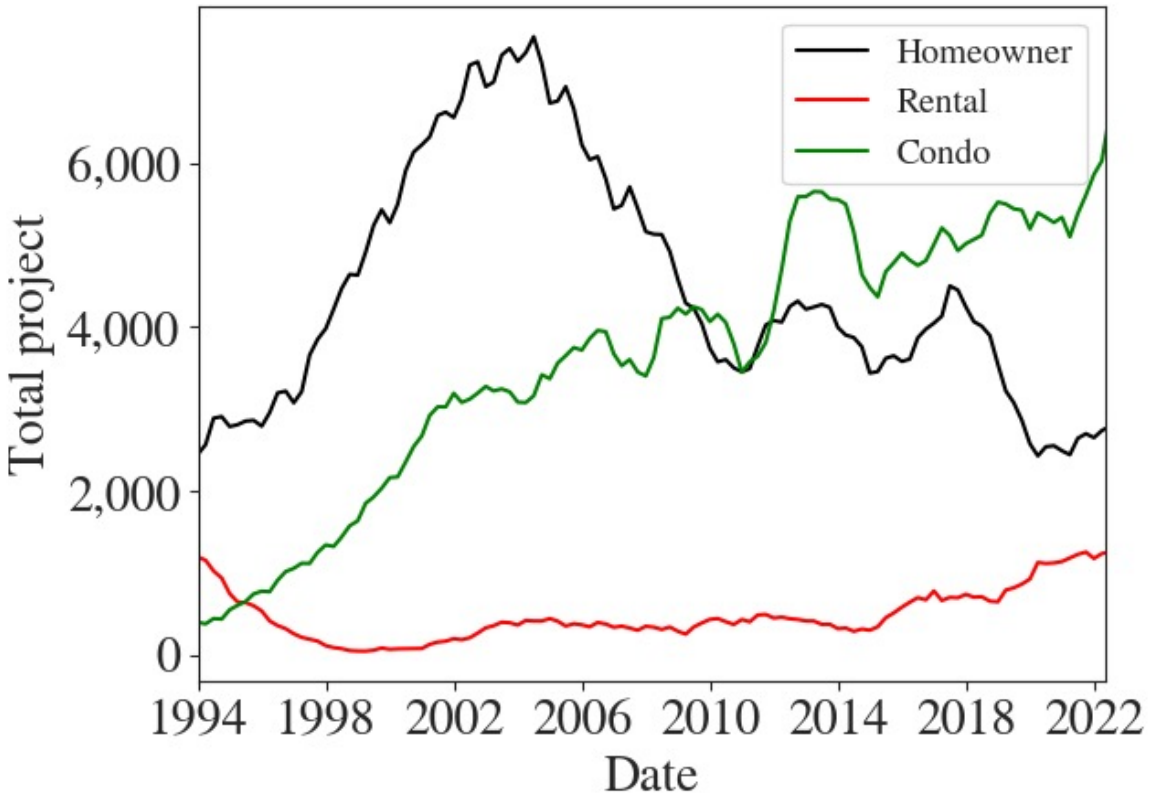

Figure 2. Historical development project starts by intended market in the Toronto (CMHC, 2023).

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Introduction and background

- In spite of housing supply shortages, the GTHA is experiencing a cascade of condo cancellations.
- Since 2018, more than 36 projects and 11,000 units have been cancelled in the GTA housing market.

Lenders Foreclose On Canada's Tallest Residential Real Estate Project After $1.35B Default

Leaky Kitchener condo tower stalls before completion, leaving a legal, financial mess

Tower is 80 per cent complete at 15 storeys, but lacks a watertight roof

Motivation for research

- Many factors are put forward to explain the housing crisis, such as financialization, planning constraints, and buyer-side interest rate increases
- This work considers an additional factor- imperfect price and cost expectations of developers
- Our work strives to increase understanding of developers' supply decisions to help inform policies to prevent project cancellations and incentivize more high-density housing.

Motivation for research: Economic theory foundations

- Land and housing market actors make decisions based on price expectations
- Their interactions impact supply and prices
- Standard economic models use simplified and aggregated models of actor decision-making, assuming perfect price and cost expectations.
- Theoretical models in economics derive optimal product mix, supply quantity, or supply timing

Motivation for research: Economic theory foundations

- Examples of economic models that use dynamic optimization and game theory algorithms to represent developer decisions:
  - Haque and Asami (2014) used a single-objective genetic algorithm-based optimization model for the developer who wishes to maximize the land price of the plot without accounting for externalities.
  - Yu (2012) formulated a dynamic optimization model of real options with heterogeneous assets to explore how opportunity costs of delayed development can impact developer decisions.
  - Xu and Lai (2018) used a model based on asymmetric Cournot duopoly where developers choose levels of output conditioned on their rivals' output and their own levels of optimism in a stochastic environment.

Motivation for research: Modelling to support policy

- In the real world, developers make discrete decisions about whether or not to purchase and develop a particular parcel
- They do economic analysis-using "pro-forma" to calculate net present value and rate of return for developments
- They can't perfectly predict future costs and prices—but instead make their best predictions given the data they have (***bounded rationality***)
- Price and cost expectations are updated when new data become available—potentially resulting in a change of decision to proceed with a project
- ***Our work strives to model these dynamics***

Motivation for research: Economic theory foundations

- Which models of "boundedly rational" price expectations might best represent real-world decision-making?
- How do different price expectations models compare?
- Can different price expectation model explain project cancelation decisions?

Research questions

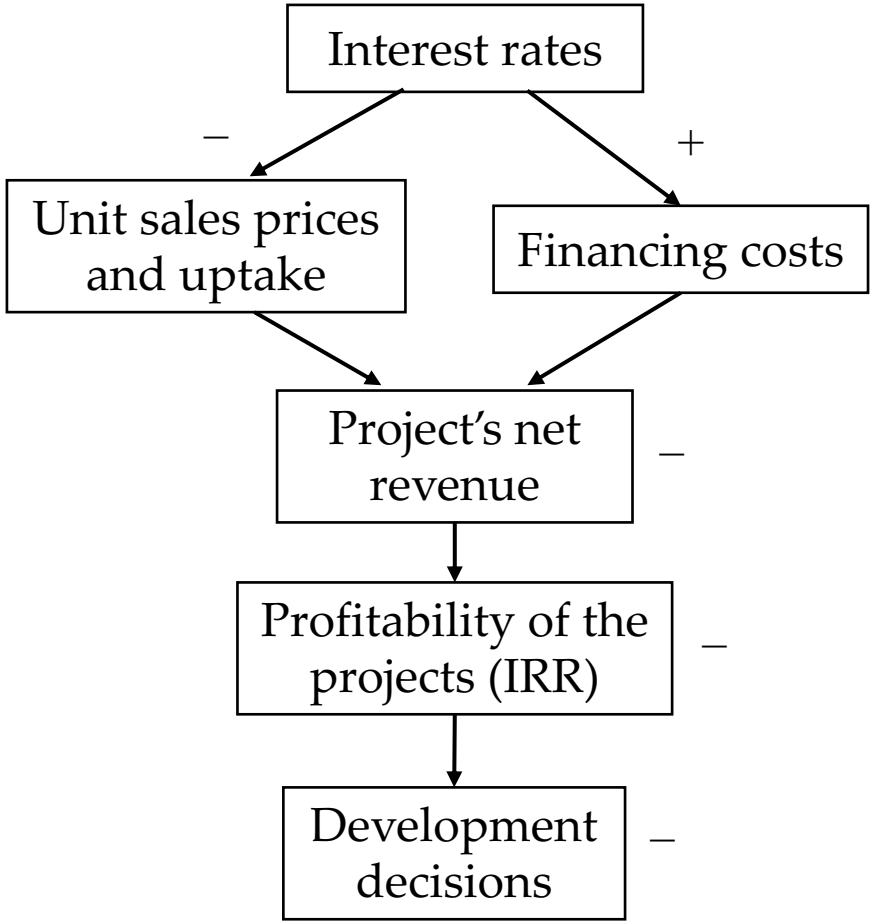
What are the main factors impacting the profitability perceptions of potential high-rise developments?

How do profitability perceptions shift when boundedly rational price expectations are used to project market trends for construction costs, unit sales prices, and interest rates?

Can boundedly rational expectations of market trends help explain project cancellations, when the housing system experiences unanticipated price shocks?

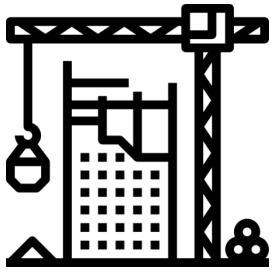
Key factors influencing development profitability

- Construction costs
  - Developers' initial construction cost expectations are based on limited information and a high degree of uncertainty.
- Housing price trends
  - Sales and rent revenues
  - Absorption rates (how quickly new builds are sold or rented when complete)
- Interest rates



Research approach and methods

1. Formulating a standardized proforma to evaluate the profitability of potential builds
2. Review existing price expectations models and identify the models to be used for this study based on the available data.
3. Modify the development proforma to include expectations mechanisms for:
   - Construction costs
   - Unit sales price
   - Interest rate



4. Conduct sensitivity analysis to assess how the profitability of development typologies **(today-high-rise condo)** varies, alone when price expectation formation is included in the proforma assessments.

Developers' financial decisions through proformas

1. Development costs

- Land costs
- Development charges
- Government fees
- Construction costs
- Other initial costs (off-site construction and amenities)

2. Project financing

- Combination of equity, pre-sales, and debt funds
- Role of investors
- Interest rate for loan funds
- Finance costs are associated with interest rates

Developers' financial decisions through proformas

3. Project cash flow

- Cash inflow (revenues) and outflow (costs) throughout the project
- Net Present Value (NPV): discounted cash flow to represent the time value of money.

4. Financial return

- Metrics to measure the profitability of the projects
- Internal Rate of Return (IRR): the rate of return at which an investment breaks even, meaning that the gains or returns equal the initial investment cost

Developers' financial decisions through proformas

5. Decision making

- The project is financially viable if the Internal Rate of Return (IRR) for the project, ρ, is greater than a Minimum Attractive Rate of Return (MARR):

$$\mu < MARR \leq \rho$$

  where μ is the return on an alternative investment.
- The MARR reflects the perceived risk premia of developers and their investors.
- The MARR is exogenous to our model of financial profitability of potential developments, and its value is selected on based input from local developers.

Case study

- A hypothetical development typology (e.g., building size and unit mix)
- A high-rise residential building located in the City of Toronto.
- The project is initiated in 07/2019 and runs over a 4-year period to be completed in 06/2023.

Table 1. Key model parameters and their values at project initiation in July 2019 for the baseline scenario (Altus group 2022; Bank of Canada 2023; CMHC 2023a; Statistics Canada 2022 2023).

Notation	Description	Variable unit	Variable value
A	Land size	Acres	2.50
N	Total units to sell	Units	357.00
A_a	Average unit area	Square feet	704.75
τ	Construction costs	Dollar per square foot	298.93
L	Land acquisition costs	Dollar	60,000,000.00
P	Planning and design	Dollar	1,150,000.00
D	Development charges per unit	Dollar	17,274.00
E	Other initial costs (amenities, off-site construction, etc.)	Dollar	8,650,000.00
ζ	Other government fees (Section 37 and Park Cash in Lieu)	Percent of total development charges	15%
θ	Annual property tax rate	Percent of land value	3%
D_f	Developer's fee	Percent of total project costs	5%
β	Broker fees	Percent of gross sales	6%
M	Management & overhead	Percent of gross sales	15%
t_{init}	Project initiation time (i.e., land purchase)	YYYY-MM	2019-07
κ	Construction rate	Unit per quarter	30.00
η	Equity amount	Percent of total development costs	20%
Y	Loan length in years	Years	3.00
i	Loan interest rate	Dimensionless percentage	3.75%
π	Sales unit price	Dollar	1,005,833.00
ω	Absorption rate	Percent of units per quarter	99%

Key drivers of the project's profitability

- We performed sensitivity analyses to explain how changes in input parameters (e.g., interest rates) impact the financial profitability of the projects.

Notation	Description	Variable value	Variable unit	Marginal change	NPV change in dollar	IRR change
N	Total units to sell	357.00	Units	1.00	257,057.30	0.001656
A_a	Average unit area	700.00	Square feet	1.00	-156,772.90	-0.001013
τ	Construction costs	298.93	Dollar per square foot	1%	-1,097,410.30	-0.007097
θ	Annual property tax rate	3%	Percent of land value	1%	-2,085,990.38	-0.013421
D_f	Developer's fee	5%	Percent of total project costs	1%	-1,097,478.19	-0.007123
β	Broker fees	6%	Percentage of gross sales	1%	-2,937,121.47	-0.019041
M	Management & overhead	15%	Percentage of gross sales	1%	-2,937,121.47	-0.019041
κ	Construction rate	30.00	Unit per quarter	1.00	547,431.80	0.003653
π	Unit sales price	1,005,833.00	Dollar	1%	2,320,325.96	0.014960
ω	Absorption rate	99%	Percent of units per month	1%	2,343,763.60	0.015111

Key drivers of the project's profitability

Table 3. Results of the numerical sensitivity analysis of the NPV and IRR with respect to change in model parameters related to project financing.

Notation	Description	Variable value	Variable unit	Marginal change	NPV change in dollar	IRR change
η	Equity amount	20%	Percent of total development costs	1%	2,432,863.90	0.015577
i	Loan interest rate	3.75%	Dimensionless percentage	0.25%	-670,723.97	-0.004338
Y	Loan length in years	3.00	Years	1.00	2,911,235.73	0.025341

Table 4. Results of the numerical sensitivity analysis of the NPV and IRR with respect to change in model parameters related to initial investments.

Notation	Description	Variable value	Variable unit	Marginal change	NPV change in dollar	IRR change
L	Land acquisition costs	60,000,000.00	Dollar	1%	-1,001,079.84	-0.006428
P	Planning and design	1,150,000.00	Dollar	1%	-18,892.77	-0.000122
D	Development charges	20,904.00	Dollar	1%	-116,443.05	-0.000752
ζ	Other government fees	15%	Percent of development charges	1%	-101,254.83	-0.000654

Recent construction cost, unit sales, and interest rate volatility

- These factors have seen abrupt upward trends-with each showing different patterns of volatility

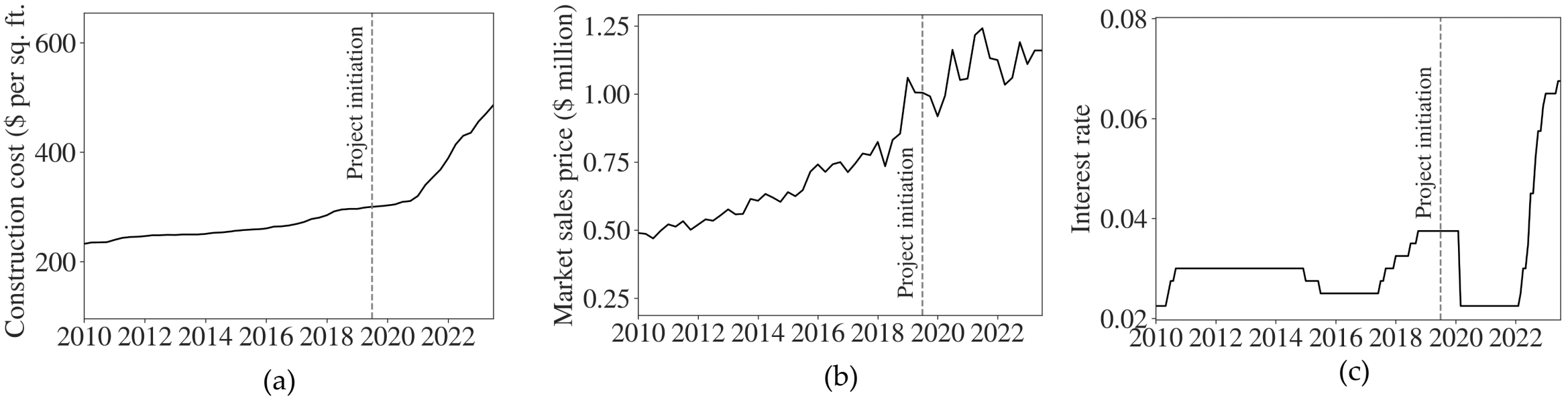


Figure 4. Historical market trends for (a) construction costs (Altus group 2022; Statistics Canada 2023), (b) sales price of properties (CMHC 2023a), and (c) loan interest rates estimated as the prime interest rate plus 2% (Bank of Canada 2023) in Toronto land and housing market.

How do developers track these volatile trends?

- Various models are used to represent development behaviours in housing market in the academic literature:
  - Boundedly rational
  - Profit-seeking
  - Risk-taking
- Developers strive to mitigate the uncertainties in their financial calculations.
- They form expectations of market trends according to their perception of the market conditions.

Price expectation mechanisms

- Many mathematical algorithms have been used to represent price expectations; most relying on historical data to create expectations.
- Heterogeneous boundedly rational algorithms take a variety of approaches:
  - **Heuristic rules** rely on simple decision rules rather than complex, data-intensive, forecasting techniques.
  - **Financial prediction models** map previous and present prices into the next periods using extrapolation methods.

Logic behind some of the price expectation mechanisms

- **Naive model**: The expected price is equal to the current price.
- **Mean model**: The expected price is the mean value of the previously observed periods.
- **Cycle model**: The price goes through recursive cycles.
- **Projection model**: The expected price is estimated using linear regression of the previously observed data.
- **Re-scale model**: The expected price is determined by scaling the current price.

Logic behind some of the price expectation mechanisms

- **Adaptive model**: The expected price is shaped based on the last observed price and the last expected price.
- **Trend-following model**: The expected price is determined by extrapolating the latest price change.
- **Learning and Adjustment model**: The expected price is a weighted average of the mean value of observed prices and the last price change.
- **GARCH**: Estimates the parameters that best describe the conditional variance of the time series.
- **Perfect expectations**: Uses actual data as estimated price.

Using the identified expectation mechanisms to project construction cost, unit sales price, and interest rate

- The expectation models behave differently due different logic behind their formulation.
- These different expectation mechanisms create different anticipated trend lines.
- The accuracy of the models' predictions are compared and reported in our paper, with reference to root mean square errors (RMSE).
- The naive model assumes no change in prices or no expectation scenario.
- The perfect expectation considers the actual data as the expected price.

Trend projections of construction cost for various expectation mechanisms in 2019

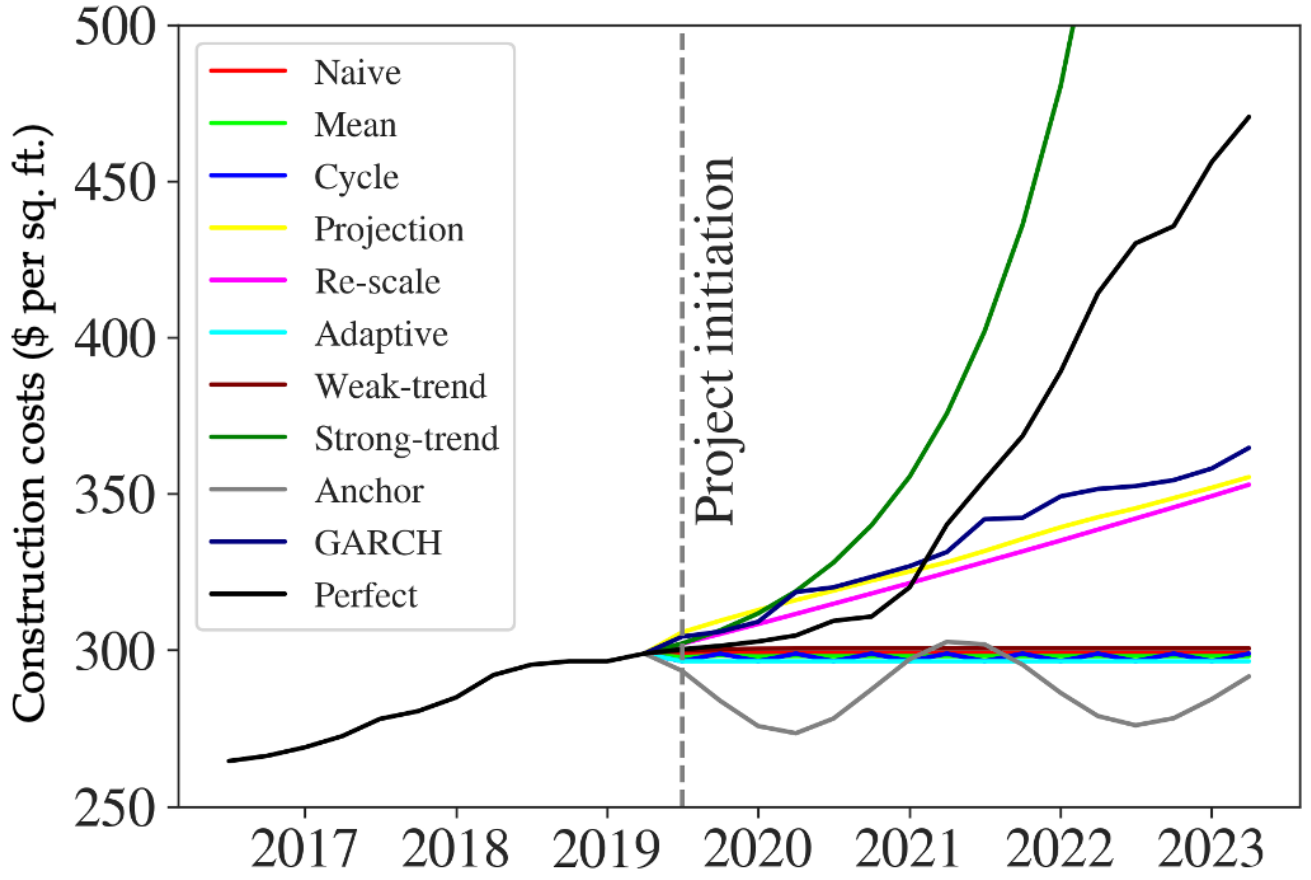


Figure 5. Parameterized expectation models at project initiation in 2019 to predict the construction costs during the project until 2023.

- The accuracy of predictions varies significantly between different models.
- There is no single best model that accurately predicts the prices.
- None of the models predicted the significant shift in construction cost trends in 2021.

Trend projections of sales price for various expectation mechanisms in 2019

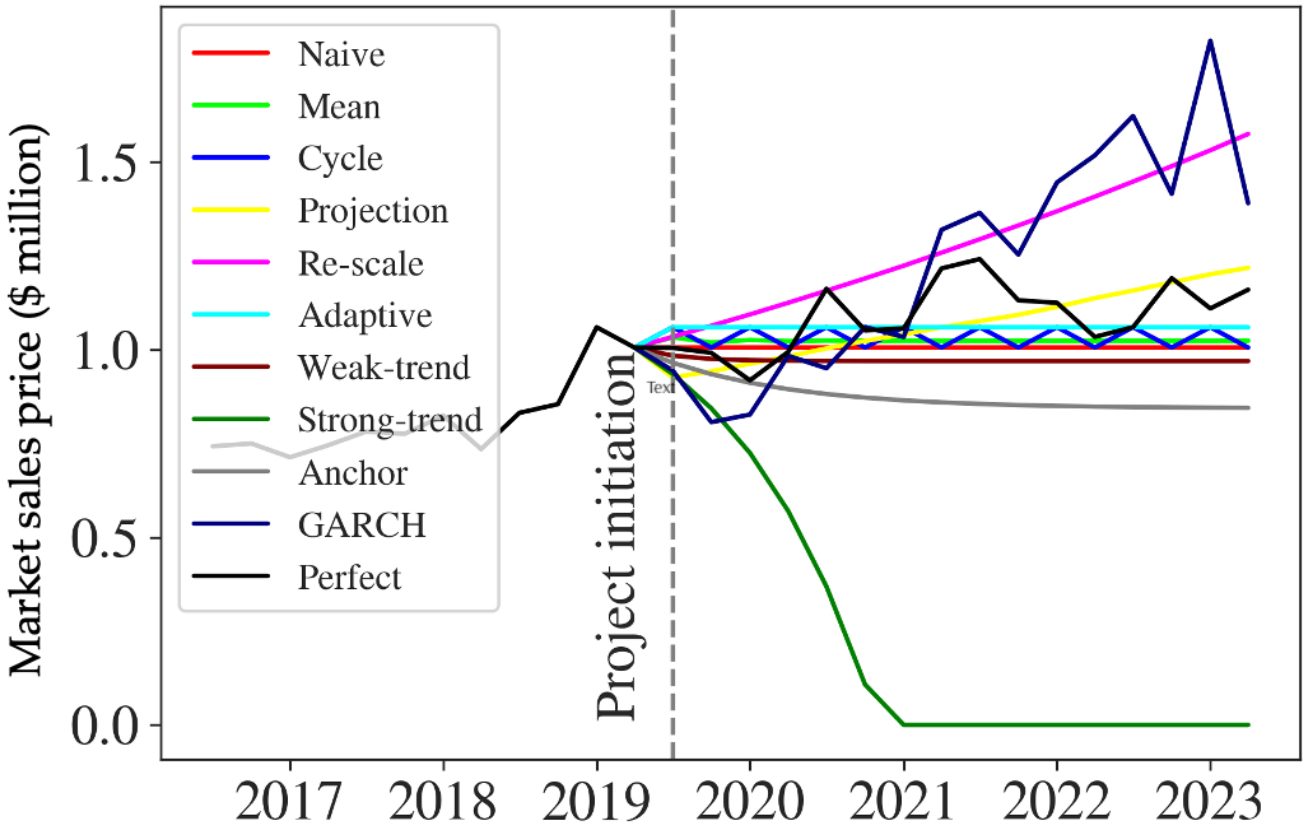


Figure 6. Parameterized expectation models at project initiation in 2019 to predict unit sales price during the project until 2023.

- Sales price are highly volatile
- The accuracy of predictions varies significantly between different models.
- The linear projection model has higher accuracy, but none of the models captured the volatility in prices.

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Trend projections of interest rate for various expectation mechanisms in 2019

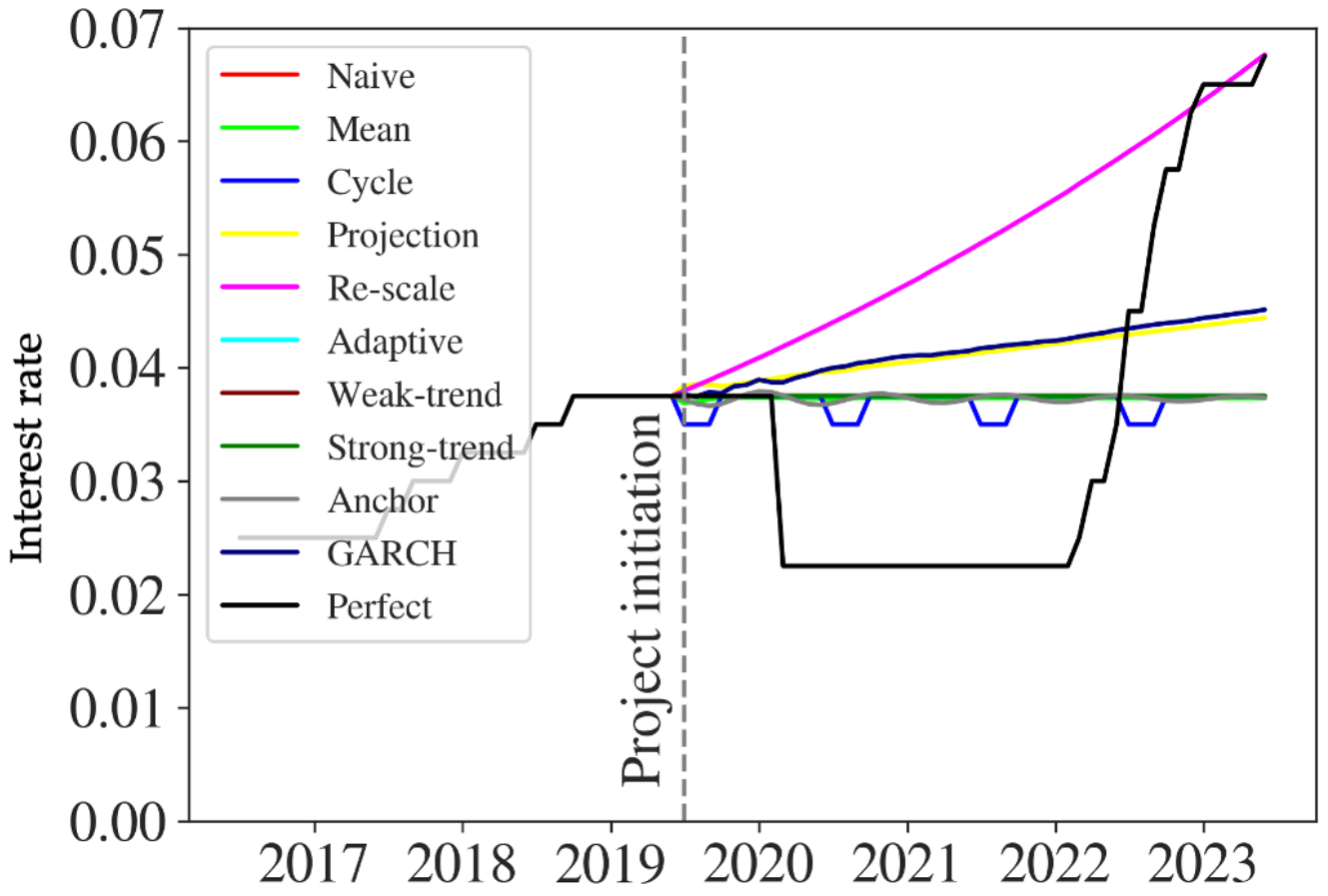

Figure 7. Parameterized expectation models at project initiation in 2019 to predict the interest rates during the project until 2023.

- Most of the models do not predict significant changes in interest rate, due to stable trends before 2019.
- None of the models predicted the downturn and upturn in interest rate trends.
- Interest rates can be considered truly exogenous to land development, creating additional prediction challenges.

Project internal Rate of Return (IRR) for different expectation mechanisms estimated in 2019

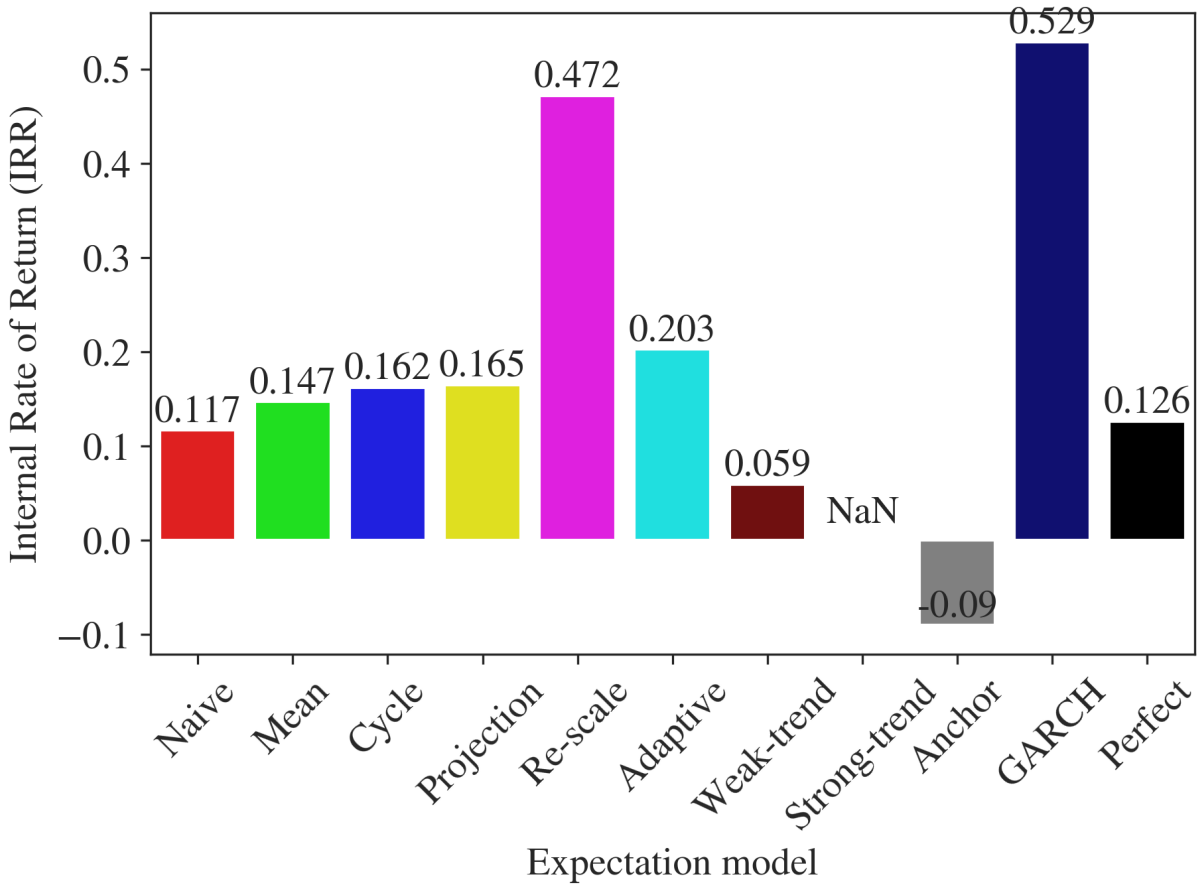

Figure 8. Estimated IRR for the development project when considering the same expectation mechanisms to project construction costs, unit sales prices, and loan interest rate.

- We estimated the IRR for the project at the project initiation (2019), for each price expectation model
- Boundedly rational developers who consider a MARR of 10% would probably undertake the project in most cases.
- Note the project ultimately passes this threshold (perfect expectations)

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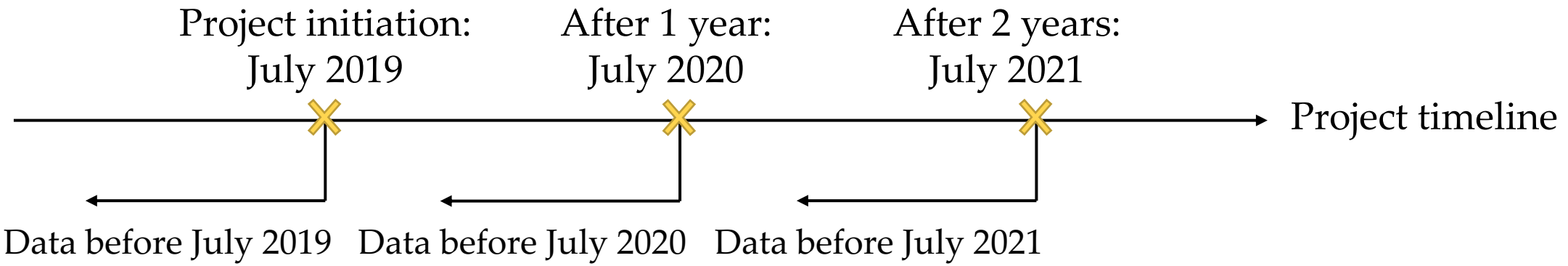
Understanding the effect of financial perception updating

- As the project proceeds, developers update their financial perceptions based on new observations of market trends.
- We assimilated new data into the different price expectation models to explore the effect of updating the expectations on financial perceptions.



Comparison of IRR estimations with annual project updating, across expectations mechanisms

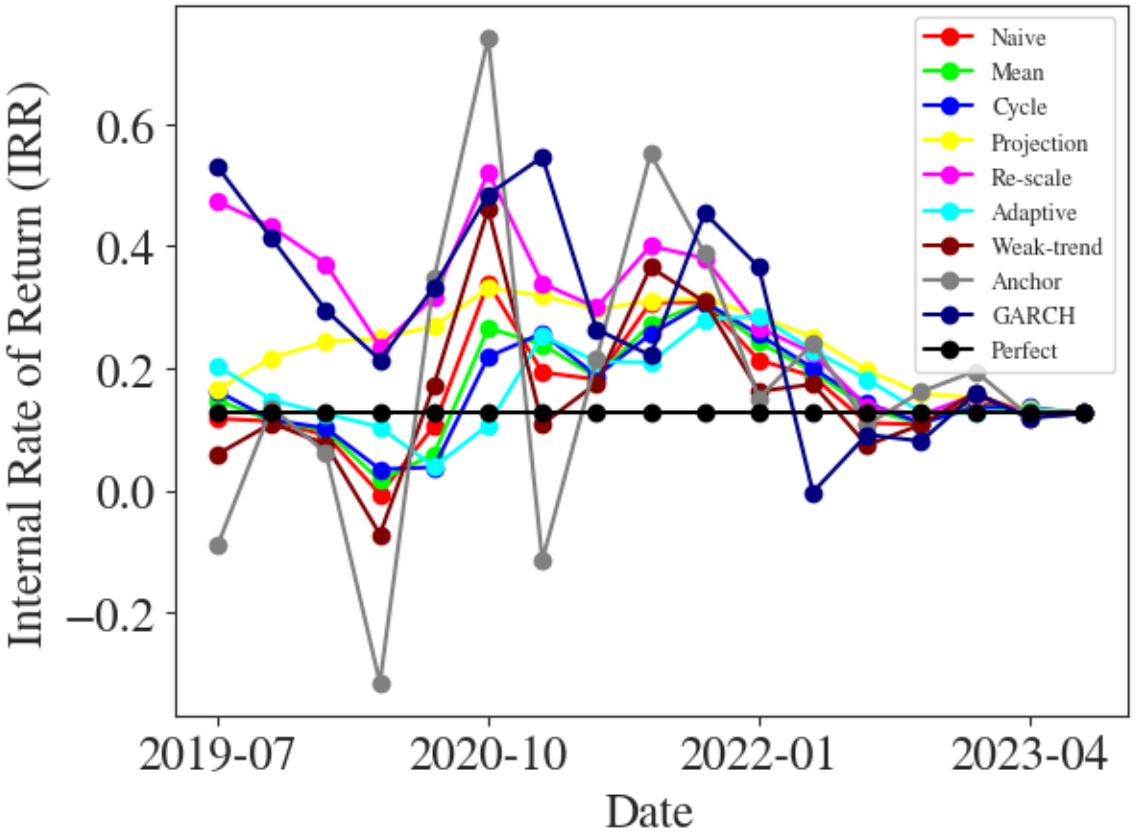


Figure 9. Estimated IRR for the project at different times during the project when the same boundedly rational expectation mechanisms are used to project construction costs, unit sales prices, and interest rates.

- Again, the initial estimation of IRR in 2019 for a MARR of 10% would support undertaking the project.
- The adaptively estimated IRR for the project can significantly drop in several periods during the project timeline.
- The result would be a project cancelation decision for a project that would ultimately be viable

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Conclusions

- Factors related to project financing and loan terms (e.g., equity funds and interest rates), property taxes, land costs, and developer's fees can substantially influence the project revenues and costs, making them important factors in development decisions.
- Factors that can be quite volatile, such as construction costs and unit sales prices, also substantively impact development decisions.
- We have demonstrated that boundedly rational expectations of prices and market trends can cause major shifts in profitability perceptions, potentially leading to project cancellations in unstable markets.

Policy Implications

- Planners and policymakers need a thorough understanding of development decisions and developers' expectations
- This will help planners carefully evaluate whether policies align with both developer's financial incentives and affordable housing goals—are policies incentive-compatible?
- Planning policy stability, at every level of government, can potentially decrease housing market volatility
- Policies should be aligned across governance scales
- Decisions on currently exogenous policies such as interest rate changes should consider housing market impacts

Industry implications

- Should development of "construction cost futures" be better supported?
- Is there scope for industry adaptation of improved price and cost expectation models?
- What impact can open-source “pro-forma” models have on the industry? Can it facilitate entry of new development actors, including non-profits and individual land owners?

Next steps:

1. Developer survey: questions

- Where do you obtain the figures and assumptions for your development proforma?
  - Use current figures
  - Cost consultants
  - Lender assumptions
  - Own assessment (if so, how they view previous price trends to create an expectation)
- Are there cases where you don't undertake a project even if proforma analysis supports profitability? If yes, why?
  - Think real-world outcomes might be different than pro-forma predictions
  - Different profitability perceptions between the developer and lenders/investors
- Do you run proforma scenarios to consider possible future price volatility or uncertainty? If yes, around what factors?

Next steps:

2. Analyzing a rental proforma

- Exploring rental construction as another major housing sector
- Exploring the effect of market volatility on financial profitability of rental projects

Next steps: Why is risk and uncertainty analysis important?

- Interest rates changes MARR
- Market volatility changes risk premiums—mandates sensitivity analysis around a wide range of MARRs
- Tools should allow developers to easily conduct scenarios (similar to mortgage stress tests)
- Tools should also provide multiple sensitivity and uncertainty analysis methods—with interpretations
- All our code from this project is published for free download (open-source) – we plan to create a user interface

Next steps:

3. Multi-method sensitivity analysis

- Various development typologies (building size, unit mix) as an input to the models
- Monte Carlo simulation analysis to evaluate how the profitability of development typologies varies, alone and in combination, when price expectation formation is included in the proforma assessments.
- Analyze the role of risk and uncertainty in the proposed models by measuring the change in the outcomes when the inputs are changed within their plausible range.

Next steps: Can our work improve land and housing market simulations?

- Several challenges for traditional models of land use and housing prices include:
  - Reliance on aggregate data
  - Lack of realistic representation of real-world factors, such as price expectations
  - Spatial and temporal variability
- Microsimulations/Agent-Based Models hold the potential to tackle these diverse dynamics, yet their effectiveness in simulating housing availability and pricing varies.
- We need more advanced and adaptable models that can better account for the real-world intricacies and uncertainties to improve our projections of prices and housing supply.

Next steps:

4. Modifying UrbanSim's proforma

- Using UrbanSim as a baseline tool for representation of land and housing market.
- UrbanSim characteristics:
  - Hybrid microsimulation/agent-based modelling environment
  - Several actors in land and housing markets, including the households, developers, and businesses.
  - Discrete choice models to simulate location choice decisions
  - Pro-forma to characterize developers' decisions
- We will incorporate the identified price expectation formation strategies into UrbanSim's proforma to model developers' decisions.

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Contacts

Feel free to reach out!

- Professor Dawn Parker, dcparker@uwaterloo.ca
- Shahab Valaei Sharif, svalaeis@uwaterloo.ca
- Ted Tsiakopoulos, ttsiakop@cmhc-schl.gc.ca
- Professor Paul Waddell, waddell@urbanism.com

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