PLACEHOLDER THESIS TITLE
A VERY MEANINGFUL THESIS

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ABSTRACT

Here is some filler text.

FOREWORD

(Place holder) acknowledgements

ABBREVIATIONS

BCA: Building and Construction Authority of Singapore

GM: Green Mark environmental certification in Singapore

DID: Difference-in-differences methodology

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

In recent years, numerous green building certification schemes have been developed, "aimed at mitigating the impact of buildings on the natural environment through sustainable design" (Vierra 2016). Many of these certifications focus on rating the sustainability and energy efficiency of buildings.

This drive towards sustainable design started in the 1990s with the Building Research Establishment (BRE) Environmental Assessment Method (BREEAM), and was followed in 2000 by the U.S. Leadership in Energy and Environmental Design (LEED) rating system (Vierra 2016). This drive for environmental sustainability in products and buildings has accelerated in recent years due to growing concerns about environmental issues.

Certifications encourage the construction of green buildings by reducing information asymmetries associated with green buildings, which cause potential buyers to not fully price in the benefits of green technology (Matisoff, Noonan, and Flowers 2016). While green features provide tangible and intangible benefits such as lower electricity bills and better environment, these features are unobservable at the demand side before purchase. Some of these features such as material sourcing might not even be observable after purchase. This problem is similar to the "market for lemons" problem (Akerlof 1970), where potential buyers cannot differentiate between the presence and absence of green features. As a result, there is a pooling equilibrium where potential buyers/tenants are not willing to fully price in the green features which landlords or developers claim to exist. Assuming green features require additional costs to build in, the lack of price premiums means that building in green features leads to lower profits. Developers and constructors will choose not to build in green features to their buildings because the additional costs are not covered by a corresponding price premium.

A credible certification can verify these unobservable green characteristics and hence act as a signal to potential buyers about the green features and quality of the building. This would justify a price premium for green features, which would in turn pay for the additional costs required to build in green features, increasing the construction of these environmentally sustainable buildings.

Some literature have shown that the costs of building green features are actually not that high, implying that developers should not require large incentives to build in green features. These studies have demonstrated that the average cost premium for green buildings are only about 1% to 2% (see Bartlett and Howard 2000; also Kats 2003).

Regardless, even if the cost premiums are low, these cost premiums still need to be offset by a corresponding price premium. Buyers and tenants are unwilling to pay for green features not because they do not value

green features, but because they cannot observe them before the purchase or rental agreement. A certification acts as a signal or assurance of quality, to allow potential tenants and buyers to fully price in the benefits from the green features.

1.1 Green Mark (GM) Certification in Singapore

The Green Mark scheme was launched in January 2005 by the Building and Construction Authority (BCA) of Singapore to encourage the construction of more environmentally friendly and energy efficient buildings. The GM scheme rates and certifies buildings according to five main criteria: energy efficiency, water efficiency, environmental protection, indoor environmental quality, and other green and innovative features (Building and Construction Authority 2017).

Buildings which apply for the GM certification would be assessed on the criteria listed above, and would be scored on a points basis. These scores would then be converted to an award type (Certified, Gold, Gold Plus, Platinum).

In order to further encourage developers to incorporate Green Building Technologies (GBTs) into their developments, the BCA set aside $20 million on the Green Mark Incentive Scheme (GMIS) in 2006. This was a scheme aimed at accelerating the adoption of green technologies, by providing cash incentives to developers, building owners, architects and mechanical and electrical (M&E) engineers who "[made] efforts to achieve at least a BCA Green Mark Gold rating or higher". The cash incentives would be split into two stages: half of which would be disbursed upon successful certification during the design or construction stage, and the remaining would be disbursed after validation, one year after the Temporary Occupation Permit (TOP) date. (Building and Construction Authority 2015)

1.2 Aim of Study

The aim of this paper is to explore the signalling effects of an environmental certification or award, using data from housing transactions in Singapore.

The signalling effects of environmental certifications are important because these certifications are meant to incentivise certain behaviour, in this case, constructing energy efficient buildings. In order for certifications to incentivise private companies to adopt certain practices, they need to act as credible signals, i.e. provide a price premium to offset the cost premium associated with "good behaviour".

This study uses a difference-in-differences (DID) approach to study the signalling effects of the GM award through its effect on housing transaction prices.

2 LITERATURE REVIEW

There is a fair amount of literature showing the price effects of environmental certifications on property prices. However, there are fewer publications on why certifications have an effect on prices. Certifications can have an impact on prices in the market through the information that they provide to the market (information effect), and also by signalling unobservable quality (signalling effect).

3 DATA AND METHODOLOGY

3.1 Data Sources

Housing transactions ranging from Jan 2003 to Mar 2016 was obtained from the Real Estate Information System (REALIS) of Singapore. Information about the GM awards was obtained by scraping the Building Construction Authority of Singapore (BCA) Green Mark Buildings Directory,[1] searching for Residential and Mixed Developments. Since the GM Buildings Directory only contained the year of award, I had to obtain the exact dates of the award by searching for "BCA Awards" the Straits Times archive from LexisNexis. Green Mark winners are announced on the BCA awards night, so I searched for the dates of the BCA awards night for each year (2005 till 2015).

3.2 Methodology

Certified buildings can have a price premium due to two reasons: either the signalling effect provided by the certification, or that good features tend to cluster together such that green buildings are also higher quality buildings in other aspects. This paper uses a difference-in-differences (DID) approach to isolate the signalling effect from any other factors that might contribute to a price premium.

This paper uses a feature of the GM program in Singapore to isolate the signalling effects of an environmental certification. Because certification takes time, developments sometimes get the award only after their launch. This makes it possible to use a DID framework to isolate the effect of the award as a signal from other unobserved characteristics. The idea is that the award is an "unexpected shock" to buyers, and hence the price premium attributed to the property after the award will be independent of other unobserved characteristics, which may cluster together with green features.

This study uses only new sales of private residential properties, excluding Executive Condominiums (ECs). I use only private residential properties, because commercial and office buildings do undergo asset enhancement initiatives (AEIs) every once in a while. If the timing of the GM award coincides with these AEIs, the DID cannot isolate the effect of the GM award from the other relevant improvements in the property as a result of the AEI. I also exclude ECs because ECs are subsidised properties and they have certain conditions that buyers must fulfil, which makes the market a bit different from other private residential properties.

[1] Website can be found here: https://www.bca.gov.sg/green_mark/KnowledgeResources/BuildingDirectory.aspx

3.3 Descriptive Statistics

4 EMPIRICAL RESULTS

Table 4.1: Effects of GM Award on Price

	Dependent variable:		
	Natural log of Price psm		
	(1)	(2)	(3)
GM Award	0.045***	0.083***	0.025***
	(0.002)	(0.003)	(0.002)
Property Type: Condominium		0.084***	0.054***
		(0.004)	(0.003)
ln(Area (sqm))		−0.178***	−0.129***
		(0.002)	(0.002)
Freehold		0.150***	0.148***
		(0.005)	(0.004)
Floor		0.008***	0.008***
		(0.0003)	(0.0002)
Floor^2		−0.00002**	−0.0001***
		(0.00001)	(0.00001)
First Floor		−0.037***	−0.044***
		(0.002)	(0.002)
Top Floor		−0.059***	−0.083***
		(0.003)	(0.002)
Distance to MRT (km)		−0.082***	−0.024***
		(0.003)	(0.002)
Years to Completion		−0.027***	−0.027***
		(0.001)	(0.001)
4-digit Postal Code Fixed Effects	No	Yes	Yes
Year-Month Dummies	No	No	Yes
Condo Facilities Dummies	No	Yes	Yes
Observations	134,183	103,123	103,123
R^2	0.003	0.825	0.927
Adjusted R^2	0.003	0.824	0.926
Residual Std. Error	0.375 (df = 134181)	0.163 (df = 102612)	0.106 (df = 102451)
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 4.2: Difference-in-difference Models

	Dependent variable:		
	Natural log of Price psm		
	(1)	(2)	(3)
GM Award	0.015^{***}	0.023^{***}	0.017^{***}
	(0.002)	(0.003)	(0.002)
GM x After GM	0.016^{***}	0.029^{***}	0.012^{***}
	(0.002)	(0.002)	(0.002)
Property Type: Condominium	0.054^{***}	0.052^{***}	0.049^{***}
	(0.003)	(0.005)	(0.003)
ln(Area (sqm))	-0.129^{***}	-0.110^{***}	-0.129^{***}
	(0.002)	(0.002)	(0.002)
Freehold	0.147^{***}	0.095^{***}	0.145^{***}
	(0.004)	(0.005)	(0.004)
Floor	0.008^{***}	0.008^{***}	0.008^{***}
	(0.0002)	(0.0002)	(0.0002)
Floor^2	-0.0001^{***}	-0.0001^{***}	-0.0001^{***}
	(0.00001)	(0.00001)	(0.00001)
First Floor	-0.044^{***}	-0.052^{***}	-0.044^{***}
	(0.002)	(0.002)	(0.002)
Top Floor	-0.083^{***}	-0.075^{***}	-0.083^{***}
	(0.002)	(0.002)	(0.002)
Distance to MRT (km)	-0.024^{***}	-0.004	-0.025^{***}
	(0.002)	(0.003)	(0.002)
Years to Completion	-0.028^{***}	-0.030^{***}	-0.027^{***}
	(0.001)	(0.001)	(0.001)
CONQUAS Score		0.004^{***}	
		(0.0002)	
CONQUAS Score: 71-80			0.218^{***}
			(0.010)
CONQUAS Score: 81-90			0.179^{***}
			(0.009)
CONQUAS Score: > 90			0.209^{***}
			(0.009)
CONQUAS Score: Missing			0.193^{***}
			(0.009)
4-digit Postal Code Fixed Effects	Yes	Yes	Yes
Year-Month Dummies	Yes	Yes	Yes
Condo Facilities Dummies	Yes	Yes	Yes
Observations	103,123	65,403	103,123
R^2	0.927	0.940	0.927
Adjusted R^2	0.926	0.939	0.927
Residual Std. Error	0.106 (df = 102450)	0.100 (df = 64951)	0.106 (df = 102446)
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 4.3: Placebo Difference-in-difference Tests

	Dependent variable:	
	Natural log of Price psm	
	(1)	(2)
GM Award	0.020^{***}	-0.018^{**}
	(0.006)	(0.007)
GM x After (6 months before GM)	0.066^{***}	
	(0.004)	
GM x After (12 months before GM)		0.078^{***}
		(0.005)
Property Type: Condominium	0.048^{***}	0.053^{***}
	(0.006)	(0.006)
ln(Area (sqm))	-0.114^{***}	-0.114^{***}
	(0.002)	(0.002)
Freehold	0.156^{***}	0.155^{***}
	(0.006)	(0.006)
Floor	0.009^{***}	0.009^{***}
	(0.0002)	(0.0002)
Floor^2	-0.0001^{***}	-0.0001^{***}
	(0.00001)	(0.00001)
First Floor	-0.050^{***}	-0.050^{***}
	(0.002)	(0.002)
Top Floor	-0.083^{***}	-0.083^{***}
	(0.003)	(0.003)
Distance to MRT (km)	0.025^{***}	0.030^{***}
	(0.006)	(0.006)
Years to Completion	-0.023^{***}	-0.022^{***}
	(0.001)	(0.001)
CONQUAS Score	0.007^{***}	0.007^{***}
	(0.0005)	(0.0005)
4-digit Postal Code Fixed Effects	Yes	Yes
Year-Month Dummies	Yes	Yes
Condo Facilities Dummies	Yes	Yes
Observations	45,451	45,451
R^2	0.946	0.946
Adjusted R^2	0.946	0.946
Residual Std. Error (df = 45029)	0.091	0.091
Note:	*p<0.1; **p<0.05; ***p<0.01	

5 CONCLUSION

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