PROPERTY RIGHT RESTRICTION AND HOUSE PRICES

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Abstract

Using a natural experiment in Singapore, we examine the economic impact of temporarily restricting owners' rights to transfer their property. Executive condominiums (ECs), introduced to address housing affordability for the middle class, are subject to restrictions regarding their transferability within the first ten years, unlike private condominiums. If applying to the option theory, EC buyers have the forward start American put option with the right to sell their properties only after the contract date. Among transacted units matched by location, completion and transaction dates, and complex- and unit-level characteristics, we find that prices of new EC units are about 21% lower compared to counterpart private condominiums. At the tenth year, when property right restrictions are fully removed, the price gap between ECs and private condominiums narrows to about 3%. These results suggest that property right restrictions and illiquidity generated by the forward start American put option for 10 years lead to about an 18% discount. An implication for affordable housing policies is that middle-class domestic beneficiaries enjoy initial price discounts.

Keywords: property rights, housing affordability, option price, forward start, middle class

JEL classification: R31; R23

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1. Introduction

In the context of real estate ownership, private property rights are often viewed as a bundle of "sticks," with each "stick" representing a right or stream of benefits to the owner. The bundle typically includes the exclusive right to use the asset, the exclusive right to the produce of the asset, and the freedom to transfer the asset to others (Segal and Whinston 2010). In other words, a property owner has unencumbered rights to occupy, rent, and sell the property.

One of the best-known examples of property right restrictions is land use restrictions, such as zoning, growth management laws, minimum lot size, and density restrictions. Many studies have examined the impact of these restrictions on the prices of the properties subjected to the restrictions, as well as those of nearby properties that are not subjected to them (Sprerer 1989; Netusil 2005; Quigley and Rosenthal 2005; Ihlanfeldt 2007; Michael and Palmquist 2010; Munneke et al. 2013). A few studies have also investigated the economic impact of restricting other rights to use the property, including: (1) age restriction of the occupants (Allen 1997; Guntermann and Moon 2002; Guntermann and Thomas 2004; Lin, Liu, and Yao 2010); (2) keeping pets in residential dwellings (Cannaday 1994; Lin, Allen, and Carter 2013); and (3) other covenants and regulations imposed by private homeowners associations (Hughes and Turnbull 1996; Rogers 2006; Meltzer and Cheung 2014). These studies have generally concluded that property right restrictions have a positive impact on house prices by reducing the potential negative externalities and improving the predictability of future neighborhood characteristics, or by inducing supply constraints.

While these studies have provided useful insights on the effects on the property value of restricting the owners' rights to use the property, none of them has investigated the economic impact of restricting the owner's right to rent and sell the property. We believe that the paucity of related research does not indicate a lack of interest in this issue, but rather reflects the lack of data to undertake such research. Despite the universal recognition that each bundle of rights influences property values differently, previous research has failed to isolate their marginal contributions.

In this paper, we examine the economic effect of restricting property rights to sell or rent a property for a predetermined period. Specifically, we take advantage of a natural experiment that uses the Executive Condominium (EC) scheme introduced in 1995 to meet the housing aspirations of the "sandwiched" middle-class citizens in Singapore. In terms of amenities, ECs are very similar to private condominiums, which feature swimming pools, tennis courts, and a clubhouse within a gated community. The main novelty of the scheme is that newly built EC units are sold with a set of temporary restrictions on private property rights. Specifically, new EC units are subjected to a five-year minimum occupation period (MOP) so original buyers cannot rent or sell their condominium units within the first five years. After the fifth year, the EC units can be rented or sold in the resale market, but only to Singapore citizens or permanent residents (PRs). When EC developments become fully privatized after the tenth year and onwards, they attain the equivalent status of a private condominium, which means that the units can be sold to anyone, including foreign buyers.

The EC scheme provides a unique opportunity to examine the impact of restricting private property rights on housing prices. In our empirical investigation, we examine the economic value associated with these restrictions by comparing the price of an EC unit against its predicted price, if it is sold without the encumbrances. Our identification strategy involves identifying private condominiums located within a 2km radius of each EC development, and matching the ECs with these private condominiums by complex- and unit-level characteristics, transaction date, and administrative planning area. Hence, all else being equal, the differences in prices between ECs (the "treatment" group) and private condominiums (the "comparison" group) would be attributed to the restrictions on property rights. We also take advantage of the fact that the restrictions will be relaxed partially after the fifth year, and fully after the tenth year of the EC's physical completion. Controlling for price movement in the market and inflation, resale transactions of ECs compared with those of their counterpart private condominiums after the fifth and tenth years provide an alternative way to identify the counterfactuals. As the property right restrictions are lifted, we would expect the price gap between the treatment and comparison groups to converge over time.

On analyzing the matched sample of 22,912 EC and 22,912 private condominium units, we find that the selling prices of new EC units are about 21% lower than those of the otherwise identical private condominium units. This discount reflects the upper bound of restricting the owners from renting and selling their units for a period of ten years. Next, we find that the selling price of EC units narrows to about 8% off the price of equivalent private condominium units on the fifth year when EC buyers are no longer subject to the property right restriction associated with selling to Singaporeans but still restrained to sell to foreigners. The significant price discount implies that

this restraint is still a binding constraint. Finally, we observe that the price gap between the EC and private condominium units narrows over the next five years and eventually becomes about 3% after the ECs cross the 10-year milestone, when the remaining restrictions on the transferability of property rights are removed.

This paper directly contributes to the literature on property rights. The classical literature on property rights has generally focused on the role of property rights in transitioning a society towards economic growth and market efficiency (see Coase 1960; Demsertz 1967; Libecap 1989; North 1990; Mahoney 2005). In the context of real estate ownership, most prior studies have focused on the effects of restricting the owners' rights to use the property (McMillen and McDonald 1993; Munneke and Slawson 1999; Netusil 2005; Sirmans et al. 2006). To the best of our knowledge, this study is the first to provide an analysis that quantifies the economic impact of placing temporary restrictions on the owners' rights to rent and sell their residential property. By isolating the marginal impact of the bundle of transferability on the property value, we discuss how this impact is comparable to that of other bundles of property rights that have been studied in previous research.

Our results are also useful in understanding the role of illiquidity in asset pricing. If connecting the property right restriction of ECs to the option theory, buyers of newly built EC units have the two Forward start American Put Options (FAP) at time of the purchase: FAP(S) which is the option to sell the property to Singaporeans starting only at the 5^{th} year and FAP(F) which is the option to sell the property to foreigners starting only at the10th year. In other words, EC buyers would experience complete illiquidity for temporary periods due to these forward start contracts

for their options. We are able to analyze the initial discounts in these Forward start American Put Options relative to regular American Put Options as well as how these discounts diminish over time as FAP(S) and FAP(F) reach their contract dates (5^{th} year and 10^{th} year, respectively). The current finance literature has mostly relied on data from the financial markets in the context of stock trading illiquidity and assessed the impact of such illiquidity on asset pricing (e.g. Bailey and Jagtiani 1994). This study contributes to the literature by directly estimating the negative impact of complete, temporary illiquidity on asset pricing in the case of residential properties.

Finally, most previous research on place-based housing programs using supply-side subsidies has focused on non-economic outcomes of assisted low-income families, such as mobility and neighborhood quality (Newman and Schnare 1997; Rohe and Freeman 2001; Ellen and Horn 2011; Talen and Koschinsky 2014), or the external effects of subsidized housing on surrounding communities (Cummings et al. 2002; Schwartz et al. 2006). In this paper, we evaluate the effectiveness of using property rights restrictions for the initial price discount that is the direct economic benefits provided to EC purchasers. As the EC program is a unique, affordable housing policy that targets the middle-class homeownership of citizens and PRs in Singapore, our evaluation of ECs will also be of policy interest, particularly to many global cities that have experienced heavy financial and human inflow from foreign countries, and in turn, the significant reduction in affordable homes for domestic middle-income families. We expect our findings to add new insights to the discourse on the effectiveness of housing policies that bar foreign buyers from certain local housing markets.

The remainder of the paper is structured as follows. Section 2 discusses the scholarly and institutional backgrounds. Section 3 describes the data and methodology. Section 4 presents the results, and Section 5 concludes.

2. Institutional and Scholarly Backgrounds

2.1. Previous Research on Property Rights in the Real Estate Context

Mahoney (2005) lists three important criteria of property rights: (1) universality—all scarce resources are owned by someone; (2) exclusivity—property rights are exclusive rights; and (3) transferability—to ensure that resources can be allocated from low- to high-yield uses.[1] In the context of real estate ownership, the bundle of property rights includes the exclusive right to use the asset, the exclusive right to the produce of the asset, and the freedom to transfer the asset to others.[2]

Pertaining to the rights to use the property, a myriad of land use regulations have been employed to protect and manage private real property and achieve environmental goals. Many studies have examined the economic impacts of these regulations, including: 1) growth management laws, minimum lot size (Spalatro and Provencher 2001); 2) density restrictions (Chamblee, Dehring, and Depken 2009); and 3) zoning (McMillen and McDonald 1993; Munneke and Slawson 1999; Netusil 2005; Sirmans et al. 2006; Michael and Palmquist 2010). While a few studies find that these restrictions affect property values adversely (for instance, Munneke and Slawson 1999),

[1] Similarly, according to Alchian (2008), the three basic elements of private property are: (1) exclusivity of rights to choose the use of a resource; (2) exclusivity of rights to the services of the resource; and (3) rights to exchange the resource at mutually agreeable terms.

[2] Prior research has revealed that formal, legal title does matter the exercise of property rights and affects property values (for example, Miceli et al. 2002). Our research focus is on restricting property rights.

most studies suggest either positive or no significant effects. For example, zoning regulations positively affect property values by limiting the supply of developable land and/or by enhancing environmental amenities that increase the demand for property (Michael and Palmquist 2010). Consistent with this aspect, much empirical evidence suggests that regulation-induced supply constraints, whether intended or unintended, have increased real estate prices (Quigley and Rosenthal 2005; Ihlanfeldt 2007; Munneke et al. 2013). In addition, there is evidence of the positive spillover effects of property right restriction. Sprerer (1989) finds that homes in neighborhoods with either zoning or restrictive covenants command higher values than those in neighborhoods without these land use controls.

While land use restrictions are primarily imposed by policymakers, irreversible restrictions on the use or sale of property have also been adopted voluntarily by owners by incorporating deed restrictions or covenants in private contracts. Hughes and Turnbull (1996) find that restrictive deeds and covenants have a positive effect on house prices by credibly committing all future property owners to actions that mitigate negative neighborhood externalities, thus reducing housing consumption risk. The implementation of use restrictions and regulations by residential community associations (RCAs) have also been found to be associated with higher house prices (Rogers 2006). Similarly, Meltzer and Cheung (2014) find that properties in private homeowners' associations (HOAs) in Florida sell at a premium. Both studies suggest the existence of some regulatory value arising from the owners'/residents' willingness to pay more for control over current and future neighborhood restrictions.

A few studies have also examined the economic impact of imposing restrictions on keeping pets in residential dwellings (Lin, Allen, and Carter 2013)[3], and on the age of the occupants, who must be at least 55 years old.[4] Empirical evidence on the effect of restricting sale of houses to seniors and elderly buyers are mixed. Do and Grudnitski (1997) and Carter et al. (2012) find that age-restrictive houses command lower prices, while Allen (1997), Guntermann and Moon (2002), Guntermann and Thomas (2004), and Lin, Liu, and Yao (2010) find a significant positive effect because older people place a high value on living among senior people, ceteris paribus.[5] Another aspect highlighted by these studies is that age restriction can negatively affect property values if the house is already located in a senior community, where consumption uncertainty has been greatly minimized.

[3] Interestingly, a study on the effect of pet restrictions on house prices concludes that the net effect ultimately depends on what types of pets are allowed. Specifically, allowing cats has a positive impact, while allowing dogs has a negative impact on condominium prices (Cannaday 1994).

[4] To address the housing needs for elderly Americans, the Fair Housing Act essentially made it legal to impose age-restrictive covenants on a property and permissibly discriminate against non-aged households. As noted in Lin, Liu, and Yao (2010), an age-restricted property must meet the Act's requirements that at least 80% of its occupied units have at least one occupant who is over the age of 55, and that it should publish and follow policies and procedures that demonstrate an intent to be an elderly housing unit. The restrictive covenants on these houses specify that "no dwelling shall be occupied unless at least one person in permanent residence is 55 years of age or older." The restriction on a house is permanent (that is, it is automatically imposed on the next owner of that house) and is clearly identified in the detailed listing information as a property restricted to "55 plus" buyers. Although the age restriction could technically be removed, the authors highlighted that from a practical standpoint, the cost and effort required for the potential owner to undergo a public hearing before the area community, city planners, and the city council to obtain approval is likely to be far too great.

[5] Allen (1997) finds a positive price effect (14%) from age restriction in the Broward County, Florida, condominium market. While Guntermann and Moon (2002) find a similar premium in age-restricted single-family homes in Mesa, Arizona, Guntermann and Thomas (2004) find an even larger premium (18%) in Youngtown, Arizona. Lin, Liu, and Yao (2010) also find that imposing age restrictions increases the values of single-family units in Phoenix, Arizona by 10.5% to 12.7%, because living in an age-restricted property is a "privilege."

2.2. Institutional Framework

With 90% of its citizens and permanent residents owning their apartments, Singapore presents one of the highest homeownership rates in the world.[6] To qualify for a public flat built by the Housing and Development Board (HDB), applicants must be Singapore citizens, should not own any other property, have a minimum family size of two, and a household income below S$10,000. However, this income ceiling, which is applied at the time of applying for the flats, created a class of "sandwiched" middle-income earners who do not qualify for public housing and cannot afford to buy private properties. The need to resolve the middle-income class housing problem became more pressing when private property prices in Singapore rose dramatically in the early 1990s.

The EC scheme was introduced in 1995 as a new housing solution for the "sandwiched" class of citizens in Singapore.[7] Riding on their growing aspirations to upgrade from public housing to private residential properties, the EC scheme was envisioned as a form of private housing, which is to be developed, priced, and sold by private developers. For several pioneering EC projects, the government has directly allocated the land to government-linked developers at subsidized prices. For subsequent EC projects, government land sales have been tendered out competitively for EC projects. Amenity-wise, ECs are designed and built to imitate private condominiums (PCs) in that they feature gated communities and common facilities such as swimming pools,

[6] This does not mean the absence of the rental market in Singapore. Many non-residents (nearly 1.7 million which accounts for over 30% of the nation's population) are renters.

[7] When the EC scheme was first announced in August 1995, the term "sandwiched class" was used to refer to potential home buyers who earned marginally more than S$8,000, which was then the monthly income ceiling for public flat buyers. The income ceiling for EC flats, which was originally set at S$10,000, was subsequently raised to S$12,000 from August 2011 and to S$14,000 from August 2015.

gyms, tennis courts, and a clubhouse. Like private condominiums, they are also sold with strata titles, meaning that common property like parking lots and recreational facilities are owned collectively by the unit owners. The contractual relationships between the purchasers and developers of ECs are governed under the same regulations as the private condominiums, namely the Housing Developers (Control and Licensing) Act. Moreover, EC buyers have to seek financing from commercial banks, just like private condominium buyers. They do not qualify for subsidized mortgages, which are enjoyed by HDB flat buyers.[8]

Like private condominiums, the sale and pricing of EC units are handled by private developers and their marketing agents. However, only Singaporean households whose combined monthly income is less than S$14,000 at the time of application are eligible to buy an EC first-hand from the developers. Similar to an HDB flat application, the applicant must be over 21 years old, and the family nucleus must comprise at least another Singaporean or PR, who could be the applicant's spouse,[9] children, parents, or siblings. In addition, the applicants, their spouses, and any occupiers must not own or dispose any private properties within 2.5 years before the date of application. These eligibility conditions, which are summarized in Panel A, Table 1, serve to confine ECs to the "sandwiched" middle-class Singaporean citizens. In contrast, the eligibility conditions do not apply to the sale of private condominiums, which can also be purchased freely by foreigners. There is also no restriction on the sale and purchase of private condominiums,

[8] However, similar to homebuyers in the public and private housing markets, EC unit buyers may use savings from their Central Provident Fund—a mandatory social security savings scheme in Singapore funded by contributions from employers and Singaporean employees—to pay the 15% down payment for their property purchase (buyers have to secure a minimum 5% cash down payment). If they are first-time homebuyers, they can also receive a housing grant of up to $30,000, depending on their household income.

[9] Under the Fiancé/Fiancée scheme, a couple intending to get married can apply to buy an HDB or EC flat, but they must produce their marriage certificate within three months from the date of taking possession of the flat.

which are categorized as non-restricted properties under the Residential Property Act. The application process for ECs is project-specific just like private condominiums. If households are eligible in terms of income and other requirements described above, they can apply for any EC project and it is sold on a first come and first serve basis.

Table 1. Features of Executive Condominiums

Panel A: Eligibility Conditions of for Executive Condominiums

Citizenship	Applicant must be Singaporean. The family nucleus must comprise at least another Singaporean or Permanent Resident (PR).
Age	Applicant must be at least 21 years old at the time of application or at least 35 years old if buying an EC under the Joint Singles Scheme.
Income ceiling	Gross monthly household income must not exceed S$14,000.
Private property ownership	Occupiers must not own or dispose or have any interest in other private flat, house, building or land: (1) within 30 months before the date of application, and (2) between the application date and the date of taking possession of the EC.
Owners/Ex-owners of subsidized public housing	Those who have already bought two housing units (HDB flats, EC unit or Design, Build, and Sell Scheme (DBSS)[1] unit from developer or resale flat with CPF housing grant are not allowed to apply as an essential occupier in an application.
First-time applicants	Applicants and his essential family members must not: (1) Own a flat bought direct from HDB, or DBSS/EC bought direct from developer; (2) Sold a flat bought direct from HDB, or DBSS/EC bought direct from developer; (3) Received CPF Housing Grant for the purchase of an HDB resale flat; (4) Enjoyed other forms of housing subsidy; (5) Enjoy higher quota set aside for EC first-timer applicants (95% during initial launch period).
Existing Owner or Ex-owner	Existing owner or ex-owner of a: (1) flat bought directly from HDB; (2) DBSS flat bought from developers; (3) resale flat bought under the CPF Housing Grant Scheme, may apply to buy an EC on condition the 5-year (excluding any period of subletting of the whole flat) has lapsed from the date of taking possession of the flat to the date of application for a new EC.
Ex-owners of an EC	Ex-owners of an EC need to meet a 5-year period from the date of taking possession of the earlier EC; and need to wait out a 30-month period from the effective date of disposal of the EC before they can apply for another EC directly from the developer.

Panel B: Rent and Resale Restrictions for Executive Condominiums

Minimum Occupation Period (MOP)	5 years from TOP before the owner can sell it in open market
Rental restrictions	Renting out the whole EC unit within the 5-year MOP is not allowed. However, renting out of bedroom(s) is permissible.[2]
Resale Restrictions	Owners can sell their EC unit to Singaporean citizens and PRs after the 5 years of occupation. Owners can sell their unit to anyone including foreigners after 10 years of occupancy.

[1] The Design, Build and Sell Scheme (DBSS) was introduced by HDB in 2005 to offer greater choice and wider variety to meet the housing aspirations of higher income flat buyers for better design and finishes, by involving the private sector in the design and construction of public housing. Since 2005, 13 DBSS developments have been built and sold.

[2] EC owners may rent out bedroom(s), but not the whole EC unit during the first five years MOP. With effect from February 1, 2010, EC owners are required to obtain prior approval from HDB for renting out of bedroom(s) within the MOP.

Data Source: Housing Development Board

Upon obtaining the Temporary Occupation Permit (TOP) in respect of the EC development, the developer will invite the buyers to take possession of their respective EC units.[10] Buyers of newly built EC units are subject to a set of restrictions as listed in Panel B, Table 1. One particular condition is that EC buyers cannot sell or rent their unit within the first five years. After the fifth year, the EC units can be sold in the open market. Buyers of resale ECs from the open market are not bound by most of the eligibility conditions, with the exception that they must be Singaporean citizens or PRs if the EC is between the sixth and tenth year of its occupation period. After the tenth year, all restrictions are lifted and the former quasi-private EC is then considered a fully privatized condominium. This means that foreigners can buy ECs in the open market freely from the eleventh year of the EC project completion. During the five-year MOP, EC owners cannot invest in private residential property in Singapore or overseas. EC owners, therefore, cannot cash out when property prices are high, or buy private condominiums when prices are depressed. The rationale for imposing these restrictions on EC owners is to

[10] In practice, the MOP for an EC unit is computed from the date of TOP, which is the physical completion date, of the EC development. In cases where the development is completed in phases, the MOP will correspond with the TOP date of the respective blocks in the development.

ensure that the scheme is effective in accommodating the aspiration of the "sandwiched" middle class to own and live in an affordable private condominium.[11]

2.3. Economic Intuitions

The basic mechanism for ECs is the government land use planning and land sales. [12] In Singapore, 90% of land is owned by the government and made available through land sales (99 year lease in the case of ECs) to private developers. The government releases the land parcels considering market conditions and appropriate timing through the developers' bidding system called the Government Land Sales Programme (GLS). And for GLS, the government indicates the specific land use regulations attached to the parcel. So, developers that bid for land parcels designated for ECs know that they can only build ECs and are likely to bid less compared to similar land parcels designated for private condominiums. From the government perspective, therefore, it has to forego the revenue from land sales of ECs compared to similar land sales of private condominiums.[13]

[11] The occupation rules are similar for HDB flats. To ensure strict compliance, the government is empowered to re-acquire the flats of owners who do not occupy their units during the first five years after purchase or who sell their flats to foreigners during the next five years.

[12] One may question why the government has not chosen alternative policy measures such as rental assistance or first-time buyer's tax credit. First, Singapore has a long legacy of homeownership promotion since its independence.. Along with the government's commitment to homeownership, most Singaporean residents have a very high aspiration for homeownership and affordable homeownership programs such as HDB and EC are popular among Singaporean residents. Of course, these programs are costly to the government and may not make a huge economic sense. However, as the government does think homeownership creates positive externalities to the country, it is willing to maintain these programs. Next, from the government perspective, foregoing the land sales revenue may be politically more viable than providing huge tax credits to the specific group of households. Moreover, the advantage of ECs is that the government can control the minimum occupancy of buyers to prevent speculation activities as well as promote real estate development and construction which would in turn contribute to economy.

[13] Therefore, the amount of subsidy for the EC scheme would be the loss in revenue on sale of development sites designated for ECs instead of private condominium developments. For example, the sale price in per square meter (PSM) of gross floor areas (GFA) was S$3,133 for one EC site (Watercolours), while the sale prices PSM of GFA for private condominiums located on the adjacent block and sold in the same year (Searstrand, Sea Esta, and Ripple Bay) ranged from S$3,604 to S$4,332

The option theory is particularly useful to facilitate the understanding of the underlying economic mechanisms related with ECs. As Figure 1 illustrates, let us assume that there are two types of put options: the put option to sell the property to Singaporean residents and the put option to sell to foreigners. Buyers of private condominiums have the American options for both: AP(S) which is the option to sell the property to Singaporean residents at any time and AP(F) which is the option to sell the property to foreigners at any time. On the other hand, buyers of newly built EC units have the forward start American put options for both at time of the purchase: FAP(S) which is the option to sell the property to Singaporeans starting only at year 5 and FAP(F) which is the option to sell the property to foreigners starting only at year 10. In other words, EC buyers can sell their properties at any time beyond the specified contract years (5^{th} year for FAP(S) and 10^{th} year for FAP(F), respectively) before the lease term expires (99^{th} year). This requirement has been set by the government and all buyers of newly built EC units must follow the requirement (see Section 2.2).[14]

The forward start contracts would impose temporary property rights restrictions to EC buyers and reduce the option price of EC units compared to counterpart private condominiums that have regular American put options. EC buyers already know this property right restriction at time of the purchase and we believe that this would contribute to discounts in the new sale transactions (including presales) of ECs. Then, the discounts in the option price associated with forward start contracts will diminish over time and eventually disappear when a given EC unit passes the contract date (5^{th} year for FAP(S) and 10^{th} year for FAP(F), respectively). We are able to observe

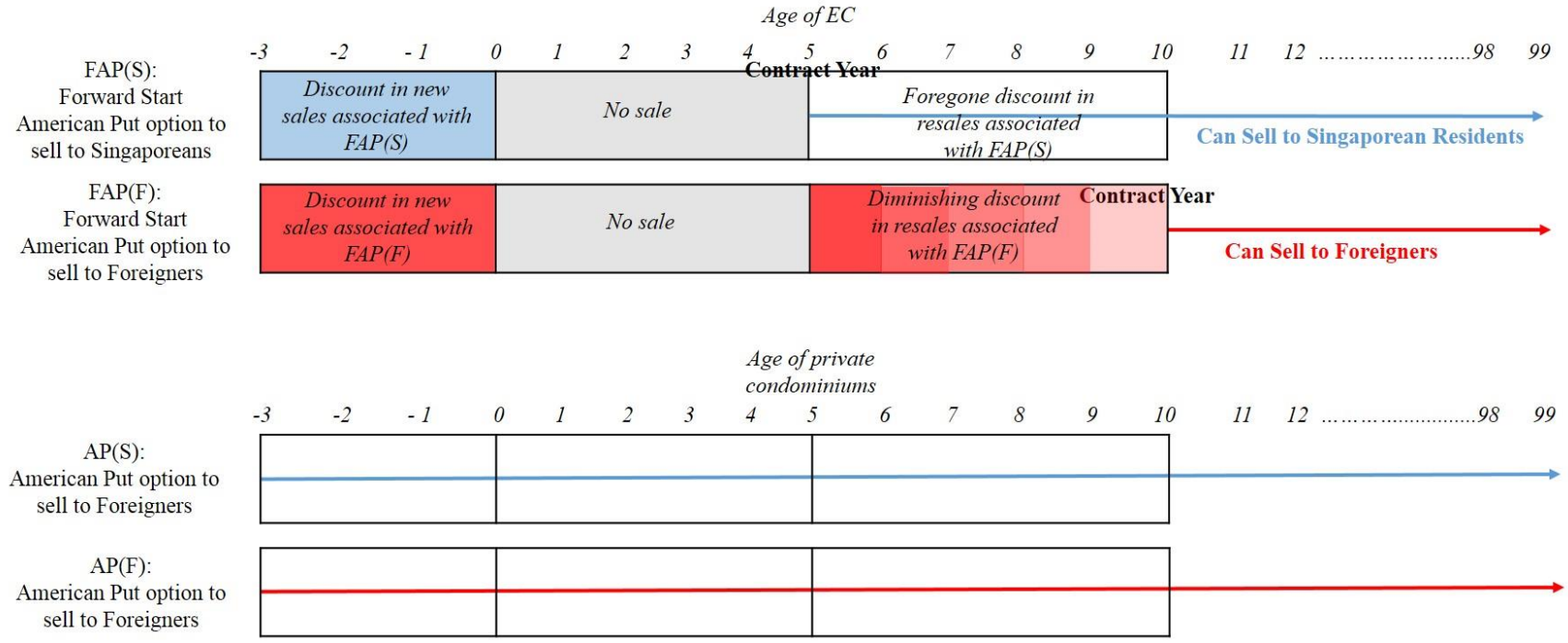
[14] Note that subsequent buyers of ECs in the resale market are still subject to the requirement if the purchased EC unit has not reached the 10^{th} year milestone.

these dynamics of discounts of ECs for new sales as well as resale transactions between the 5th to 10th year when newly built EC units can be sold only to Singaporean residents and beyond the 10th year when these ECs can be sold to anyone.

To sum up, there are three players in the market of newly built ECs. The government provides subsidies in a form of the discount in land sales prices for land parcels designated as EC sites. Hoping to encourage homeownership among middle-class Singaporean residents, the government sets eligibility conditions. To make sure that ECs serve actual users rather than speculators, the government also sets the requirement of property right restriction which works like the forward start American put option. The government does not own any EC units. However, after the lease term for ECs expires (99 years), the land would be returned to the government and this is same for both ECs and private condominiums in our sample. For EC buyers, everything is similar to buying private condominiums except that they have to meet the eligibility condition set for ECs and they have the forward start American put option for their properties. The expected discount in the option price for ECs relative to the option price for comparable private condominiums is likely to affect the potential buyers' utilities attached to EC units, so they would be willing to pay less than what they would have paid for the similar private condominiums.[15] In this context, we hypothesize that the market price for ECs will clear at a lower price than that of private condominiums especially for their new transactions. We also expect that the discount found in later resale transactions of ECs will decrease over time as contract dates become closer and property right restrictions are removed.

[15] Even though EC units are sold at a lower price, EC developers can still earn profits by paying less for land parcels designated for ECs.

Figure 1. Illustration of the Option Price Application



Note 1: The typical lease term for the government-sold residential land is 99 years and the land should be returned to the government upon the term expiration.
Note 2: Presales are quite common in Singapore residential markets and they usually start 3 years before the completion of the project. Once purchased as presales, EC units cannot be transacted until specified years (5^{th} and 10^{th} year) after the completion of the project.
Note 3: The MOP (Minimum Occupancy Period) is the first five years and buyers are prohibited for selling during this period.

2.4. Scholarly Contributions

Although studies presented in Section 2.1 provide useful insights on property right restrictions among real estate properties and their impacts on property values, their focus is on restricting the owners' rights to use the property, which is only one of the dimensions of property rights. Few researchers have focused on the rights to transfer real estate properties and the economic impact of restricting such rights on property values. Most prevailing studies on transferability restrictions have relied on data from the financial markets, particularly in the context of stock trading illiquidity; for example, Bailey and Jagtiani (1994) analyze the impact of foreign ownership restrictions on Thai firms' stock prices and report that this restriction accounts for a discount of about 10%.

We attempt to address a gap in the literature by focusing on the impact of curtailing the rights of owners to transfer (that is, sell or rent) their properties in the context of real estate. Taking advantage of the EC policy that only impose transferability restrictions on EC units for the temporary period, we are able to estimate the economic impact of such restriction on property values of ECs. Linking to the option theory presented in Section 2.2, this economic impact would be equivalent to the discount associated with the forward start contract (i.e. the value of the delayed option to sell the property). Hence, our findings will provide the insight on the negative impact of complete, temporary illiquidity on asset pricing and contribute to the finance literature.

3. Data and Methods

3.1. Data

First, the main source of the data related to the individual unit transactions is the Real Estate Information System (REALIS) published by the Urban Redevelopment Authority (URA), Singapore's national land use planning authority. The transaction data contain the sale price, contract date, floor area, level, and address of the units. The data are based on caveats lodged by the purchasers to protect their interest soon after an option to purchase a property is exercised.[16] The transaction price is the agreed purchase price of the property, and excludes stamp duties and legal and agency fees, which are fairly standard in Singapore. Next, project-level information is obtained from the quarterly Property Market Information (PMI), which is also maintained by the URA. The quarterly publication contains the dates of written permission, building approval, grant of sale license, marketing launch, and completion of the individual developments. Finally, we use the Geographic Information System (GIS) to compute information on the location, such as distance to the closest subway (MRT) station and to the central business district (CBD). Table 2 presents a list of the variables used in our analyses, with their definitions and sources.

Table 2. Description of Variables and Data Sources

Variable Name	Description	Source
PRICE	Transaction price (in 2014 S$)	Real Estate Information System (REALIS) developed and managed by the Urban Redevelopment Authority (URA)
T_YR	Year of unit transaction	Property Market Information (PMI) published by URA
C_YR	Year of project completion	PMI
FL_AREA	Floor area of unit (m^2)	REALIS
FL_LEVEL	Floor level of unit	REALIS
SALE_TYPE	Type of sale (1=new sale including presale; 2=resale)	REALIS

[16] Caveats are legal documents filed by home purchasers (through their lawyers) with the Singapore Land Authority to register their legal interest in the property. Typically, caveats are lodged two to three weeks after a purchaser signs an option to purchase at the model unit. Since it is not mandatory to lodge a caveat, it is technically possible that the transaction database does not include all of the units sold. However, such omissions are likely to be few in practice, since most home purchases involve mortgage loans, in which case the solicitors acting on behalf of the banks insist on lodging a caveat to protect their client's interest in the property (Munneke et al. 2015).

DEVT_SIZE	# units in each development	PMI
AGE	# years between unit sale and project completion (0 if new sale or presale)	PMI
DIS_SUB	Distance to the nearest subway station (km)	GIS
DIS_CBD	Distance to CBD (km)	GIS
NEIGHBORHOOD	Planning area[17]	PMI
PPI	Private Residential Property Price Index (quarterly)	URA

Note: We use NEWSALE (1 if new sale including presale; 0 if resale) and EC (1 if EC units; 0 otherwise) as well as the a set of interactions between EC and the number of years after the project completion in our regressions (see Table 6). The source of these variables is REALIS.

3.2. Identification Strategies

Table 3 shows that a total of 32,817 transactions were recorded in the 41 EC developments between June 1996 and June 2016. About 79% were new sale transactions from developers, which usually take place before the actual completion of the project (that is, presales), while the balance of 21% were resale transactions where the original EC buyers sell their units after satisfying the five-year MOP (Minimum Occupancy Period). Out of the 6,775 resale transactions, 2,654 (39.2%) involved the sale of EC units that have achieved full privatization status.[18] Property right restrictions on ECs and their subsequent relaxation over time provide an opportunity to investigate empirically the impact of restrictions on the rights to rent and sell a property and to calculate the discount associated with forward start contracts (see Section 2.3). Our investigation concentrates on both new sale and resale transactions of individual units from 41 EC developments that were launched between June 1996 and June 2016. Appendix 1 shows that 23 EC projects passed the contract date for the forward start American put option to sell to

[17] To facilitate urban planning, the URA divides Singapore into 55 planning areas. Each planning area has a population of about 150,000 and is served by a town center and several neighborhood commercial/shopping centers. We consider these to be neighborhoods in our analysis.

[18] During the initial eight years, there is no resale transaction. This can be explained by the normal practice of developers preselling the units before their physical completion, and the five-year MOP after the developments are physically completed.

Singaporeans (FAP(S)) as of the end of 2012. EC owners in these developments are therefore allowed to rent or sell their units to Singapore citizens and PRs. Apart from La Casa, which was physically completed in February 2008, 22 projects passed the contract date for the forward start American put option to sell to foreigners (FAP(F)) and achieved full privatization status; that is, the owners are no longer prohibited from selling their property to foreign buyers.

Table 3. Sale Transactions of EC Units (1996-2016)

Year of sale	New Sale (including Presale)	Resale (5^{th} - 10^{th} year)	Resale (> 10^{th} yr)	Total
1996	499	-	-	499
1997	1,597	-	-	1,597
1998	1,876	-	-	1,876
1999	1,567	-	-	1,567
2000	384	-	-	384
2001	1,533	-	-	1,533
2002	945	-	-	945
2003	430	-	-	430
2004	236	86	-	322
2005	304	203	-	507
2006	172	465	-	637
2007	117	658	-	775
2008	81	597	-	678
2009	1	740	161	902
2010	571	394	593	1,558
2011	2,693	286	559	3,538
2012	3,113	323	482	3,918
2013	3,967	237	281	4,485
2014	1,195	72	184	1,451
2015	2,954	52	263	3,269
2016 (until June)	1,807	8	131	1,946
1996-2016	26,042	4,121	2,654	32,817

Note 1: This table tracks the aggregate sale transactions in our sample of 41 ECs by new sale transactions as well as resale transactions during the partial and full removal of restrictions on property rights.

Note 2: Note that most new sale transactions are presale ones, therefore they usually happen 2–3 years before actual project completion. For example, the completion year of the earliest batch of ECs is 1999.

Note 3: Note that units completed after 2011 (new sale transactions (usually presales) starting from 2009 onwards) are not eligible for resales because they have not reached MOP.

Data Source: Compiled by authors using the data from Real Estate Information System (REALIS) and Property Market Information (PMI)

The intuitive approach to investigate the economic impact of restricting the transferability of property rights is to compare the observed price of an EC unit against the price it would have achieved had it been sold without the encumbrance. Since such a comparison would not be practically feasible, because a property cannot be sold both with and without restrictions on property rights at the same time, we employ the standard logic of a counterfactual causal inference design (for example, Rosenbaum 2002; Morgan and Winship 2007). In other words, we intend to identify a comparison group that shares similar attributes with the treatment group, except for their non-participation in the treatment.

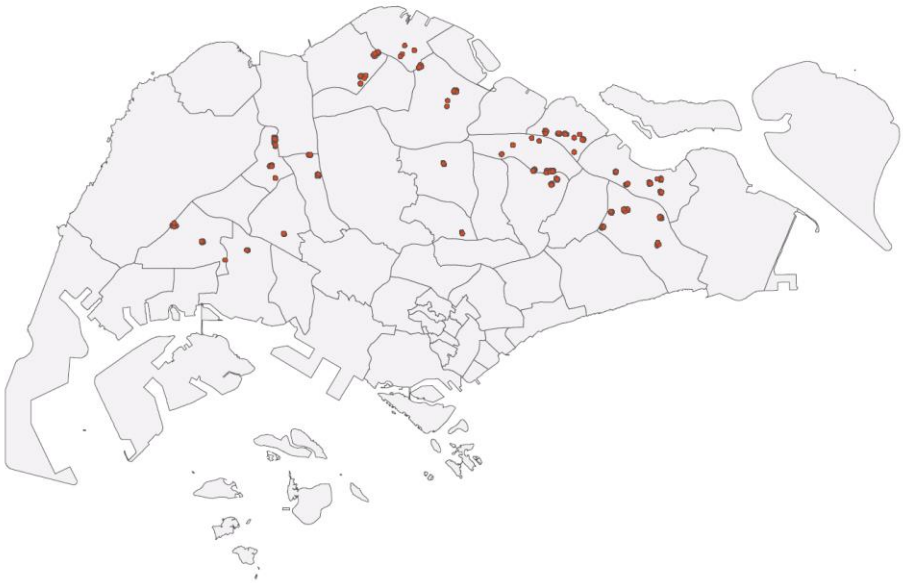
Private condominiums are good candidates as they are very similar to ECs in terms of amenities, but are not associated with any restriction on property rights. To find the appropriate counterfactuals, however, we have to ensure that both the treatment and comparison groups are exposed to the same set of spatial and time-varying factors.[19] To identify the potential comparison group, therefore, we first select private condominium projects that are located within 2km radii from the ECs by using the GIS. Figure 2 shows the locational distribution of private condominiums that are within a 2km radius from the center point of each EC. We further restrict the potential counterfactuals to those that were launched in the same period as the ECs (between June 1996 and March 2013), and have a 99-year leasehold.[20] This results in a pool of 106 private

[19] All the EC developments are built on sites with a 99-year leasehold tenure, and are located outside the prime residential district (see Figure 1). Private condominiums in Singapore, on the other hand, are sold on either leasehold or freehold tenure and are spread throughout the island.

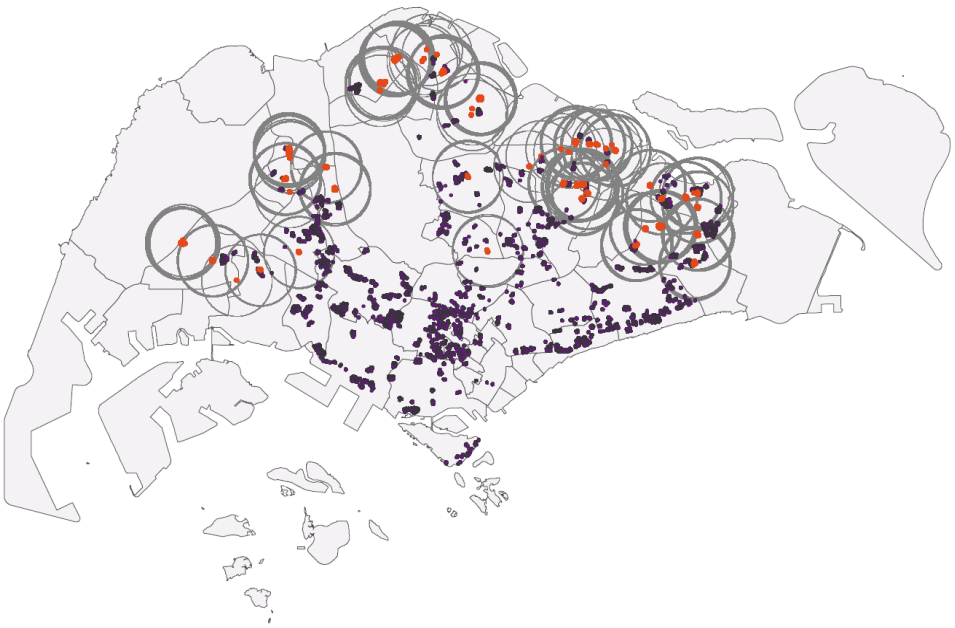
[20] A freehold-tenured property is typically priced higher than its leasehold counterpart because the owner of a freehold property has a perpetual option to redevelop the property (Capozza and Sick 1991; Capozza and Li 1994; Grenadier 1995; Childs, Riddiough, and Triantis 1996). In Singapore, freehold land can command a premium as high as 22.8% to 36.5% (Tu and Bao 2009). A more conservative freehold premium of 10.6% was recorded by Ooi and Le (2013). Moreover, freehold properties tend to have better construction and workmanship quality than leasehold properties do (Ooi, Le, and Lee 2015). Over the study period, 370 new condominium developments with

condominiums for the potential comparison group. There were 53,358 sale transactions in these counterfactual private condominiums between 1996 and 2016. About 72% of the transactions involved new units purchased from the developers directly, and the balance of 28% comprised resale transactions in the secondary market. Our initial sample comprises 85,175 sale transactions, including these private condominium sale transactions together with the 32,817 EC sale transactions.

Figure 2. Locations of Executive Condominiums (in Red) and Private Condominiums (in Purple) Located within 2 km radii of ECs



more than 100 units each were launched. Out of these, 182 were built on freehold or 999-year leasehold sites. These developments are not included for the potential comparison group.



Note: The red dot is the center point of each EC and the purple dot is the center point of each private condominium. The grey circle is a 2 kilometer circle drawn from each EC and private condominiums within this circle are selected as a comparison group.

So far, we have identified the potential comparison group of private condominiums by considering geographic proximity to ECs, lease terms, launch periods, and transaction dates. A similar approach to identify the comparison group has been employed in many prior studies, such as Eichholtz, Kok, and Quigley (2010). However, it is still possible that our treatment group (EC units) and potential comparison group (private condominiums) differ in terms of other unit- and project-level characteristics, which could affect the price differences.

In order to further ensure a causal interpretation of our analysis results, we match the EC transactions to the private condominium transactions from the potential comparison group. We use a propensity score matching procedure to select matches for each EC transaction from the pool of 53,358 private condominium sale transactions. To estimate the predicted values to be used as a propensity score, we use logistic regression, in which the dependent variable is the EC

dummy (1 for EC units and 0 for PC units), and the independent variables are transaction year, completion year, floor area, floor level, type of sale, number of units in the development, distance to the MRT station, distance to CBD, and planning area (neighborhood). We match each treatment observation to one comparison observation closest in propensity score within the caliper width of 0.003 without allowing replacement to improve the covariate balance and reduce bias. During this matching process, we lose 9,905 EC observations from our treatment group as no transactions in the pool of the comparison group had a propensity score within the caliper width of 0.003 of these treated transactions' propensity score, and therefore they were left unmatched. Our final matched sample comprised 22,912 EC unit and 22,912 PC unit transactions.

3.3. Empirical Models

For the empirical investigation, we start with a standard hedonic price model as follows:

$$log\ P_{ik} = \pi x_{ik} + \varepsilon_{ik} \quad (1)$$

where P_{ik} is the selling price of the i^{th} condominium unit in the k^{th} condominium development, x_{ik} is a vector of the explanatory variables containing physical attributes and locational characteristics of unit i and development k, and ε_{it} is the i.i.d. error term. The physical attributes include the unit's floor area (in square meters), floor level, and age (expressed in number of years from the date of physical completion to the date of sale). Floor area is expected to be positively related to selling price, while age will have a negative price impact. In a high-rise living environment, the sale price is expected to be related positively with the floor level, because units located on higher floors tend to have a better view, are more airy, and are less exposed to visual intrusion from neighboring buildings (Munneke et al. 2011). The squared term of these variables is also included in the models to account for the possibility of a nonlinear effect on the condominium prices.

Locational characteristics include spatial distances of the units from the *CBD* and the subway station (*MRT*). We also control for the size of the condominiums, which is represented by the total number of dwelling units in each development. Meltzer and Cheung (2014) find that membership in larger HOAs devalues the price of their properties.

To analyze the price difference between ECs and private condominiums in new sale transactions, we include several important variables to the standard hedonic model. Controlling for all physical attributes stated above, the binary variable *EC* measures the difference in transacted prices between EC units (treatment group) and comparable private condominiums (comparison group). To control for unobserved spatial heterogeneity, a set of binary variables representing the planning areas (neighborhood) where condominium projects are located (τ_k) is included. We also include the quarterly property price index (PPI_t) and a set of fixed effects for the year of transaction (φ_t) as well as the neighborhood-by-year fixed effects ($\tau_k * \varphi_t$) to control for time-varying market conditions. In summary, our base regression equation is represented as follows:

$$Log(P_{ikt}) = \alpha + \pi_k x_{ik} + \beta\, EC_i + \delta\, PPI_t + \tau_k + \varphi_t + \tau_k * \varphi_t + \varepsilon_{ikt} \quad (2)$$

where α is the intercept and β is the estimated coefficient of our treatment, which has a value of 1 if the unit is within an EC development. The Equation (2) is the specification used for the matched sample comprising only new sale transactions. Here, the coefficient of *EC*, β, reflects the initial discount for EC units compared to matched private condominium units and we expect the sign of this coefficient to be negative. This discount should be equivalent to the discount associated with the forward start contracts (or property right restriction) of ECs plus any unobserved differences between ECs and private condominiums (see Section 2.3 for the explanation of the difference between the forward start American put option and the American

put option). The coefficients of the log-linear model have a simple and appealing economic meaning, because they can be interpreted as approximately the percentage change in the value, given a unit change in the independent variables that are continuous.[21]

Then, we estimate our models for the full sample combining both resale and new sale transactions. In this specification, we add a dummy variable $NEWSALE_{it}$ in the regression model to control for potential differences in the price discovery process in the new sale transactions (where new units are purchased from the developers) and the resale transactions (where existing units are sold by individual owners). We also add *AGE* to account for physical depreciation of the development structure over time that would matter for transacted prices for both ECs and private condominiums. Finally, to examine the change in the price differences between ECs and private condominiums over time as EC units move toward full privatization with no property rights restriction, we include a set of dummies that account for the number of years after the completion of ECs (*EC*YR5*, *EC*YR6*, . . . , *EC* YR10*).[22]

$$Log(P_{ikt}) = \alpha + \pi_k x_{ik} + NEWSALE_{it} + \beta\, EC_i + \lambda\, AGE_{kt} + \rho_1\, EC_i * YR5 + \rho_2\, EC_i * YR6 + \rho_3\, EC_i * YR7 + \rho_4\, EC_i * YR8 + \rho_5\, EC_i * YR9 + \rho_6\, EC_i * YR10 + \gamma\, PPI_t + \tau_k + \varphi_t + \tau_k * \varphi_t + \varepsilon_{ikt} \quad (3)$$

In the Equation (3), the coefficient of *EC*, β, reflects the initial discount for EC units compared to matched private condominium units. Controlling for this, a set of coefficients, ρ, indicates the specific price change in resale prices of ECs transacted in a given year. Hence, this model allows

[21] Since *EC* is a dummy variable, the price discount for the encumbered EC units is *exp* $[\widehat{\beta_1} - \frac{1}{2} var(\widehat{\beta_1})] - 1$. See Kennedy (1981), where $var(\widehat{\beta_1})$ is the square of the standard error for $\widehat{\beta_1}$.

[22] If EC properties have passed the 10-year milestone, the variable $EC*t_{10}$ has the value of 1.

calculating the change in discounted value associated with the forward start contract over time.[23] For example, the coefficient for *EC*YR5*, ρ_1, indicates the price difference of ECs transacted in the 5th year relative to new sale transactions of ECs. It would reflect the foregone discount associated with the delayed option to sell to Singaporeans (FAP(S)) as this option becomes active in the 5th year while also reflecting the remaining discount from the forward start for the option to sell to foreigners (FAP(F)) which has not reached the contract date yet. Therefore, we expect the sign of this coefficient, ρ_1, to be positive but its magnitude to be smaller than the magnitude of β, and the discount for ECs in the 5th year will be approximated by $\beta + \rho_1$. As the YR gets closer to 10 when FAP(F) reaches the contract date, the discount associated with FAP(F) would diminish more and the magnitude for the interaction of EC and YR (ρ) is expected to become larger. As there should be no more discount for ECs associated with forward start contracts in the 10th year and onwards and option prices of ECs should be same as those of private condominiums, ρ_6 would represent the fully recovered discount caused by forward start contracts. This will be identical to the full difference in values between American put options and forward start American put options.

At the same time, the Equation (3) allows testing how the resale prices of EC units converge with those of matched private condominiums as ECs move closer to the full removal of property rights restrictions. Based on the above hypotheses based on the option theory, ρ_1 represents the

[23] In addition to running the regressions, we directly use the option pricing formula and simulate values of the American put option attached to private condominiums and values of forward start American put option attached to ECs over time (Barone-Adesi and Whaley, 1987; Rubinstein 1991). For this simulation, we assume that the current prices for ECs and private condominiums are same as we control for all other unit and development characteristics (i.e. the average price of all new sales in our matched sample, $797,169) and their strike prices are same as the current prices. We use the average annual price change for the volatility (15.39%), the market interest rate for the risk-free rate (2%), the market yield of condominiums for the dividend (2.54%), and the lease duration for the maturity (99 years). We attempt to compare theoretical discounted values of ECs suggested by this option theory with our regression results in Section 4.2.

value of the partial removal of transferability restrictions on ECs and ρ_6 represents the value of the full removal of these restrictions. Hence, the discount for resale prices of ECs compared to those of counterpart private condominiums in the 10th year and onwards, approximated by $\beta + \rho_6$, would be smaller than the discounts for ECs in earlier years. If the magnitude of the coefficient for *EC*YR10*, ρ_6, remains smaller than the magnitude of β, it would be due to unobserved differences in quality and public perception between ECs and private condominiums instead of any property right restrictions.

4. Results

4.1. Summary Statistics of the Matched Sample

Table 4 presents the summary statistics of the initial sample before we perform the propensity score matching procedure. Monetary values are expressed in Singapore dollars throughout.[24] The average selling price for the full sample is S$803,698, with the average unit located on the eighth floor and occupying a floor area of 110 square meters. The average age of the transacted units is about 1.7 years, reflecting that most of the sampled private and executive condominiums are new developments. Due to the small physical size of Singapore, the average distances of the condominium units to the CBD and the closest subway station are only 14.11 km and 0.94 km, respectively. The mean selling price of EC and private condominium units is S$736,019 and S$845,323, which indicates a 12.9% price discount for the EC units. However, EC units tend to occupy a larger floor area and are located slightly further away from the CBD and subway stations. The average size of private condominium developments is bigger than that of EC developments.

[24] The exchange rate in January 2017 was S$1 to US$ 0.71.

Table 4. Summary Statistics of the Initial Sample (Before Matching)

Variable	All Units		Executive Condominiums		Private Condominiums Located within 2 km Radii of ECs	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
PRICE	803,698	1,457,045	736,019.2	177,775	845,322.9	1,845,189
T_YR	2008.23	5.90	2008.52	6.24	2008.05	5.67
C_YR	2008.43	7.24	2008.42	7.50	2008.44	7.07
FL_AREA	110.40	320.95	115.54	23.43	107.23	407.43
FL_LEVEL	8.37	5.49	8.51	4.96	8.28	5.79
SALE_TYPE	1.28	0.52	1.21	0.40	1.33	0.57
DEVT_SIZE	530.15	180.91	486.81	170.80	556.81	181.80
AGE	1.71	3.62	1.848	3.81	1.623	3.50
DIS_SUB	0.94	0.55	1.01	0.51	0.89	0.57
DIS_CBD	14.11	2.61	15.02	2.47	13.56	2.53
NEIGHBORHOOD	10.46	4.99	12.24	4.13	9.37	5.16
PPI	121.63	25.54	123.06	25.10	120.75	25.77
# of sale transactions	**86,175**		**32,817**		**53,358**	

Note 1: This table presents the definition and summary statistics of the initial sample before matching. The descriptive statistics are based on the initial sample of 86,175 sale transactions between 1996 and 2016.

Note 2: NEIGHBORHOOD indicates planning areas in Singapore. Each planning area has a population of about 150,000 and is served by a town center and several neighborhood commercial/shopping centers.

Note 3: For our analyses, we use the Private Residential Property Price Index for non-landed properties.

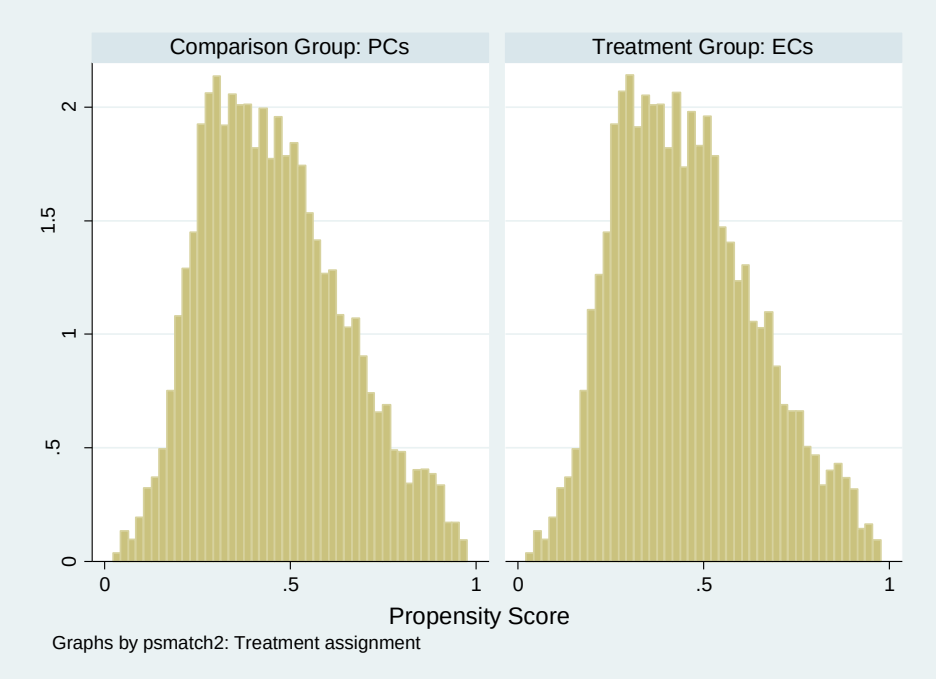
Table 5 presents the summary statistics of our final matched sample, including 22,912 EC unit transactions and 22,912 private condominium unit transactions. Based on the covariate balance of this matched sample, EC and PC units are statistically homogeneous with respect to the transaction and completion years, floor area and level, sale type (new vs. resale), number of units in development, distance to MRT and CBD, and neighborhood planning area. This contrasts with some heterogeneities found between ECs and PCs in the initial sample as stated above. Therefore, we are able to claim that by using our final matched sample, any observed treatment effects will not be biased by differences between the treatment and comparison groups in property and locational characteristics. Figure 3 and Appendix 3 also confirm the good quality of our matching by showing the balance diagnostics of the propensity scores.

Table 5. Quality of Matched Sample

	Mean		% Bias	P-value from 2 sample t-test	Variance ratio	Cochran's rule of thumb
	Treatment: EC	Comparison: PC				
T_YR	2008.4	2008.2	2.4	0.186	1.24	pass
C_YR	2008.2	2008.2	0.9	0.309	1.17	pass
FL_AREA	114.1	112.8	4.3	0.101	0.33	pass
FL_LEVEL	8.5	8.5	-0.7	0.454	0.73	pass
SALE_TYPE	1.2	1.2	2.5	0.162	1.04	pass
DEVT_SIZE	509.5	509.6	-0.1	0.940	1.01	pass
DIS_SUB	1.0	1.0	-2.2	0.152	0.79	pass
DIS_CBD	14.5	14.5	1.1	0.221	1.05	pass
NEIGHBORHOOD	11.5	11.5	-1.1	0.237	0.76	pass

Note: This table summarizes the statistics of the matched sample created using propensity score matching. "Cochran's rule of thumb" reports whether the mean difference of a variable with the matched sample is less than a quarter of a standard deviation of the respective variable ("pass" indicates that the mean difference is smaller than this threshold, suggesting that good balance is achieved after matching), following Cochran (1968) and Ho et al. (2007). See Appendix 2 for the detailed calculation process for "Cochran's rule of thumb."

Figure 3. Propensity Score Histograms of Treatment vs. Comparison Groups



Note: See Appendix 3 for the propensity score histograms of these groups overplayed with that of unmatched, full sample.

Based on Table 5, we can infer that the majority of transactions in our sample are new sales and are completed in around 2008. However, we do have quite a large number of resale transactions

around 2008 as units from the earlier batch of ECs began to go through the removal of property right restrictions (partial removal from 2004 and full removal from 2009). For our final matched sample, we have 10,223 resale transactions and 35,601 new sale transactions. The average treated EC unit and its counterpart PC occupy a floor area of 114 square meters and are located between the eighth and ninth floors. Regarding the project size, the average EC and PC projects have about 510 units. In terms of locational characteristics, the average distances of the condominium units to the CBD and the closest subway station are 14.5 km and 1 km, respectively. Given that Singapore is a small city state, this suggests that both EC and PC units in our final matched sample tend to be located outside the top prime residential district in the central region. Assessment of the planning areas (i.e. NEIGHBORHOOD) where these units are located consistently shows the concentration of units in the non-central regions.[25]

4.2. Effects of Property Right Restriction on House Prices

Table 6 reports the parameter estimates for the hedonic models, which are estimated using ordinary least squares corrected for heteroskedasticity. Model (1) employs the matched subsample of transactions in the new sale market, while Model (2) employs the matched full sample of transactions in both the new sale and resale markets. Model (3) employs the matched subsample of projects completed before 2009. ECs in this sample are considered the pioneering batch and all of these units are eligible for resale transactions. With this more balanced sample, we can examine the potential change in the economic effect of property right restrictions depending on the vintage of ECs and test the stability of our main results from Model (2). Model (1) uses

[25] The URA divides Singapore into four regions: central, east, west, and northeast. None of the units in our final matched sample is located in the central region.

Equation (2) while Model (2) and (3) use Equation (3). All models include planning area-by-year fixed effects to address confounding changes in market conditions and standard errors are clustered by planning areas.[26] Overall, the three models perform well: the equations are significant at the 1% level, while the regressions explain between 90% and 92% of the price variations in the condominium units.

Not surprisingly, the price movements of residential properties at the broad market level (PPI) have a significant influence on condominium prices. Most of the structural variables also have the expected signs. Selling price is related positively with the condominium unit's floor area, but its influence increases at a decreasing rate. Units located on the upper floors of a building are also popular, supported by the higher prices they fetched. Distances to the MRT are related negatively to the sale price, which implies that condominium units located near subway stations are sold at a premium. This is contrary to the findings of Munneke et al. (2011), Ooi and Le (2013), and Ooi, Le, and Lee (2015). A possible explanation for this result is that our study sample covers only entry-level condominiums whose buyers may have a tighter budget on car ownership. For them, the positive externality of easy access to mass transportation is stronger than the countervailing negative externality from pedestrian congestion or noise from a metro station.

[26] The resale transactions of both ECs and private condominiums are done by units and between individual owners and new purchasers. Our sample shows that about 30% of units that have ever had resale transactions have multiple resales, mainly two resales. Multiple resales are not related with the property right restriction, meaning that the 5- and 10-year milestones remain same even after the ownership transfers. Because we account for the age of each unit and transaction year in our model, we do not think that including multiple resales would be problematic. Still, to address the potential statistical concern, we also try to cluster standard errors by units and our results remain consistent.

Table 6. Regression Results Using the Matched Sample (comparison group within 2km radii of the treatment group of ECs)

Variables	(1) New Sales	(2) All Sales	(3) All Sales (completed before 2009)
Constant	11.9955**	11.9977**	12.0606**
	(0.20872)	(0.12736)	(0.14175)
FL_AREA	0.01267**	0.01195**	0.00960**
	(0.00064)	(0.00051)	(0.00050)
FL_AREA^2	-0.00002**	-0.00002**	-0.00001**
	(0.00000)	(0.00000)	(0.00000)
FL_LEVEL	0.01226**	0.01036**	0.00949**
	(0.00172)	(0.00185)	(0.00193)
FL_LEVEL^2	-0.00034**	-0.00028*	-0.00026**
	(0.00009)	(0.00009)	(0.00008)
DEVT_SIZE	-0.00007+	-0.00009*	-0.00003
	(0.00004)	(0.00003)	(0.00005)
DIS_SUB	-0.05859**	-0.05356**	-0.02637
	(0.01286)	(0.01126)	(0.02049)
DIS_CBD	-0.01104	-0.01393+	-0.01819*
	(0.00975)	(0.00668)	(0.00613)
PPI	0.00875**	0.00854**	0.00893**
	(0.00169)	(0.00076)	(0.00095)
EC	-0.22839**	-0.23270**	-0.21541**
	(0.02099)	(0.02073)	(0.03072)
AGE		-0.01403**	-0.01626**
		(0.00137)	(0.00257)
NEWSALE		0.05580**	0.08608**
		(0.01652)	(0.02388)
*EC*YR5*		0.12167**	0.07931**
		(0.02192)	(0.02582)
*EC*YR6*		0.10210**	0.07791**
		(0.02346)	(0.02319)
*EC*YR7*		0.12518**	0.08764**
		(0.02493)	(0.02211)
*EC*YR8*		0.13791**	0.10083**
		(0.02633)	(0.02488)
*EC*YR9*		0.15696**	0.12544**
		(0.02262)	(0.02317)
*EC*YR10*		0.16596**	0.12308**
		(0.02166)	(0.03242)
Year dummy	yes	yes	yes
Neighborhood dummy	yes	yes	yes
*Year*Neighborhood dummy*	yes	yes	yes
Observations	35,599	45,824	23,086
Adjusted R-squared	0.924	0.914	0.903

Note 1: This table presents the OLS estimation results with natural log of PRICE as a dependent variable. Model (1) employs observations of condominium transactions in the new sale market while Model (2) employs transactions in both the new sale and resale markets. Model (3) employs the subsample of observations completed before 2009, which belong to the first batch of EC

*projects. The set of interactions, EC*YR5, EC*YR6, . . . , EC* YR10, account for the number of years after the completion of ECs. Other right-hand side variables are defined in Table 2.*

*Note 2: Robust standard errors are clustered by planning areas and reported in parentheses. + P < .10; * P < .05; ** P < .01.*

Turning our attention to the economic impact of restricting property rights, the coefficient for *EC* in the models represents the discount of EC units relative to private condominium units in the new sale market. The results in Table 6 show a negative and statistically significant coefficient for *EC* across all specifications. Its economic impact is quite substantial. Controlling for observed unit and project attributes, this suggests that imposing restrictions on the transferability of property rights for ten years is associated with the initial price reduction of these properties by about 21% (Model 1 and Model 2) compared to similar properties with no restrictions.[27] When we limit our sample to the earlier batch of ECs (Model 3), the initial price discount is about 19%. For illustration, the average private condominium unit in our sample, which was sold for S$845,323, would have a discount of S$169,065 if similar property rights restrictions were imposed. This significant price discount caused by restricting the transferability of property rights is comparable to the 17.7% to 23.1% decrease in residential condominium prices due to age restrictions of occupants in Broward County, Florida (Carter et al. 2012). The magnitude of its effect is larger than the 11% price premium created by an unrestricted pet policy (Lin, Allen, and Carter 2013).

Consistent with houses depreciating as they age, Models 2 and 3 show that the coefficient for *AGE* is negative and statistically significant. The depreciation rate observed for our matched sample, ranging from 1.4% to 1.6% per annum, is slightly smaller with the 2.5% annual

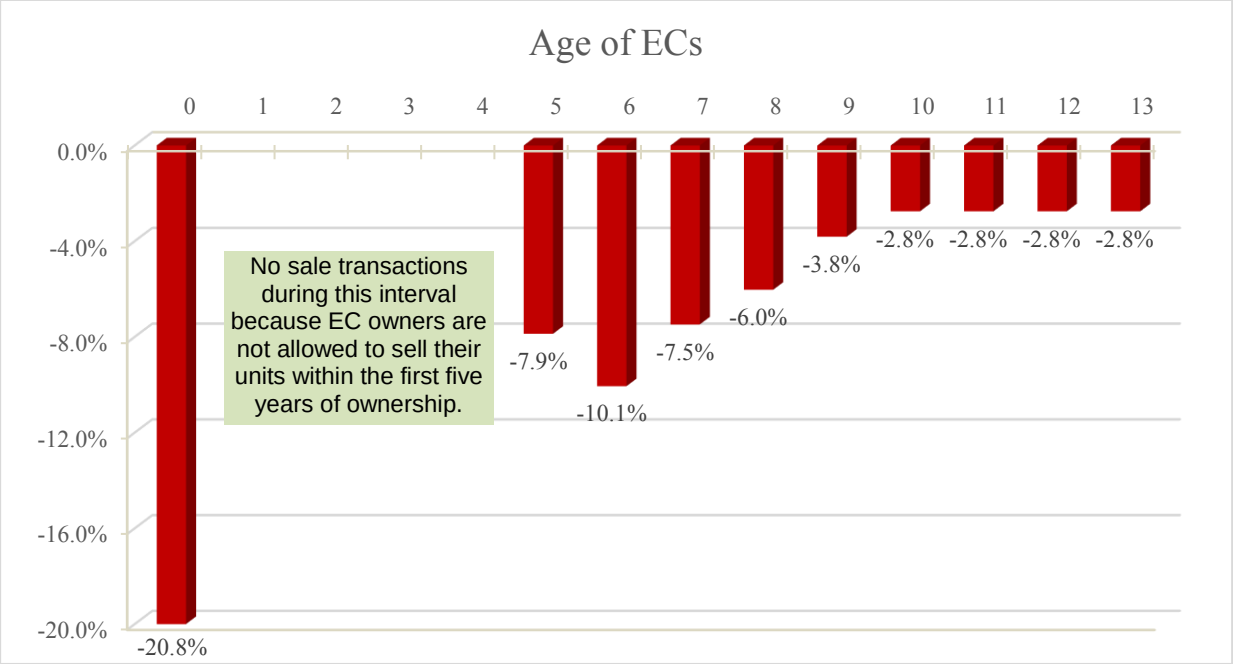
[27] Following Kennedy (1981), the initial price discount for the EC units is calculated as $\exp\left[\widehat{\beta_1} - \frac{1}{2}\text{var}(\widehat{\beta_1})\right] - 1$, where $\text{var}(\widehat{\beta_1})$ is the square of the standard error for $\widehat{\beta_1}$. To provide more accurate estimation results, we use this method for all our reports of the price discount and recovery in this section.

depreciation rate recorded in the US housing market by Harding, Rosenthal, and Sirmans (2007). We believe this is because most units in our sample are relatively new and many transactions are actually new sales. As described in Section 3.3, the purpose of adding the interaction terms between *EC* and *YR* in Models 2 and 3 is to separate the impact of aging among ECs from that among private condominiums. In contrast to the negative coefficient for *AGE*, therefore, the coefficients for *EC*YR* are positive. For example, ECs transacted in the 5th year have about a 13% premium compared with the new sale transactions of EC units (Model 2). In other words, these units have only about an 8% discount compared to the 21% discount found among newly-built EC units. The 13% price recovery for these units is associated with the partial removal of property right restrictions as initial EC buyers can now sell their units to Singaporeans. The coefficients of *EC*YR* stay positive and become larger as the year moves toward the 10th year. ECs transacted in the 10th year and onwards recover about the 18% of their initial discount and these units have only about a 3% discount relative to private condominiums (Model 2). Controlling for observed market changes, this 5% additional price recovery is associated with the full removal of remaining property right restrictions to sell to foreigners.

Figure 4 further illustrates the price discount of an EC unit relative to a similar private condominium unit over time, based on the results of Table 6, Model 2. When the EC unit was sold in the new sale market, that is, before its physical completion, the price discount is at its highest at 21%. The price gap for EC units between one and five years old is not observable, because EC owners are prohibited from selling their units in the first five years of their ownership and they experience complete illiquidity. Starting from the 5th year, the EC units can be sold in the resale market to Singaporean buyers and EC buyers are only subject to partial

illiquidity. At this point, the EC price discount drops to around 8%. The discount is widened slightly and temporarily in the 6th year potentially due to a surge in the supply of ECs available in the resale market. Then, the price gap continues to narrow between the 6th and 10th year, as the EC development moves towards full privatization status. Starting from the 10th year, EC owners are free to sell their units to anyone, including foreign buyers, without any prohibitions and they are not subject to any illiquidity constraints. Figure 4 shows that the price gap between EC and private condominium units decreases to about 3% in the 10th year and onwards.

Figure 4. Simulated Price Gap between ECs and Private Condominiums



Note 1: This figure simulates the price discount of ECs to their counterfactual private condominiums from the time when they are sold in the presale market (age =0) to just after they have crossed the 10-year milestone. Following Kennedy (1981), the initial price discount for the EC units is calculated as exp $\left[\widehat{\beta_1} - \frac{1}{2}var(\widehat{\beta_1})\right]$*-1, where* $var(\widehat{\beta_1})$ *is the square of the standard error for* $\widehat{\beta_1}$ *. To calculate the changes of the price differential between ECs and their counterpart PCs, we use coefficients and standard errors from results shown in Table 6, Model 2.*
The coefficient and standard error of EC are used as $\widehat{\beta_1}$ *and* $var(\widehat{\beta_1})$*. Then, we use the coefficients of the set of interactions (EC*YR5,….., EC*YR10) to account for the price changes of ECs transacted in a given year toward the full removal of property right restrictions.*

Note 2: Transactions at Age 0 include all presale transactions. In Singapore, presales are common for newly developed residential properties.

When we limit the sample to the earlier batch of ECs (Table 6, Model 3), we still find the significant discount of initial sales prices of ECs relative to their counterpart private condominiums. We also find the significant decrease in the price discount of ECs – reducing from the initial discount of 19% to 11% in the 5th year and 6% in the 10th year and onwards. Here, the price recovery from removing the restriction to transfer the property to Singaporeans in the 5th year is smaller at 8% compared with 13% in Model 2 while the additional price recovery from the full privatization in the 10th year remains similar at about 5%. EC units without any property right restrictions have about a 6% permanent discount compared to a 3% discount in Model 2. These results suggest that earlier batches of ECs have experienced the lower levels of the price discount and recovery regarding their forward start put options for the short, temporary period potentially because markets were still uncertain about the outcomes of ECs.

Finally, we attempt to compare these regression results with option price values directly simulated based on the option pricing formula (Barone-Adesi and Whaley, 1987; Rubinstein 1991). As presented in Table 7, results are strikingly consistent with our regression results shown in Table 6. The initial option values of ECs with two forward start American put options (FAP(S) and FAP(F) with the contract dates in the 5th and 10th year, respectively) are about 15.9% lower compared to the initial option values of counterpart private condominiums that have regular American put options (AP(S) and AP(F)). When one of the forward start contracts reaches the contract date in the 5th year, the gap in the option values reduces to about 4.6%. It means the foregone discounts (or the recovery from the EC's initial price) associated with reaching the contract date for FAP(S) and the half milestone for FAP(F) as well as being free from complete illiquidity are about 11.3%. This falls between 8% from the Model 3 and 13%

from the Model 2 (Table 6). As FAP(F) moves toward the contract date in the 10th year, the options prices of ECs and private condominiums converge and finally become same. In other words, the foregone discount associated with moving from the half to full milestone of the contract date for FAP(F) as well as being free from all illiquidity constraints is about 4.6%. This is quite consistent with the 5% price recovery from the full privatization that were shown in our regression results in Table 6 (Model 2 and Model 3) and Figure 3. Further, the magnitude of the discount associated with temporary foreign transferability restrictions and partial illiquidity from these restrictions[28] is comparable to the 10% discount observed by Bailey and Jagtiani (1994) on stocks in the Thai Main Board, which are subject to permanent foreign ownership restrictions.

While the theoretical calculation indicates that ECs' option prices completely converge with the prices of private condominiums after contract dates, our regression results using the actual transaction data suggest a remaining price differential between them even after the removal of property right restrictions. We believe that there are two possible reasons. As we have not included explicit controls for housing quality in our main regressions, unobserved lower quality of ECs compared to their counterpart private condominiums may explain a permanent discount attached to EC units. In Section 4.3, we attempt to address this issue. On the other hand, as many prior studies demonstrate that the presence of place-based subsidized housing reduces nearby housing prices (e.g. Cummings and Landis 1993; Galster et al. 1999; de Souza Briggs et al. 1999), a remaining 3% discount for ECs may be due to negative perceptions on place-based subsidized housing rather than the physical inferiority of such housing.

[28] As the 5% foregone discount does not account for the discount associated with reaching the first half milestone of the contract date for FAP(F), the total discount associated with FAP(F) should be larger than 5%.

Table 7. Results of Option Price Values Based on the Option Pricing Formula

Year	0	1	2	3	4	5	6	7	8	9	10
Option Price for ECs											
FAP(S)	$223,095	$234,248	$238,887	$243,618	$248,442	$253,361	$253,409	$253,452	$253,488	$253,518	$253,542
FAP(F)	$202,539	$212,635	$216,833	$221,114	$225,480	$229,931	$234,471	$239,100	$243,820	$248,633	$253,542
Total	$425,634	$446,883	$455,720	$464,732	$473,922	$483,293	$487,880	$492,552	$497,308	$502,152	$507,083
Option Price for Private Condominiums											
AP(S)	$252,927	$253,118	$253,186	$253,249	$253,308	$253,361	$253,409	$253,452	$253,488	$253,518	$253,542
AP(F)	$252,927	$253,118	$253,186	$253,249	$253,308	$253,361	$253,409	$253,452	$253,488	$253,518	$253,542
Total	$505,855	$506,235	$506,371	$506,498	$506,615	$506,722	$506,819	$506,904	$506,976	$507,037	$507,083
Option Price Differences											
Discount for ECs	-15.9%	-11.7%	-10.0%	-8.2%	-6.5%	-4.6%	-3.7%	-2.8%	-1.9%	-1.0%	0.0%

Note 1: This table shows the option price values directly simulated based on the option pricing formula. We calculate the American put option attached to private condominiums and values of forward start American put option attached to ECs over time. For this calculation, we assume that the current prices for ECs and private condominiums are same as we control for all other unit and development characteristics (i.e. the average price of all new sales in our matched sample, $797,169) and their strike prices are same as the current prices. We use the average annual price change for the volatility (15.39%), the market interest rate for the risk-free rate (2%), the market yield of condominiums for the dividend (2.54%), and the lease duration for the maturity (99 years).

Note 2: As pretend in Section 2.3, AP(S) is the option to sell the property to Singaporean residents at any time and AP(F) is the option to sell the property to foreigners at any time. Unlike these options given to the private condominiums, newly built EC units have FAP(S) which is the option to sell the property to Singaporeans starting only at year 5 and FAP(F) which is the option to sell the property to foreigners starting only at year 10. In our analysis, we assume that the only difference between FAP(S) and FAP(F) is the contract date.

4.3. Robustness Checks

First, as mentioned in Section 4.2, one potential competing hypothesis is that the significant discount for ECs is not from the property right restrictions but from the significantly lower quality and lack of amenities of ECs. Thus, we collect information on the construction quality[29] and project amenities of ECs and private condominiums in our matched sample. From the t-test results (see Appendix 4), we find little evidence that the construction quality and amenities of private condominiums are superior to those of ECs. We incorporate these variables in our regression model as control variables. Results presented in Table 8 (Model 1) show that construction quality has a positive impact on the pricing of condominium units. While the common project amenities such as playground, gym, and BBQ pit that are available in most condominiums appear insignificant to prices, some unique amenities like sauna and mini mart have a positive effect.

Most importantly, results (Model 1, Table 8) demonstrates that the initial price discount of ECs compared with their counterpart private condominiums is consistent with that shown in Table 6 (Model 2) even after controlling for construction quality and project amenities. When using this result to perform a simulation in the same way as we did for Figure 4 (not shown), we also find

[29] Under the Construction Quality Assessment System (CONQUAS) scheme, the workmanship and construction quality of new buildings in Singapore is assessed independently by the regulators throughout their construction phase. The scoring metric was first introduced by the BCA in 1989 as a standardized method of quality assessments for homebuilders to set targets for their contractors and to grade the quality of their finished buildings. For more information on the CONQUAS scheme, see Ooi, Le, and Lee (2014). As this CONQUAS score information is publicly published, there is no information asymmetry between developers and buyers (Chau and Choy 2011). The assessment covers three main components, namely structural, architectural, and mechanical and electrical works. An aggregate score (out of 100%) is given for each building. For example, a score of 80 means that 80% of the items checked for workmanship quality met the CONQUAS standard. Due to missing information, the total number of observations is reduced from 22,912 to 16,713 units for ECs and from 22,912 to 16,501 units for the matched private condominiums.

the consistent pattern for ECs' discount over time. The initial discount for ECs is about 20% and the foregone discount associated with the partial removal of property right restrictions in the 5th year is about 11%. After the 10-year milestone when all property right restrictions are removed, the price gap between EC and private condominium units is about 1.5%, which is even smaller than 3% from our main results (Table 6, Model 2). Based on these findings, we can safely conclude that the initial discount for ECs and price recovery of ECs over time are significant even after controlling for the differences in the construction quality or project amenities. They also indicate that the evolution of ECs' pricing is largely explained by property right restrictions, while a remaining permanent discount of 1.5% for ECs is likely to be attributable to negative perceptions attached to subsidized housing or unobserved differences in housing quality between ECs and private condominiums.

Second, we did our best to get rid of observed differences between ECs and private condominiums by using a very stringent matching approach and including the construction quality and set of project amenities. However, one may still be concerned about unobserved differences for our matched sample and potential statistical biases. To test the stability of our estimation result of ECs' discount, we use the bounding technique (Altonji et al. 2005; Oster 2013). Setting the maximum R^2 to be 1 and assuming the proportional selection relationship on observed and unobserved variables, we calculate the coefficient of proportionality δ for which the effect of EC is zero ($\beta = 0$).[30] The bounding estimate of δ is 6.51 which significantly exceeds the common heuristic value of 1. In other words, the unobservable would need to be 6.5 times as

[30] For the calculation of bounding estimates, we use PSACALC, the STATA module provided by Oster. See https://ideas.repec.org/c/boc/bocode/s457677.html.

important as the observables to produce the zero discount in initial prices of ECs. Given the stringent matching and detailed set of controls and fixed effects that we include in our regression model, we believe that this is very unlikely. Based on other test results using the similar bounding technique, we are also confident to conclude the non-zero effects of the set of interactions of EC and YR. For example, the bounding estimate of δ for EC*YR5 and EC*YR10 are 2.82 and 96.98, respectively.

Third, our main model specification analyzes specific price changes in resale prices of ECs transacted in each year starting the 5th year. As price changes may be only distinct at the particular milestone years, we only include two variables, *EC*YR5* and *EC*YR10* and rerun our regression. Results shown in Table 8 (Model 2) suggest that the initial discount of ECs is robust at around 20.7%.[31] The coefficients for both *EC*YR5* and *EC*YR10* are positive and statistically significant. The magnitudes of the price recovery in the 5th and 10th year are 13.6% and 17.8%, respectively, and the permanent discount for ECs is about 3%. These are consistent with the results in Table 6 (Model 2). To address potential remaining confounding changes in market conditions even after controlling for the area-by-year fixed effects, we also attempt to use different sample cuts and test the stability of our results. We limit one sample to be transactions between 2001 and 2009 and another to be transactions after 2009 and rerun regressions with the same specification used for Table 6 (Model 2). Results (not shown) suggest that while the initial discount is slightly larger for the post-2009 sample at 22.5%, the pattern of the price recovery and a 2-3% permanent discount of ECs found to be consistent for both sample cuts. Hence, our

[31] Similar to what we did in Section 4.2, we follow Kennedy (1981) to report the price discount and recovery.

main findings on the economic impact of temporary property right restrictions remain robust to different model specifications and different sample cuts.

Table 8. Robustness Checks

Variables	(1) Adding Construction Quality and Project Amenities	(2) Only with particular milestone years	(3) Comparison group within 1km radii of ECs
Constant	11.9283**	11.9853**	12.0972**
	(0.1214)	(0.1290)	(0.1764)
FL_AREA	0.01133**	0.01195**	0.01201**
	(0.00063)	(0.00051)	(0.00053)
FL_AREA^2	-0.00002**	-0.00002**	-0.00002**
	(0.00000)	(0.00000)	(0.00000)
FL_LEVEL	0.00976**	0.01036**	0.01058**
	(0.00169)	(0.00184)	(0.00160)
FL_LEVEL^2	-0.00022*	-0.00028**	-0.00025**
	(0.00008)	(0.00009)	(0.00008)
DEVT_SIZE	-0.00010*	-0.00009*	-0.00008*
	(0.00004)	(0.00003)	(0.00003)
DIS_SUB	-0.04453**	-0.05349**	-0.06568**
	(0.01134)	(0.01131)	(0.00586)
DIS_CBD	-0.01125	-0.01360+	-0.01760**
	(0.00707)	(0.00680)	(0.00474)
PPI	0.00849**	0.00857**	0.00868**
	(0.00071)	(0.00075)	(0.00084)
EC	-0.22826**	-0.23200**	-0.23137**
	(0.02850)	(0.02095)	(0.02398)
AGE	-0.01740**	-0.01322**	-0.01505**
	(0.00200)	(0.00144)	(0.00132)
NEWSALE	0.03547+	0.06390**	0.03698*
	(0.01750)	(0.01661)	(0.01653)
*EC*YR5*	0.10958**	0.12741**	0.11059**
	(0.02538)	(0.01863)	(0.02275)
*EC*YR6*	0.10970**		0.09206**
	(0.03423)		(0.02264)
*EC*YR7*	0.13755**		0.14766**
	(0.03007)		(0.01887)
*EC*YR8*	0.15600**		0.15190**
	(0.03198)		(0.02405)
*EC*YR9*	0.16466**		0.15926**
	(0.03349)		(0.03183)
*EC*YR10*	0.17440**	0.16418**	0.16292**
	(0.03422)	(0.02154)	(0.02078)
CONST_QUALITY	0.00052*		
	(0.00164)		
Project Amenities	yes	no	no
Year dummy	yes	yes	yes
Neighborhood dummy	yes	yes	yes

*Year*Neighborhood dummy*	yes	yes	yes
Observations	33,214	45,824	38,556
Adjusted R-squared	0.918	0.914	0.920

Note 1: Model 1 adds the construction quality and project amenity variables to the model specification used for Table 6 (Model 2). It uses the matched sample of the treatment group (ECs) and comparison group (PCs) within 2 km radii from ECs after excluding observations without CONQUAS (construction quality) data. Since the CONQUAS scores may be correlated with the attributes of the development and market, we try to employ both the raw and orthogonalized CONQUAS scores as alternative proxies for construction quality. The latter are essentially the residuals from regressing the actual CONQUAS scores against a set of development characteristics and a set of fixed effects for planning districts and time. Results are very similar and we present the result using the raw CONQUAS scores.

Note 2: Model 2 removes several interactions of EC and YR in between the 5^{th} and 10^{th} year milestones from the model specification used for Table 6 (Model 2). It uses the matched sample of the treatment group (ECs) and comparison group (PCs) within 2 km radii from ECs..

Note 3: Model 3 presents the regression results using the matched sample of the treatment group (ECs) and comparison group (PCs) within 1 km radii from ECs. The model specification is identical to those in Table 6 (Model 2). The matched sample is comprised of 19,278 EC unit transactions and 19,278 PC unit transactions. The matching process is identical to that shown in Table 4 (caliper=0.003 with no replacement), and all variables passed Cochran's rule of thumb.

*Note 4: Robust standard errors are clustered by planning areas and reported in parentheses. + P < .10; * P < .05; ** P < .01.*

Finally, we test if our estimation results using the matched sample of ECs and private condominiums are robust to more rigorous matching methods. We re-perform our analysis by restricting the potential comparison group within the 1km radius of each EC development, and by matching ECs with these private condominiums using complex- and unit-level characteristics, transaction date, and administrative planning area. Model 3, Table 8 demonstrates that the results using this new matched sample are quite robust with our main results shown in Table 6 (Model 2). We consistently find the significant initial discount of ECs and their price recovery over time. In addition, we experiment with other robustness tests, such as using a one-to-many matching procedure instead of a one-to-one matching; controlling unobserved fixed effects for the individual project developments; and using a smaller geographical boundary (geographic

sectors[32]) for the neighborhood fixed effects. The regression results on the economic impact of temporary restrictions on property rights are robust to these tests.[33]

4.4. Implications for Affordable Housing Policies

First, according to our estimation results presented in Section 4.2 and Section 4.3, restricting the right to transfer one's property for a temporary period significantly reduces the initial house prices. For illustration, consider the average private condominium unit in our sample, which would have the transaction price of S$845,323. However, the same unit would be worth around S$169,065 less when two kinds of property rights restrictions are imposed on the initial homebuyer. In other words, these restrictions have the effect of making EC units more affordable to initial purchasers. Our results indeed demonstrate that the major source of such initial affordability of EC units is the lower option value of ECs associated with the forward start contracts.[34] Of course, initial EC buyers would face a trade-off between paying a lower initial price and forfeiting the freedom to sell or rent their units before they reach contract dates (the 5th and 10th year for FAP(S) and FAP(F), respectively). We believe that the temporary restraint and forward start contracts would be less of a concern for bona fide homebuyers who intended to occupy, rather than speculate on, the units.

[32] Singapore is divided into 118 geographic sectors for computing the development charge, which is a tax on development projects that involve an increase in the value of land, such as rezoning to a higher value use or increasing the plot ratio.

[33] Results are not shown, but are available upon request.

[34] The new EC buyers are given two forward start American put options (FAP(S) and FAP(F)) instead of American put options given to private condominium buyers. This would decrease the EC buyers' utility and the market price for ECs is likely to clear at a lower price.

Second, our analysis suggests that ECs could be a good stepping stone for middle-income households that aspire to transition from public housing to private condominiums. Analysis results reveal that 17,546 out of 22,912 EC buyers from the final matched sample (76.6 %) lived in public housing, while only about 60% of private condominium buyers from the same sample lived in public housing. This is not surprising, because there are eligibility conditions for ECs. Our estimation results report that if the buyer is eligible to purchase a new EC unit and occupy the unit beyond the contract dates, the discount associated with forward start contracts would disappear and the price difference of the EC unit with comparable private condominiums would become much smaller over time. Hence, the initial EC buyer who paid the lower price in the beginning would be able to achieve higher capital gains compared to those who purchased the comparable private condominiums. As the EC buyers have given up American put options with which they could sell their units at any time even before contract dates, however, these capital gains would be matched by their foregone opportunities for exercising the option. Again, if these buyers do not have strong speculative motives, they may not deem this opportunity cost to be very large.

Third, it appears that most economic benefits of ECs are transferred to citizens and PRs. Singaporean residents who are eligible and can afford to purchase the new EC units directly from the developers would enjoy the highest initial discount as well as the highest potential capital gains if they could continue to occupy the units and wait until the contract dates. Our analysis results shown in Table 6 (Model 2 and Model 3) and Figure 4 also suggest that Singaporean and PRs buying ECs from the resale market starting from the 5^{th} year can still share some of the

economic returns associated with the full removal of property right restrictions at the 10th year and onwards.

Finally, given the initial discount and capital gains of ECs, one may be concerned about the significantly higher or lower turnover of ECs. We find that ECs experience a slightly higher resale probability than private condominiums do between the 5th and 9th years and the resale probabilities of ECs and PCs converge from the 10th year. On the other hand, the resale probability of ECs is not too small, either. There were 9,742 new sales for the first-batch EC projects (completed before 2009, so 7 or more years old as of 2016) and 5,100 units among them have transacted in resale markets. The probability that initial EC buyers remain in their units for 7 or more years and even after the partial removal of property right restrictions is about 48%. As the annual average turnover rate of private condominiums is about 7% during the first 12 years based on our data, the turnover patterns of ECs and private condominiums are not significantly different. We believe that the absence of extreme turnover patterns of ECs suggests that initial discounts and capital gains of ECs are economically fair because they directly reflect the loss and recovery of option values.

5. Conclusion

This paper contributes to the literature by offering empirical evidence on the economic impact of restricting property rights, namely the rights to rent or sell a property. Based on a carefully matched sample of 22,912 ECs and 22,912 private condominiums transacted between 1996 and 2016 in Singapore, we find that EC units are sold at 21% lower than the otherwise identical private condominiums, during the initial launch. The magnitude of the discount provides an

upper limit to the impact of imposing restrictions on the transferability of property rights for ten years. It is possible that the discount could also be attributable to the eligibility conditions that filter some potential buyers who do not meet the conditions, negative perceptions attached to subsidized housing or unobserved differences in housing quality between ECs and private condominiums. We observe that the price discount narrows to 8% in the 5th year, when initial EC buyers are allowed to sell their units in the resale market to Singapore residents. The price gap becomes smaller over the next few years and decreases to about 3% in the 10th year and onwards, when the restrictions on transferability of property rights are completed removed. The remaining 3% discount is likely to be a permanent discount due to unobserved lower quality of ECs and negative perceptions attached to them.

These results suggest that placing property right restrictions on the owners' rights to rent or sell their residential property has a significant, negative impact on property values; however, this impact is removed once the restriction is lifted. This economic impact associated with the transferability of property rights is about 18% and appears quite comparable to the impact associated with use rights such as keeping a pet in the property and restricting the age of the occupants. Our results also suggest a significant role of illiquidity to asset pricing in the context of real estate. These results suggest that complete and partial illiquidity generated by the forward start American put options during the 10 years leads to about a 17% discount in the option prices during this period. Compared to complete illiquidity for the first five years, partial illiquidity caused by restrictions to sell the property to foreigners has a reduced but still negative impact on asset pricing and this is comparable to the impact of the permanent foreign ownership restrictions found in the stock markets.

Our empirical results have an important implication for affordable housing programs that especially target middle-class citizens. Initial EC buyers not only enjoy the benefits of living in a higher quality product and environment, but also stand to reap higher investment return as their EC units appreciate in value when the property rights restrictions are lifted. Assuming a price discount of about S$140,000 per EC unit, and multiplying this by the total number of EC units (including those that have been completed as well as those in the pipeline), the potential capital appreciations amounted to about S$1.44 billion and S$2.2 billion for the pioneering and recent EC vintages, respectively. The aggregate sum of S$3.64 billion is enjoyed by about 32,817 "sandwiched" class families that are eligible and can afford to purchase the EC units directly from the developers.

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Appendix 1. List of ECs

No	Development	Units	Launch	Completion	MOP Expiry	Full Privatization
1	EASTVALE	312	1996 Jun	1999	Yes	Yes
2	WESTMERE	280	1996 Jun	1999	Yes	Yes
3	PINEVALE	322	1997 Dec	1999	Yes	Yes
4	SIMEI GREEN CONDOMINIUM	602	1997 Jan	1999	Yes	Yes
5	CHESTERVALE	396	1997 Jun	1997	Yes	Yes
6	WINDERMERE	395	1997 May	1999	Yes	Yes
7	SUMMERDALE	432	1998 Apr	2000	Yes	Yes
8	THE RIVERVALE	671	1998 Apr	2000	Yes	Yes
9	YEW MEI GREEN	712	1998 Jan	2000	Yes	Yes
10	NORTHOAKS	720	1998 Jul	2000	Yes	Yes
11	THE FLORIDA	496	1998 Jul	2000	Yes	Yes
12	WOODSVALE	696	1998 Jul	2000	Yes	Yes
13	THE FLORAVALE	754	1999 Apr	2003	Yes	Yes
14	BISHAN LOFT	384	2001 Aug	2003	Yes	Yes
15	THE EDEN AT TAMPINES	430	2001 Jun	2003	Yes	Yes
16	THE DEW	248	2001 May	2003	Yes	Yes
17	LILYDALE	318	2001 Nov	2003	Yes	Yes
18	NUOVO	297	2001 Oct	2004	Yes	Yes
19	THE ESPARIS	274	2002 Aug	2005	Yes	Yes
20	PARK GREEN	391	2002 Jan	2004	Yes	Yes
21	WHITEWATER	397	2002 Oct	2005	Yes	Yes
22	THE QUINTET	459	2003 Sep	2006	Yes	Yes
23	LA CASA	444	2005 May	2008	Yes	No
24	PRIVE	680	2010 Dec	2014	No	No
25	ESPARINA RESIDENCES	573	2010 Oct	2014	No	No
26	THE CANOPY	406	2010 Oct	2014	No	No
27	ARC AT TAMPINES	574	2011 Aug	2015	No	No
28	AUSTVILLE RESIDENCES	540	2011 Jan	2014	No	No
29	RIVERPARC RESIDENCE	504	2011 Jul	2014	No	No
30	BELYSA	315	2011 May	2014	No	No
31	CITYLIFE@TAMPINES	514	2012 Dec	2016	No	No
32	TWIN WATERFALLS	728	2012 Feb	2016	No	No
33	1 CANBERRA	665	2012 Jan	2015	No	No
34	BLOSSOM RESIDENCES	602	2012 Jan	2014	No	No
35	THE RAINFOREST	466	2012 Jan	2015	No	No

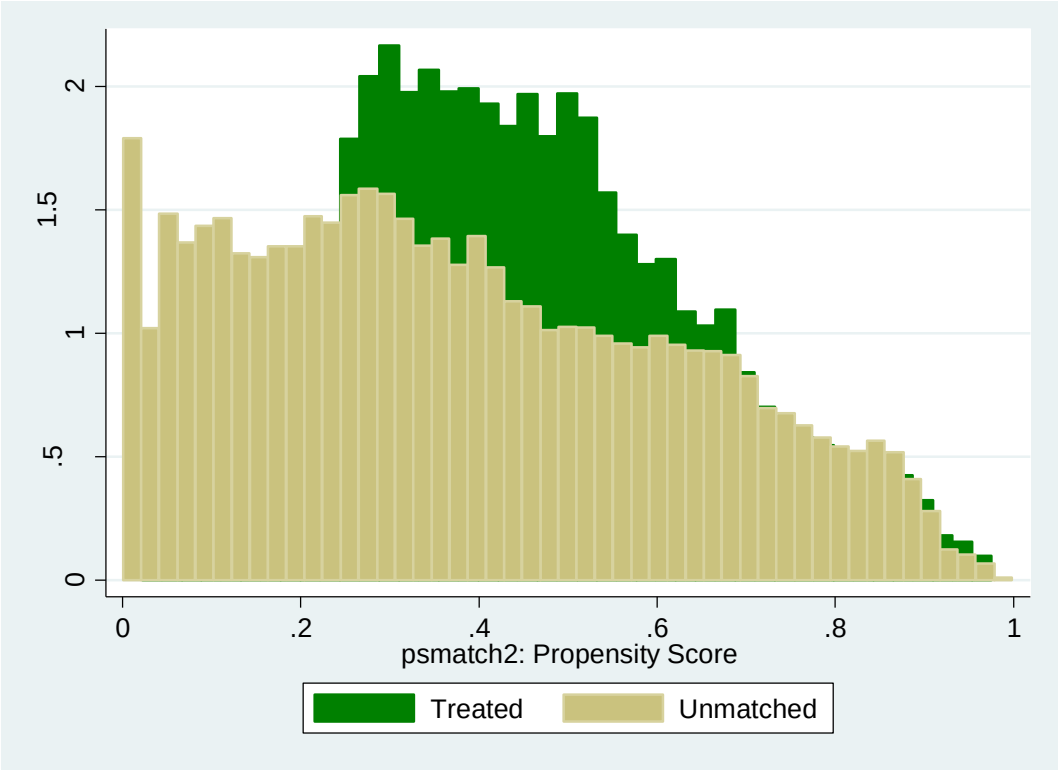
36	THE TAMPINES TRILLIANT	670	2012 Jun	2015	No	No
37	WATERCOLOURS	416	2012 May	2016	No	No
38	THE TOPIARY	700	2012 Nov	2016	No	No
39	WATERBAY	383	2012 Oct	2016	No	No
40	HERON BAY	394	2012 Sep	2016	No	No
41	TWIN FOUNTAINS	418	2013 Mar	2016	No	No

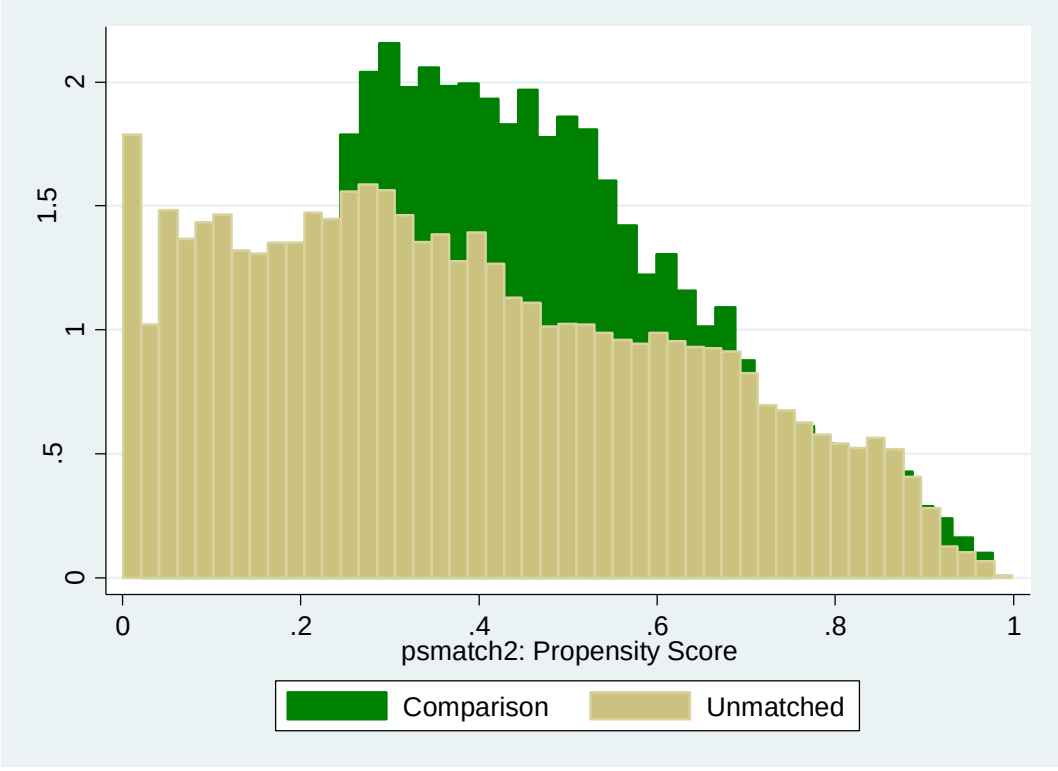
Note: This table lists the details of the sampled ECs and their legal status as of June 2016. "Units" refers to the number of dwelling units in the development. "Launch" and "Completion" refer to the month the project was first marketed and finally completed, respectively. "MOP expiry" refers to the satisfaction of the minimum occupation period, while "full privatization" refers to the complete removal of the property rights.

Appendix 2. Cochran's Rule of Thumb Calculation for the Matched Sample Shown in Table 5

		Mean		Difference	% reduction	Difference in means as proportion of standard deviation	Cochran's rule of thumb
		Treatment: EC	Comparison: PC				
T_YR	Unmatched	2008.5	2008.1	0.46			
	Matched	2008.4	2008.2	0.20	57%	0.0344	pass
C_YR	Unmatched	2008.4	2008.4	0.01			
	Matched	2008.2	2008.2	0.00	100%	0.0000	pass
FL_AREA	Unmatched	115.5	107.2	8.31			
	Matched	114.1	112.8	1.26	85%	0.0394	pass
FL_LEVEL	Unmatched	8.5	8.3	0.23			
	Matched	8.5	8.5	0.04	83%	0.0070	pass
SALE_TYPE	Unmatched	1.2	1.3	0.12			
	Matched	1.2	1.2	0.01	90%	0.0293	pass
DEVT_SIZE	Unmatched	486.8	556.8	70.00			
	Matched	509.5	509.6	0.11	100%	0.0007	pass
DIS_SUB	Unmatched	1.0	0.9	0.12			
	Matched	1.0	1.0	0.01	90%	0.0213	pass
DIS_CBD	Unmatched	15.0	13.6	1.46			
	Matched	14.5	14.5	0.03	98%	0.0116	pass
NEIGHBORHOOD	Unmatched	12.2	9.4	2.88			
	Matched	11.5	11.5	0.05	98%	0.0110	pass

Appendix 3. Comparison of Propensity Score Histograms with the Full, Unmatched Sample





Appendix 4. Comparisons of Construction Quality and Amenities of the Matched Sample

Panel A

	Treatment Group: ECs		Comparison Group: PCs		Difference
	Mean	S.D.	Mean	S.D.	P-Value ($Mean_{PC} > Mean_{EC}$)
Construction Quality	83.11	7.27	85.38	6.46	0.112
No. Observations	16,713		16,501		

Panel B

Amenities at the Project Level	Treatment Group: ECs		Comparison Group: PCs		Difference
	Mean	S.D.	Mean	S.D.	P-Value ($Mean_{PC} > Mean_{EC}$)
Swimming Pool	0.974	0.161	0.998	0.042	0.000
Children Pool	0.611	0.487	0.504	0.500	1.000
BBQ Pit	0.940	0.237	0.912	0.283	1.000
Gym	0.944	0.231	0.807	0.394	1.000
Mini mart	0.048	0.214	0.023	0.149	1.000
Pavilion	0.172	0.378	0.160	0.367	0.999
Playground	0.884	0.321	0.853	0.354	1.000
Sauna	0.533	0.499	0.484	0.500	1.000
Club House	0.645	0.479	0.646	0.478	0.415
Exercise Area	0.657	0.475	0.626	0.484	1.000
Basketball Court	0.118	0.323	0.100	0.300	1.000
Tennis Court	0.885	0.319	0.892	0.310	0.006
Lounge	0.098	0.298	0.044	0.204	1.000
Game Room	0.109	0.312	0.070	0.255	1.000
No. Observations	22,912		22,912		

Note 1: Construction quality data are the scores for each building (out of 100%) from the CONQUAS scheme managed by the BCA. For more information on the CONQUAS scheme, see Ooi, Le, and Lee (2014).

Note 2: Amenities of each development project of ECs and PCs are collected from propertyguru.com.sg, which is equivalent to zillow.com in the United States.