

Land Fragmentation and Tragedy of the Anticommons

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Land Assembly as a Type of Anticommons

In a city where land is scarce, it cannot continue growing to accommodate increasing households or firms without re-use of developed sites. Even if this city is not growing, land use might be changed to adapt to new economic and social environments. To say the least, buildings need to be replaced at the time when they reach the end of their economic life. Taking Taipei as an example, the Population and Housing Survey (The Directorate General of Budget, Accounting and Statistics, DGBAS, of Executive Yuan) shows that among 827,538 buildings in Taipei of Year 2000, the percentage of one-storey, two to five storey, six to twelve storey and thirteen or above storey buildings are 3.2%, 59.1%, 29.8% and 7.9%, respectively.

<http://www.dgbas.gov.tw/public/Attachment/0761118271.pdf> Only a fairly small minority of Taipei residents owns a building of two storey or higher by their own. It is therefore fair to suggest that only 3.2% of buildings might be redeveloped without the need to seek agreements from neighborhoods of the same buildings. Behind the redevelopment of high-rise buildings is the assembly of individual joint ownership of land. Demolition of a high-rise building and replacement by a new one is actually a process of consolidating a number, often a considerable number, of joint shares in land ownership. Naturally, uncertainty and risk are throughout the course of land assembly. Uncertainty and risk will be even more intensified when a great number of sites are involved. However, for a city with nowhere to expand further, the thorny process of land redevelopment or land assembly is an everyday life.

Redevelopment of the old parts of a city pivots on assembly of many small parcels of land with different owners. This creates problems of cooperation and coordination. The high transaction costs associated with cooperation and coordination among owners tend to contribute to a bias towards land fragmentation. Fragmentation of land will likely lead redevelopment of a larger site to being prohibitively expensive. In contrast to the high costs of redevelopment of a large site, economies of scale in development creates a lure for the endeavour of assembling land parcels.

Consolidation of multiple ownerships provides an incentive for each of landowners to halt the redevelopment by refusing to sell at the market price. The opportunity for the last

seller to capture part of the gain from assembly produces the incentive for all owners to hold out to be that last seller. Fennell (2004: 928-929) believes that this price gouging can destroy the surplus that would otherwise be enjoyed by the would-be assembler and all of the other fragment holders who are now precluded from engaging in mutually beneficial trades. Heller (1998: 622-626) coins the above hold-out phenomenon as the anticommons. "When too many owners hold such rights of exclusion, the resource is prone to undersue- the tragedy of the anticommons...resources can become stuck in low-value uses." If we put the anticommons argument in the context of urban redevelopment, it is naturally concluded that many land in old city centres tend to be overfragmented and underused. The land there is underused in the sense that if it were assembled for redevelopment it would be worth more than enough to fully compensate all the original owners for giving up their parts. In conclusion, public planning is supposed to guide land use, including redevelopment, but it is the private market that will carry out the process.

Wanhua is Taipei's Old Downtown where Land Assembly is in Need

Wan-Hua district, as evidenced in the statistics of net floor space supply, is one of the places where new development rarely occurred over the past 10 years. In other words, it is an area in decay. However, Wan-Hua, originally called Man-Ka, is one of the earliest development areas of Taipei City. It is geographically located in the southwest part of the City with Dan-Shui river flowing along the west and Shin-Dian river along the south. Several bridges were built across the rivers to connect Taipei City and New Taipei City (previously called Taipei County).

In order to understand how old declined areas are redeveloping, Wan-Hua Railway Station Special Zone (WRS area) is chosen for a close examination. The ideas of WRS project area was originally proposed in a research project on the redevelopment for Shi-Men downtown and the Surrounding Areas in Wan-Hua Railway Station (西門市中心區暨萬華火車站附近地區再發展), jointly undertaken by Urban Development Department of Taipei City and Taipei City Open Space Foundation (台北市開放空間文教基金會). This research suggested to incorporate the then underground railway and Taipei metro system to revitalize the surrounding areas of WRS area. The zoning allocation of the WRD area is shown as Figure 3. This area is designed to serve multi-purposes. Sites in the northern part of the WRS area are primarily zoned for commercial functions. A number of marketplaces cluster along the famous Long-Shan Temple, together with the Shi-Men-Ting area with a reputation of cultural diversity and retailers. In contrast, residential sites are largely assigned to the southern part of the WRS area. Housing here are occupied by low to middle classes by income featured by numerous public housing and resettlement apartments. Later, the passage of Urban Renewal Act in 1999 provided

further legal stimulus, such as floor space bonus, at the government's disposal.

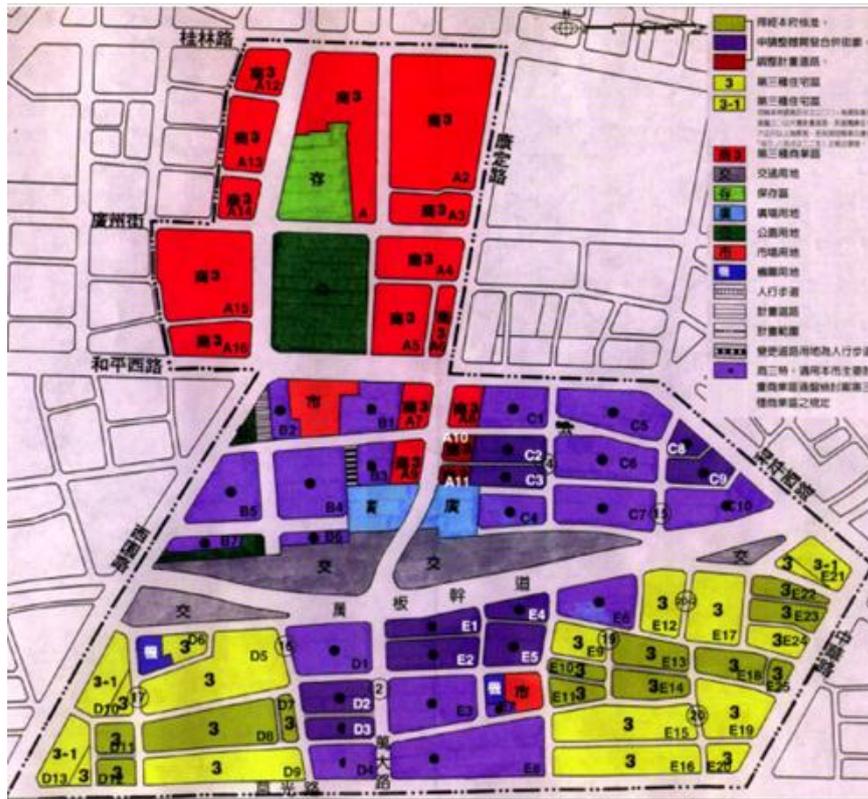


Figure 1 Allocation of Land Uses within Wan-Hua Railway Station Special Zone

Following the transformation of the WRS area, the original configuration of sites and ownerships within this area will be inappropriate for the new economic functions of this area, and sites are expected to be redeveloped accordingly. Figures 4-1, 4-2 and 4-2 are taken from google earth and exhibit the present development situations.



Figure 2-1 The Wan-Hua Railway Station Special Zone and its Surroundings at Present



Figure 2-2 The Wan-Hua Railway Station Special Zone and its Surroundings at Present



Figure 2-3 The Wan-Hua Railway Station Special Zone and its Surroundings at Present

At a first glance, this area does not seem to have redeveloped as depicted by the WRS plan. It is understandable that the consolidation of sites and ownerships for new development or redevelopment are time-consuming and risky. However, this prolonged process of land redevelopment is exactly what we attempt to understand in that it decides how a city has reshaped itself.

Through the official records of building permits kept by the City government, we are able to locate all the buildings that were built from the 1970s up to the present time.



Figure 3 Land Development and Redevelopment within Wan-Hua Railway Station Special Zone over Time (Red - 1970s; Green - 1980s; Yellow - 1990s; Blue - after 2000)

Measuring Land Fragmentation

The theoretical argument suggests that land fragmentation causes the need for assembly of land, and that, in the anticommons framework, leads to the tragedy of underuse of land resources. However, empirical evidence is called for if this anticommons argument is to be taken seriously.

The figures of housing price index and housing stock in Taipei City in Figure 1 indicate a rapid rise of price but an inert response of supply. This is a clear evidence of inelasticity of housing supply with respect to price. The elasticity of housing supply between 2009 and 2012 is only 0.0663. One possibility for an inelastic housing supply is due to the overregulation of land use control. Glaeser (2009) suggests that the variations in the rise of housing price among US cities in booming times can be largely accounted for by the various strictness of land use control. Another possibility is implicitly suggested in the land size-price hypothesis. Colwell and Munneke (1997) finds a convex relationship between land size and price. The price per unit rises with the size of plots in the city center where land tends to be small and ownership fragmented. Among the two

alternative explanations, Taipei fits much better into the second explanation.

Table 1 Housing Price and Housing Stock in Taipei City 2009 onwards

| Quarter | Housing price index | Housing stock (Units) | Elasticity of housing supply |
|------------------------|---------------------|-----------------------|------------------------------|
| 2009Q1 | 164.68 | 890,831 | -- |
| 2009Q2 | 177.92 | 892,306 | 0.0206 |
| 2009Q3 | 190.25 | 894,303 | 0.0323 |
| 2009Q4 | 201.97 | 894,550 | 0.0045 |
| 2010Q1 | 209.79 | 899,113 | 0.1317 |
| 2010Q2 | 217.66 | 897,941 | -0.0347 |
| 2010Q3 | 223.02 | 899,956 | 0.0911 |
| 2010Q4 | 236.59 | 917,553 | 0.3214 |
| 2011Q1 | 240.76 | 918,906 | 0.0837 |
| 2011Q2 | 246.12 | 920,163 | 0.0614 |
| 2011Q3 | 245.73 | 921,589 | -0.9780 |
| 2011Q4 | 251.68 | 922,944 | 0.0607 |
| 2012Q1 | 254.19 | 924,211 | 0.1377 |
| 2012Q2 | 262.70 | 926,230 | 0.0653 |
| 2012Q3 | 268.28 | 927,960 | 0.0879 |
| 2009Q1 to 2012Q3 | -- | -- | 0.0663 |

Table 2 provides the size of plots over time in our study area, the Wanhua train station and its surrounding areas. There was a clear change before and after 1977. In year of 1977, land cadaster in this area was simplified and ownership had thus become less complicated. Prior to 1977, the average size of plots was around 93 m². Plots became around 1.5 times larger than before after 1977, but are still far too small for a proper housing project.

Table 2 Size of Plots in Wanhua Train Station Areas

| Year | No. of Plots | Average Size (m ²) | Standard Deviation |
|------|--------------|--------------------------------|--------------------|
| 1970 | 3,811 | 93 | 634 |

| | | | |
|------|-------|-----|-----|
| 1971 | 3,812 | 93 | 634 |
| 1972 | 3,813 | 93 | 634 |
| 1973 | 3,814 | 93 | 634 |
| 1974 | 3,868 | 92 | 629 |
| 1975 | 3,925 | 90 | 624 |
| 1976 | 3,970 | 89 | 619 |
| 1977 | 2,526 | 155 | 880 |
| 1978 | 2,549 | 153 | 873 |
| 1979 | 2,566 | 152 | 870 |
| 1980 | 2,576 | 153 | 860 |
| 1981 | 2,643 | 149 | 848 |
| 1982 | 2,674 | 148 | 843 |
| 1983 | 2,810 | 140 | 820 |
| 1984 | 2,851 | 138 | 815 |
| 1985 | 2,919 | 135 | 805 |
| 1986 | 2,953 | 134 | 779 |
| 1987 | 2,972 | 133 | 776 |
| 1988 | 3,023 | 131 | 769 |

In order to measure the degree of land fragmentation in this area, we apply the methods that are often used to study the relation of fragmentation of agricultural land to its productivity. The first method is Januszewski index. The theoretical JI value is between 0 and 1. The smaller the JI, the more fragmented the land parcels are. The figures in Table 3 clearly show that the distribution of land parcels in our study areas is fairly fragmented. There are clearly a large number of small land parcels in this area all the time. The same conclusion is drawn from another similar fragmentation index, the Simpson index (Table 4). The theoretical SI value is between 0 and 1. The larger the SI, the more fragmented the land parcels are. Both JI and SI suggest a high degree of land fragmentation in this area and no sign of improvement over 19 years.

Table 3 Measurement of Land Fragmentation (Januszewski index)

| Year | Jl | Year | Jl |
|------|---------|------|---------|
| 1970 | 0.02138 | 1980 | 0.02670 |
| 1971 | 0.02138 | 1981 | 0.02644 |
| 1972 | 0.02138 | 1982 | 0.02630 |
| 1973 | 0.02137 | 1983 | 0.02591 |
| 1974 | 0.02123 | 1984 | 0.02580 |

| | | | |
|------|---------|------|---------|
| 1975 | 0.02104 | 1985 | 0.02562 |
| 1976 | 0.02092 | 1986 | 0.02556 |
| 1977 | 0.02691 | 1987 | 0.02556 |
| 1978 | 0.02674 | 1988 | 0.02547 |
| 1979 | 0.02669 | | |

Table 4 Measurement of Land Fragmentation (Simpson index)

| Year | SI | Year | SI |
|------|---------|------|---------|
| 1970 | 0.98750 | 1980 | 0.98732 |
| 1971 | 0.98751 | 1981 | 0.98735 |
| 1972 | 0.98751 | 1982 | 0.98747 |
| 1973 | 0.98752 | 1983 | 0.98747 |
| 1974 | 0.98753 | 1984 | 0.98747 |
| 1975 | 0.98752 | 1985 | 0.98749 |
| 1976 | 0.98762 | 1986 | 0.98816 |
| 1977 | 0.98692 | 1987 | 0.98816 |
| 1978 | 0.98690 | 1988 | 0.98820 |
| 1979 | 0.98689 | | |

We also apply another measure that has been used to study the land distribution among people in ancient China. Gini coefficient measures the (in)equity of income or assets among its owners. The theoretical *GI* value is between 0 and 1: the larger the value, the more unequally land is distributed among owners. It is interesting to find that in Table 5 over time, the *GI* has slowly but persistently reduced. In the long term, the size distribution of land parcels has widened. In other words, the land parcels are not equally small; some continue to be fragmented but others (likely a very small number though) have become larger through land assembly.

Table 5 Measurement of Land Fragmentation (Gini index)

| Year | Gini | Year | Gini |
|------|---------|------|---------|
| 1970 | 0.68382 | 1980 | 0.70226 |
| 1971 | 0.68372 | 1981 | 0.70559 |
| 1972 | 0.68379 | 1982 | 0.70683 |
| 1973 | 0.68371 | 1983 | 0.71594 |
| 1974 | 0.68345 | 1984 | 0.71859 |
| 1975 | 0.68155 | 1985 | 0.72273 |
| 1976 | 0.68177 | 1986 | 0.72722 |

| | | | |
|------|---------|------|---------|
| 1977 | 0.70034 | 1987 | 0.73009 |
| 1978 | 0.69846 | 1988 | 0.73409 |
| 1979 | 0.69975 | | |

The long-term adjustment of parcel size, or the ongoing activities of land segmentation and land assembly is evidenced in Figure 4 through the changes of Simpson and Gini indexes.

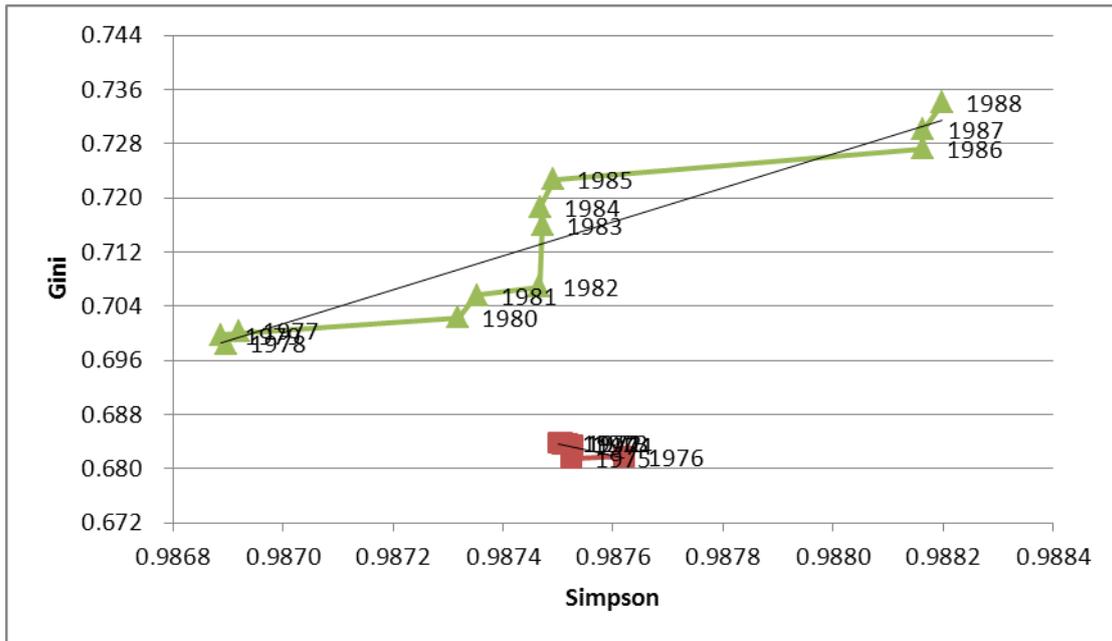


Figure 4 The Simpson and Gini Indexes over time

Tragedy of the Anticommons is Real

The statistical measurement of land fragmentation over time suggests on-going activities of land assembly. In order to provide further evidence, we compare the size distribution of land between those of newly developed and others. Figure 5 indicates that the size of newly developed projects tends to be larger than the rest. This again provides evidence of land assembly.

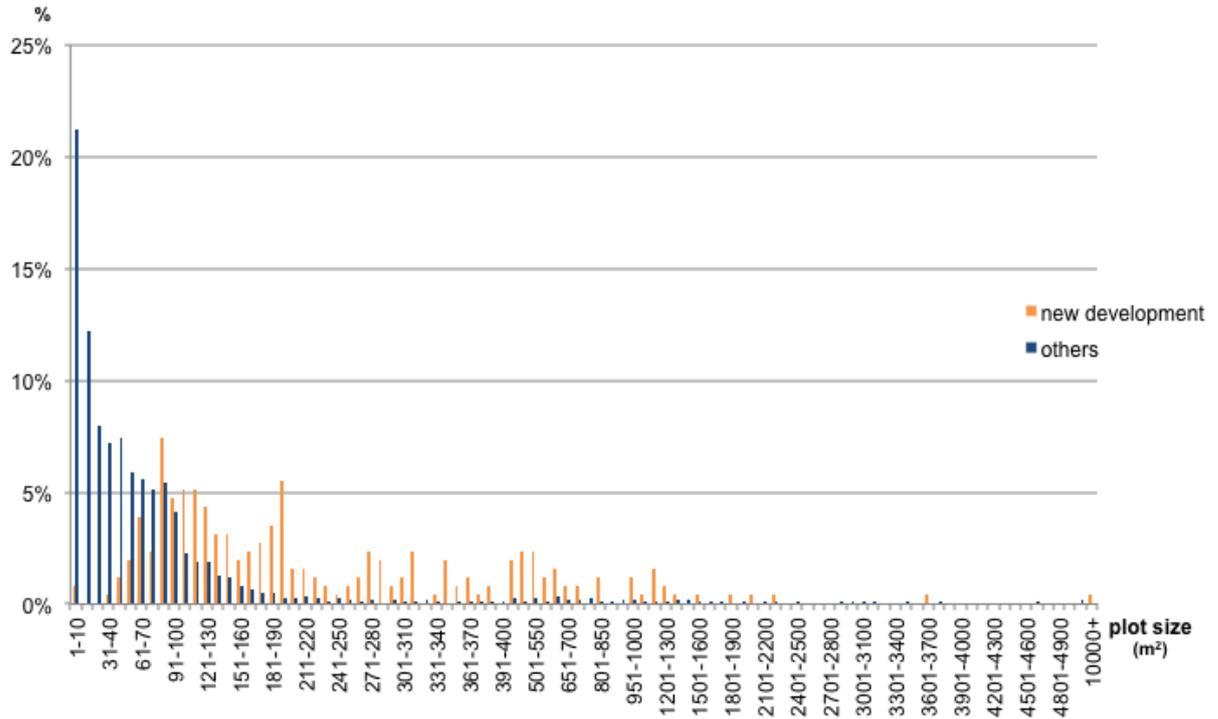


Figure 5 Distribution of Sizes for New Development Sites and Others

We carry out a t-test to see if the size of newly developed projects is larger than the rest. The statistical results support our expectation (Table 6).

Table 6 The Size Differences between New Development Sites and Others (t-test)

| Year | Development States | No. of Observations | Average Size | Standard Deviation | t Value | P value |
|------|--------------------|---------------------|--------------|--------------------|---------|---------|
| 1970 | new development | 72 | 336 | 570 | 3.628 | .001 |
| | others | 3674 | 90 | 641 | | |
| 1971 | new development | 78 | 329 | 550 | 3.790 | .000 |
| | others | 3647 | 90 | 644 | | |
| 1972 | new development | 85 | 322 | 532 | 3.947 | .000 |
| | others | 3620 | 90 | 646 | | |
| 1973 | new development | 99 | 348 | 606 | 4.183 | .000 |
| | others | 3569 | 90 | 647 | | |
| 1974 | new development | 107 | 326 | 583 | 4.139 | .000 |
| | others | 3604 | 89 | 644 | | |
| 1975 | new development | 129 | 609 | 3253 | 1.860 | .065 |
| | others | 3617 | 76 | 203 | | |

| | | | | | | |
|------|-----------------|------|-----|------|-------|------|
| 1976 | new development | 139 | 566 | 3125 | 1.851 | .066 |
| | others | 3630 | 76 | 204 | | |
| 1977 | new development | 156 | 564 | 3056 | 1.749 | .082 |
| | others | 2246 | 136 | 466 | | |
| 1978 | new development | 162 | 549 | 2999 | 1.760 | .080 |
| | others | 2259 | 134 | 457 | | |
| 1979 | new development | 166 | 540 | 2963 | 1.770 | .079 |
| | others | 2267 | 133 | 456 | | |
| 1980 | new development | 175 | 516 | 2834 | 1.782 | .076 |
| | others | 2258 | 134 | 464 | | |
| 1981 | new development | 184 | 510 | 2765 | 1.864 | .064 |
| | others | 2314 | 130 | 456 | | |
| 1982 | new development | 194 | 495 | 2693 | 1.896 | .059 |
| | others | 2334 | 128 | 454 | | |
| 1983 | new development | 207 | 477 | 2605 | 1.963 | .051 |
| | others | 2438 | 121 | 441 | | |
| 1984 | new development | 212 | 468 | 2575 | 1.965 | .051 |
| | others | 2461 | 120 | 439 | | |
| 1985 | new development | 222 | 450 | 2516 | 1.971 | .050 |
| | others | 2521 | 117 | 433 | | |
| 1986 | new development | 238 | 444 | 2346 | 2.161 | .032 |
| | others | 2517 | 115 | 431 | | |
| 1987 | new development | 249 | 438 | 2294 | 2.233 | .026 |
| | others | 2533 | 113 | 429 | | |
| 1988 | new development | 255 | 439 | 2302 | 2.281 | .023 |
| | others | 2569 | 110 | 424 | | |

We also undertake a non-parametric Mann-Whitney test and the results remain robust. The size of newly developed projects is larger than the rest (Table 7).

Table 7 The Size Differences between New Development Sites and Others (M-W test)

| Year | Mann-Whitney U Statistic | Z Statistic | Significance Level |
|------|-----------------------------|-------------|--------------------|
| 1970 | 41126.5 | 10.029 | .000 |
| 1971 | 42498.5 | 10.613 | .000 |
| 1972 | 46229.0 | 11.041 | .000 |
| 1973 | 49924.0 | 12.195 | .000 |
| 1974 | 54658.0 | 12.65 | .000 |
| 1975 | 62950.0 | 14.114 | .000 |
| 1976 | 66224.0 | 14.779 | .000 |
| 1977 | 61769.0 | 13.541 | .000 |
| 1978 | 62933.0 | 13.968 | .000 |
| 1979 | 63963.5 | 14.216 | .000 |
| 1980 | 65762.5 | 14.724 | .000 |
| 1981 | 67671.5 | 15.422 | .000 |
| 1982 | 70658.5 | 15.943 | .000 |
| 1983 | 74540.0 | 16.855 | .000 |
| 1984 | 75302.0 | 17.211 | .000 |
| 1985 | 78751.0 | 17.776 | .000 |
| 1986 | 81766.0 | 18.566 | .000 |
| 1987 | 83014.5 | 19.212 | .000 |

Finally, we examine the frequency of change of ownership, through land sales, over time. The clear finding is that several times of land sales are needed prior to a development project. For example, a project of between 500 and 600 m² on average requires 7 to 8 times of land assembly. And it takes an average of 6 years between each land sales. Given this development pace, this study area will take a total of 85 years to complete development.

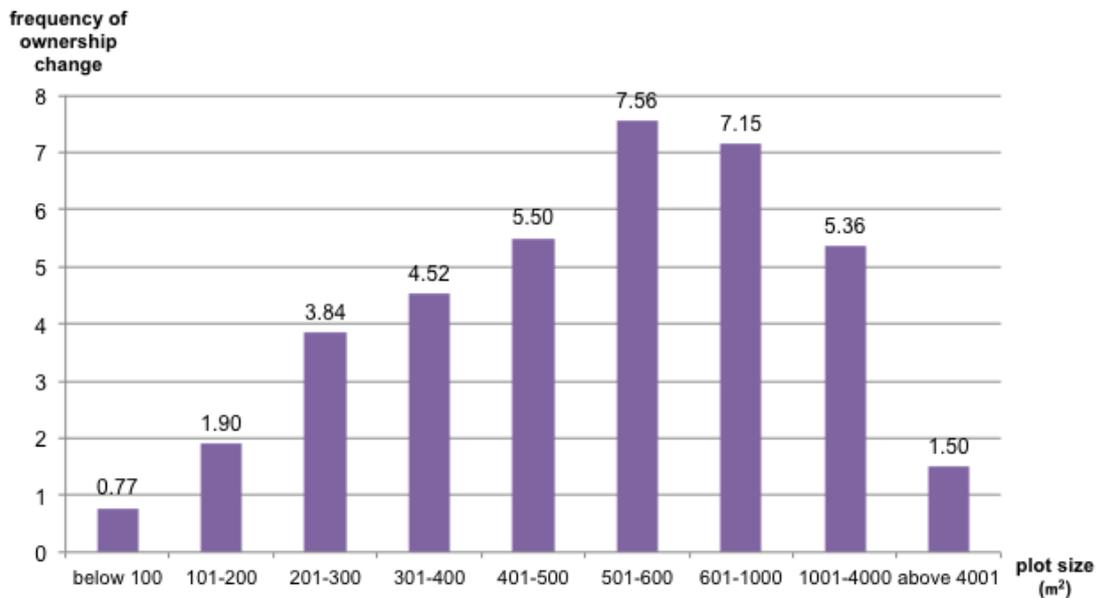


Figure 6 The Frequency of Ownership Changes in Sites of New Development

Attenuation of Property Rights when Land is at Stake

Our study evidently shows that a significant development project at a larger scale will need to solicit a great number of owners for their agreement. A unanimous consent from numerous owners is fairly unlikely if not impossible at all, but it is needed for virtually every land redevelopment project. Likely because of this kind of dilemma, several pieces of legislations employ the majority rule in development of land in joint-ownership. Below are some of them.

Land Act: Article 34- 1

For the disposal of ownership, or changes of, or setting encumbrance of superficies, Agricultural Right , Servitude of real property, or dien over co-owned land or constructional improvements, the consent of more than half of the Co-owners whose holding of ownership is more than half of the total share shall be required. But if the holding of ownership is more than two thirds, the numbers of consenting co-owners need not be taken into account.

Urban Renewal Act: Article 10

The owners of the lands and legal buildings of an area that has been designated for renewal implementation may designate the renewal units by themselves as per renewal units defined by the authority, or based on the criteria for designating a renewal unit, conduct a public hearing. They may then present a business summary together with the public hearing records to the municipal, county (city) authority to apply for approval.

Finally, they can organize a renewing group to implement the urban renewal business of that area or entrust it to an urban renewal business institution for implementation.

The application mentioned in the above paragraph should be agreed by more than 10% of the owners of the private lands and legal private buildings within the renewed area, and the total land areas and the total floor areas of the legal buildings owned should also exceed 10%. If the proportion of agreement has reached the value in article 22, presenting a business summary can be omitted and replaced by presenting an urban renewal business plan directly.

Urban Renewal Act: Article 22

When the implementers is drafting or revising the urban renewal business plans to submit for approval, the applying for approval of urban renewal business in accordance with the regulations in Article 10 should obtain enough agreement as follow. On one hand, in the urban renewal area designated in accordance with article 7, it should be agreed by more than 50% of the owners of private lands and private legal buildings owners within a renewal unit. Furthermore, the sum of their land area and floor area of the legal buildings should be more than 50% of all. On the other hand, it should be agreed by more than 60% of the owners of the owners of private lands and private legal buildings within a renewal unit. Moreover, the sum of their land area and floor area of the legal buildings should be more than two thirds of all. In addition, the applying for approval of urban renewal business in accordance with the regulations in Article 10 should obtain more than two thirds of the owners of private lands and private legal buildings owners within a renewal unit. Furthermore, the sum of their land area and floor area of the legal buildings should be more than 75% of all. However, if the sum of consenters' private land area and floor area of the legal buildings is more than 80% of all, the computing of owners' agreement can be neglected.

The computation of the proportion between the number of persons and the ownership's of the lands and buildings mentioned in the preceding paragraph can be done to the regulations in Article 12. Competent authorities should verify the proportion of agreement by the end of the exhibition, except the affairs ruled in Article 88, Article 89 and Article 92 in civil law or both of the two ends agree the revoke. If the owners disagree with the urban renewal plan exhibited publicly, they can revoke their agreements by the end of the exhibition except the rights and obligation have not been changed since they assigned the agreement.

Under most situations, the right of ownership to land is protected by property right rule,

the owner of a parcel of land has the absolute and upmost right to accept or refuse an offer, or asking for any price he/she demands. However, as demonstrated in the Land Act and Urban Renewal Act, owners' property right to land is attenuated when development under consideration involve numerous owners. Under this circumstance, the decision of an owner will affect other owners participating in the same development project. And now the rights to land ownership are protected instead by the liability rule that only warrant a fair compensation to the owners who does not agree to a joint project that is believed to benefit the general public.

Conclusions

Land assembly is a common phenomenon in redevelopment of old downtown of a city. The anticommons theory convincingly suggests an inevitable tragedy, but so far has little supporting empirical evidence. This paper sets out to empirically test this theory. Our study suggests that the tragedy of the anticommons has an element of truth, at least in this old part of Taipei City. The challenge faced by the Taipei City is to find a balance between the tragedy of anticommons in land redevelopment and the protection of private property rights.

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