The Environmental "Cent"iment Behind Urban Design - Effect of various urban environmental elements on Singapore's housing price

Case Study: Punggol Eco-town

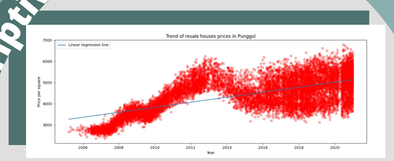
Objective

With Singapore's Punggol housing estate as a case study, this project will zero in on the pricing trends in the pioneering Punggol Eco-Town and its vicinity. As Singapore's first eco-sustainable residential project, the Punggol estate is distinguished by its integrated structural greenery in addition to its waterways and communal gardens. True to an eco-town, Punggol is also embellished with eco-sustainable features like rainwater harvesting systems, extensive installation of solar panels, optimized passive ventilation, natural lighting, and temperature regulation through cooling paints. This project will offer comparative insights into the effect of these novel features on housing prices.

Analytical Method

Our research question lies in whether environmental-friendly designs of a district will bring positive impacts to the prices of the houses. Therefore, we zoom in on our focus on a specific case study, which is the newly constructed Punggol eco-town in Singapore. The Punggol eco-town, first announced in Punggol 21-Plus Plan in 2007, is named for its water-efficiency and energy-saving designs, such as the Punggol Waterway Park. To help us visualize its impact, we adopt the **Difference-in-Difference(DID)** method and compare it to a control group. The DID method aims to isolate the effect of treatment, the announcement of the eco-town project, from the effect of extraneous factors, by analyzing a treatment and control group pair to reduce bias. As such, the effects of environmental-friendly designs can be visualized with the coefficients generated from our model.

Descriptive Statistics Analysis



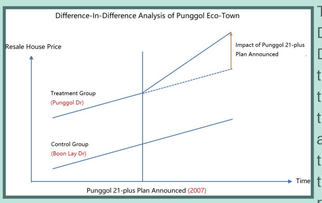
The figure above shows the scatter plot of the housing prices in Punggol over years. Some insights can be drawn from the primary analysis:

1. Housing prices are more centralized before the 2010s, making it easier to identify trends in that time period.
2. Even though there is an increasing trend in prices between 2006 to 2008, the plot alone is not conclusive enough to find the causal relationship between the announcement of the Eco-town project and housing prices, as its effect is not able to be isolated.

Hypothesis

We assume that Boon Lay District has a similar trend of housing prices as compared to Punggol District before the treatment and there will be a positive effect of the announcement of Punggol 21-plus plan in 2007 on the price of resale houses in Punggol

Model Specifications



To better understand the results obtained from the DID method, we sketched a graph to illustrate the DID method. Assuming that the treatment group and the control group have a similar initial coefficient (k), the impact of the Punggol 21-plus plan, which is the treatment, will increase the treatment group's k value at the treatment time (2007). As such the difference in the initial k value and the treated k value will show us the impact of the Punggol 21-plus plan on prices of resale houses.

Results Analysis

Linear regression — Number of obs = 350; F(3, 346) = 592.50; Prob > F = 0.0000; R-squared = 0.8240; Root MSE = 279.89

unit_price	Robust Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
after_2007	284.4522	31.04459	9.16	0.000	223.3923	345.512
in_punggol	743.9556	50.74276	14.66	0.000	644.1525	843.7587
did	446.2217	63.26889	7.05	0.000	321.7817	570.6617
_cons	2046.009	20.30065	100.78	0.000	2006.08	2085.937

	after_2007	in_punggol	unit_price
1	0	0	2046.009
2	0	1	2789.964
3	1	0	2330.461
4	1	1	3520.638

From the results table of the DID method (up), we can obtain that the change in k is equal to 446. This suggests that there is an average 446 SDG per year increase in the price of houses is due to the treatment. This effect is also visible from the table of mean values of the groups over time (down), as the treated difference over time is larger than that of the control group by around 60%. Hence, we can conclude that an environmentally-friendly urban design proves to be favored by the consumers to a large extent.

To explain our results, resale houses in Punggol were made more competitive due to the future prospects of a having better environment brought by the announcement of the Punggol 21-plus plan.

General Study: Effect of locale on housing prices in SG

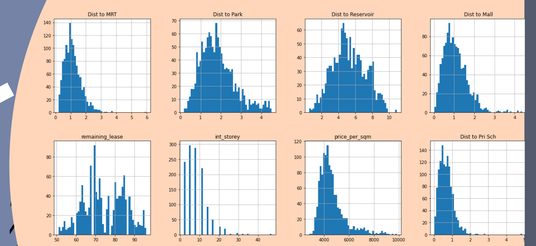
Analytical Method

The **Hedonic Price Model** is used to evaluate the economic value of certain features of a product. It assumes that consumers attribute different implicit values to each of the features. In the context of the housing market, the prices of the houses can be due to several environmental factors such as distance to parks, reservoirs, or non-environmental factors, such as distance to transport hubs, retail shops, and schools. Through the use of multi-regression analysis, we are able to separate the weights of these factors on the housing prices, which represents the consumer's marginal willingness to pay for an increase in these factors, ceteris paribus. Based on past literature1, the housing prices can be modeled by the following equation

$$\ln P = \alpha_0 + \alpha X + \epsilon$$

Where P is the price of house per sqm, X is the set of independent features of the house that affects its price, a is the coefficient matrix of X, a_0 is the base price and ε is the error term. Ordinary least squares is used to estimate the coefficients and base price of the hedonic pricing model.

Descriptive Statistics Analysis



The figure above shows a histogram of the different features of the 1250 houses sold in January, 2015, to isolate any changes in economic conditions that may affect the price. The distances are expressed in km and the price per sqm is expressed in SGD. We observe that most of the houses enjoy close proximity to MRT stations, primary schools, and malls, compared to parks and reservoirs. This might indicate that environmental factors may not be as important as other factors in deciding the location of houses. However, The plot alone is not conclusive as it does not demonstrate if there is a causal relationship between environmental factors and housing prices

Hypothesis

Singaporeans are pragmatic when making choices and would value accessibility to commercial and economic developments more than access to green spaces and natural environments.

Model Specifications

In our model, to prevent multicollinearity, we only used Executive as a feature for flat type. To determine the storey of the house, the median is chosen from the range of values provided by the dataset. Hence, the features used in our model are the following

- Closest distance to MRT Station(Dist to MRT)
- Closest distance to park (Dist to Park)
- Closest distance to reservoir (Dist to Reservoir)
- Closest distance to mall (Dist to Mall)
- Closest distance to primary school (Dist to Pri Sch)
- Storey of the house (int_storey)
- Remaining lease of the flat (remaining_lease)
- If the flat is executive (EXECUTIVE, type: dummy variable)

All of the following features were normalized (rescaled from 0 to 1) to ensure that the coefficients can be compared fairly.

Results Analysis

OLS Regression Results

Dep. Variable:	log_price/sqm	R-squared (uncentered):	0.861
Model:	OLS	Adj. R-squared (uncentered):	0.860
Method:	Least Squares	F-statistic:	961.3
Date:	Sat, 13 Mar 2021	Prob (F-statistic):	0.00
Time:	13:35:48	Log-Likelihood:	567.17
No. Observations:	1250	AIC:	-1118.
Df Residuals:	1242	BIC:	-1077.
Df Model:	8		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
Dist to MRT	-0.3590	0.045	-7.904	0.000	-0.448	-0.270
Dist to Park	0.0601	0.022	2.777	0.006	0.018	0.103
Dist to Reservoir	0.2137	0.021	10.003	0.000	0.172	0.256
Dist to Mall	0.2584	0.033	7.773	0.000	0.193	0.324
remaining_lease	0.1239	0.018	6.717	0.000	0.088	0.160
int_storey	0.6192	0.038	16.459	0.000	0.545	0.693
Dist to Pri Sch	0.6898	0.055	12.447	0.000	0.581	0.799
EXECUTIVE	-0.0209	0.017	-1.245	0.213	-0.054	0.012

From the results above, our price model is able to account for an 86.1% variance in the housing prices. We observe that consumers have stronger opinions on commercial and economic development in the area surrounding their houses, with large coefficients for MRT stations, malls, and primary schools. They prefer to be closer to MRT stations but further away from primary schools and malls. On the other hand, they do not value factors directly related to the environment, such as distances to parks and reservoirs, as seen from the smaller positive coefficient between prices and those distances. However, they do value the floor of their houses, which can be argued as a more practical environmental factor as higher floors tend to have better views and less noise pollution.

Introduction

For years, Singapore's characteristic geographical constraints have exacerbated concerns over competing land uses, thereby underlining the pressing need for rapid urbanisation. As a country with one of the densest urban populations, Singapore has earned itself a reputation for its sophisticated urban development. This research project aims to study the determinants housing prices by investigating the relationship between locale and estate pricing.

Data Collection and Process

The data of resale housing prices are fetched from the Singapore government's website, including approval date, location of the house, housing area and total price, etc.

This data will then be used in our analysis to ensure the credibility of our model.

We further process the data in two steps.

1. Price per square meter was calculated for each housing
2. Walking distance from each housing unit to the nearest MRT station, shopping mall, schools, parks, and reservoirs was extracted from Google Maps.

Conclusion

Although seemingly contradictory results were obtained for the two-part analysis, there is reason for the justification that environmental factors have negligible effects on the general resale market in relation to other, more tangible factors. However, the value of a favorable environment is more prominent in the case of specialized projects where it is pitched as the main selling point.