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# Evolution of Skyscraper Block Typology Affected by Air Rights Development: A Case Study of Manhattan

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**Abstract** Air Rights techniques, including floor-area ratio (FAR) transfers, FAR bonuses, and FAR storage, have been widely applied among skyscraper constructions in New York City for profit maximization goals. Since 1916, air rights regulations in New York zoning system have been revised and improved over the years to cater the urban development needs of different periods, and they also result in typical skyscraper block typologies. This research firstly performed spatial overlay analysis to reveal the spatial correlation between skyscraper blocks and air rights application blocks; secondly, Spacematrix parameters and cluster analysis are applied to divide the skyscraper urban block of New York City into four categories. Compared with air rights application data, the research attempts to illustrate how various air rights techniques have acted on the formation and evolution of skyscraper block typologies in the pre-1916, 1916-1961, 1961-2010, and 2010-present periods respectively, in order to reveal the relationship between public policies and urban morphology in a broader sense and also provide references for policy making in future.

**Keywords** Air Rights Development, Manhattan, Skyscrapers, Urban Form

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## 1. Introduction

According to the data from the Council on Tall Buildings and Urban Habitat (CTBUH, 2022), 50 percent of the top 100 tallest skyscrapers in New York City were built after 2010. This ratio even reaches higher among the top 50 tallest skyscrapers; nearly 68 percent of the city's tallest buildings were built in the last 10 years, with an average 67.4 number of floors and an average height of 295.5 meters (969.5 feet).

Throughout history, the primary determinants of tall buildings' origination and evolution can be summarized under three headings: economic and market demands, emerging technologies and political forces (Al-Kodmany, 2012; Barr, 2012). Among them, economic development of land prices, land consumption and market demand, such as population growth and global competition are the internal factors that make things happen. It is well accepted that the history of Manhattan is a chronicle of the finite supply of land and rising real estate prices (Flowers, 2009). Thus, land value and the construction of skyscrapers are inextricably linked (Barr, 2016). Besides, emerging technologies such as the combination of the elevator and metal-skeleton construction in late 19th century (Ahlfeldt & Barr, 2020), the introduction of fluorescent bulbs in the 1940s (Willis, 1995), and other technological advances that allow extraordinarily tall buildings to be built on very small sites (MASNYC, 2013) are the external supports that enable skyscrapers to constantly develop and grow. Political forces, demonstrated in the form of municipal codes and zoning resolutions, which periodically provide property incentives, are the practical foundations that determine where and when skyscrapers can be built (Fig. 1).

By and large, skyscraper constructions are consistent with profit maximization (Clark & Kingston, 1930), whether considered from the perspectives of technical construction costs, economic market profits or governmental policy benefits. Those factors also influence the building form and urban block typology of skyscraper development. The book *Form Follows Finance: Skyscrapers and Skylines in New York and Chicago* expresses the same idea stating that economics is the chief determinant of form, and further divides the building form of skyscrapers into the 1920s /Vernacular Style and 1950s/International Style (Willis, 1995). On the other hand, scholars mention the use of air-rights markets to satisfy the demand for supertall buildings (Barr, 2016). However, little work has been done to investigate how air-rights policies have affected the urban block typology of skyscraper developments specifically, and no work has looked at this issue with

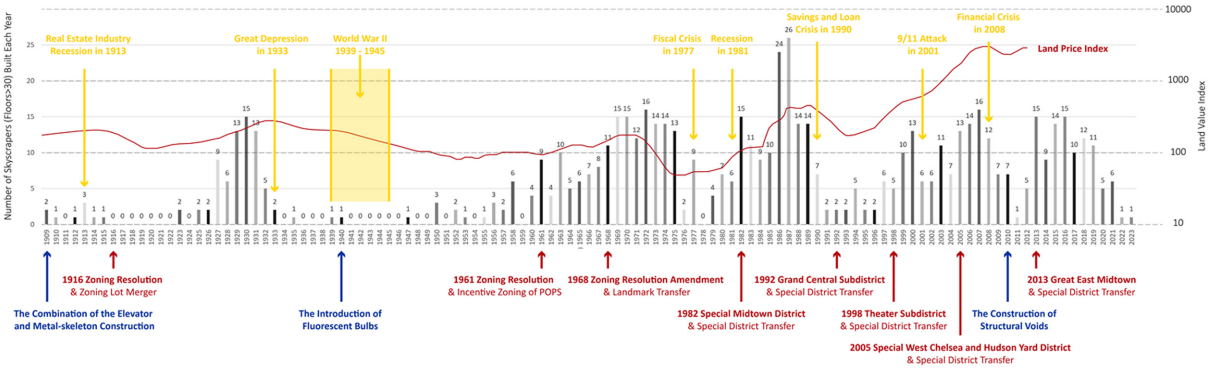



**Figure 1.** Economic, technical and political factors that affect skyscraper development in New York City. (Source: Land Price Index data adapted from Barr, 2016)

quantitative analysis methods.

The aim of this paper is to investigate the relationship between skyscraper construction and air rights application in New York City, specifically in Manhattan, and answer the questions: what are the air rights techniques that support the construction of skyscrapers in New York City; why are they needed; and how does the application of air rights policies affect the evolution of the skyscraper block typology?

## 2. Air Rights Techniques that Facilitate Skyscraper Construction

Nearly all zoning may be said to be fiscal zoning (Fischel, 1987); air rights policies in the zoning system of New York City are not exceptions. Air rights, normally known as "unused development rights" (NYC Planning, 2022), refer to the amount of empty space above a property that can still be built or transferred, based on that lot's zoning. Since the numerical expression of development rights is Floor Area Ratio (FAR), the mechanism of air rights are essentially the FAR control techniques, which include FAR transfers, FAR bonuses and FAR storage. In practice, air rights techniques are regulated by the zoning system to achieve various development goals. In New York City, there are four major air-rights techniques that are closely related to the construction of skyscrapers: Zoning Lot Merger (ZLM), Landmark Transfer, Special District Transfer and Privately-Owned Public Space (POPS). They all act as planning tools to maximize economic benefits.

### 2.1. Zoning Lot Merger

The earliest application of Zoning Lot Merger can be traced back to the 1916 NYC Zoning Resolution, when the concept of "lot" was defined: a "zoning lot" can be a tract of land that consists of two or more lots of record, contiguous for a minimum of 10 linear feet, located within a single block, under a building permit that treats those multiple tax lots as one zoning lot (NYC Zoning Resolution Section 12-10, 2011). It means two or more adjacent zoning lots can be combined into one new zoning lot. Once the zoning lots are merged, the development rights are combined, and private owners are allowed to freely transfer bulk and density, or air rights, among their tax lots (Boffard, 2014).

In the 1920s, population growth and the high demand for commercial space resulted in the first skyscraper construction boom. At that time, elevators and steel-frame structures were new technologies in building construction, however, they are expensive to apply. Through cost-benefit calculation, the most practicable form of skyscraper would be at least 100 × 200 feet (30.5 × 61.0 m) of ground floor size, with 63 stories (Willis, 1995), which would achieve the highest rate of economic return. From the perspective of construction economics, big buildings on large sites are in need. However, the historic grid of Manhattan, with its initial colonial pattern of lots dimensioned at 25 × 100 feet (7.6 × 30.5 m), makes it hard to achieve the construction of skyscrapers. As a result, the Zoning Lot Merger became a necessary zoning tool.

Additionally, there was a special regulation in 1916 Zoning Resolution stating that, when the building coverage ratio is less than 25 percent of the lot area, it can exceed the setback and height limitations. That is to say, developers can construct buildings with unlimited height if technology and economic conditions permit. Under this incentive, developers began to expand their lot sizes with the Zoning Lot Merger tool, in order to satisfy the "25 percent rule," to construct significantly tall buildings on their sites.

In its implementation process, the Zoning Lot Merger is defined as "as-of-right" development and does not require discretionary action by the City Planning Commission. It means that the Zoning Lot Merger has the lowest transaction costs among other air rights techniques, and in practice, it become the most commonly-used air rights tool until the present day. In recent years, with the rapid growth of land prices, there has been a significant demand for very tall buildings on narrow sites, so as to produce the highest rate of return on the money invested. Zoning Lot Mergers have recently come back in vogue, helping to facilitate the skyscraper condo boom to the south of Central Park

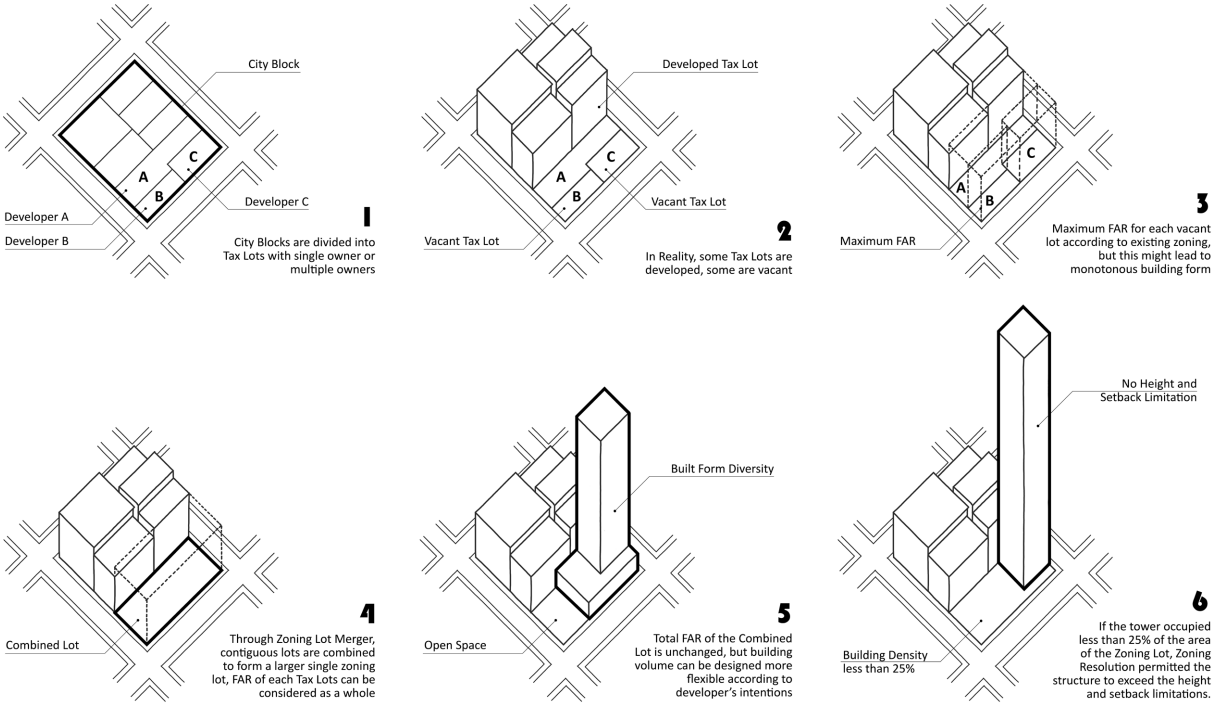



**Figure 2.** Mechanism of Zoning Lot Merger and "25% rule".

in Manhattan. Developers collect the air rights from nearby merged lots, so as to achieve higher FARs than allowed on the chosen lot, so as to build the highest economically feasible buildings.

In different development periods, the Zoning Lot Merger has served different functions to facilitate skyscraper development. In the early 1920s, Zoning Lot Mergers helped enlarge the size of the site to optimize the construction cost. From 1920s to 1950s, with the "25 percent rule", Zoning Lot Mergers were used to achieve unlimited height. After 2010s, when FAR became the the primary standard that determined the building bulk, the Zoning Lot Merger was used to gather extra FAR value. Faced with technical issues, political forces and land prices in different development contexts, the Zoning Lot Merger technique proved useful in helping to maximize economic benefits for developers (Fig. 2).

## 2.2. Landmark Transfer

In 1965, New York City passed the Landmark Preservation Law and established the Landmark Preservation Commission. A list of landmarks and historic districts are designated, and the development rights of destruction, demolition or functional change are restricted on protected buildings. At the same time, in the 1968 Zoning Resolution, Section 74-79, "Transfer of Development Rights from Landmark Sites" ("Landmark Transfer") ordinance was also issued, to enable landmarked building owners to sell air rights to "adjacent" lots, which include "contiguous" lots, plus those directly across the street or that share an intersection, provided that a that the maintenance plan for the landmark is accompanied (NYC Zoning Resolution Section 74-79, 2011) (Fig. 3).

When market mechanisms cannot protect landmarks under the pressure of land value escalation, government must use political force (such as issuing a Landmark Preservation Law) to ensure protection. However, a new problem arises, since restrictive policies mean great economic losses for landmark owners; at the same time, governments do not have enough funds for compensation, which means the protection law is hard to carry out. Under this circumstance, the Landmark Transfer technique is put forward, in which landmark owners are allowed to sell their air rights for economic compensation, developers can buy air rights for higher buildings, and government can benefit from new tax revenues from new projects. Landmark Transfer is considered to be an urban control tool that economically benefits all stakeholders.

Since landmarks are normally located in urban core area with high FAR index (such as a FAR 15 in Grand Central Terminal area), they control a large amount of air rights. At the same time, the lot contiguous or adjacent to the landmarks are assigned the same high FAR levels. When air rights transfer from landmark sites to adjacent lots, the receiving sites would gain much higher FAR, thus facilitating better conditions for skyscraper construction.

## 2.3. Special District Transfer

Air-rights transfer techniques in their early application, such as Zoning Lot Merger and Landmark Transfer, all

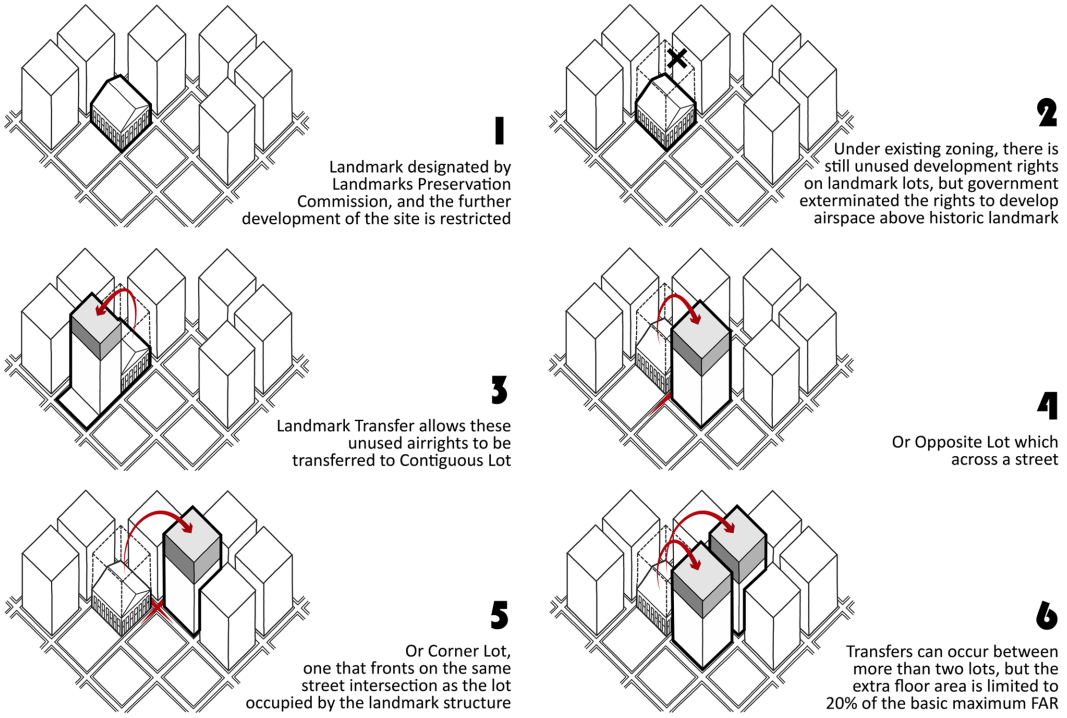



**Figure 3.** Mechanism of Landmark Transfer.

limited their receiving sites to adjacent lots, which greatly affect the success ratio of air rights market. Therefore, several special transfer districts were designated since the 1970s, which expanded the eligible receiving site to a certain geographical area, so that air rights could be transferred between all developers within the special district (Fig. 4).

Compared with Zoning Lot Mergers and Landmark Transfers, the Special District Transfer goes a step further towards expanding the air-rights market. Geographically, air rights are permitted to transfer over a wider range of area, which increases the possibilities for fulfilling air-rights construction within a controllable scope. Functionally, Special District Transfers serve more urban development goals, as the eligible air-rights sending sites are not limited to landmarks, but also other situations, such as culture facilities in the Theater Subdistrict, transportation improvement in the Grand Central Subdistrict, High Line Park construction in the West Chelsea District, and historic district protection in South Street Seaport District.

Similar to the mechanism of Landmark Transfer, most of the Special Transfer Districts are regulated with high FAR levels, and the outcome of air rights transfer within special districts will likely be the construction of skyscrapers, such as One Vanderbilt in the Grand Central District, and the skyscraper cluster zone in Special Hudson Yards and West Chelsea districts.

### 2.4. Privately Owned Public Space

Privately Owned Public Space (POPS) refers to the public space that, although privately owned, is legally required to open to the public under a city's zoning ordinance or other land use law (Kayden, 2000). Privately Owned Public Space has been widely used by New York City since the 1961 Zoning Resolution, in which instituted an incentive zoning system that actively engaged private developers in providing public amenities in exchange for addition FARs (Schmidt, 2011) (Fig. 5). FAR bonus for POPS is usually regarded as a kind of non-transferable air right, since it adds additional development rights to original properties.

The commencement of POPS is closely related to the development of high-rise buildings. When more and more high-rises occupied the central land of the city with huge building volumes, it greatly reduced the street sunlight and ventilation level, and resulted in healthy and safety issues, government began to realize the significance of urban public space. However, in 1960s, most of the governments in the United States were experiencing the dilemma of shrinking public finances and were unable to support public goods construction. Thereby, the strategy of exchanging floor area for public space was initiated by the government.

The economic logic of POPS is similar to that of Landmark Transfers, in which public goods are provided, developers receive extra development rights for more profit, and government benefits from tax revenue from new projects. POPS are proposed to improve the environmental quality in high-rise blocks, and typically result in greater building heights due to the FAR bonus. Thus, most of the

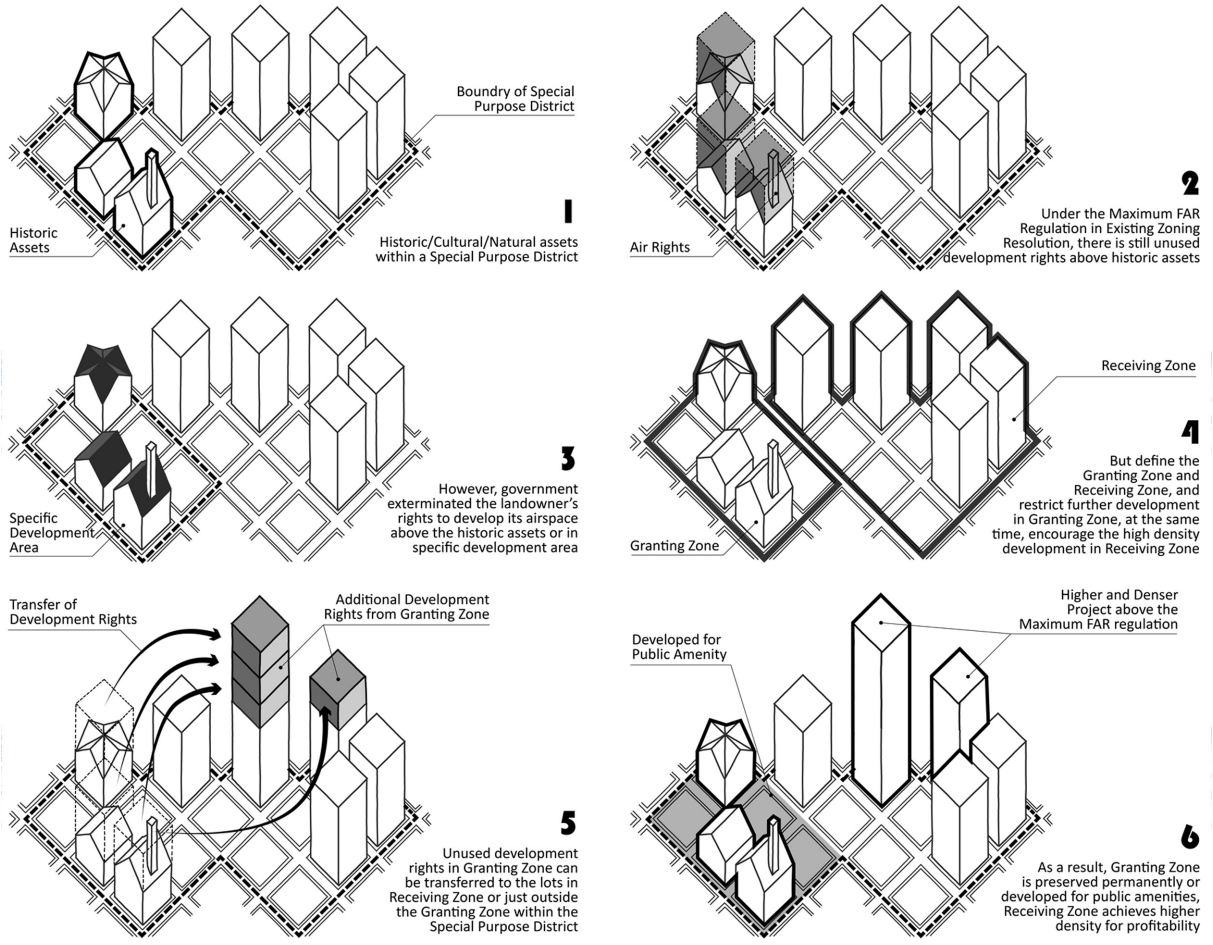



**Figure 4.** Mechanism of Special District Transfer.

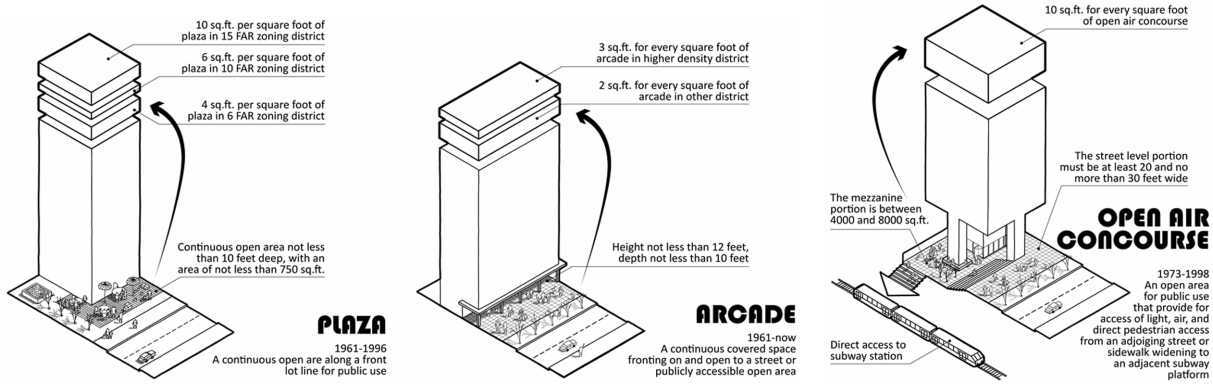



**Figure 5.** Mechanism of Privately-Owned Public Space (Plaza, Arcade and Open-air Concourse).

skyscraper developments in New York City have benefited from this air rights technique.

## 3. Method

### 3.1. Study Area and Study Object

Manhattan in New York City is selected as the case study area, since there are plenty of skyscraper cases that benefit from air rights techniques. We define a "skyscraper" as a multi-story building whose architectural height is at least 100 meters (Al-Kodmany, 2012) or has an average number of 29.6 floors or greater (Barr, 2010). Our research examines the urban block that contains buildings taller than 30 floors, to analyze how and in what manner the policy change of air rights has affected the evolution of the skyscraper block typology.

### 3.2. Data Collection

To answer the question "where are the skyscrapers and air rights cases in Manhattan?" skyscraper block data and air-rights application data are collected and become the two primary data sets used in our research.

Skyscraper block data comes from the 2022 "PLUTO" file provided by the New York Department of City Planning (City of New York 2022a). This file lists extensive information for every property in the City of New York, including building address, year completed, number of floors, floor area ratio, lot size, building area, building type, and other information related to zoning and land use. For our analysis, we included observations from 1900 to 2020, for structures taller than 30 floors, and removed some properties that had extreme outlier characteristics, such as floor area ratios greater than 100. This created a base dataset of skyscraper blocks with 675 total properties.

Air-rights application data sets come from various sources, due to their type. POPS data comes from NYC OpenData by NYC government, which include the location, year built, and area of 388 POPS cases (City of New York 2022b). Zoning lot merger data primarily comes from the research report of the Furman Center at New York University (Furman, 2013). Landmark Transfer and Special District Transfer case data all come from a research report conducted by New York Department of City Planning (2014), in which the name of the project, built year and amount of air rights transferred were collected. In addition, some air-rights transfer cases implemented in recent years are also added, according to data or information in news or government reports.

### 3.3. Spatial Correlation Analysis

With the research question of "to what extent are air-rights applications related to skyscraper development?", we analyzed the association between air rights and building height throughout Manhattan. We first calculated the building height map of Manhattan and then applied bivariate Moran's I in GeoDa software. The bivariate Moran's I is a measure of spatial association between variables at neighboring locations. Moran's I index ranges from -1 to 1. If the value is larger than 0, that indicates positive spatial autocorrelation. The higher the value, the more obvious the spatial correlation. A value smaller than 0 indicates negative spatial autocorrelation; the smaller the value, the greater the spatial difference. A "0" represents no relationship, or the space is random. In this study, we divide the urban block into three categories: low-rise blocks, in which buildings are lower than seven floors; mid-rise blocks, in which buildings are higher than seven floors but lower than 20 floors; and high-rise blocks, in which buildings are taller than 20 floors. Then, we analyze the correlation relationship between air-rights application cases and low-rise blocks, mid-rise blocks and high-rise blocks. Accordingly, positive and higher bivariate Moran's I values suggest a stronger correlation between the application of air rights and skyscraper development.

### 3.4. Spacematrix Typology Cluster Analysis

Pursuing the question of "how air rights applications affect the evolution of the skyscraper block typology", we firstly use Spacematrix method to quantify the density character of various building block types, in we which combine four quantitative indices: Floor Space Index (FSI), Ground Space Index (GSI), Open Space Ratio (OSR) and Building Height (L) to describe the urban fabric pattern (Berghauser-Pont and Haupt, 2010). Secondly, Pearson correlation analysis is conducted in SPSS software among the air rights cases and four Spacematrix indices, in order to see which density index is strongly affected by air rights applications. Finally, cluster analysis in GIS, based on the Spacematrix index, is applied, in which we divide the skyscraper urban block typology into groups, use this division to analyze how different categories of urban block typologies are related to the application of air rights.

## 4. Results

### 4.1. Relationship Between Building Height and Air Rights Applications

To determine how building height and air rights development are related, we first create the building height map of Manhattan according to the "number of floors" data in MapPLUTO. As is shown in Fig. 6 (left), skyscrapers whose floor number is above 30 are mostly clustered in Midtown and the Lower Manhattan area. Besides this, there are also some small skyscraper clusters in newly developed districts such as the Special Hudson Park District and along the Hudson River. Through distribution analysis of air-rights cases of landmark transfer, special district transfer, zoning lot merger and privately-owned public space, as is shown in Fig. 6 (right), most of the air-rights transfer cases take place in Midtown and Lower Manhattan, while zoning lot mergers and POPS cases are also partly located to the east of Central Park.

To further explore the relationship between building height and air rights applications, bivariate Moran's I analysis is applied to air-rights cases in low-rise, mid-rise, and high-rise blocks, respectively. As is shown in Fig. 7, the relationship between low-rise blocks and air-rights cases showed a comparatively strong negative association, where the bivariate Moran's I value was –0.0843 ($p$ = 0.014), meaning air-rights cases are normally not located in low-rise blocks: a so-called "spatial mismatch." The bivariate Moran's I value of air-rights cases and mid-rise blocks is 0.038 ($p$ = 0.079), showing a slightly positive relationship. In contrast, air-rights cases and high-rise blocks have comparatively strong positive relationships, with the bivariate Moran's I value of 0.096 ($p$ = 0.086) suggesting air-rights cases are mostly located in high-rise

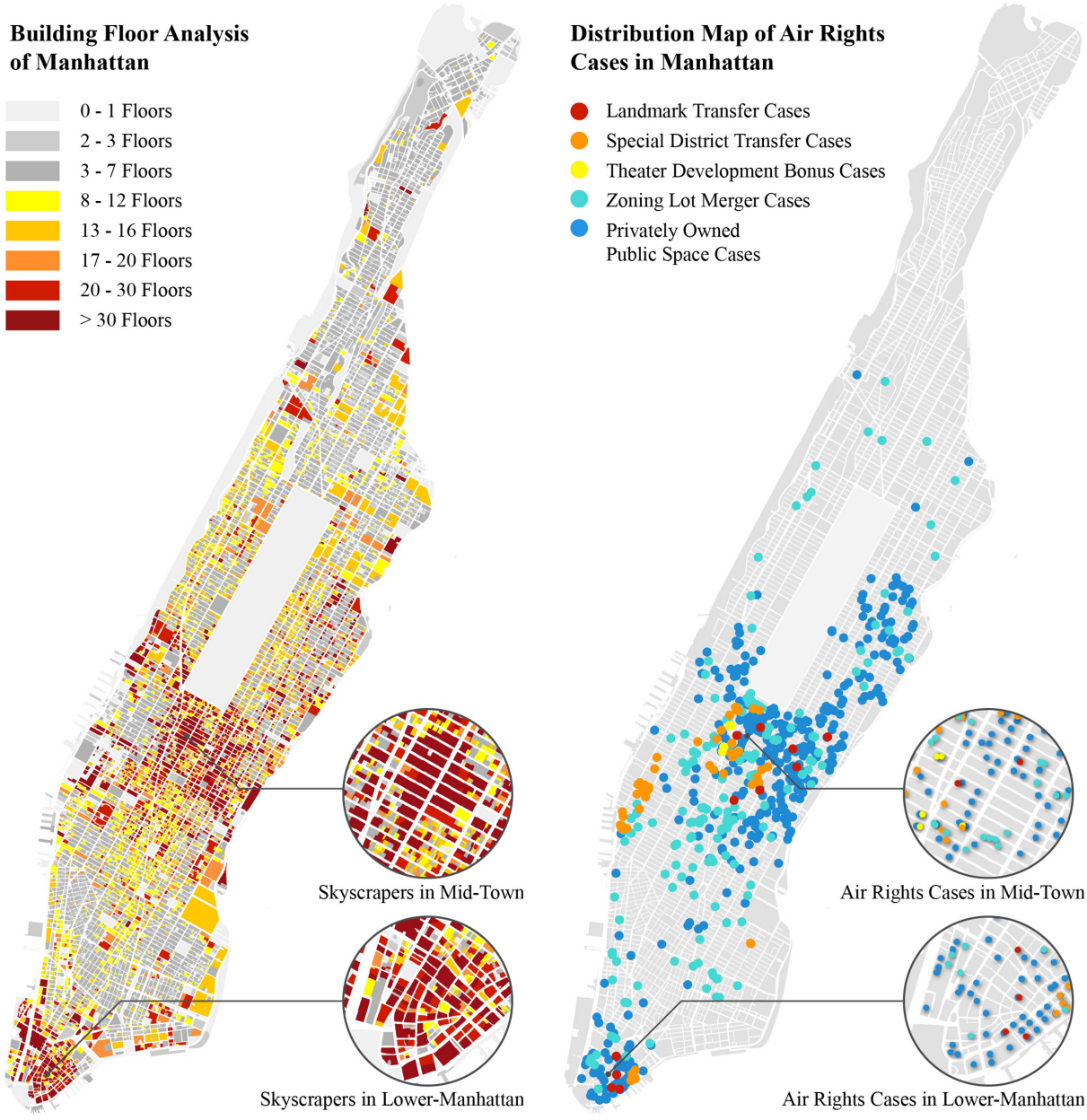



**Figure 6.** Building Height Map (Left) and Air Rights Application Map (Right) in Manhattan.

blocks, and that air-rights techniques have contributed to the development of high-rise buildings.

### 4.2. Development Trends of Skyscraper Projects in Manhattan

In order to explore how air rights affect the evolution of the skyscraper typology, we selected the urban blocks with 30-floor buildings or higher as a new dataset for further study. In general, the average Floor Space Index (or Floor Area Ratio, FAR) of 675 selected sample skyscraper blocks is 18.85, and the average Ground Floor Index is 0.744. Besides, there are 343 air-rights applications among these selected 675 skyscraper blocks; that is to say, nearly 50.8 percent of the skyscrapers in the study used air-rights techniques in their development process (Fig. 8).

From a chronical development perspective, most of the air rights cases take place after 1961. From the 1970s to the 1990s, nearly 80 percent of the skyscrapers are related to air-rights applications, and POPS with FAR bonuses contribute the greatest number of air-rights categories. Therefore, the average Ground Space Index (GSI) values, which indicate the intensity level of urban blocks, are comparatively low in the same time periods, as most of the developers built urban plazas in exchange for higher FSIs. Another wide application of air rights boomed after 2000, with transfer of development rights as the dominant form that contributes to the skyscraper development (Fig. 9).

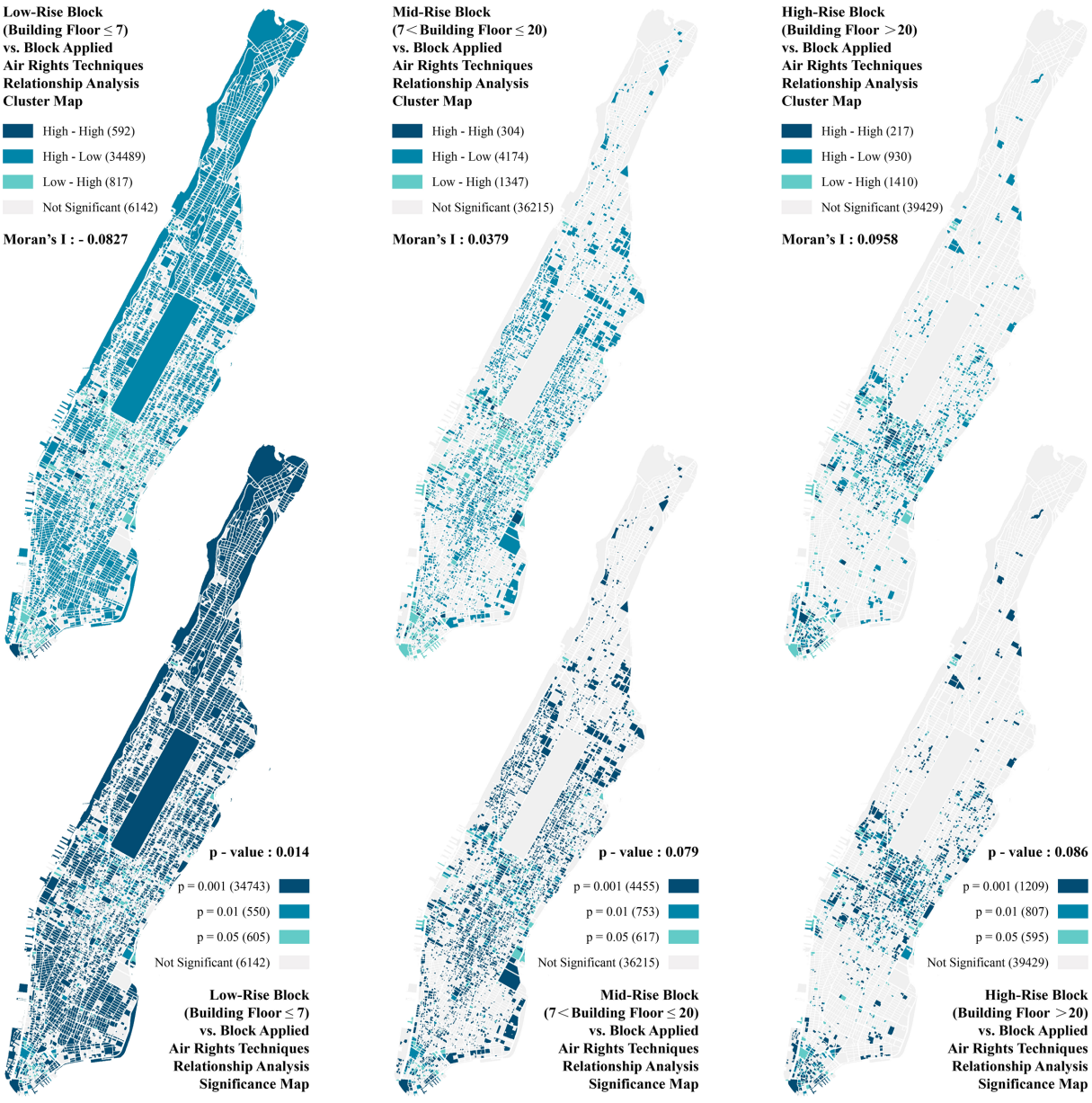



**Figure 7.** Bivariate Moran's I analysis of air-rights cases and block types of different building heights.

The correlation analysis between the number of air-rights cases applied each year after 1960, and the number of skyscrapers built, averaging GSI, OSR, FSI and building floors, demonstrates the same conclusion. As Table 1 shows, the number of air-rights cases shows strong correlation with the number of skyscrapers built in each year, with the r-square of 0.766 and 2-tailed significance index of 0.000. Besides, the average of GSI and OSR is slightly correlated to the application of air rights, with r-square values of –0.278 and 0.036, respectively, with correlation significant at the 0.05 level.

### 4.3. Relationship between Air-Rights Cases and Skyscraper Block Typology

With cluster analysis in GIS, we further divide the skyscraper block data sets into three groups: High-GSI/High-FSI, High-GSI/Mid-FSI and Mid-GSI/Mid-FSI group, according to the Spacematrix index. Through development period analysis, it is found that High-GIS/High-FIS group are the main block typology of 1920s and 2010s, with high building density and intensity, while the Mid-GSI/Mid-FSI group represents the dominant block typology from the 1960s to the 1980s, indicating more open space in the skyscraper block (Fig. 10).

## 5. Discussion

In New York City, zoning lot mergers, landmark transfers, special district transfers and privately-owned public spaces are the four air-rights policies which either enable

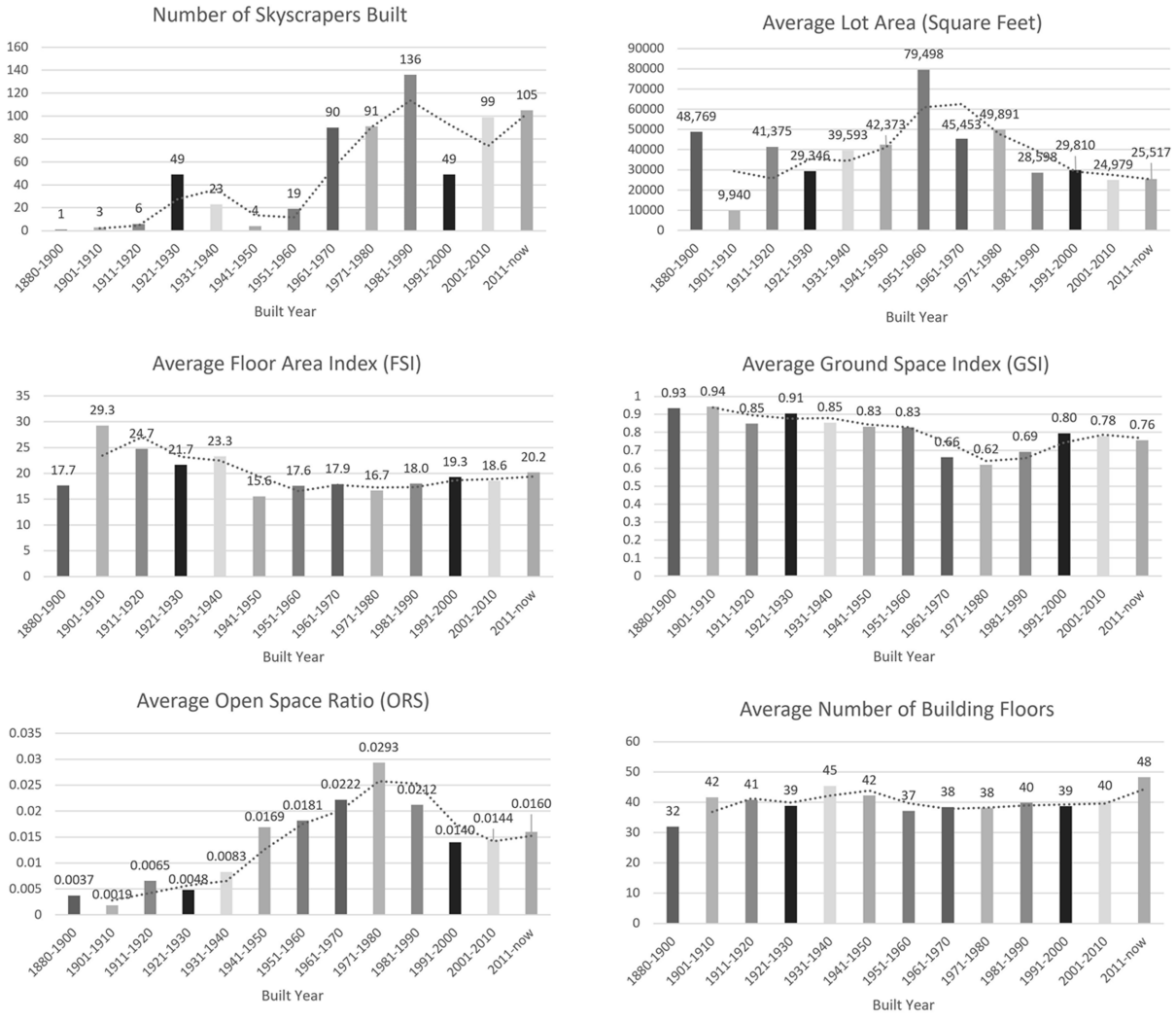



**Figure 8.** Evolution of Skyscraper Block Density Feature in terms of FSI, GSI, ORS and Building Floors.

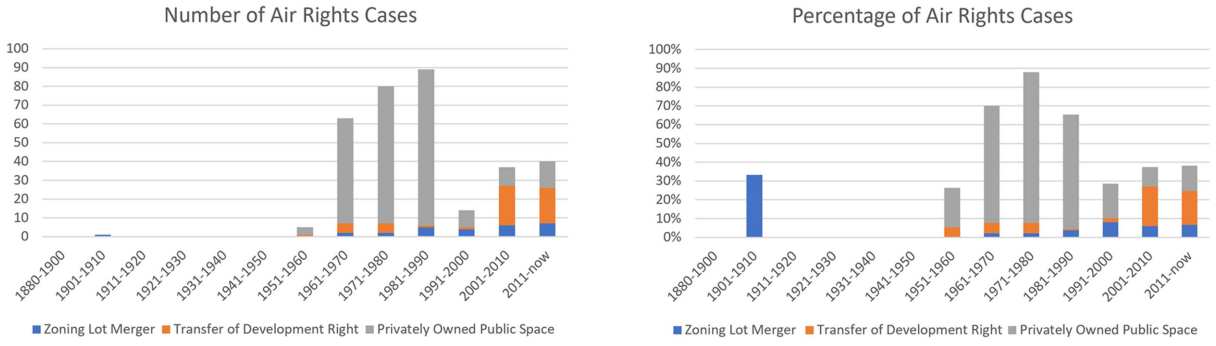



**Figure 9.** Number of air rights cases applied among skyscraper blocks over the years 1880-present.

FAR transfer or provide FAR bonuses, which give property incentives for skyscraper development. Each air-rights technique has its own effectiveness, such as providing a large construction site, facilitating the extension of a building beyond existing height limits, encouraging the construction of public space in exchange for a higher FAR, or enabling the breakthrough of FAR limitations through air-rights transfers. All affect the patterns of the urban fabric to some extent. According to the Spacematrix analysis, the typology of skyscrapers can be placed in the the following categories, and they all can be explained as the outcome of certain air-rights techniques.

**Table 1.** Pearson Correlation between air rights and skyscraper density features (after 1960)

| Number of Air Rights Cases Applied (After 1960) | Number of Skyscrapers Built | Average of GSI | Average of OSR | Average of FSI | Average of Building Floors |
|---|---|---|---|---|---|
| Pearson Correlation | 0.766** | –0.278* | 0.306* | –0.165 | –0.217 |
| Sig. (2-tailed) | 0.000 | 0.027 | 0.015 | 0.197 | 0.088 |

*Correlation is significant at the 0.05 level
** Correlation is significant at the 0.01 level

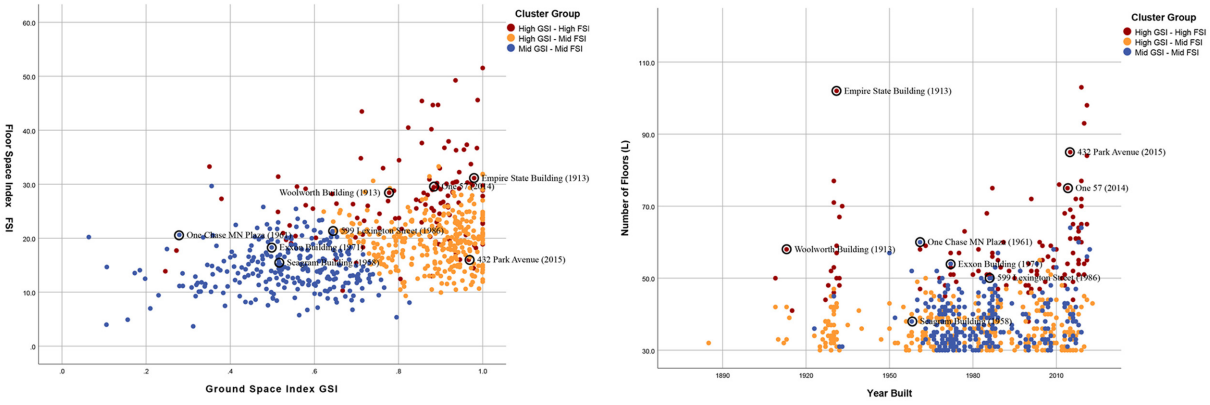



**Figure 10.** Cluster analysis of skyscraper blocks, according to the Spacematrix Index. Cluster analysis of skyscraper blocks, according to the Spacematrix Index.

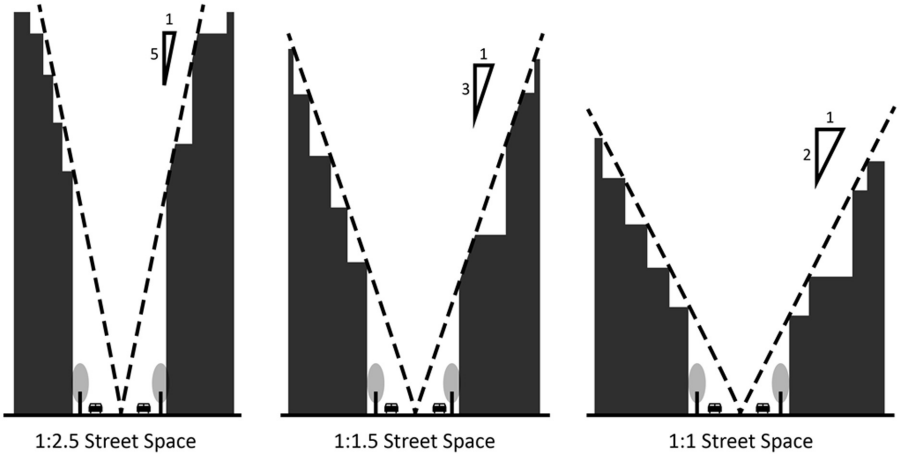



**Figure 11.** Setback line rules in the 1916 New York City Zoning Resolution.

### 5.1. POST-1916 STYLE - Setback Line and Zoning Lot Merger in 1916 Zoning Resolution, and the Development of the "Wedding-Cake-Style" Skyscraper

To ensure sufficient lighting and ventilation quality of the street, a setback line regulation was included in the 1916 Zoning Resolution of New York City, which recommended that the lower bulk of the building adjoin the street line and the higher part retreat inside of the block. At the same time, driven by the ideal of interest maximization, developers used zoning-lot merger techniques to combine adjacent lots and make full use of the buildable space to build skyscrapers; thus the development of the "wedding-cake-style" high-rise, occupying the entire ground site and having numerous terraced setbacks.

Pioneered in the early 1910s in advance of the zoning change with the Woolworth Building (Fig. 12), the typology dominated in the 1920s and 1930s, with the best-known example being the Empire State Building (Fig. 13). Since the setback line regulation did not involve the open space issues, the urban fabric pattern of that time shows the characteristics of large floor space, high GSI, high building height and low OSR.

### 5.2. PRE-1961 STYLE – The "25% Rule" in Zoning Lot Mergers and the Formation of "Grand Plaza Skyscraper" before 1961

In 1916 Zoning Resolution, there is one exceptional

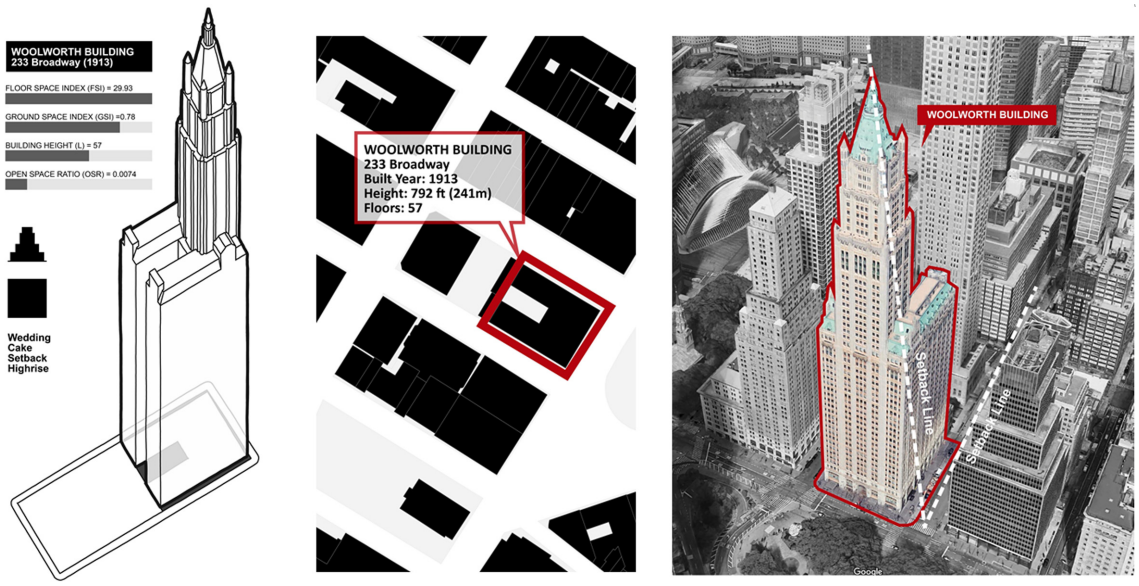



**Figure 12.** The Woolworth Building was achieved by zoning lot merger in 1913.




**Figure 13.** The Empire State Building, whose construction was achieved by way of a zoning lot merger in 1931.

regulation of setback line control rules, that is the "25 percent rules" in zoning lot mergers; e.g., if the building coverage area is no more than 25 percent of the site's area, it can be exempted from building height and setback line restriction. Therefore, developers at that time took advantages of the zoning-lot merger methods to expand their site area, thus provide the large site area for the construction of super high-rise buildings. Well-known examples include the Seagram Building (Fig. 14.) and 28 Liberty Street (Fig. 15). The building type is normally a regular cubic volume without a setback, but accompanied by a large urban plaza. It forms the urban fabric pattern of high FSI, low GSI, high building height and high OSR. Since this regulation is not conducive to the efficient use of land, it was abolished by a 1961 amendment of the Zoning Resolution. In 2001, a new version of Zoning Resolution proposed that the building density of the zoning-lot merger program should not be less than 33 percent; herefore, this kind of urban fabric pattern only existed for a short period of time before 1961.

### 5.3. POST-1961 STYLE - Skyscrapers Developed with Privately-Owned Public Spaces (POPS) after 1961

In the 1961 Zoning Resolution Amendment, the concept of Floor Area Ratio (FAR) was formally introduced to control the intensity and bulk of urban development. At the same time, plazas and arcades were two kinds of privately-owned public space (POPS) proposed to deal with the shortage of public space in Manhattan's core area. It was regulated that developers could exchange no

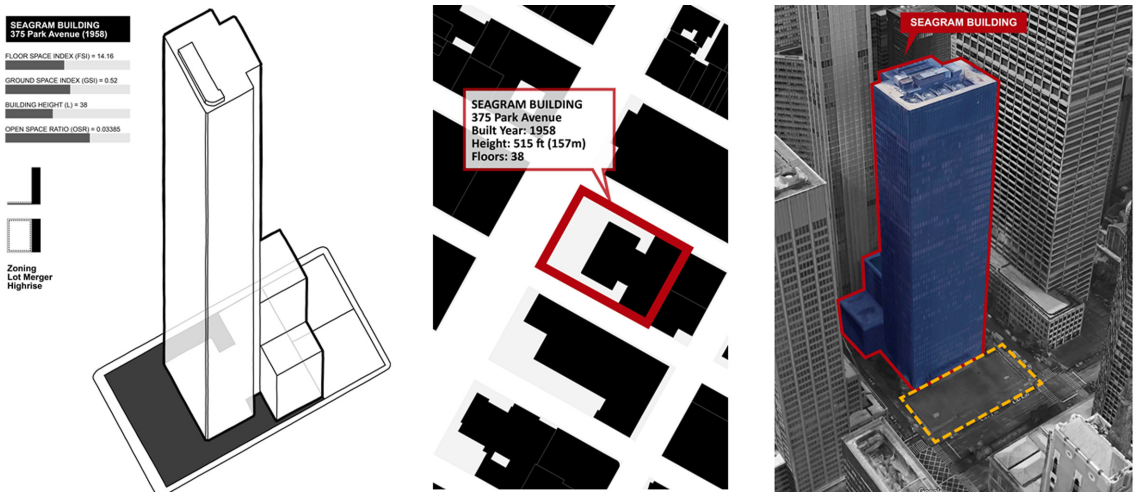



**Figure 14.** The Seagram Building, with its signature plaza, was made possible through the "25% rule" in 1958.




**Figure 15.** One Chase Manhattan Plaza (28 Liberty Street) was also achieved by the 25% rule, in 1961.




**Figure 16.** The Exxon Building (1971), which took advantage of the POPS provision in the 1961 Zoning Resolution Amendment.

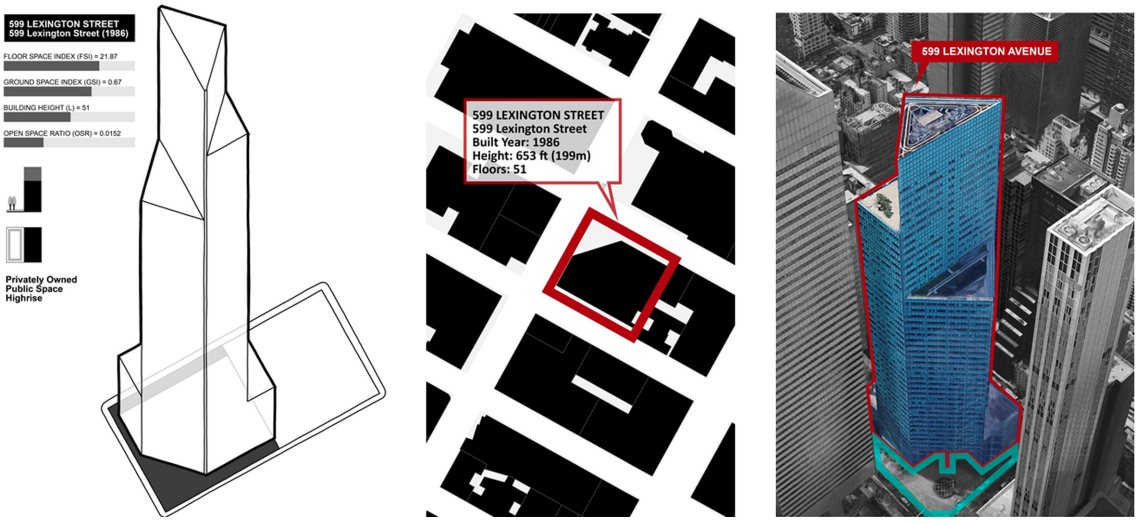



**Figure 17.** The office tower at 599 Lexington Avenue was also achieved by POPS regulations, in 1986.

more than 20 percent of the base FAR as a bonus for providing POPS. As a result, a new construction boom appeared after 1961. According to statistics, from 1966 to 1975, 88 percent of the new office buildings in the Manhattan core area were awarded FAR bonuses through POPS zoning methods, and 70 percent of these new office buildings provided POPS in the form of plazas. Since POPS-based skyscraper projects normally covered more than 60 percent of the land area , through providing a urban plaza in media size to achieve a floor area index higher than that permitted by regulations, the urban fabric pattern of this kind is featured with high FSI, medium GSI, high building height and medium OSI. Famous cases include the Exxon Building (Fig. 16) and 599 Lexington Avenue (Fig. 17).

### 5.4. POST-2010 STYLE - Super Skyscrapers with Multiple Air Rights Techniques, after the 2010 POPS Policy Reform

In 2007, due to the surplus of privately-owned public space in New York City, POPS policy reform was applied, resulting in the elimination of some types of POPS options, an increase in the difficulty of the approval process, etc., resulting in a sharp decrease in the number of newly-built high-rise buildings that applied POPS zoning method.

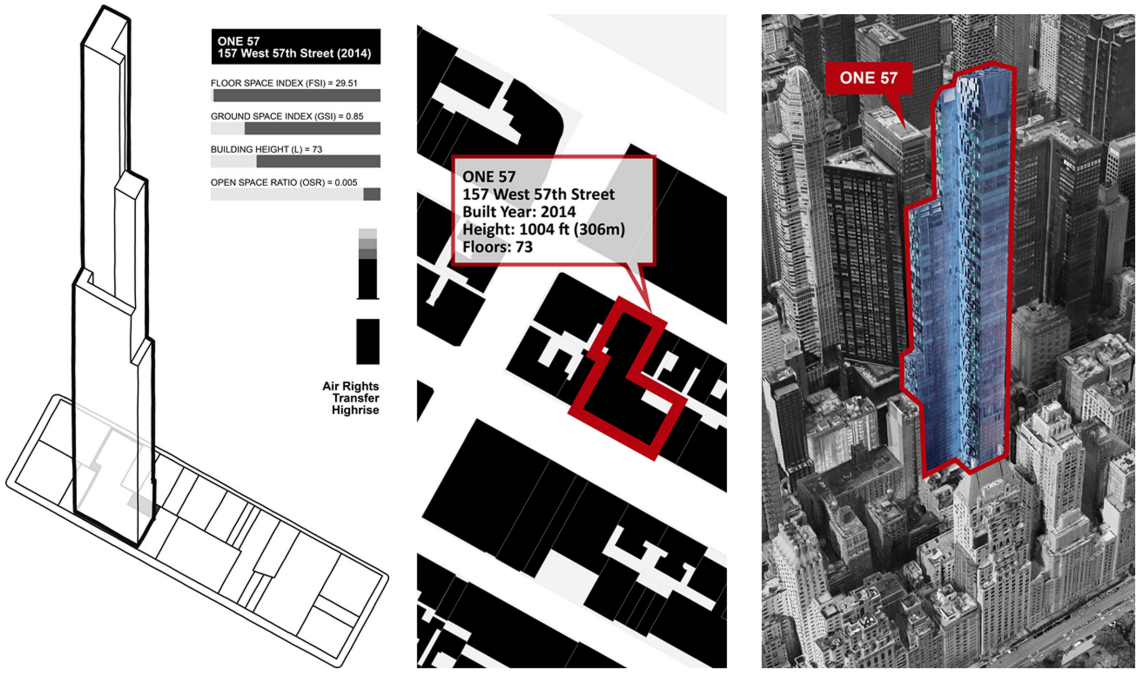



**Figure 18.** One57 was achieved by way of zoning lot mergers and landmark transfers in 2014.

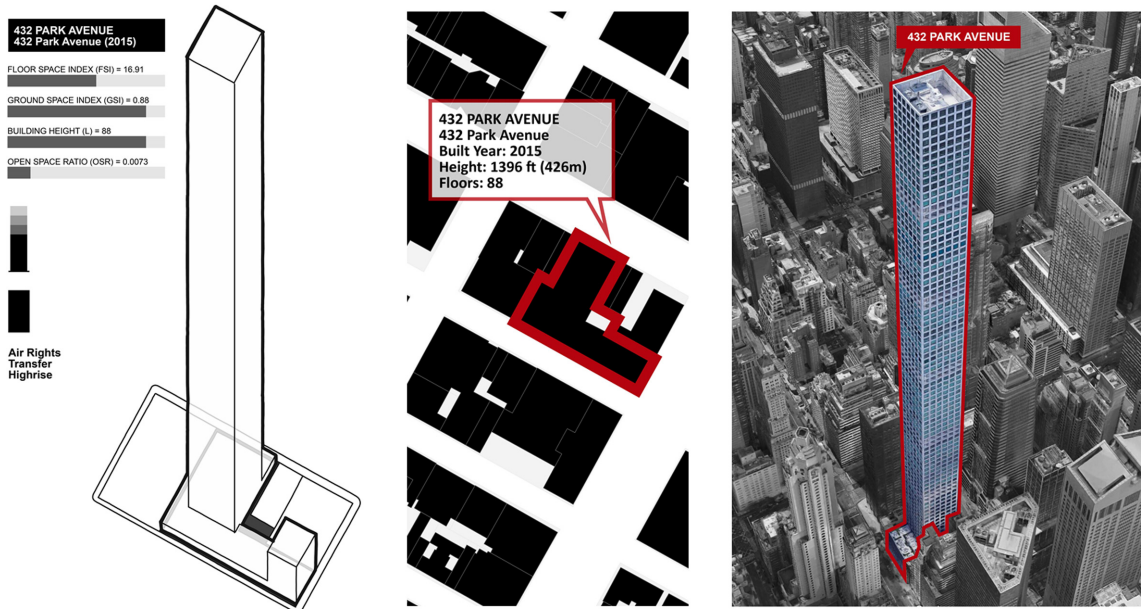



**Figure 19.** 432 Park Avenue was made possible by way of a zoning lot merger, and POPS in 2015.

However, the policy reform has not dampened the developer's enthusiasm for new high-rise construction in Manhattan core area; and the battle for space over the city has been in full swing since 2010. Developers use a variety of air-rights techniques, such as landmark transfers, special district transfers, zoning lot mergers, as well as POPS, to purchase and transfer the unused development rights from more than one site, and achieve projects with extremely high slenderness ratios. The built FAR normally exceeded the base FAR by a factor of 2; thus the building height is usually more than 1,000 feet (305 meters) tall.

Since these skyscrapers generally occupy the whole area of the limited land without any open space left, they form the new urban block typology with a very high FSI, high GSI, very high building height and low OSR. Notable cases include One World Trade Center (2014), Central Park Tower (2020), 111 West 57th Street (2021), One Vanderbilt (2020), 432 Park Avenue (Fig. 19), and One57 (Fig. 18).

### 6. Conclusion

It is undeniable that economic profit is the dominant factor that determines skyscraper development; however, public policies act as a tool to help the profit maximization process, and constitute the most direct factor in shaping the urban form. In this study, we examine how air-rights policies and the change of the policies have affected the evolution of the skyscraper block typology in Manhattan. It is found that air-rights applications have had positive spatial correlation with high-rise urban blocks, compared with low-rise or mid-rise blocks. Among skyscrapers built after 1960 in Manhattan, more than half applied air-rights techniques, including zoning lot mergers, landmark transfers, special district transfers or privately-owned public spaces, or the combination of them. Different air-rights techniques have had various impacts on the urban form, and the typical form includes the setback skyscraper with no plaza that predominated in the 1920s; block skyscrapers with grand plazas in the 1960s, skyscrapers with media plazas under POPS rules in the 1980s, and extremely high skyscrapers with no plazas after 2010.

Air rights played an active role in the urban built-up area regeneration process, and eventually contributed to profit maximization and economic development goals. However, urban rules and urban form are closely related. When we pursue the efficiency of land use and land economy, we should also think about potential negative impact this optimization may have on environmental quality or public-facility capacity. The skyscraper boom supported by air-rights techniques is not an unmitigated good. But this question is left for future research.

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