The recovery of real-estate market using system of differential equations

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Table of Contents

Table of Contents

Table of Contents

Table of Contents

What is system of differential equations?

- **Differential equations**: an equation that involves a function and its derivatives, which links the quantity and its rate of change.

$$\frac{dy}{dt} = 3y$$

$\Longrightarrow$ The rate of change of y with respect to t is 3 times the value of y.

- System of differential equation is a set of 2 or more differential equations.
  These systems are used to model processes where multiple quantities change together over time or space and influence each other.

$$\begin{cases} \frac{dx}{dt} = ax - bxy \\ \frac{dy}{dt} = -cy + dxy \end{cases} \tag{1}$$

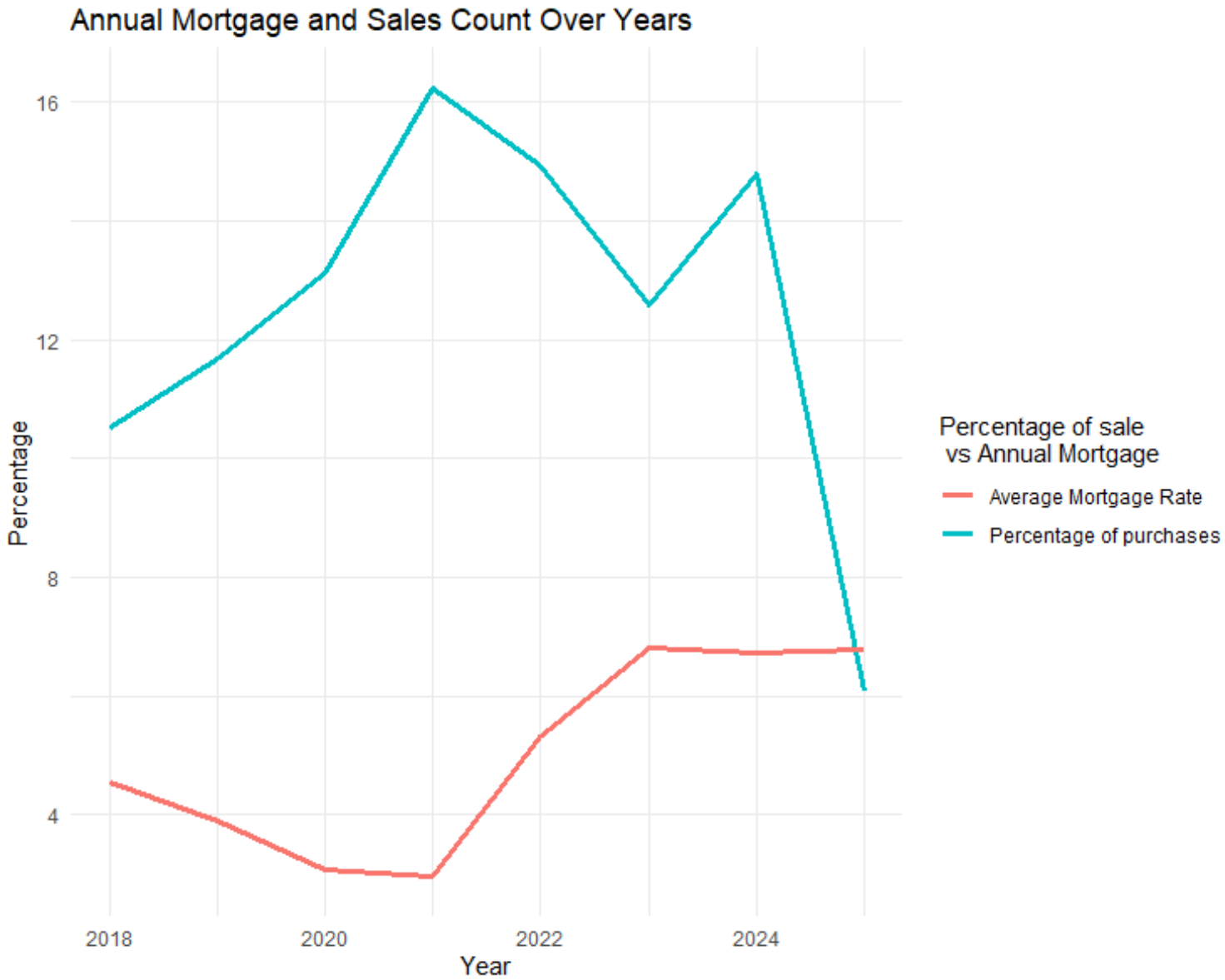
Where:

- $x(t)$: prey population
- $y(t)$: predator population
- a, b, c, d: positive constants

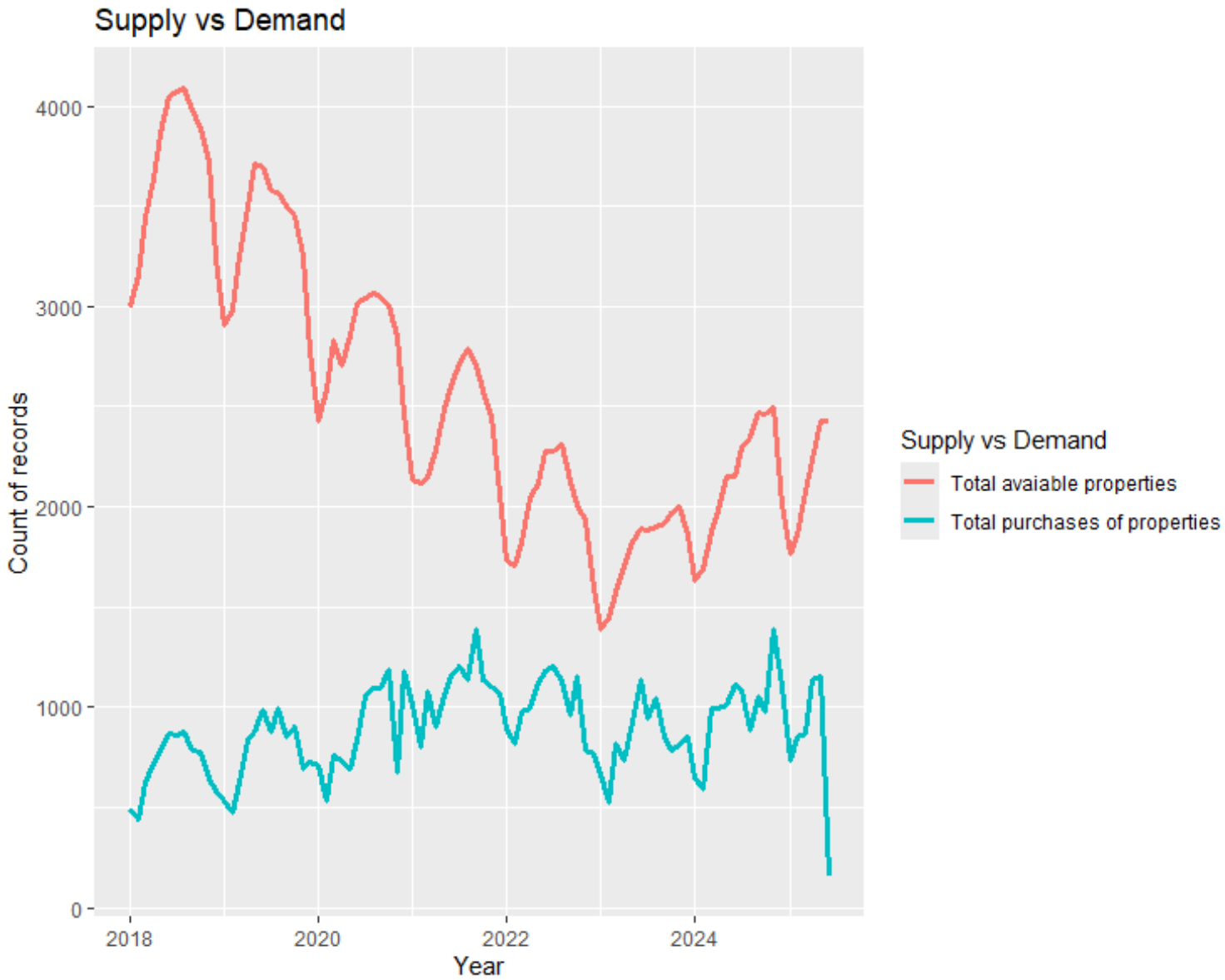
Introduction to the data set

- Primary data: historic sales in Hamilton county from 2018 to 2025 including date of the sale, sale price, properties information (area of the houses, basement construction, etc.)
- Additional variables: annual mortgage in Hamilton county, total listing, unemployment rate.

Sales record vs Annual mortgage

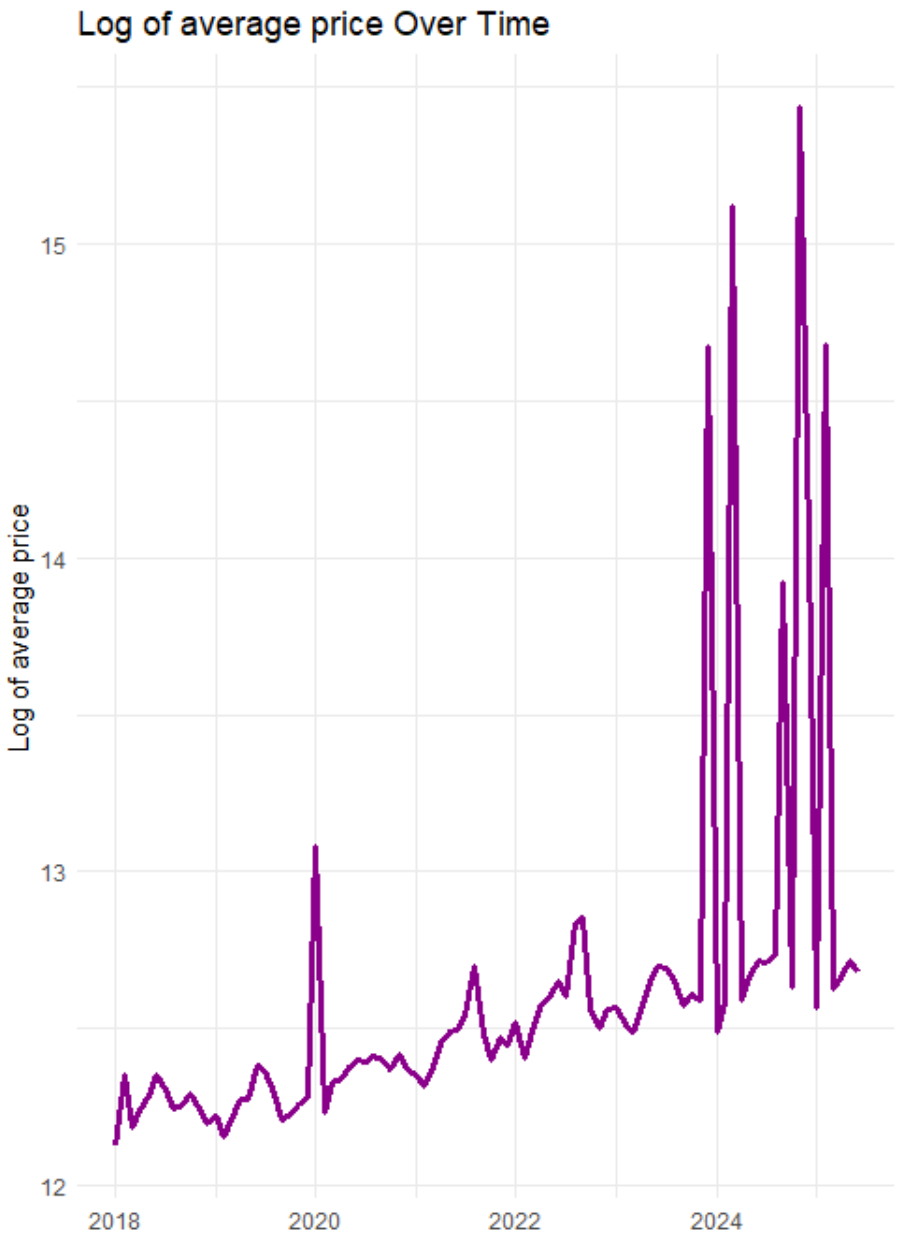


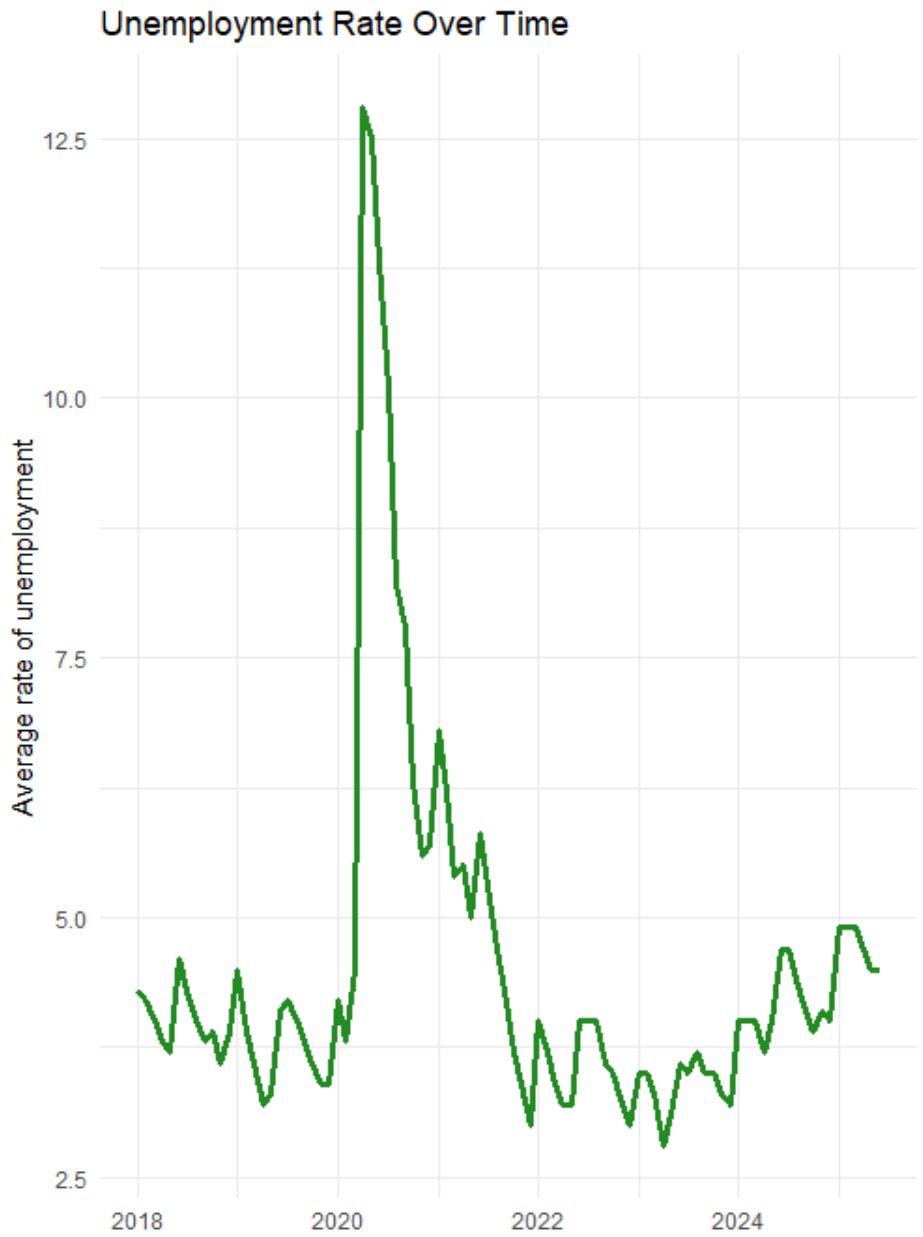
Sale Price vs Area groups



Note: transactions are revealed/effective demand – the demand that resulted in an actual purchase.

Effects of unemployment rate on price of property





Stochastic Process

What is Stochastic?

A mathematical model for a system that evolves over time with randomness.

Real-life applications:

- Finance: Stock prices
- Physics: particle motion, diffusion
- Biology: Spread of disease, gene expression

Application of Stochastic on this research

We use a Stochastic process to model how property values in Hamilton changed from 2018 to 2025, including the effects of randomness(such as politics, move of population, natural causes, etc.)

Plan of action in the future

- These visualizations help us to understand the relationship visually and lay the foundation for future development.
- Introducing further explanatory factors including the distance to the closest business district, or population in the area, etc.
- Building the mathematical model that effectively describe and forecast the recovery process.
- (Maybe) Building an algorithm that could evaluate if a property is more suitable for investment or residency.

THANK YOU