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Article

Economies of Scale of Co-living – an empirical study of the New Zealand Rental Housing Markets

Yiu, C.Y.[1], Cheung, K.S.[1]*, and Xiong, C.[2,]
[1] Department of Property, University of Auckland Business School
[2] Three Gorges Finance Co. Ltd., Beijing 100197, China
* Correspondence: william.cheung@auckland.ac.nz

Abstract: Co-living was commonly considered inferior compared to single-family occupied homes. However, with the chic of sharing economy and the sophistication of online peer-to-peer accommodation platforms, co-living has become more common and popular nowadays. Yet, there have been very few empirical studies on the co-living discount in rents and the economies of scale benefit to landlords, probably due to the lack of data. This study is a novel attempt to examine the disutility of co-living and the economies of scale effect by using hedonic price model to estimate the impacts of the number of co-living flatmates on total rents, *ceteris paribus*, in the New Zealand housing markets. The results confirm the hypothesis of non-linear economies of scale benefit of co-living to the landlords. There is a 17.3% substantial fall in rents between 0 and 1 flatmate, but a gradual marginal increase in total rents from 2 flatmates onwards. This study also provides comprehensive results on other key determinants of co-living rents.

Keywords: co-living; flatmates; housing rents; New Zealand

1. Introduction

Co-living may sound like a new trendy term, but collective housing, where tenants share communal spaces and facilities, has been long-standing in low-rent or informal housing markets (Leung & Yiu, 2019). Co-living was typically considered inferior in the past. However, with the chic of sharing economy and the sophistication of online peer-to-peer accommodation platforms, co-living has gained popularity and is considered by some organisations as a solution to the housing affordability crisis, especially in cities with high house rents (Corfe, 2019). Also, co-living provides spaces and opportunities for better social interactions and engagements with other tenants.

Several models of shared living space exist, including co-housing, co-living and

sub-divided units. Co-housing is like a dormitory where tenants share both private and communal living spaces. Co-living is defined as a housing arrangement in which individual tenants have a private self-contained housing space (a house, a flat, or a bedroom) but share a range of communal facilities with other tenants, such as shared living areas, dining spaces, gardens, etc. This is a common residential community living model in many Western countries, including New Zealand, as the case in this study. Co-living has become a new way of living in cities focusing on community and convenience. (Coricelli, 2022) Sub-divided units, on the other hand, are more common in high-density cities such as Hong Kong, and they are independent housing sub-units without sharing any space except the main entrance and the corridor leading to the units.

More and more startups have been established to run co-living businesses, such as *Common.com* in New York, the U.S., *Old Oak (thecollective.com)* in London, the U.K., *Woozoo (coliving.com)* in Seoul, South Korea, *Oootopia (coliving.com)* in Hong Kong and *thecoh.co.nz* in Auckland, New Zealand. These are cities witnessing notoriously unaffordable housing rents. Taking the rental index of New York as 100, that of Hong Kong, London, Auckland and Seoul are 67.99, 61.69, 39.99, and 33.18, respectively, in mid-2022 (Numbeo, 2022). Furthermore, they are famous cities accommodating many visitors, ex-pats, as well as local and international students of colleges and universities. The demands for rental housing in these cities are incredibly high and volatile, especially during peak seasons. This explains why co-living is commonly and intensively adopted in these cities.

Yet, there have been very few studies on the rents of co-living. It is plausible to expect a discount in renting a co-living home in comparison with a single-tenant occupied home, *ceteris paribus*, due to the disutility of less privacy. For example, Kim, Woo & Cho (2020) surveyed 1000 young single adults in Seoul and found that the willingness to pay rent for a shared housing unit was about two-thirds of the average market rent. The vast difference in the willingness to pay between single-tenant-occupied and co-living homes is also confirmed to be the value of privacy. Unfortunately, their results are limited by the stated preference approach and cannot identify the actual discount in rents of various scales of co-living. Yan (2020) empirically studied the discount in co-living in China, but the dataset is very small, with just 1,158 housing data in 4 cities. The model simply includes a co-living dummy variable to test the switching discount from 'whole rent' to 'share rent'. The hedonic price model is subject to omitted variables bias as it is hard to collect comprehensive attributes in measuring housing characteristics and amenities. The rental discount of co-living is also unlikely to be linear, but subject to a diminishing marginal disutility pattern as the value of privacy at home is largely lost even when it is shared with just one flatmate. Also, all these studies

considered co-living from renters' perspectives. The commonplace of co-living in big cities reflects the financial viability of the business model to landlords. We hypothesise that shared living spaces such as co-living can achieve economies of scale benefit to the landlords, even though there is a disutility discount to individual tenants.

This study exploits a comprehensive rental listing database in New Zealand to examine the rental discount from a single-family occupied housing unit to a co-living unit and the economies of scale power of the number of flatmates to the total rental incomes. New Zealand's housing market is investigated because it has a more balanced distribution between ownership outright, ownership with a mortgage, and private rental, as shown in **Table 1** (OECD, 2020). Also, it has a negligible proportion of subsidizedthe subsidised rental market and other unknown tenures. This study is novel not only because there have been very few studies on the determinants of housing rents. More importantly, no previous studies have tested the hypothesis of the economies of scale effect of co-living.

The research question of this study is on the financial costs and benefits of co-living from both renters' and landlords' perspectives. Theoretically, renters would forsake some values of privacy, but enjoy closer social interactions with flatmates in co-living setting. Landlords, on the other hand, may suffer from a rental discount for a small scale co-living, but can grasp a premium by achieving economies of scale. This paper is divided into six sections. The ensuing section reviews the related literature on the co-living arrangement, and the determinants of co-living rents. Section 3 describes the data and the research design. Sections 4 and 5 report and discuss the empirical results. Section 6 concludes.

Table 1. Housing Tenure Distributions of Some Major Economies

Country	Own outright	Owner with mortgage	Rent (private)	Rent (subsidised)	Other, unknown
Australia	31.1%	31.8%	32.1%	..	4.9%
Canada	29.9%	39.3%	30.8%	..	..
France	38.6%	23.1%	17.5%	18.5%	2.3%
Germany	25.6%	18.2%	47.3%	6.6%	2.3%
Netherlands	9.2%	48.8%	40.8%	..	1.1%
New Zealand	31.2%	34.3%	32.4%	..	2.1%
Switzerland	4.5%	33.5%	55.5%	5.7%	0.9%
United Kingdom	39.3%	28.0%	11.1%	20.0%	1.6%
United States	25.7%	39.7%	32.7%	..	1.8%

Source: OECD (2020)

2. Related Literature

The concept of co-living has started gaining traction from researchers across disciplines such as property, urban planning, sociology and urban geography. Researchers have recognised an increase in co-living in many developed cities and have attempted to contextualise the co-living trend within housing studies research. In essence, co-living is a "for-profit, intentional, purpose-driven, privately managed and delivered shared housing, emerging as a commercial [response] to the specific needs of young professionals sharing in large cities" (Heath et al. 2018, p. 129).

Indeed, co-living is associated with financial necessities, practical reasons, or deliberate intentions to live in a community (Vestbro 1992). Demographic changes, such as population growth, income stagnation, and asset price inflation, have resulted in a lack of affordable housing solutions in many cities. They have contributed to the rising of the rental sector (Kemp, 2015) and the surge of home-sharing in short-term and long-term rentals (Maalsen, 2020). Commercially driven co-living rental providers have emerged in London, New York and some other cities adding housing share options.

Unlike the traditional housing market, where the supply of housing units depends on new housing production and construction costs (Ibrahim et al., 2022), the co-living arrangement can expand and contract more flexibly within the existing housing stock, making housing supply more elastic. Nevertheless, it is difficult to obtain information about supply and demand in this informal housing sector (See Hargreaves & Chen (2001) and Farhi & Young (2015), which evaluates different residential rental indices but not on shared housing or co-living. Many shared accommodation arrangements are not regulated via formal rental tenancy agreements and are rarely reported as a specific market sector. Census data in most nations report on the number of group households, but this provides the only reference point to determine the extent to which the housing stock is being "shared" by unrelated adults. It also does not differentiate between co-living and subdivided units, etc.

Besides, sharing economies are catalysing the co-living trend. The informal renting of rooms and houses has been enabled by digital platforms for short-term stays through sites such as Airbnb and longer-term house-sharing sites. Co-living housing plays a significant role in the digitalisation of the rental housing market, and this is manifested in an emerging body of literature that highlights the role of digital platforms in searching for houses (Nasreen & Ruming, 2020).

Besides, a growing body of research shows a significant change in housing demographics. People are sharing for a more extended period of time and later

into their life due to delayed pathways into homeownership or out of reach to homeownership with the rapid increase in housing prices compared to wage growth (Maalsen 2019). The barriers to homeownership faced by the younger generation and deterring complexities of the framework regulating the private rented sector make co-living an attractive and viable option, especially with the unaffordable housing market in New Zealand (Hargreaves, 2003).

The benefits of co-living are not only practical and financial but also social. Co-living also offers an instant way into a community and the possibility of establishing social contacts. Despite changing dynamics, and rising economic imperative underpinning decisions to share accommodation and housing costs with others, the social value of shared housing remains strong (Maalsen, 2019). Individuals penalised financially in the housing market may find that co-living can offer opportunities to develop intimate relationships beyond familial networks (Wilkinson 2014).

However, one of the major costs of co-living is on housing privacy. De Macedo, Ornstein & Elali (2022), for instance, found by a literature review that people's quality of life is related to privacy. Bashari et al. (2021) analysed by a structural equation modelling on a questionnaire survey with low-income households in Nigeria, and found a moderating effect of privacy in the residential livability and residents' life satisfaction. In contrast, some studies showed the opposite. For example, Gaeeta & Bridges (2020) and Losada-Baltar et al. (2020) showed the association of loneliness with psychological distress. McCartney & Rosenvasser (2022) also showed a positive correlation between social interactions and students' well-being in university dormitories. However, very few of the previous studies are related to the financial costs and benefits of co-living.

3. Data and Methods

3.1. Data

We collected 99,146 residential rental listings data from TradeMe (2022), one of the biggest online real estate agents. This is one of the most comprehensive data sets of housing rental data, which covers all the residential rental listings in all the major cities of New Zealand, with the end dates of listings from November 2021 to January 2023. Each house's total rent per week is estimated by the listed rent multiplied by the number of flatmates plus one. It represents the maximum total sum of rental income per week generated from renting either a single-family occupied house or a co-living home. The data set also contains various attributes for controlling their effects on rents. These variables include our primary variable of interest, i.e., the number of flatmates (co-living or not); housing types such as apartment, house and townhouse; housing structures such as the number of

bedrooms and bathrooms, facilities and appliances such as washing machines and television, housekeeping rules such as pets and smoking, districts such as Auckland and Wellington, and neighbourhood amenities such as the accessibility to various types of transportation means and shops, etc. As the rental listings are open to all interested parties, it implies that flatmates can be strangers. Detailed descriptions of the variables and their descriptive statistics are provided in **Table 2** and **Table 3**.

Table 2. Descriptions of Variables

Category	Variable	Description
Total Rent	R	Listed rent x (no. of flatmates + 1) in New Zealand dollars (NZD) per week
Rental Types	COL	0=without co-living, 1=with co-living
	NF	Number of flatmates: 0, 1, 2, 3, 4, 5, 6, 7, 8
Property Types	PT	0=Apartment, 1=House, 2=Townhouse, 3=Lifestyle block, 4=Unit
Structure Attributes	NBED	Number of bedrooms: 1, 2, 3, 4, 5, 6
	NBATH	Number of bathrooms: 1, 2, 3
Facilities, Furniture & Appliances	RF	0=without refrigerator, 1=with refrigerator
	TV	0=without television, 1=with television
	BED	0=without bed, 1=with bed
	MW	0=without microwave, 1=with microwave
	OVEN	0=without oven, 1=with oven
	WM	0=without washing machine, 1=with washing machine
	WD	0=without wardrobe, 1=with wardrobe
Housekeeping Rules	SMOKE	1=no smoking, 2=smoking allowed, 3=na
	PET	1=no pets allowed, 2=pets allowed, 3=negotiable, 4=na
Neighbourhood Amenities	SUPER	0=no supermarket nearby, 1=supermarket nearby
	MALL	0=no shopping mall nearby, 1=shopping mall nearby
	HOS	0=no hospital nearby, 1=hospital nearby
	UNI	0=no university/college nearby, 1= university/college nearby
	TRANS	0=no public transportation means nearby, 1=public transportation means nearby
	MOTOR	0=no motorway nearby, 1=motorway nearby
	BEACH	0=no beach nearby, 1=beach nearby
	PARK	0=no park/playground nearby, 1= park/playground nearby
	BAR	0=no club/bar nearby, 1= club/bar nearby
Time	MONTH	End dates of the listings in yyyymm
District	DISTR	78 districts[1]

[1] The top five districts are Auckland City, Wellington, North Shore City, Manukau City, and Hamilton, which account for 26.32%, 9.24%, 8.03%, 7.77%, and 5.4% of listings, respectively.

In the dataset, 23.8% of listings are co-living, and the average number of flatmates is about 2.2. As shown in **Table 3**, small numbers of flatmates are overwhelmingly dominant in the rental market, as the majority of houses in New Zealand are built with less than 5 bedrooms. Less than 5% of the co-living listings have more than 4 flatmates.

Table 3. Descriptive Statistics

Variable	Desc.	Mean	Std. Dev.	Min	Max
R	Total Rents (NZD)	624.176	233.753	155	6,900
COL	Co-living dummy	0.238	0.426	0	1
NF	No. of Flatmates	2.239	1.238	1	8
NF = 0		70,047			
NF = 1		6,962			
NF = 2		7,458			
NF = 3		4,468			
NF = 4		1,943			
NF = 5		633			
NF = 6		182			
NF = 7		65			
NF = 8		147			
PT	Property Type	1.290	1.210	0	4
PT=Apartment		20,038			
PT=House		50,484			
PT=Townhouse		8,496			
PT=Lifestyle block		452			
PT=Unit		12,425			
NBED	No. of bedrooms	2.721	1.148	1	6
NBATH	No. of bathrooms	1.415	0.598	1	3
RF	Refrigerator	0.058	0.234	0	1
TV	Television	0.030	0.171	0	1
BED	Bed	0.088	0.282	0	1
MW	Microwaves	0.022	0.146	0	1
OVEN	Oven	0.030	0.172	0	1
WM	Washing Machine	0.063	0.243	0	1
WD	Wardrobe	0.012	0.109	0	1
SMOKE	Smokers Okay	1.194	0.557	1	3
PET	Pets Okay	1.344	0.772	1	4
SUPER	Supermarket	0.085	0.278	0	1
MALL	Mall	0.246	0.431	0	1
HOS	Hospital	0.028	0.165	0	1
UNI	University or College	0.122	0.327	0	1
TRANS	Public Transportation	0.159	0.365	0	1
MOTOR	Motorway	0.066	0.248	0	1
BEACH	Beach	0.047	0.212	0	1
PARK	Park or Playground	0.116	0.320	0	1
BAR	Club or Bar	0.025	0.156	0	1
MONTH	Listing Date	Listing end dates ranged in 16 months, from 2021M10 to 2023M01			
DISTR	Districts	78 districts			
No. of valid samples		91,905			

3.2. Methodology

The hedonic price model is commonly used to examine the effects of housing attributes. Rosen (1974) theoretically interpreted the hedonic method and extended it to the housing market. It suggests that consumers' utility is derived from their properties or characteristics. Goods are valued for their utility-bearing attributes, and the bundles of characteristics define a set of implicit prices.

Baseline Model

This study conducts a traditional semi-log hedonic price model analysis (Equation 1) on the individual housing level using the total listed housing rents in New Zealand to test the disutility and the economies of scale effect of co-living.

$$\ln(R_i) = c_1 + \alpha_1 COL_i + \sum_{m=2}^{M}\sum_{k=2}^{K} \beta_{m,k} X_{i,m,k} + \varepsilon_1 \dots\dots (1)$$

where R_j, COL_i are the total listed rents and a co-living dummy of housing unit *i*, resptectively. Co-living dummy measures the average rental income difference for landlords leasing houses as single-family occupied housing units or co-living spaces. $X_{i,m,k}$ represent all other control variables, including structure attributes and amenities (see **Table 2**) of each house *I,* neighbourhood dummies in districts where house *i* is located, and time dummies in the month when the listing of house *i* ends.

Model 1 serves as the baseline model testing the rental difference between single-family occupied housing units and co-lived housing units. This is the typical approach to studying co-living rental effects, as Yan (2020) adopted. However, it ignores the marginal effect of co-living; we further explore the following two models to test the disutility and economies of scale effect of co-living.

Continuous Marginal Effect of Co-living

Model 2 includes a new variable NF_i, the number of flatmates in housing unit *i,* as shown in Equation (2). The model tests the non-linearity of the marginal rental difference between single-family occupied housing units and co-lived housing units with various flatmates.

$$\ln(R_i) = c_1 + \alpha_2 NF_i + \alpha_2 {NF_i}^2 + \sum_{m=2}^{M}\sum_{k=2}^{K} \beta_{m,k} X_{i,m,k} + \varepsilon_1 \dots\dots (2)$$

where NF_i is the number of flatmates which together with its quadratic term measure the non-linear marginal effect of number of flatmates on the total net rental incomes to the landlords.

Discrete Marginal Effect of Co-living

Model 3 further tests the marginal effect of number of flatmates co-living by relaxing the assumption of a quadratic function (Equation 3). The number of flatmates is discrete, which can test the turning point of financial viability of the switching from a single-family-occupied unit to a co-lived unit.

$$\ln(R_i) = c_1 + \sum_{n=1}^{N} \alpha_n NF_{i,n} + \sum_{m=2}^{M} \sum_{k=2}^{K} \beta_{m,k} X_{i,m,k} + \varepsilon_1 \dots\dots (3)$$

4. Results

4.1. Results of the Marginal Effect of Co-living

Table 4 shows the empirical results of the estimations[1]. The baseline model (Model 1) shows a strong positive coefficient, indicating that landlords of co-living spaces can have a 3.86% rental increase compared with the rental incomes that can be earned by leasing the house as single-family occupied housing units. However, it seems to be too trivial to justify leasing houses as co-living spaces. Model 2, in contrast, shows a U-shaped effect of flatmates on total rents, but the turning point is negative[2]. Model 3's results show more clearly the initial marginal disutility of co-living with a 17.3% switching discount of co-living but a gradual increase in the economies of scale effect from an increasing number of flatmates. In other words, even though individual co-living tenants may have some rental discounts, the overall total sum of rental incomes can be increased by sharing communal space with more flatmates in co-living houses. The economies of scale effect of co-living are not only valid at the national level, but it is found to have a similar inimpact on the biggest city in New Zealand – Auckland, as shown in Model 4. **Figure 1** compares the disutility and the economies of scale effects of the number of flatmates in New Zealand and Auckland City. The similarity in the economies of scale effects of co-living between Auckland, which is the most unaffordable city in New Zealand, and the whole country, reflecting that the discount is not likely to be affected by rental level.

Table 4. Empirical Results.

Variable	Baseline Model 1	Continuous Marginal Model 2a	Discrete Marginal Model 3	Discrete Marginal Model 4 AKL

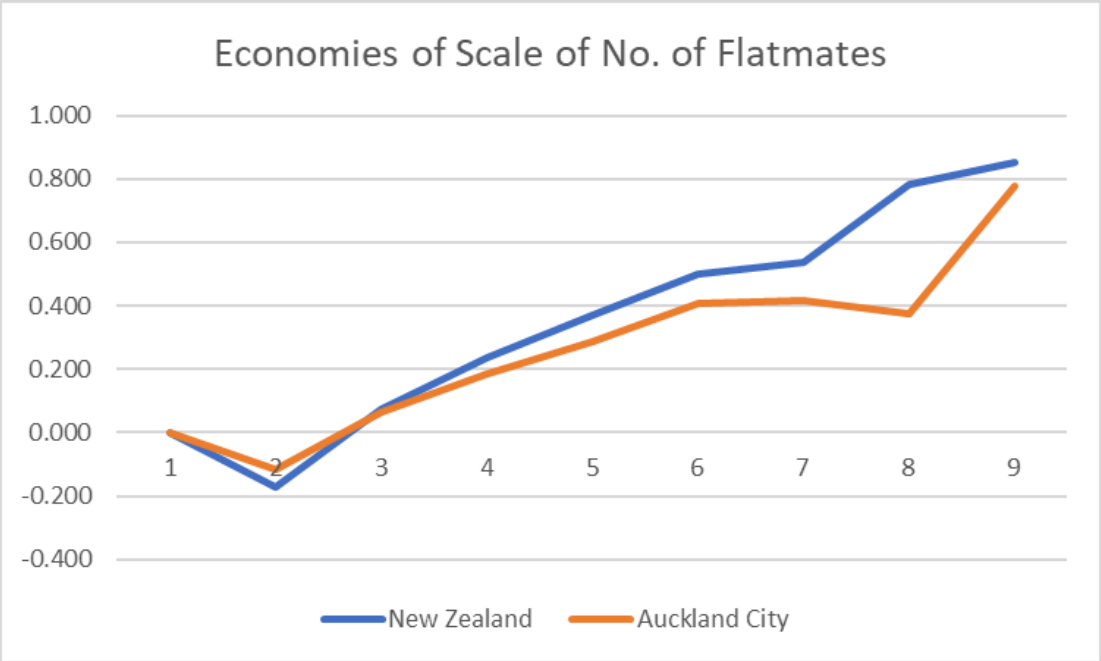
[1] Table 4a in the Appendix shows the results of the models with the variables of facilities, amenities and housekeeping rules omitted to avoid overcontrol. The results of the co-living variables are highly similar to that in Table 4.

[2] excluding the variables of facilities and amenities, the results of Model 2a in the Appendix show that the turning point at 0.6.

Dependent Variable	$\ln(R_i)$	$\ln(R_i)$	$\ln(R_i)$	$\ln(R_i)$
COL_i	0.039 (13.23)***		-	-
NF_i	-	0.018 8.87)***	-	-
${NF_i}^2$		0.017 41.58)***		
$NF_{i,n} = 1$			-0.173 (-51.28)***	-0.118 (-15.17)***
$NF_{i,n} = 2$			0.076 (22.13)***	0.067 (8.26)***
$NF_{i,n} = 3$			0.236 (56.51)***	0.186 (20.26)***
$NF_{i,n} = 4$			0.370 (63.17)***	0.286 (23.34)***
$NF_{i,n} = 5$			0.502 (52.26)***	0.408 (20.74)***
$NF_{i,n} = 6$			0.535 (30.90)***	0.415 (9.78)***
$NF_{i,n} = 7$			0.784 (27.37)***	0.377 (3.67)***
$NF_{i,n} = 8$			0.851 (44.48)***	0.779 (18.66)***
Housing Structure Fixed Effect	Yes	Yes	Yes	Yes
Neighbourhood Fixed Effect	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes
No. of Observations	71,613	71,613	71,613	18,779
Adj. R-squared	0.50	0.56	0.59	0.56

*, **, *** represent significant at the 10%, 5%, 1% levels, respectively.

Figure 1. Disutility and Economies of Scale of Number of Flatmates



4.2. Other Determinants of Housing Rents

Besides studying the disutility and economies of scale of co-living, this study also examines other housing rental determinants. **Table 5** shows the results of the determinants in three major groups, viz. structure attributes, facilities, furniture and appliances, neighbourhood amenities, and housekeeping rules, of Model 3. The results of districts and time dummies are not shown.

Taking house as the base of property type for comparison, the estimations show expected results: apartments and units are of lower rents per week (at 6.5% and 8.9% lower than houses). More bedrooms and bathrooms are favourable, with 10.8% and 8.1% higher rent per week for one more bedroom and bathroom, respectively. Concerning facilities, furniture and appliances: ovens, washing machines, and refrigerators are the most valuable, their implicit prices are 4.4%, 1.1% and 0.9% higher rents. Other facilities and appliances are found to negatively affect prices, probably because tenants prefer to use their own furniture, such as beds (-4.6%) and wardrobes (-5.2%).

Proximity to beach, club or bar, university or college, and park or playground are the top four most favourable neighbourhood amenities; their implicit rents are 4.8%, 4.7%, 3.2%, 1.0%, respectively. In contrast, proximity to noisy or crowded amenities, such as public transport, motorway, mall and supermarket, impose negative effect on rents at -1.8%, -0.3%, -2.2%, -0.7% discounts, respectively. But it requires further studies to investigate why the convenience of these amenities is

not paid for. Lastly, housekeeping rules are also found to have significant impacts on house rents. For example, 'smokers-okay' and 'pets-okay' tenancy have a -1.9% and +2.0% on rents.

Table 5. Other Determinants of Housing Rents in Model 3.

Structure Attributes		Facilities, Furniture & Appliances		Neighbourhood Amenities		Housekeeping Rules	
PT=0 (Apartment)	-0.065 (-23.90)***	RF	0.009 (2.31)**	SUPER	-0.007 (-2.23)**	SMOKE	-0.019 (-10.38)***
PT=1 (House)	0	TV	-0.009 (-1.96)**	MALL	-0.022 (-10.03)***	PET	0.020 (17.16)***
PT=2 (Townhouse)	0.044 (14.10)***	BED	-0.046 (-14.79)***	HOS	0.005 (1.03)		
PT =3 (Lifestyle block)	-0.003 (-0.29)	MW	-0.031 (-5.49)***	UNI	0.032 (12.08)***		
PT=4 (Unit)	-0.089 (-29.73)***	OVEN	0.044 (9.48)***	TRANS	-0.018 (-7.60)***		
NBED	0.108 (97.97)***	WM	0.011 (3.03)***	MOTOR	-0.003 (-0.95)		
NBATH	0.081 (44.82)***	WD	-0.052 (-7.16)***	BEACH	0.048 (12.27)***		
				PARK	0.010 (3.56)***		
				BAR	0.047 (9.11)***		

*, **, *** represent significant at the 10%, 5%, 1% levels, respectively.

5. Discussion

The rental discount of a co-living home for 2 people is about 17% of the total rent in comparison with leasing it as a single-family home. It probably reflects the disutility of less privacy in co-living spaces. However, one of the significant benefits of subletting as co-living spaces is the economies of scale effect. Let's say the highest affordable rent for a single-family occupied housing unit is limited by 30% of a household's disposable income, no matter how big the size or how good the quality of the housing unit is. However, as the consumer substitution theory predicted, tenants would consume less floor area or poorer housing quality for living closer to the city centres as the unit rent is higher (Leung & Yiu, 2022). Housing units are therefore found to be smaller and of higher density in city centres. Informal housing is also commonly found in city centres. There are two approaches to subdividing a house or a housing unit into several rooms or units, either by converting them into several self-contained units with independent facilities or a co-living space with shared communal facilities. Both can help increase the overall total rental income even with a substantial discount for

individual tenant rent.

For example, in the sample, a whole house with three bedrooms was rented a $639.6 per week to a tenant on average. But then, if the house is converted into a co-living space, with the three rooms rented for flatmates, the listing rent was reduced to $227.6 each. The total rental income can still be increased by 7%. The conversion cost is minimal as the facilities, such as the kitchen and toilet, are shared communal facilities. The results also show that the marginal increase in total rents for further increase in the number of flatmates is fast. Once privacy is no longer a concern for the tenants, more flatmates may enhance networking and engagements, provided that the shared communal facilities are sufficient to accommodate the basic needs.

In contrast, the conversion cost can be huge if the house is converted into five self-contained subdivided units. The conversion requires building an independent pantry and toilet for each room and often involves re-routing pipes, raising the floor level, etc. All these require approval or consent from the authority, or they will become illegal or informal housing units. Even though the unit rent of subdivided units can be higher than co-living spaces, the risks of upfront intensive capital investment and regulatory approval can be insurmountable. It probably explains why subdivided units are mostly found in informal housing markets while co-living spaces are more common in formal housing markets.

6. Conclusions

This study provides two major contributions. First, it tests the hypothesis of disutility and the economies of scale effect of co-living. The results confirm a substantial switching discount (of about 17%) from a single-family occupied housing unit to a co-lived one for 2 tenants, but an increasingincreasingly positive effect of number of flatmates on the total rental incomes to landlords. The result indicates the financial viability of the business model of co-living spaces when the houses are large enough to accommodate a higher number of flatmates. In contrast, in overcrowded cities, such as Hong Kong and Seoul, where housing units are in general small in size, subdivided units are more common rather than co-living spaces because each subdivided unit can be self-contained with an independent pantry and toilet without sharing facilities with co-tenants (Leung & Yiu, 2019).

The results reconcile the conflicting findings in the previous studies on the role of housing privacy in the residential quality of life. The costs and benefits of co-living on renters and landlords in big cities result in a rental discount to individual renters but a rental premium to landlords of co-living. It has important practical and policy implications on regulating co-living spaces in cities.

Besides disutility of less privacy in co-living, there can have three other plausible alternative hypotheses to explain for the switching discount in total rents when the number of flatmates is small. Times Property (2023) provides an anecdotal evidence that 'co-living generally offers a 20-30 percent discount on total housing cost, compared to studio products on a per unit basis'. Other possible reasons for the discount are (1) co-living renters can be of shorter terms (tenancy specificities), (2) the market competitors are studio units rather than detached houses (price discrimination on renters of housing subsectors), and (3) co-living landlords can charge shared-utility fees, such as Wi-Fi and electricity.

Second, the study also provides one of the most comprehensive studies on the determinants of housing rents. The determinants are grouped into seven categories; besides the above-mentioned co-living factors, other six include (a) housing structure attributes, (b) facilities, furniture and appliances, (c) neighbourhood amenities, (d) housekeeping rules, (e) districts factor, and (f) time factor. The findings not only provide essential research implications on further studies of co-living and rental determinants but also help draw practical implications on the rental optimisation of subletting whole units or subdivided units or co-living spaces. A cross-city study of co-living rents will be conducted to identify the determinants of co-living rental discount. discounts. A limitation of this study is the use of second-hand data collected from rental listings. The listings provide limited information on neighbourhood amenities, for instance, without details on the distances from the amenities to the subject rental unit. It can be another further study to test the impact of the distance of amenities on housing rents.

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Appendix

Table 4a. Empirical Results with the Variables of Facilities and Amenities Omitted.

Variable	Baseline Model 1a	Continuous Marginal Model 2a	Discrete Marginal Model 3a	Discrete Marginal Model 4a AKL
COL_i	0.017 (8.22)***		-	-
NF_i	-	-0.024 (-14.74)***	-	-
${NF_i}^2$		0.021 (57.66)***		
$NF_{i,n} = 1$			-0.198 (-69.04)***	-0.141 (-20.93)***
$NF_{i,n} = 2$			0.040 (14.23)***	0.031 (4.48)***
$NF_{i,n} = 3$			0.189 (52.02)***	0.139 (17.61)***
$NF_{i,n} = 4$			0.309 (57.75)***	0.229 (20.61)***
$NF_{i,n} = 5$			0.432 (47.48)***	0.334 (17.93)***
$NF_{i,n} = 6$			0.453 (27.12)***	0.324 (7.81)***
$NF_{i,n} = 7$			0.731 (26.37)***	0.296 (2.93)***
$NF_{i,n} = 8$			0.783 (42.31)***	0.715 (17.49)***
Facilities	No	No	No	No
Amenities	No	No	No	No
Housekeeping Rules	No	No	No	No
Housing Structure Fixed Effect	Yes	Yes	Yes	Yes
Neighbourhood Fixed Effect	Yes	Yes	Yes	Yes
Time Fixed Effect	Yes	Yes	Yes	Yes
No. of Observations	91,905	91,905	91,905	24,186
Adj. R-squared	0.53	0.57	0.59	0.54

*, **, *** represent significant at the 10%, 5%, 1% levels, respectively.