Transfer of development rights applied in public facilities acquisition in Taiwan: an analytic model

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ABSTRACT：*The public sector has for many years suffered a financial burden in acquiring the land for public facilities in Taiwan. The Regulation of Transferable Floor Area for Urban Planningis adopted to acquire land. Of priority concern is the influence on environmental quality when the lot receives floor area. The"Farm Land Release" policy will release 160,000 hectares of farm landsin the future. The policy's influences on space structure resulting from surplus floor areas need to be analyzed. The research areais located in a newly developing district that was changed due to the farm-land release policy from agricultural to urban development use. The aim of this studyis to determine the developer's profits under various scenarios based on game theory by the discounted cash flow method. The role of the public sector in this game is to maximizethe development intensity, and to offer a suitable environment for future floor area to transfer. The developer and the owner of the land reservation for public facilities make decisions during the game when the floor area amount for transferred is announced. Finally, this study employs the strategic form of matrix to convertthe result of financial analysis into payoffs in order to identify the Nash Equilibrium solution.*

JEL Classifications: **Q25; Q51; R11**

KEYWORDS:*Financial Burden, Transferable Floor Area, Farm Land Release, Discounted Cash Flow, Nash Equilibrium*

I. INTRODUCTION

According to Tai 90 Nei Ying Tzu No. 9083967 of the Ministry of the Interior on June 8, 2001, Items 2 and 3 of Paragraph 1 of Article 6 of Regulations of Floor Area Transfer for Urban Planning（RFATUP） took effect on July 1, 2001. According to these Items, RFATUP can be applied to acquire land reservation for public facilities. Acquiring land reservation with transferable floorarea rights can help the government eliminate the several-year impasse on expropriating land reservation. However, considering the regional overall environmental aspects, forcibly transferring public facility land areas to neighboring regions is likely to affect the traffic, living quality, public facility service quality and street landscape. RFATUP currently prescribes that land area should not exceed 30% of its base regulated layout. Restated, if the instructions providedby thisregulation are obeyed, then the land area to be received will increase by up to 30%. The external costs,such as crowded traffic, housing shortages, deteriorated environment, insufficient public facility and decadent social order will damage the city if too much land area is transferred.

Additionally, financial feasibility is essentialfor transferring floorarea rights. Most recent studies have conferred that land in an old town is easy to receive due to its high land value. Accordingly, transferable floorarea rights can only be applied to old towns, and would significantly affect the surrounding areas. Moreover, public sectors often compensate land owners for 140% of the Current Assessed Land Value while expropriating their land. Notably, the benefits of selling the floor areas will be compared with the accepting price offered by the government when land is transferred. Therefore, they will find out the way which better meets land owners' interests.

The problem of obtaining land for public facilities has not been solved recently. Due tothe urgent need to acquire land reservations with transferable floor-area rights, this study attempts to take a "financial perspective" from the two parties in floor-area transferring activity, and analyze the contendingprocess between the owner of public facility reserves and the developer on the basis of game theory.Moreover, a survey is performed on the ability to acquire land for public facilities with transferable floor-area rights.

II. LITERATURE ONTRANSFERABLEDEVELOPMENTRIGHT

Taiwan's floor-area transfer system derives from the Transfer of Development Rights (TDR). Development rights originatedfrom the nationalization of development rights in England, and later spread to the United States. The United States initiallyapplied Purchase of Development Rights（PDR） and TDR in the conservation and

maintenance of historic relics and landmarks, the acquiring of open space and the compensation for restricted development areas[1][1-7]. Canada and Japan later employeda floor-area transferring system based on the concept of TDR. Since each country has its own legal, political, social and economic environment, the method and result of the enforcement of the system varies among countries. Floor-area transfer means transferring unused floor area within the legally permitted maximum to other regions and developing it, and is a similar concept to TDR.

Research in Taiwan on acquiring land reservation for public facility with transferable floor-area rights can be approximatelyclassified into pertaining laws, environmental influences, the receiving lot, the sending lot and financial affairs. Most investigations argue that if the receiving lot is located in highly-developed area, then the environment of the receiving area is likely to face a heavy burden. In contrast, floor-area transfer in a newly developing area it is promising and worthy of government's proactive promotion. Additionally, the gross floor area in urban development area should remain unchanged when a newly developing area is considered as the receiving lot of floor-area transferring. Transferable Development Rights should be adopted to prevent the floor area from increasing when developing new urban planning areas. According to the report from Construction and Planning Agency, Ministry of the Interior, the selection of floor-area receiving lot should considerthe following points: 1) newly developing areas; 2) areas with high house value and more demand than supply, and 3) neighboring areas around mass transit stations. The above studies indicate that a newly developing area is the best choice of receiving lot of floor-area transferring.

Newly developing areas have some limitations in terms of environmental ecology. The gross development of the area can be controlled with the concept of TDR in newly developing areas. Therefore, the traffic accessibility and the integration of neighboring public facilities should be seriously consideredwhen choosinga location. Settling the location and the relevant service quality of the receiving lot becomes an incentive for the development of the area, and will surely attract companies to the floor-area transfer market.

Moreover, establishing a floor-area market depends on the housing market boom and financial considerations of the developer. A financial analysis based on discounted cash flow (DCF) was performed on acquiring land reservation for public facilities with transferable floor-area rights. Analytical resultsindicateland in an old town is easy to receive due tothe high land value. However, land in a new town is difficult to receive due to the lower land value. The opposite case applies tothe sending lot. If the sending lot is in a new town, then the development rate of the land for public facilities rises, while the development of real estate market is sabotaged. According to the Taipei City Government's report, the feasibility can be assured only when the following points are considered.The floor-area transfer should be undertaken cautiously without adjusting the development gross. Additionally, the selection scheme and requirements for the floor area of the receiving lot should be confirmed. Finally, the current assessed land value of the receiving lot and the sending lot should not differ significantly.

To ensure fair compensation for floor-area transferring, the land owners can choose between compensation for development right and cash compensation for expropriation. Analytical resultsindicate that the cash compensation is below the level acceptable to owners, making floor-area transferring harder to achieve than it first appears. The study indicates that floor area should be increased, instead of determiningthe ratio of floor-area with that of the neighboring land.

We can infer the following fromthe results of the preceding studies. 1) Newly developing area is preferred as the receiving lot of floor-area transfer. 2) If the receiving lot is in an old town, then it is easy to receive transferring due to the high land value. If the receiving lot is in a new town, then it is more difficult to receivebecause of the reduced land value. Therefore, the current assessed land value of the receiving and the sending lotsshould not differ significantly. 3) Owners of land reservation for public facilities need to choose between compensation for development right and cash compensation for expropriation. The cash compensation is too low for the owners to accept, making the floor-area transfer too difficult to achieve. Based on these points, this investigation further considers the location of the receiving lot and the developer and land reservation owners' considerations in order to analyze the feasibility ofacquiring of public facility land reservation with transferable floor-area rights.

III. FLOOR AREATRANSFERRINGFRAMEWORK

Selection of the receiving lot location

Newly developing areas are clearly preferred for the location of the receiving lot. An old town cannot easily receive floor-area transfers, because it is built with a different floor-area ratiofrom a new town. Additionally, most landowners would make full use of the floor-area, leaving no extra floor area to purchase. The only possibility lies in significantly increasing the floor-area ratio. However, this approach degrades environmental

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[1]More than fifteen state and thirty-four local governments permanently preserve farmland by purchasing development rights, or by enabling the transfer of development rights among landowners based on American Farmland Trust. When a landowner enrolls a parcel in a PDR/TDR program, he sells the rights to develop the land, but retains ownership of the parcel.

quality, but may be feasible in newly developing areas. Accordingly, the existing floor-area incentives, which are too easy to obtain, should initially be canceled. Meanwhile, the base floor-area ratio of farms releasing land from around the city should be reduced to create extra demand for floor-area transfers, and to prevent numerous troublesome aftereffects. Hence, a farmland release policy best matches floor-area transferring. These two approaches should work together, with developers being asked to pay reasonable prices, and offering appropriate compensation to owners of land reserved for public facilities.

However, the floor-area transferring is applicable to urbanized areas, and is not applicable to farmland that does not belong to the city area. In light of the effect of farmland release policy and the globalization of economy and for the need of Taiwan's economic development, farmland that is not suitable for planting should be allocated for floor-area transfer under the principle of fairness and scheduledness. Such farmland areas should be categorized as agricultural areasfor urban planning. The analysisof the application of the released agricultural area reveals that its advantage lies in its internal economic scale. Cities enjoy completepublic facilities and low cost of developing surrounding areas. Therefore, the land in cities can be developed and fully exploited, preventing "leapfrogging" development, and increasing flexibility due to the changed land use category. The location of urban planning areas provides better potential in environmental development than agricultural areas without any adjacent cities. Changing agricultural areas of urban planning into urban development land is likely to increase the profitability of the land significantly.

Thisanalysis indicatesa closer distance between the receiving lot and the downtown area results in a lower cost of constructing public facilities. Conversely, although the land value falls as the distance rises, the cost of constructing public facilities increases. Moreover, the market developer's investment risk and investing cost becomes too high, restricting the success of the development plan. Therefore, the development area should be confined to that within the existing urban planning area, and improvement projects should be executedon the land in the city, preventing the city from over-sprawling. The international division of labor under globalization will reduce the rate of farmland use in the future. A farmland release policy releases farms that are not economically valuable or suitable for planting. Thus, if both urban environment and quality are addressed, then low-use urban farmlands can be converted into new receiving lots for floor-area transfer. These land areas have higher accessibility, more convenience, more promising market potential and reduced public facility construction cost than old-town land, making them more feasible. Therefore, this investigationconsiders the transfer of residential land converted from agricultural urban planningareas.

The use of Game Theory in floor area transferring

In Taiwan, the main patterns how scholars apply Game Theory to the acquiring of land reservation for public facilities can be identified to established a theoretical model for the interaction and policy enforcement between executive and lawmaking sectors based on Game Theory. Investigating the lawmaking and enforcement problems in the law system of land reservation for public facilities is of priority concern. The use of Game Theory has been proposed in the system of land reservation for public facilities. The main issues are the number of peopleto be involved in the game , the completeness of the information, whether the information is infinite or finite and the number of times that the game needs to be played to find the winner.

The public sector is taken as an example of floor-area transferring in Taiwan. The situation of lots and limitations for their developments should first be studied to determine whether floor-area transfers need to be enforced. The executive authority of urban planning individually informs the private owners of the land preservation for public facilities following deliberate evaluation. Additionally, the authority publicizes the content of the tabulation. The public sector is involved in enquiry, coordination and contact during the entire process. Therefore, a developer who wants to bring floor-area transferring into the receiving lot should get in touch with the owner of the sending lot through the relevant authority. This authority would then become the intermediary for timely coordination. Accordingly, this study applies "A Prisoner's Dilemma", which is a famous Game Theory example, to analyze the process of the competition between the two parties. Figure 1 shows the interrelationship between the measures that might be taken by the developer and the owner of the land reservation for public facilities. In this Figure, the measures the developer takes is denotedby Y (to buy or not to buy floor area), and the measures taken by the owner is denotedby X (to sell or not to sell floor area). X and Ytogether form four results, namely A, B, C and D. Hence, each player in this game must identify the option that one is most profitable to itself.

The public sector, plays a very important role in the negotiation between the developer and the owner,must offer equal information to both sides, and profiteers from buying reserved land intended for public facilities without adequately compensating the original owners. With equal information, the two sides can undertake and complete the dealings. Conversely, providing sufficient public information can prevent profiteers from forming an oligopoly. Competition between developers increases the price at which land owners can sell their land, and enables the public sector to acquire the land smoothly.

Constructing the enforcement method

Planning a newly developing area the case in this study is the agricultural area of urban planning by the public

sector involves marking the area as the receiving region for floor-area transfer. The public sector becomes the game formulator when the urban planning of the newly developing area is settled, setting the development intensity within the duration (year-based) as the upper bound, and deriving the developer's profit by DCF. To maximize the profit and return for the developer and ensure financial sensitivity analysis, the floor-area ratio, corresponding to Internal Rate of Return (IRR), should be adjusted and the development intensity should also be rectified. The development intensity is the standard floor area for the future development of the area. The future difference between the uncompressed and compressed floor area is the transferable floor area. The developer and the owner of land reservation for public facilities are the contenders once the planned floor area is announced and enforced. In the game, the two sides try to make the best choice to maximize their profits. The developers can decide whether to buy the floor area at will (If they buy, then the floor area can be increased. However, the price must meet the development cost. If the developers donot buy, then they should undertake the development with the planned floor area). The owner of land reserved for public facilities, whennegotiating with the developer, will surely compare the price offered by the developer offers the uncertain price from expropriation in the future, and employ the Social Discount Rate to convert the price from future expropriation into Net Present Value (NPV) and make the best choice through the comparison. Hence, both the two sides would make the best judgment as explained in Figure 2. Finally, the strategic form game is applied to transform the result of financial analysis into payoffs in order to form judgments. The contender throughout the game is not the public sector, but return designer, like the police in the Prisoner's Dilemma theory—"You'll be treated better if you make a confession, and you'll be treated worse if you refuse to."Thus, only the developer and the owner contend against each other during the game, and the public sector does not take part in the competition process.

Figure 3 showsthe calculation and judgments of the payoff in game simulation shown in. The developer Y's expected profit from the development is labeled IRR. It interacts with the owner's profit, and the interaction constitutes payoffs in four situations. The payoffs are converted into present value according to the social rate of time preference, and the Nash Equilibrium solution is obtained.

IV. CASE ANALYSIS

This section is the case simulation analysis, whereby the previously proposed concept of transferring floor-areas to acquire land reserved for public facility is applied to simulate trial balance and verify the conclusion of the hypothesis.The case being explored is the undergoing floor-area transfer in Hsinchu as the subject, where the sending lot is 422 LunTzu section North-West of the unexpropriated land reserved for public facility, and "cultural and elementary school district"is the zoneof the sending lot. The receiving lot is based on "Hsinchu freeway interchange nearby specified urban planning agricultural area expansion and modification project, the case of Hsinchu city" (abbreviated to Chu Second Science Park Project; CSSPP) as the subject for case analysis. The calculation of the case focuses on its financial feasibility and game analysis, whereby the conclusion of the analysis can be adoptedto verify the feasibility.

Hypothetic description

Simulatinga case similar to a real situation requiresthe following hypothetical description of the simulated case. Hsinchu Science Park is a place where many high-tech workers are based.The concentration of high quality human resources makes the living environment inadequate. The uneconomic land in the surrounding urbanized agricultural area is being transformed by Hsinchu City Government, and various regions are being planned. To acquire land reserved for public facility, the Ministry of the Interior implemented RAFTUP.The Urban Development Bureau has set the appropriate percentage of newly developed area as the receiving area to ensure a 30% increase in floor space, to minimize the environmental impact. Therefore, the Bureau proposes the use of the residential areas converted from urban planning agricultural areas as the receiving areas for floor-area transfer, and plans to reduce the floor-area ratio of the residential area to facilitate floor area transfer before project announcement. The Bureau initially proposed a game as a rule, enabling the prospective developer to opt to purchase floor area from the owner of the unexpropriated land reserved for public facility to maximize the profits by increasing the total floor area. However, if the developer has no intention of purchasing, the existing development intensity should be maintained. Both developer and owner of the land reserved for public facility can opt for the optimal solution based on the rules.

The assumption for the simulated case

Table 1 shows the relative assumptions of the simulated case can be listed based on the above descriptions.

Development intensity expected estimate

- *Development Intensity for Estimated Project Periods*. Dueto the difficulties in calculating development intensity following land conversion, CSSPP is adopted as a reference where the building coverage ratio is 50% and the floor area ratio is 240%. Hence, the building coverage ratio and floor area ratio in the case are the upper bounds of bulk development in the project period.
- *Development Intensity Adjustment*. Table 2 shows the developer's returns from a development plan based

on 50% building coverage ratio and 240% floor area ratio,with a discounted cash flow where the discounted rate is 8%. Table 3 liststhe resuts of a sensitivity analysis of floor area ratio is performed to explore the range for downward adjustment of floor area, and the fluctuationof developer's returns according to the floor area ratio. If floor area ratio is between 198% and 199% as demonstrated in Table 3, then NPV = 0, i.e. this floor area ratio is the developer's break even point. The investigationconsiderssome of the developer's profits and risks is adopted as the minimal expression of interest of Large scale developers generallyexpect IRR>20%.Therefore, the floor area ratio is adjusted downward to 205%.

● *Announced Area Development Intensity.* Based on the calculation of development intensity adjustment, the downward adjusted basic floor area ratio is 205%.Accordingly, the Development Bureau stipulates that the development intensity of residential area is 205%.

Development assessment of developers in actual examples

The developer acquires 2,000m^2(605 ping) of residential land in an urbanized area at NT\$24,200 per m^2 (NT\$80,000 per ping),and knows how to increase the total floor areaby using floor-area transfer to purchase floor area. Therefore, the developer assesses the feasibility of purchasing floor area from the landowner within a land reservation for public facility.

● *Direct Development (not Purchasing Floor Area).* The rate ofreturn when developing at a building coverage ratio of 50% and a floor area ratio205% is 23%. The NPV is NT\$1,160,400, and IRR is 24%. Therefore, the project is viable.

● *Purchasing Floor Area from the Landowner withinPublic Facility Reserve.* The total floor area can be increasedby 700m^{2}when the floor area ratio is 240%. Therefore, the extra cost of construction is 15,975 NT\$/m^2 after deducting the risein floor area. The developer's ceiling price for floor area is 12,415NT\$/m^2; the relative NPV for development benefit is NT\$5,616,553, and the IRR is 35%. Thesestatistics listed in Table 4 demonstrate that if the price for purchasing floor area is 12,415 NT\$/m^2 where IRR 35%> 24%. Therefore, purchasing the floor area is more profitable than direct development (not purchasing the floor area).

The dilemma of selling floor area and expropriation from the landowners of public facility reserve

The hypothesis in this section is based on the assumption that the landowners of public facility reserve are fully aware of the measures adopted by the Development Bureau of Hsinchu City, which proposes floor-area transfer for public facility reserve. The main current concerns of landowners are whether the price of the agreement with the developers is reasonable, and whether the expropriation price is more unfavorable than that of selling the floor area. The landowners will sell the floor area only if the price of the agreement is reasonable; otherwise, they would rather wait for a better expropriation price from the government.

● *Current Expropriation Price Trial.* The expropriation price is the current assessed land value plus 40% under Hsinchu City's current regulations.The public facility reservation landowner's calculation of future expropriation value is as follows:

1.4 × (199m^2× NT\$28,000/m^2) = NT\$7,800,800. The expropriation value following calculation is NT\$7,800,800, while the floor area purchase value is NT\$5,929,404.Therefore, the value difference (NT\$1,871,396) is not worthwhile.

● *The Value of Social Time Preference Rate and the Ceiling Price for Floor Area by Developer is Employed for Comparison.* Since the immediate benefit and the future value of each individual in society are different, the social discount rate is the ratio of these values. Although the concept of social discount rate is similar to that of the 'discount rate', the market interest rate is not used for calculation. The Social time preference rate is the benefit discount rate in future spending relative to the present. The case studied is based on a rate of 6% as listed in Table 5. Current expropriation value is converted to the discount value of the nth year witha social time preference rate of 6%, as indicatedin Table 5. The content of Table 5 is derived based on 12,415 NT\$/m^2(Total amount is NT\$5,929,404).

The expropriation value after the fifth year is less than the developer's ceiling price.Therefore, the current assessed land value in public facility reserve is not expected to fluctuate within five years. Meanwhile, Hsinchu City Government is not expected to expropriate the reserve in five years, since the developer's ceiling price is much higher than the expropriation price based on the 'discount' concept.

The calculations according to social time preference rate vary according to circumstances. Table 6 shows the sensitivity analysis of difference based on different social time preferences.

The landowners in the public facility reserve can address the variations in social time preference rate (3–9%) between the fourth and tenth yearswhen expropriation is not expected to occur. Thus, the landowners are best off employing bulk transfer to maximize their returns when social time preference rate is 9%,sincein this case the landowners do not expect expropriation within ten years.

V. STATEGIC ANALYSIS OF THE PARTICIPANTS

The calculated results, shown in Figure 4, are converted into the following strategies indicated by the four quadrants AC, AD, BC and BD.

AC Quadrant
The transaction took place in AC, where the calculated returns are in both sides' best interests, i.e. both parties struck a deal with the best intention.

AD Quadrant
After preliminary calculations, the developer decides that floor area purchased would maximize the marginal returns and thus enhance the benefit, whereas the landowner considers the purchase price to be too low. During the transaction process the developer takes a high-profile and explicitly states the ceiling price.If the price is to be increased, then the risk will rises while revenues decrease due to the uncertainty of the market in the future. With the dominance of the developer, the landowner of public facility reserve would be either unwilling to sell the floor area or eager to undercut the price to acquire the funds. In AD, the landowner is at a disadvantage while the developer has an advantage.

BC Quadrant
The developer in BC expresses interest in buying from the landowners in a public facility reserve, where the landowner is fully aware that the profits would increase with the floor area increments. The developer actively seeks a potential landowner to purchase public facility reserve, while landowner wait and see what comes along and hope for a higher price. The landowner takes a high-profile in dealing with the prospective developer, in turn either increasing the purchase price in exchange for an increased profit, or turning to another landowner for negotiation. In BC Quadrant, the developer is at a disadvantage while the landowner in the public facility reserve has an advantage.

BD Quadrant
Both the developer and landowner in public facility reserve either fail to negotiate the deal, or do not express interest.
Since different expropriation periodsyield different results, a social time preference rate of 6% is applied to analyze the case for the following two conditions. Scenario 1 simulates the case where the expropriation is bound to occur within five years (take the third year as an exampleof expropriation bound), while Scenario 2 simulates the case with no expropriation within five years.
Scenario 1: Expropriation Is Bound to Occur within Five Years (Take the Third Year as an Example). Figure 5 lists the payoffs of landowner in public facility reserve and developer, where the computational unit is the price accepted by the landowner accepted,and the IRR represents the developer's rate of return.
A The Developer Intends to Purchase while the Strategy for the Landowner in Public Facility Reserve Is as Follows: 5,929,404 <6,549,702, so the best strategy for the landowner is 'not to sell'.
B The Landowner in Public Facility Reserve Intends to Sell while the Strategy for the Developer Is as Follows: 35%>25%, so the best strategy for the developer is to 'buy floor area'.
C The Landowner in Public Facility Reserve Opts for the Strategy of not Selling Floor Transfer while the Strategy for the Developer Is as Follows: 36%>24%, so the optimal strategy for the developer is to 'buy floor area'.
D The Developer Opts for not Buying Floor Area Strategy while the Strategy for the Landowner in Public Facility Reserve Is as Follows: 7,362,204>6,549,702, so the most desirable strategy for the landowner is to 'sell floor area'.
Based on the above investigation, Nash Equilibrium is placed in QuadrantAC, i.e. when the payoffs between the landowner in public facility reserve and the developer is ≤ 6,549,702 or ≥ 0.36, then the transaction is not completed, and the floor area transfer does not occur.
Scenario 2: No Expropriation Occurs within Five Years (Take the Fifth Year as an Example,as Presented in Figure 6)
A The Developer Intends to Purchase while the Strategy for the Landowner in Public Facility Reserve Is as Follows: 5,929,404>5,829,212, so the most favorable strategy for the landowner in the public facility reserve is to 'sell'.
B The Landowner in Public Facility Reserve Intends to Sell the Floor Area while the Strategy for the Developer Is as Follows: 35%>25%, so the optimal strategy for the developer is to 'purchase floor area'.
C The Landowner in Public Facility Reserve Decides not to Selling Strategy while the Strategy for the Developer Is as Follows: 36%>24%, so the most desirable strategy for the developer is to 'purchase floor area'.
D The Developer Chooses not to Purchase Floor Area while the Strategy for the Landowner in Public Facility Reserve Is as Follows: 7,362,204>5,829,212, so the optimal strategy for the landowner in public facility reserve

is to 'sell floor area'.

In the above case, the Nash Equilibrium is in QuadrantAC, i.e. the transaction is likely to complete when the payoffs between the landowner in public facility reserve and the developer are at 5,929,404 or 0.35as listed in Fig.6. The landowner sells the floor area to obtain the funds; the developer obtains the benefit from the acquisition,and Hsinchu City Government, which the initiator of the game, can acquire 422 LunTzu section 'cultural and elementary school district'without paying.

Two possible conditions are analyzed according to the above calculations in various conditions where different payoffs are taken into the game for inductive judgment. Empirical data demonstrate that the land value outbids the developer's ceiling price in the landowner's calculation when the public sector intends to expropriate public facility reserve within five years, even though it provides the incentive for developer to participate. The negotiation for the deal is not likely to complete, and floor area transfer for public facility reserve is likely to fail. If the landowner determines that the public facility reserve is going not to be expropriated by the government in the next five years, then the discount process in the social time preference rate enables the landowner to choose to sell the floor area while the developer's ceiling price falls within the range of the landowner's acceptability. The floor area transfer for public facility reserve will has its intended effectsat this point in time.

VI. CONCLUSION

In Taiwan, current regulations enable public facility reserve land to be acquired in various ways, including the application of "RAFTUP" to obtain land reserved for public facility. The implementation of floor area transfer is still in the early stages. Therefore, caution is required when performing such a plan in order to prevent additional burdenson the local environment. The most feasible land acquisition approaches are currently Eminent Domain, Zone Expropriation and Urban Land Consolidation. This study concludes that newly acquired urbanized land converted from agricultural land is appropriateas the receiving area of floor area transfer. The environmental conditions of the receiving lot, sending lot and relative measures need to be considered.If the receiving lot of a floor transfer is located in newly developed area, then the added value from related industries, such as the Science Park, should be addressed in order to increase market acceptability. Since regional basic industry can bring a large influx of employed population, thus creating a floor area transfer market when combined with the real estate market. The case analysis shows that the floor area transfer is least likely to succeed when the public sector intends to expropriate in the short run (this case study takes five years as the example), because the current assessed land value plus 40% in compensation is likely to exceed the developer's ceiling price. The floor area transfer is viable when the future expropriation is delayed (over five years as the case example), at this point in time the "Nash Equilibrium" is in the quadrant where both parties agree that floor area transfer is to be adopted to negotiate the deal. Meanwhile, the public sector can also acquire land reserved for public facility without compensation, and create a win-win-win situation. The future priority for the public sector in obtaining land reserved for public facility is to investigate the feasibility of floor area transfer in land reserved for public facility.Floor area transfer should be employed for land acquisition when the outcome of financial feasibility holds true in the game. If the calculation fails the feasibility test, then the land can be listed for preferential expropriation, and the public facility reserve acquisition can be expedited.

Regarding recommendations for future study, numerous categories are available in terms of land reserved for public facility. The existing "RAFTUP" is determined from the ratio of the current assessed land values of both lots. Different land reserved for public facility applies the current assessed land value of the peripheral area as reference point.Whether this principle is reasonable is currently unclear. The competition process in the game is variable, so the ongoing interactive negotiation in the next run of the game should be the focal point when floor area transfer fails. The public sector and other developers/ landowners of the land reserved for public facility can participate, thus improving the outcomes after a number of runs. Additionally, the participation of lawmakers, pressure groups, non-profit organizations, the grass roots and the unpredictable local election all become variables in the game.

VII.   Acknowledgements

REFERENCES

[1].   Anderson, J. E., State tax credits and land use: policy analysis of Circuit- Breaker effects, *Resource Energy Economics, 15*, 1993, 295-312.
[2].   Anderson, J. E., Bunch, H. D., Agricultural property tax relief: tax credits, tax rate, and land values, *Land Economics, 67*, 1989, 13-22.
[3].   Blakely, M., *An economic analysis of the effects of development rights purchases on land values in King County, Washington*, M. S. thesis, Washington State University, 1991.

[4]. Henneberry, D. M., Barrows, R. L., Capitalization of exclusive agricultural zoning into farmland prices, *Land Economics, 66,*1990, 249-258.

[5]. Nickerson, C. J., Lynch, L.,The effects of farmland preservation programs on farmland prices, *American Journal of Agricultural Economics, 83（2）,*2001, 341-351.

[6]. Pasour, E. C. Jr.,The Capitalization of real property taxes levied on farm real rstate, *American Journal of Agricultural Economics February, 1975,*539-548.

[7]. Vitaliano, D. F., Hill, C., Agricultural districts and farmland prices, *Journal of Real Estate Finance, 8,*1994, 213-223.

Table 1
Case assumption

Item	Content
Sending lot land number	HsinchuCity 422LunTzu section
Sending lot size	199m^2
Sending lot zoning	cultural and elementary school district
Sending lot land value as of 2001	28,000 NT\$/ m^2
Zoning for the peripheral area of sending lot	Class one residential
Building coverage ratio and floor area ratio for the peripheral area of sending lot	60%，180%
The current land value for peripheral area of sending lot	28,000 NT\$/m^2
Current land value of receiving lotdue to its current agricultural area status, the current land value is based on section 680 of KuangWu)	21,000 NT\$/m^2

Source: Fieldwork of this study.

Table 2
Return to private sector

Gross revenue in NT\$	Gross rate of return	Net rate of return	NPV	IRR	floor
55,591,000	0.24	0.31	7,584,189	0.75	5

Source: Fieldwork of this study.

Table 3
Floor area ratio sensitivity analysis

Floor area ratio	Gross revenue in NT\$	Gross rate of return	Net rate of returns	NPV	IRR	Compression rate	floor
2.4	55,591,000	0.24	0.31	7,584,189	0.75	0.00	5
2.35	53,048,488	0.23	0.30	6,666,505	0.69	0.98	5
2.3	50,505,975	0.23	0.29	5,748,821	0.62	0.96	5
2.25	47,963,463	0.22	0.28	4,831,137	0.56	0.94	5
2.2	45,420,950	0.21	0.27	3,913,453	0.49	0.92	4
2.15	42,878,438	0.20	0.25	2,995,769	0.41	0.90	4
2.1	40,335,925	0.19	0.24	2,078,084	0.33	0.88	4
2.05	37,793,413	0.19	0.23	1,160,400	0.24	0.85	4
2	35,250,900	0.18	0.22	242716	0.12	0.83	4
1.99	34,742,398	0.18	0.21	59179	0.09	0.83	4
1.98	34,233,895	0.17	0.21	-124358	0.06	0.83	4

Source: Fieldwork of this study.

Table 4
Comparison on the effects from development patterns

Way of development	NPV	IRR
Direct development (not purchasing floor area)	1160400	24%
Cost calculation of the purchased floor area	5,616,553	35%

Source: Fieldwork of this study.

Table 5

Comparison between developer's ceiling price and the current value

Expropriated Time	Time Period	Expropriated Present Value	Developer's Ceiling Price	Amount Difference
Current	0	7,800,800	5,929,404	-1,871,396
One Year later	1	7,359,245	5,929,404	-1,429,841
Two Years later	2	6,942,684	5,929,404	-1,013,280
Three Years later	3	6,549,702	5,929,404	-620,298
Four Years later	4	6,178,964	5,929,404	-249,560
Five Years later	5	5,829,212	5,929,404	100,192
Six Years later	6	5,499,256	5,929,404	430,148

Source: Fieldwork of this study.

Table 6

Duration required under varied social time preference rates

Social Time Preference Rate	3%	4%	5%	6%	7%	8%	9%
The Positive Value Happened at the Nth Year	10	7	6	5	5	4	4

Source: Fieldwork of this study.

		The developer (Y)	
		To buy the floor area	Not to buy the floor area
The owner of land reservation for public facilities (X)	To sell the floor area	A： 1. To pursue biggest profits, the developer buys the floor area, and the owner is willing to sell it. The development can be undertaken. 2. The game is (fulfilled OR completed).	B： 1. The developer is not willing to develop due to lack of demand. 2. The profit for investment is low or even negative 3. The law is too strict. 4. The TDR market information is not soundly publicized. 5. The developer has the right to act alone.

		C：	D：
	Not to sell the floor area	1. The owner of the land reservation dismisses TDR. 2. Wait and see. 3. Maintain the status quo. 4. Consider other approaches, (including OR such as) expropriation, zone expropriation and land readjustment.	1. Unequal information is available, and both of the two sides dismiss TDR. 2. The owner and the developer wants to wait and see. 3. The law is too strict to play the game. 4. TDR system is not solid enough.

Fig. 1. Interrelationships among the measures taken by the developer and land owner
Source: Fieldwork of this study.

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┌─────────────────────────────────────┐
│   Public sector formulates the game   │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│ ● Estimate the development intensity  │
│   of the area within the duration     │
│   period                              │
│ ● Financial analysis: (calculate OR   │
│   compute OR derive OR obtain OR       │
│   determine) the private sector's      │
│   profit                              │
│ ● Adjust the floor area ratio: the     │
│   profit of floor area when the        │
│   developer does not buy it under      │
│   certain return                      │
└─────────────────────────────────────┘
                  │
                  ▼
┌─────────────────────────────────────┐
│ Game starts (Make public floor-area   │
│ ratio)                                │
└─────────────────────────────────────┘
           │              │
           ▼              ▼
┌──────────────────┐  ┌──────────────────────┐
│  The developer    │  │ The owner of land     │
│                   │  │ reservation           │
└──────────────────┘  └──────────────────────┘
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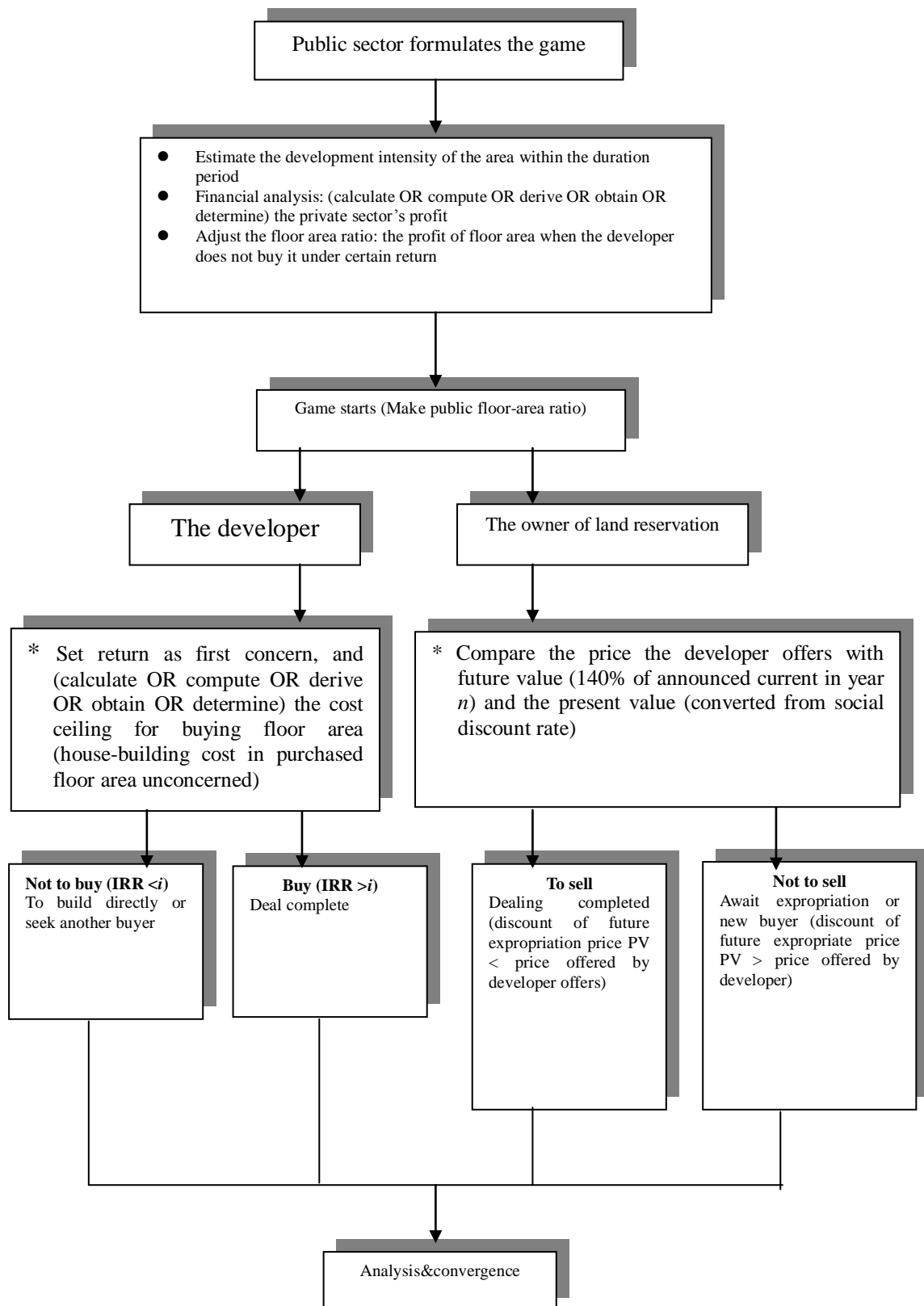
The developer — * Set return as first concern, and (calculate OR compute OR derive OR obtain OR determine) the cost ceiling for buying floor area (house-building cost in purchased floor area unconcerned)

The owner of land reservation — * Compare the price the developer offers with future value (140% of announced current in year *n*) and the present value (converted from social discount rate)

Not to buy (IRR <*i*)
To build directly or seek another buyer

Buy (IRR >*i*)
Deal complete

To sell
Dealing completed (discount of future expropriation price PV < price offered by developer offers)

Not to sell
Await expropriation or new buyer (discount of future expropriate price PV > price offered by developer)

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                  │
                  ▼
┌─────────────────────────────────────┐
│        Analysis&convergence           │
└─────────────────────────────────────┘
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Fig.2. Operation flow chart
Source: Fieldwork of this study.

		Strategies of Y-the developer	
		Buy	Not to buy
Strategies of X-owner of land reservation	Sell	PV\IRR	PV\IRR
	Not to sell	PV\IRR	PV\IRR

Fig.3. Strategy form between the developer and the owner of land reserved for public facilities
Source: Fieldwork of this study.

		Developer's strategies	
		A-buy	B-not to buy
Public facility reserve landowner's strategies	C-sell	Mutual cooperation with the best intention	Advantage/Disadvantage
	D-not to sell	Disadvantage/Advantage	No transaction

Fig. 4. Strategies between developer and owner of land reserved for public facility
Source: Field work of this study.

		Developer's strategies	
		A-buys	B- not to buy
Public facility reserve landowner's strategies	C-sells	5,929,404\0.35	7,362,204\0.25
	D-not to sell	≤6,549,702\≥0.36	6,549,702\0.24

Fig. 5. Strategies and payoffs of developer and owner of land reserved for public facility — expropriated in the third year
Source: Fieldwork of this study.

		Developer's strategies	
		A-buys	B- not to buy
Public facility reserve landowner's strategies	C-sells	5,929,404\0.35	7,362,204\0.25
	D-not to sell	≤5,829,212\≥0.36	5,829,212\0.24

Fig. 6. Strategies and payoffs of developer and owner of land reserved for public facility — expropriated in the fifth year
Source: Fieldwork of this study.