Research-Based Article

Commodification of Development Rights and What It Does to the Urban Housing Market in Taiwan

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Abstract

The enactment of the transfer of development rights (TDR) policy in Taiwan since the late 1990s is part of a broader trend of commodification and deregulation of development rights. This study examines the spillover effect of TDR on the sale prices of existing housing stock that constitutes the main housing market for the majority of urban residents. Three hedonic models, ordinary least squares (OLS) regression, quantile regression, and spatial lag regression, show that the presence of TDR utilization in real estate development is a significant price driver that generates a financial burden that disproportionally affects poor families.

Keywords

development rights, commodification, housing price, TDR, Taiwan

Introduction

This article aims to examine the effect of the commodification of development rights on the sale prices of existing residential apartments in Taiwan. In recent years, profit-oriented property development has characterized the process of urban transformation in Taiwan. Escalating housing prices have borne witness to the ascendancy of market influences in the cities. Both newly built apartments and existing housing stock have undergone sharp increases in sale prices. Existing apartments are preowned, older units whose price range is relatively moderate in comparison with newly built residences; these units therefore constitute an important housing choice for the majority of urban residents. Between 2004 and 2015, the average sale price for an existing apartment increased from 6.10 million NTD[1] to 15.05 million NTD in Taipei, the capital city of Taiwan, and from 3.90 million NTD to 9.77 million NTD in New Taipei City, the country's most populous metropolis and home to almost 4 million people. For newly built apartments, the average sale prices in 2015 reached 23.38 and 16.45 million NTD in Taipei City and New Taipei City, respectively.[2] These heavy housing costs have led to growing social discontent and a greater demand for policy intervention to safeguard housing affordability.[3]

Scholars attribute the booming real estate market to several roll-out neoliberal policies that have driven market-oriented urban development in recent decades in Taiwan. These policies include privatization of public assets (i.e., the selling of state-owned land to private entities), public–private partnerships (i.e., government-supported corporations monopolizing redevelopment activities on public-owned land), and financial liberalization (i.e., the removal of barriers to the financial capital's cross-investment in real estate markets) (Hsu and Hsu 2013, 688; Jou, Clark, and Chen 2016, 566, 571). One practice that has also gained widespread popularity in market-oriented urban redevelopment is the utilization of tradable development rights to permit the building density of new developments to exceed existing regulations on floor–area ratio (FAR).[4] In Taiwan, the granting of extra development rights was initially in the control of the planning authority, who used these rights as an incentive to reward individual development projects when certain criteria of public interest were met, such as provisions for parking or open spaces, exhibition of public art works, historical

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preservation, etc. However, since the late 1990s, the transfer of development rights (TDR) policy has turned development rights into a commodity traded between private parties for real estate development whose utilization is characterized by the deregulation of planning intervention (see next section).

In its general construct, the operational essence of TDR involves allowing development rights (in floor area) to be spatially "adrift" from privately owned lands under restrictive regulations (i.e., sending sites) to growth-desired areas designated by planners (i.e., receiving sites) (Costonis 1974) and "monetizing" those transferable development rights by creating a market for their trading (Stinson 1996). Since development rights do not need to be realized in situ, TDR is touted as a flexible, market-based design that helps planners circumvent rigid Euclidean zoning, reduce financial burdens on local governments, and at the same time, achieve public-oriented goals. In the United States, these goals include farmland protection (Pfeffer and Lapping 1994), historical preservation (Stinson 1996), and more recently, affordable housing (Furman Center 2014). In Taiwan, the implementation of TDR policy since the late 1990s has largely served two purposes: (1) as a compensatory mechanism to resolve the "reserved land issue," a long-lasting planning challenge that has resulted in uncompensated private landowners for lands zoned for public facilities; and (2) as a stimulus for real estate market development (see Section Two). Between 1999 and 2011 in Taiwan, there were in total 1,673 TDR cases involving 166.62 hectares (ha) of reserved land—sending sites that generated 345.87 ha of commodified development rights in the form of buildable floor area for the real estate sector (The Control Yuan[5] 2013, 21–22). New Taipei City, a city that had the largest amount of reserved land in its jurisdiction and was the first local government to experiment with TDR in 1997, had 941 cases, creating a total of 196.20 ha of extra building density in the same time period (ibid.).

This article asks a twofold question about TDR's impact on the housing market. It asks whether the use of TDR in one real estate development site is associated with higher sale prices for existing apartments in the surrounding area, and if so, whether the used quantity of TDR matters. Existing scholarship on TDR practices mostly focuses on operational and institutional mechanisms (Mukhija 2003; Linkous 2016), legal challenges over claims of regulatory taking (Juergensmeyer, Nicholas, and Leebrick 1998), sociopolitical consequences associated with the marketization of space (Doshi 2013; Singh and Das 1995), and spatial impacts due to density increase and concentration (Linkous 2016; Shih and Chang 2016). However, there are very few empirical studies examining the impact of TDR on the housing market, especially on the prices of the existing housing stock. For example, Arik Levinson constructed a partial equilibrium model of urban zoning and formalized the argument that market-based TDR produces high-priced properties (1997). While his theoretical model predicts that "overall development will unambiguously increase" in areas with higher rents under TDR (ibid., 294), the existence or magnitude of TDR's overall spillover effects on the existing housing stock in terms of value increase was not considered. Similarly, Shih and Chang's case study of Taiwan clearly shows that TDR receiving sites concentrate in prime locations where luxurious residential developments take place but leaves unexamined the larger implications for the housing market in which such intensification of real estate development occurs (2016). Empirical observations reported by NGOs and realtors also suggest a strong association between locations where TDR-utilizing real estate projects concentrate and the competitiveness of housing prices in surrounding areas in Taiwan. For example, in Taipei City, the three districts (Nangang, Zhongshan, and Nenhu) that have received the most TDR in the past decade are also the areas that have seen the most rapid increase in housing prices, causing a nongovernmental organization to comment critically that "all those [new apartments] built [under TDR] is what ordinary citizens cannot afford" (Yang 2010). However, the question of whether TDR has also led existing housing stock to become less affordable remains unexamined.

These combined pieces of conceptual and empirical evidence point to the importance of understanding TDR's spillover effects on housing prices—especially considering that an estimated 25,000 ha of private land are currently eligible to release tradable development rights under the deregulated TDR policy in Taiwan. Since real estate projects transfer development rights to booming, expensive areas (as predicted by Levinson's model) and produce new, costly apartments (as observed on the ground in Taiwan), the question of whether TDR has a spillover effect that drives the sale prices of existing housing stock higher, and if so, whether a greater TDR use is associated with a greater price increase, matters greatly to the majority of residents in the city. Our analysis shows that the use of commodified development rights is a significant driver of housing sale prices, and the increased housing costs burden lower-income families disproportionally. However, the quantity of TDR used has no statistically significant impact (see Section Three).

The analysis presented in this article is based on a case study of Sanchong District in New Taipei City. Among the 29 districts in New Taipei City, Sanchong is small (1,632 ha), accounting for only 0.79 percent of the total land area of the city (205,257 ha), but is the fourth most populous district, housing almost 390,000 people. Sanchong has several property development groups with strong ties to local affairs and politics. Sanchong's active real estate market means that it consistently ranks in the top five among all districts both in terms of the numbers of building permits and of housing sales. Sanchong has experienced a great number of TDR cases in its real estate market, making it a useful case for an empirical examination of TDR's spillover effect in the housing market. In what follows, this article will first situate Taiwan's commodification of development rights in the larger scholarship on TDR, the role of planning and its relationship

with the private market in the second section. The third section presents a description of the data sets used, the research design, and the results of three hedonic regression models: ordinary least squares (OLS), quantile, and spatial lag. Finally, the article concludes by discussing the broader planning implications for using TDR as a market-based tool.

Commodifying Development Rights: A Tug of War Between Planning and Market

In the United States, where private property rights are an important basis for sociopolitical and cultural institutions, planners' pursuit of (the contested concept of) public interest is often challenged by market logic and private interest (Campbell and Fainstein 2003). The classical liberal perspective on private property holds that "to own property is to have exclusive control of something" and naturalizes the right to develop land as something inherent in private land ownership (Grey 1980, 69). This thing-like, absolute notion of private property rights is antithetical to planning interventions. Planners at times circumvent this absolute perspective with the help of TDR. Contrary to the unitary, thing-ownership concept of private property, TDR builds on the concept that property is a bundle of rights, of which development rights are part. Since the case of *Penn Central Transportation Co. v. City of New York*, in which the US Supreme Court established that TDR practices "undoubtedly mitigate whatever financial burdens" were caused by the New York City Preservation Law on the railroad company in 1978 (Juergensmeyer, Nicholas, and Leebrick 1998, 442), TDR has helped planners defend legal challenges of regulatory taking by private property owners and reduce financial burdens on government budgets while achieving planning goals. Since then, more than two hundred programs have protected more than 140,000 ha of land in the United States. The political implication accompanying the shift from an absolute to a bundle-of-rights perspective is significant. Thomas Grey argues, private property now needs to be understood "as a web of state-enforced relations of entitlement and duty between persons, some assumed voluntarily and some not" (1980, 79). In other words, the bundle-of-right conception requires *more* planning intervention, not less.

Planning Challenges in Leveraging Market Forces through TDR

Recent scholarship on TDR has shown that in places where property development pressure is high, TDR is an important regulatory tool through which planners leverage market forces to achieve a wide range of planning goals. The employment of TDR, however, is often entangled with political and economic interests and leads to complex sociopolitical consequences (Linkous 2016; Mukhija 2003; Shih and Chang 2016). Evangeline Linkous's (2016) study of "rural TDR" in Florida highlights a shift in program focus from land conservation in sending area to land development in receiving area. This reorientation is driven by private capital that seeks fewer barriers to development in fringe locations outside Florida's urban growth boundaries, and is therefore dubbed "rural TDR." The most interesting findings are that the very limited number of large landholdings involved in TDR led to a situation where "buyers and sellers are one and the same" and development rights are "simply moved spatially rather than traded" in rural Florida (ibid., 167). The result is the coexistence in the countryside of a mix of conservation and new town development. Linkous argues that TDR serves as an incentive that restructures development conditions for large property owners and developers.

In Mumbai, India, the incorporation of TDR in the 1995 Slum Rehabilitation Scheme has reinvented the city's slum redevelopment strategies (Mukhija 2003). Cross-subsidization from the private real estate sector promises to give slum dwellers free housing on site without relocation; in return, TDR allows property developers to build and sell housing units in places of higher property value elsewhere in the city. Singh and Das call TDR a "commercial paper" with a lucrative market, a basis on which "private developers and builders will be the engine" for slum rehabilitation and the government only needs to play a monitoring role with no financial contribution (1995, 2478, 2481). Based on his case study in Mumbai, Vinit Mukhija, however, points out that the state needs to play a new role in a market-enabling approach such as TDR (2003, 129, 136). Mukhija argues that while TDR was a key intervention that created additional land values in the slums and deregulated profit limits for developers, what was also required from the state, paradoxically, was a wide range of new interventions, including resolving conflicts between different actors such as slum dwellers, NGOs, and private developers; regulating the city's overall FAR to prevent a fall of property values due to overbuilding; and responding to the private sector's demand for development finance assistance (2003). These studies show that the methodological design of commodification and spatial transferability renders TDR adaptable to different planning contexts and able to address various urban challenges. However, market-based TDR is not a panacea. Planners need to make sure real estate market forces are harnessed while, at the same time, negative impacts such as displacement or overheated property markets are prevented. TDR presents a difficult task that requires more, not less, planning involvement, a caution forewarned by Thomas Grey (1980) and echoed in Vinit Mukhija's work (2003).

TDR in Taiwan: A Compensatory Mechanism and a Real Estate Market Stimulus

In Taiwan, two parallel forces have underpinned the institutionalization of the commodification of development rights since the late 1990s. At the local level, the long-lasting

Figure 1. A transfer of development rights (TDR) development (right) and an existing community (left) separated a street market.

planning challenge of the "reserved land (*baoliudi*)" issue urged city government planners to look for a market-based compensatory mechanism. *Reserved land* is an official term used in government documents to describe privately owned land that has been deprived of development potential as a result of being zoned for public facilities—such as roads, parks, schools, etc.—but whose landowners have yet to receive monetary compensation due to fiscal deficiency. This thorny issue historically originated in the urban planning practices under Japanese occupation (1895–1945) and continued to worsen in the 1960s and 1970s when most resources were directed to national economic development in Taiwan (Shih and Chang 2016). Once a parcel is designated as reserved land, no development can take place there with the exception of minimal, low-rising constructions for short-term uses, such as parking grounds. It is estimated that there are currently 25,000 ha of reserved land in Taiwan, of which New Taipei City accounts for 25 percent (Xu and Zeng 2013). At the central level, there has been a shift in economic development strategy to focus on promoting urban redevelopment in the city (Hsu and Hsu 2013), and establishing "a free market of transferable development rights" was seen as a key to stimulate market interest in real estate development (Ministry of the Interior 1997, 58). The outcome is a TDR policy that is both pragmatically and ideologically oriented toward real estate development. Since the central government amended the Urban Planning Law to legalize TDR in the early 2000s, a highly deregulated form of TDR has been practiced in cities in Taiwan.

The centrality of commodification in the TDR policy manifests in three aspects. First, all reserved land parcels are eligible as sending sites. No regulation exists to require the minimal size of a sending parcel, resulting in a problematic outcome called "piecemeal transfer" in which a landowner subdivides a reserved land parcel and only part of it is used for TDR. This is usually done to tailor the exact amount of extra development rights needed by the developer or to circumvent lengthy negotiations between multiple owners holding one single parcel of reserved land.[6] "Piecemeal transfer" fragments the already complex reserved land issue and increases the administrative burden of property subdivision and registration for local land bureaus. Second, planning designation of receiving sites is absent. In New Taipei City, property developers can build purchased development rights in any site as long as it meets two primary physical and locational criteria: that it is more than 500 m^2 in size and has a connection road at least 8 meters wide.[7] This has led to high-density developments towering right next to older, long-standing communities, often without additional infrastructure improvement plans in place (Figures 1 and 2). Third, because a third-party TDR bank does not exist, the buying and selling of development rights take place directly

Figure 2. New transfer of development rights (TDR) developments (left) stand side by side with existing apartments (right).

between market participants without regulatory constraints. In practice, "brokers" who specialize in local land deals function as mediators between individual reserved landowners and private developers. While the dynamic of the TDR market is beyond the scope of this article (for a detailed study, see Shih and Chang 2016), it is widely recognized that the negotiation power is in the hands of brokers and developers, because for thousands of reserved landowners TDR is the only channel through which they can receive compensation for the loss of development potential of their lands. However, the TDR market has also energized all participants and effectively smoothed the political pressure of the reserved land issue.

The heavy use of TDR in the real estate sector, however, has since 2010 instigated the Control Yuan of the central government to investigate. Among the issues identified in a 2013 report are unequal distribution of profits, in that property developers capitalize on TDR by purchasing developing rights cheaply from reserved landowners and selling them as high-priced apartments; potential impacts on urban growth management resulting from lack of designation for receiving sites; public safety concerns over towering buildings with limited road access; worries about traffic congestion and declining service capacities of public facilities due to overbuilding (The Control Yuan 2013). The report recommends that the current TDR policy be reformed by including more stringent regulations on the total amount of TDR allowed and the institutionalization of TDR banks. So far, no major reforms have taken place.

Measuring the Spillover Effect of TDR

Data Sets, Data Selection, and Fieldwork Observation

We use two data sets—TDR utilization data and housing sale data—to measure the spillover effect of TDR on the existing housing stock in Sanchong District, New Taipei City. Both data sets contain parcel coordinates, allowing each data point to be geocoded at the parcel level. The TDR data set is maintained by the New Taipei City Government, which records real estate development projects that purchase and utilize development rights. Between 2004 and 2012, 333 parcels (16.21 ha) in Sanchong District underwent new development involving TDR. The housing sale data set is maintained by the Department of Land Administration of the Taiwanese central government. On a quarterly basis, each sale transaction record offers information on building and locational attributes of sold apartments, as well as transaction times and sale prices. We define existing housing stock as those apartments that are at least ten years old at the time of transaction. Because of the marine tropic climate and the quake-prone

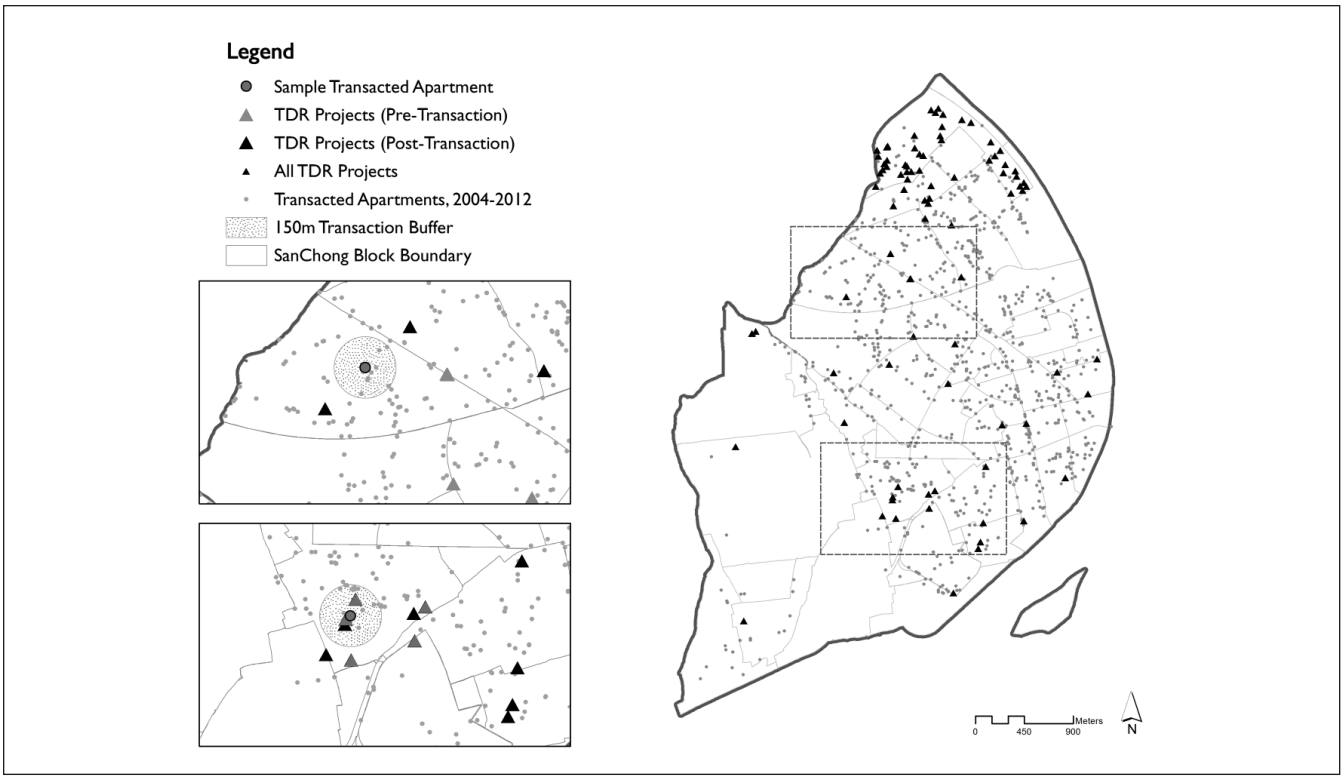

Figure 3. Spatial unit of analysis.

ecology in Taiwan, on average an apartment is considered old when it hits the ten-year mark, at which time major renovations are usually carried out. During the period 2004 to 2012, a total of 1,885[8] existing apartments of ten years or older were sold in Sanchong District.

Spatial Unit of Analysis

In combining the two data sets and designing the analysis, we defined our spatial unit of analysis based on a radial distance of 150 meters. We based this 150-meter definition both on fieldwork observation in Sanchong and on a sensitivity test using different distances. In the summers of 2014 and 2015, we visited several TDR receiving sites in Sanchong and focused our observations on the type of TDR development (e.g., luxurious residential high-rises or commercial office buildings), the nearby communities (e.g., mature or new), real estate activities in the area (e.g., advertisements and asking prices), spatial configuration of land uses (e.g., mixed or zoned), traffic impact (e.g., congestion, parking spaces, and access to public transit), economic activities and organizations (e.g., informal, open street markets or regularized commerce in stores), and the overall sense of how the new developments transformed the existing neighborhoods. During fieldwork observation, we found that 150 meters was a natural parameter that defined a residential block within which socioeconomic interaction and walkability was consistently observed. A distance threshold of 150 meters also yielded the best goodness of fit in a sensitivity test. As Figure 3 shows, within each spatial unit, the number of TDR-utilizing projects may range from none to several, accounting for the variety of TDR volumes (measured in square meters, m^2) used. This design enables us to measure two types of effects at the same time: the use of TDR (a dummy variable) and the volume of TDR used (a continuous variable) on the sale price.

Regression and Empirical Results

To measure the effect of TDR, we controlled other variables that might also influence housing prices. Hedonic models enable assessment of the effect of TDR on apartment sale prices while holding constant building and location characteristics. In this analysis, we use the following hedonic model

$$\ln Price = f(building\ characteristics, location\ conditions, neighborhood\ conditions, TDR\ measures$$

where ln*Price* is the natural logarithm of the sale price per unit floor area (in square meters) of the apartment. *Building characteristics* include variables such as age, height, construction material, elevator facilities in the building, square footage, land area, and floor level. In Sanchong District, the average age of existing apartments is twenty-eight years, reflecting the fact that these existing units are preowned and

have been in use for years. *Location conditions* include variables such as road width, site connectivity, zoning status, etc. Also included is *Landreadjust*, a dummy variable measuring whether the apartment is located within a land readjustment zone. Land readjustment is a land consolidation and betterment technique employed by local governments to promote development. *Neighborhood conditions* include three spatial variables that measure the shortest distance between the apartment to three important public facilities: subway train station, park and elementary school. In Taiwan, subways and parks are not only major public infrastructures but also important amenities, especially given the high population density in the city. Elementary schools are often used as open spaces for local neighborhoods and sometimes also treated as an amenity. In principle, one would also like to include income and demographic data, which are currently not available at the community level. However, Sanchong District has a relatively homogenous population, and on average no obvious segregation can be observed based on these two factors. We therefore do not expect a significant impact on analysis results because of data unavailability. *TDR measures* include *TDR*, a dummy variable that records whether any TDR-utilizing project exists within a 150-meter radius area of a sold apartment. The other TDR variable, *SumTDR*, measures the total volume of TDR used (in square meters) in the analysis unit. This model includes all possible variables that may have any confounding effects due to various kinds of urban development. Definitions of all the variables and their descriptive statistics are presented in Table 1.[9] The hedonic model is in a log-lin form: the coefficient of each of the control variables is interpreted as the relative change in sale price per one-unit (absolute) increase in the control variable (Miller and Rodgers 2008, 134).

The analysis is based on three hedonic models: OLS, quantile regression, and spatial lag regression. The OLS model estimates, on average, the impact of predictor variables on the dependent variable (sale prices).[10] Quantile regression further helps determine the extent to which predictor variables influence the dependent variable differently across the distribution of sale prices. For example, does the presence of TDR (variable *TDR*) influence sale prices of cheaper apartments (at lower quantiles) more than more expensive ones (at higher quantiles)? Spatial lag regression helps account for spatial dependence between housing prices. Table 2 and Table 3 report the results of analysis using the three regression models.

Although regression models are not designed to establish causality, the issue of whether causal inference, as opposed to correlation, can be derived from the analysis is an important concern. We address this issue by following Andrew Gelman and Jennifer Hill's treatment (2007), which is based on three important conditions: ignorability assumption, imbalance, and lack of complete overlap (chapters 9 and 10). The online appendix explains the three conditions and test results in detail, and demonstrates that our models show very good results for all three tests.

OLS regression

Overall, the attributes in the OLS model explain 84 percent of the variation in apartment prices. In the OLS model, all statistically significant control variables have a positive impact on the total sale price of apartments except for *age*. Based on our data (Table 1), an average existing apartment of ten years or older has a total sale price of 4.2 million NTD.[11] A negative coefficient of 0.0056 on *age* indicates that an older apartment has a market price 0.56 percent lower than a newer one with similar conditions. The total sale price of an old apartment is thus about 23,000 NTD cheaper than that of a newer apartment. A positive coefficient of 0.2519 on *groundfloor* means a ground-floor location increases an apartment's total sale price by 25.19 percent or about one million NTD. This large coefficient on *groundfloor* reflects the common land-use practice of mixing ground-level commercial activities with residential units in upper levels within the same building, which results in much higher values associated with first-floor property locations in Asia. Similarly, location in a commercial zone (*zonecom*) enhances an apartment's sale price the most among all control variables (31.27 percent) as a result of the expected additional rent from commercial land use. *Distancesub* and *distancepark* show that a shorter distance to a subway train station or to a park increases the sale price. A negative coefficient of 0.000035 on *distancesub* indicates that the total sale price increases by about 73,000 (72,594) NTD if the apartment is 500 meters closer to a subway train station.[12] The effect of *distancepark* is almost double that of *distancesub*, suggesting access to urban parks drives the housing prices higher than mass transit facilities. This reflects the high population density and the need for green space in cities in Taiwan.

With regard to the effect of TDR, a positive coefficient of 0.0320 on *TDR* indicates that the presence of a TDR-utilizing development project is associated on average with an increase of 1,600 (1,638) NTD in the unit sale price, or 133,000 (132,743) NTD in total sale price, of an apartment within a 150-meter radius. This statistically significant impact has correspondingly important financial implications for poorer families. For the poor families in the lowest 20 percent income quantile, this increase is almost 37 percent of their annual income. The variable *SumTDR* is not statistically significant. This suggests that the sale price is not sensitive to how much TDR is used but only to whether it is used: a new building with four floors of TDR as opposed to two, for example, does not make the existing apartments in the neighborhood more expensive. The fact that the amount of TDR at a particular site is an insignificant variable, as opposed to the significance of the presence or absence of TDR, indicates that new developments stimulate market confidence. For prospective sellers and buyers, the presence of

Table 1. Variable Definitions and Descriptive Statistics.

Variables	Variable definition	Mean	SD	Minimum	Maximum
Dependent variable					
Price	Sale price per unit floor area (10,000 NTD per m^2)	5.12	1.94	2.47	36.93
Building characteristics					
Age (c)	Age of the building in years	27.93	7.09	10.25	56.00
Totalfloor (c)	Total number of floors in the building	5.16	2.60	2.00	27.00
Groundfloor (d)	Whether the sold apartment is located on the first floor (1=yes; 0=no)	0.07	0.26	0.00	1.00
Floorlevel (c)	The floor level on which the sold apartment is located if not the first floor	3.43	2.02	0.00	23.00
Floorarea (c)	Floor area of the sold apartment (m^2)	81.02	29.04	12.33	455.64
Landarea (c)	Land area of the sold apartment (m^2)	22.80	7.66	1.92	92.00
Elevator (d)	Whether the building is equipped with elevators (1=yes; 0=no)	0.12	0.32	0.00	1.00
Material (d)	Construction material of the building (1=reinforced concrete; otherwise=0)	0.76	0.43	0.00	1.00
Location conditions					
Roadwidth (c)	Width of the major connecting road to the building	13.76	8.29	1.00	42.00
Closedstreet (d)	Whether the building is located on a closed street (1=yes; 0=no)	0.41	0.49	0.00	1.00
Zoneresi (d)	Whether the building is located in a residential zone (1=yes; 0=no)	0.89	0.32	0.00	1.00
Zonecom (d)	Whether the building is located in a commercial zone (1=yes; 0=no)	0.09	0.28	0.00	1.00
Landreadjust (d)	Whether the building is located in a land readjustment area (1=yes; 0=no)	0.04	0.20	0	1
Neighborhood conditions					
Distancesch (c)	Distance between the sold apartment to the closest elementary school (m^2)	539.80	255.66	4.68	4339.53
Distancesub (c)	Distance between the sold apartment to the closest subway train station (m^2)	720.08	366.69	9.09	5268.53
Distancepark (c)	Distance between the sold apartment to the closest park (m^2)	274.48	150.25	4.33	1036.46
TDR					
TDR (d)	Whether there is any TDR-utilizing project within a 150-meter radius of the sold apartment (1=yes; 0=no)	0.16	0.37	0.00	1.00
SumTDR (c)	Total volume of TDR utilized within a 150-meter radius of the sold apartment (m^2)	628.14	2116.66	0.00	14,530.17
Transaction year					
Trans05 (d)	Transaction in 2005=1; otherwise=0	0.07	0.25	0.00	1.00
Trans06 (d)	Transaction in 2006=1; otherwise=0	0.09	0.28	0.00	1.00
Trans07 (d)	Transaction in 2007=1; otherwise=0	0.12	0.33	0.00	1.00
Trans08 (d)	Transaction in 2008=1; otherwise=0	0.12	0.32	0.00	1.00
Trans09 (d)	Transaction in 2009=1; otherwise=0	0.12	0.32	0.00	1.00
Trans10 (d)	Transaction in 2010=1; otherwise=0	0.12	0.32	0.00	1.00
Trans11 (d)	Transaction in 2011=1; otherwise=0	0.20	0.40	0.00	1.00
Trans12 (d)	Transaction in 2012=1; otherwise=0	0.11	0.32	0.00	1.00

Note: SD = standard deviation; c = continuous variable; d = dummy variable.

TDR in the neighborhood has the effect of making that particular site a more desirable location since it is associated with development and growth.

Quantile Regression

Quantile regression illustrates a similar impact of building and location variables on unit sale price across quantiles and *SumTDR* also holds no statistically significant explanatory power (Table 3). *TDR* is associated with price increases for all apartments except for those in the 60 percent quintile. When calculated as an increase in total sale price, *TDR*'s impact drives the price up by about 104,000 (103,705) NTD for the cheapest 20 percent apartments, and about 114,000 (113,877) NTD and 133,000 (132,801) NTD for those in the middle 40 percent and the top 80 percent quantiles. When

Table 2. Model Results: OLS and Spatial Lag.

	OLS		Spatial Lag Model	
Variables	Coefficient	*t* Statistic	Coefficient	*Z* Value
Age	−0.005611	−7.62***	−0.005147	−7.08***
Totalfloor	0.002493	0.81	0.001143	0.51
Groundfloor	0.251997	14.08***	0.248185	18.12***
Floorlevel	0.000664	0.31	0.000899	0.42
Floorarea	−0.001023	−5.32***	−0.000921	−6.17***
Landarea	0.002337	3.30***	0.002126	3.77***
Elevator	0.085264	4.77***	0.087077	5.42***
Material	−0.007272	−0.83	−0.002614	−0.29
Roadwidth	0.001612	4.04***	0.001537	3.65***
Closedstreet	0.018077	2.84***	0.019469	3.11***
Zoneresi	0.229252	8.37***	0.219029	10.89***
Zonecom	0.312741	9.49***	0.290284	13.10***
Landreadjust	0.026864	1.20	0.024544	1.37
Distancesch	0.000008	0.64	0.000014	1.18
Distancesub	−0.000035	−4.46***	−0.000029	−3.60***
Distancepark	−0.000068	−2.76***	−0.000066	−3.21***
TDR	0.032051	2.83***	0.028297	2.60***
SumTDR	−0.000001	−0.27	−0.0000003	−0.13
Trans05	0.094216	7.98***	0.090728	5.47***
Trans06	0.099524	5.73***	0.104070	6.59***
Trans07	0.119465	10.33***	0.122714	8.20***
Trans08	0.170925	16.15***	0.175646	11.66***
Trans09	0.224831	20.40***	0.225644	14.84***
Trans10	0.371625	30.32***	0.368573	23.49***
Trans11	0.630163	53.51***	0.622018	41.78***
Trans12	0.789863	42.94***	0.779849	43.72***
Constant	1.163331	26.19***	0.958178	18.86***
Spatial lag rho			0.125112	6.15***
R^2	0.8436		0.8469	

Note: OLS = ordinary least squares; Moran's I = 0.0901***.
***$P < 0.01$.

considering the financial impact on families, these price increases respectively account for 29 percent, 21 percent and 11 percent of the annual household disposable income in the bottom 20 percent, middle 40 percent and the top 80 percent income groups. This shows that TDR's spillover effect does not discriminate—both cheap and expensive apartments currently in the market experience roughly the same amount of price increase (104,000 vs. 133,000 NTD). However, the financial impact on low-income families is disproportional—poor families need to spend one third of their annual household income (29 percent) to cover the increased housing cost while wealthy families only need to spend one-tenth.

Spatial Lag Regression

Finally, this study made use of a spatial lag model to measure and account for the spatial dependence between sale prices. Spatial dependence describes what Waldo Tobler called the "first law of geography": "everything is related to everything else, but near things are more related than distant things" (1970, 236). In Table 2, Moran's I, with a range of positive 1 to negative 1, measures the degree and direction of spatial dependence. The coefficient (0.0901) shows that positive spatial dependence does exist among transacted apartments in Sanchong District: two existing apartments located close to each other will have similarly high (or low) sale prices. When the spatial lag model is incorporated into the analysis, all predictor variables preserve their regression coefficient signs and statistical significance observed in the OLS model.

The spatial lag coefficient *rho* has its own significant, positive value of 0.1251, indicating that the unit sale price of an apartment is influenced by the average unit sale price of its neighboring apartments: when the latter increases by 1 percent, the former goes up by 0.13 percent (0.1251 multiplied by 1 percent). Interpreting the regression coefficients in the spatial regression model is a subtler exercise than in the OLS model. As explained by Michael Ward and Kristian Skrede Gleditsch (2008, 39), a direct interpretation like the kind used in ordinary regression does not take into account the feedback reaction caused by the spatial correlation of the dependent variables—in this case, the sale prices. For example, the immediate effect of TDR presence at a particular site is a 2.83 percent increase in the sale price at the same site. Because of spatial correlation, however, such an increase leads to a subsequent increase of 0.35 percent (0.1251 multiplied by 2.83 percent) in the sale prices at a nearby site. This, in turn, causes a further increase of 0.04 percent (0.1251 multiplied by 0.35 percent) in the sale price at the original site, creating a self-replicating feedback mechanism. For a large number of sites, this effect is encoded in a spatial multiplier matrix, as explained by Ward and Gleditsch (2008, 45). The expected relative increase in sale price at any particular site is obtained by multiplying the regression coefficient by the spatial multiplier corresponding to that site.[13] In our study, all spatial multipliers take values between 1 and 1.0041; thus, the corrections to the TDR effect due to spatial correlation are very small and negligible. To summarize, then, we can estimate the effect of TDR on the unit sale price using only the regression coefficient, or 0.0283. This means the unit sale price increases by 2.83 percent when TDR is present at a particular site. Therefore, on average, we find that the total sale price increases by about 117,000 (117,395) NTD—a slightly smaller result than that produced by the OLS model and a similar result to that generated by the quantile model.

Implications and Conclusions

In Taiwan, TDR policy has institutionalized the commodification of development rights and their use in the real estate market since the late 1990s. The policy took shape at a time when local planners were under a tremendous amount of pressure to respond to the reserved land issue in their cities and the central government was on a trajectory to roll out

Table 3. Model Results: Quantile Regression.

	Q20		Q40		Q60		Q80	
	Coefficient	*t* Statistic	Coefficient	*t* Statistic	Coefficient	*t* Statistic	Coefficient	*t* Statistic
Age	−0.006111	−8.00***	−0.005010	−5.78***	−0.004994	−6.49***	−0.005189	−5.33***
Totalfloor	0.004829	1.51	0.005581	1.26	0.002364	0.54	0.004893	0.96
Groundfloor	0.191031	9.51***	0.216059	9.89***	0.258760	10.20***	0.319031	12.19***
Floorlevel	0.001034	0.43	0.000413	0.15	0.001124	0.47	−0.004070	−1.23
Floorarea	−0.001487	−4.40***	−0.001356	−4.31***	−0.001247	−5.35***	−0.000875	−3.73***
Landarea	0.003493	3.08***	0.003662	3.51***	0.003474	5.00***	0.002564	3.32***
Elevator	0.067844	4.00***	0.086928	2.98***	0.129330	4.34***	0.121026	5.21***
Material	−0.001349	−0.16	0.002002	0.18	−0.013576	−1.60	−0.020373	−1.90*
Roadwidth	0.001333	2.90***	0.001459	3.50***	0.001172	2.98***	0.001497	2.60**
Closedstreet	0.014940	2.24**	0.014401	1.81*	0.025654	4.13***	0.027989	3.93***
Zoneresi	0.272521	8.56***	0.224381	5.27***	0.175822	5.28***	0.171244	6.33***
Zonecom	0.337106	10.42***	0.291702	6.56***	0.239979	6.89***	0.227978	7.58***
Landreadjust	0.025903	1.06	0.013111	0.53	0.048880	2.16**	0.050727	1.49
Distancesch	0.000010	0.74	0.000004	0.27	−0.000008	−0.54	0.000006	0.42
Distancesub	−0.000034	−3.52***	−0.000026	−2.50**	−0.000036	−3.64***	−0.000038	−4.04***
Distancepark	−0.000057	−2.31**	−0.000068	−2.54**	−0.000031	−1.41	−0.000045	−1.82**
TDR	0.025010	1.97**	0.027452	1.94*	0.016122	1.47	0.032014	1.65
SumTDR	−0.000001	−0.24	−0.000001	−0.57	−0.000001	−0.74	−0.000004	−1.59
Trans05	0.078914	5.44***	0.087667	5.05***	0.092038	5.61***	0.082559	6.33***
Trans06	0.062109	4.50***	0.080856	4.27***	0.120039	5.56***	0.088637	5.91***
Trans07	0.088294	5.85***	0.119578	7.81***	0.166807	7.79***	0.115050	7.65***
Trans08	0.181185	13.87***	0.171543	11.86***	0.225444	10.95***	0.154084	10.26***
Trans09	0.231215	16.13***	0.226345	15.81***	0.384443	13.57***	0.215253	16.25***
Trans10	0.348001	24.53***	0.367301	18.74***	0.637820	22.39***	0.373646	24.44***
Trans11	0.612115	38.96***	0.627210	38.78***	0.764776	37.03***	0.648019	38.10***
Trans12	0.753875	34.56***	0.775327	36.34***	1.220859	38.00***	0.784051	25.59***
Constant	1.061715	22.58***	1.106885	18.53***	0.092038	23.69***	1.279669	26.50***
Pseudo R^2	0.5811		0.6343		0.6829		0.6804	

*$P < 0.10$; **$P < 0.05$; ***$P < 0.01$.

market-oriented policies. The result is a TDR policy that is both practically and ideologically oriented toward the logic of the real estate market. The present study has examined the impact of this commodification by empirically measuring TDR's spillover effect on the sale prices of existing housing stock. This study further advances a more complete understanding of the relationship between TDR and the overall housing market.

First, all three models—the OLS model, the quantile regression model, and the spatial lag regression model—agree that TDR utilization in real estate development (variable *TDR*) is a significant price driver for existing apartments in the neighborhood, but the quantity of TDR utilized (variable *SumTDR*) is not. The TDR policy stimulates increased development of high-density, high-priced housing—an argument conceptually validated by Arik Levinson (1997) and empirically observed on the ground in Taiwan (Shih and Chang 2016)—but also permits these high-end developments to drive up the prices of existing apartments nearby. While this spillover effect is not price sensitive—apartments in all quantiles see roughly the same amount of price increase—the financial burden is disproportionally heavier on poor families, as the more nuanced assessment made possible by the quantile regression shows. In other words, the commodification of development rights, on which the TDR policy is based, is a source of inequality. Our analysis supports the general public's largely shared feeling of being drained by, priced out from, and never able to catch up with the rising housing prices in Taiwan.

Second, while the variable *SumTDR* does not hold a statistically significant explanatory power in our models, its impact deserves further examination in future research. In recent years, the large amount of commodified development rights that market-oriented TDR practices have actualized in the city has raised public concerns over overbuilding, traffic congestion, public safety, and an overheated property market (The Control Yuan 2013). These environmental externalities may be hard to quantify and measure in monetary terms in regression models. However, they matter greatly in terms of how city residents cultivate a sense of place and an attachment to their neighborhoods. While the amount of

TDR utilized in development projects does not affect housing prices, a larger quantity may potentially deteriorate the quality of life and local residents' ability to control their everyday lives in the neighborhood.

Lastly, the analysis results suggest that it is crucial to reevaluate the popularity of the Taiwanese TDR policy and also to rethink possible planning actions. The popularity of the TDR policy comes from its market success and political utility. In the real estate market, TDR provides a channel through which private developers can purchase extra building density at a relatively lower price from thousands of reserved land parcels. For local planners, TDR puts in place a market-based compensatory mechanism that responds to challenges from individual reserved landowners, who are now energized by the possibility of haggling with developers over the value of development rights from once-uncompensated reserved land. From this perspective, TDR is an institutionally creative, market-savvy, and politically effective innovation. However, the fact that TDR generates a disproportional financial burden on poor families suggests that it is also a source of inequality. An investigative report published by the Central Government argues that the distribution of profits produced by TDR trading in Taiwan is heavily skewed toward private real estate developers (The Control Yuan 2013, 22). Here international TDR scholarship provides a lesson for Taiwanese planners when redesigning the current TDR policy. TDR is powerful because it works as a market incentive that creates conducive conditions for real estate development (Linkous 2016). However, deregulation of benefits also requires new planning regulations to ensure that TDR does not fall under its own weight, such as overbuilding and market volatility (Mukhija 2003). While the market mechanism of TDR is universally adaptable, TDR impacts are context sensitive. When devising reforms for Taiwan's current, highly deregulated TDR policy, planners should consider several important tasks: analysis of TDR uses at the community level (currently local governments have mostly collected TDR data at the city level but hardly at the community or site levels), assessments of the impacts of TDR on the existing capacities of public facilities, traffic conditions, and public safety (such as whether fire trucks have easy road access to high-density buildings in case of emergency), and policy deliberations on whether any forms of development impact fees should be levied on TDR projects. The goal of providing affordable housing for lower-income residents should be prioritized and explicitly pursued. A third-party TDR bank should also be established to make sure a fraction of the trading profit of TDR is reinvested in public facilities or housing subsidies in the neighborhood. In short, the possible impacts of TDR on the urban built environment, in addition to those on the housing market, need to be carefully studied and addressed. When Taiwanese planners embrace the bundle-of-rights conception, they need to keep in mind an important key to successful TDR programs, in addition to tradable development rights: planners' role in the control of development in the city. Our present analysis suggests the need for a reaffirmation of the role of planning in coordinating the use of commodified development rights with a goal of greater public benefits.

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Notes

1. NTD means New Taiwanese Dollars. One US dollar is roughly 32 NTD. Data source: Construction and Planning Agency, Ministry of Interior.
2. Data source: Cathy Real Estate Development Corporation. For Taipei City, 10.98 million NTD in 2004 and 23.38 million NTD in 2015; for New Taipei City, 6.06 million NTD in 2004 and 16.45 million NTD in 2015.
3. In 2015, the ratios of average housing price to annual family income were 15.62, 12.52, and 8.52, respectively, in Taipei City, New Taipei City, and Taiwan as a whole. http://pip.moi.gov.tw/V2/E/SCRE0201.aspx accessed on April 19, 2016.
4. *Floor–area ratio* is defined as the maximum total area that can be built per unit of lot area.
5. The highest supervisory agency of the Taiwanese government.
6. Small land holding with multiple ownership is a recognized condition in Taiwan. Most existing planning techniques, such as land readjustment, aim to assemble and consolidate smaller parcels to larger-sized sites (Lin 2005). On the contrary, TDR adapts to this condition rather than addressing it.
7. Review Directions on Transfer of Development Rights in Urban Planning Areas, New Taipei City, http://www.planning.ntpc.gov.tw/news/index.php?mode=data&id=9053&type_id=10495 (accessed February 26, 2017).
8. Between 2004 and 2012, the Department of Land Administration requested land registration agents (who deal with and notarize housing and land transactions) to report housing sale data on a nonmandatory basis. As a result, the 2004–2012 data set is a sample of the total housing units transacted. Since 2012, it has been mandatory to report all transactions.
9. All variables were tested for problems of multicollinearity. All variance inflation factor values are smaller than 10, with a minimum value of 1.06 and maximum of 4.90.

10. The ordinary lest squares analysis in this study accounts for heteroskedasticity by estimating robust standard errors. No presence of heteroskedasticity was found.
11. 81.02 m^2 × 51.2,000 NTD/m^2 = 4,148,224 NTD.
12. Because the unit of variable *distancesub* is meters, a negative coefficient of 0.00035 on *distancesub* indicates an increase of 145 NTD in sale price if the apartment is 1 meter closer to a subway train station. We base the interpretation in the main text on a 500-meter walking distance, a common parameter used in evaluating the effect of mass transit on land and housing prices in Taiwan. The interpretation for the effect of parks, variable *distancepark*, is based on the same logic.
13. In the spatial lag model, the spatial multiplier matrix is given by the matrix inverse $M = \left(I_N - \rho W\right)^{-1}$ The quantities in the above formula are defined as follows: I_N is the $N \times N$ identity matrix, where N is the number of sites used in the model. In our study, N = 1885, ρ is the spatial lag coefficient, which in our case takes the value $\rho = 0.1251$, and W is the row-normalized weight matrix, which in our case is constructed using queen contiguity weights.

Supplemental Material

Supplemental material for this article is available with the manuscript on the *JPER* website.

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