COMMUTING COSTS OF "LEAP-FROG" NEWTOWN DEVELOPMENT IN SEOUL

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Introduction

The study aims to estimate commuting costs of the 'leap-frog' new town development in the Seoul Metropolitan Area. In order to measure the commuting costs of the 'leap-frog' new town development, we assume a contiguous new town construction to Seoul, allowing new town development within Seoul's Greenbelt.

Average commuting distance for all commuters in the SMA would fall from 10.91km to 10.75km, a reduction of about 1.5%, if the new towns had been developed contiguously to Seoul. The additional commuting costs imposed by the 'leap-frog' new town development are $39.96 million per year excluding the value of travel time, or $239.61 million per year including the value of travel time. The average commuter pays $5.47 in out-of-pocket costs per year or $32.83 in total costs including the value of travel time.

Workers who live or work in new towns suffer from the most substantial loss caused by 'leap-frog' new town development. Each commuter who lives in new towns gains commuting cost saving of $154/ year excluding the value of travel time and of $925/ year including the value of travel time if the new towns had been developed contiguously to Seoul within the greenbelt.

Seoul's Greenbelt and Newtown Development

When the new town development plan for Seoul Metropolitan Area[1] (hereafter SMA) was announced in April 1989, Korea had experienced a serious housing shortage and a great deal of housing market speculation. The housing price index has increased more than 60 percent between 1985 and 1990, while the wholesale price index increased around 10 percent during the same period. The Korean government regarded this unprecedented housing price increase as a cause of social and political unrest. Another dominant reason for new town development in 1989 was the campaign promise of President Noh Tae Woo who announced construction of 2 million houses during his presidency.

There were several factors affecting the current location of new towns (see Figure 1). Firstly, it was hardly possible to secure adequate land for large-scale new town development within Seoul. Therefore, the site for new town development had to be outside Seoul. Secondly, Seoul is surrounded by the greenbelt[2] where land development has been strictly restricted since 1971. These constraints led Korean government to locate new town development outside Seoul and the greenbelt, but within a reasonable distance from Seoul.

As shown in Table 1, five new towns were constructed for 6 years from 1989 to 1995, accommodating 1.16 million people within 50km^2. As of 1996 more than the target population had already moved to the new towns except Bundang (occupancy rate is more than 95%), totaling 1.26 million people.

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1) The SMA consists of city of Seoul, city of Incheon, and Kyunggi Province. Total population of the SMA is over 21 million in 1997, and total land area of the SMA is 11,700 km^2. Total population of City of Seoul is 10.5 million and its size is 606 km^2.

2) Though metropolitan Seoul's greenbelt area is 1450 km^2 or 12.4 percent of total metropolitan area, the total number of people who live in the Seoul metropolitan area greenbelt is only 350,000, or 1.6% of total population because of strict restriction of land uses. Most of the greenbelt residents are so-called 'native' who have lived within the greenbelt before the greenbelt designation. As Figure 1 indicates, a significant portion of the greenbelt area lies beyond the boundary of Seoul, approximately 15 to 25km from the city center.

Figure 1. Greenbelt and Location of New Towns

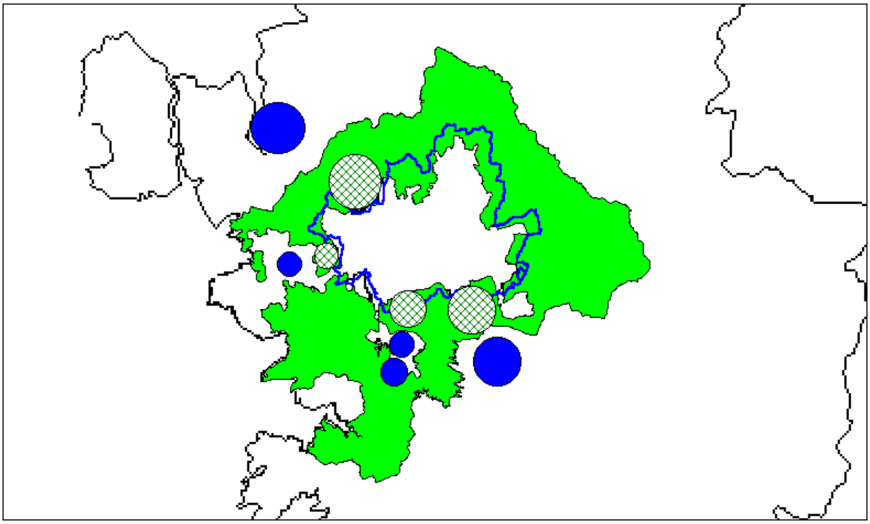

Table 1. Locations of New Towns and Their Population

New Town Name	Distance from CBD (Direction)	Construction Period	Project area (km^2)	Target Population	Population in 1996
Bundang	25km (SE)	1989-1995	20	390,000	372,414
Ilsan	28km (NW)	1990-1995	16	276,000	356,267
Jungdong	25km (W)	1994-1995	5	170,000	202,997
Pyungchon	20km (SW)	1989-1995	5	168,000	159,553
Sanbon	25km (SW)	1989-1995	4	163,000	164,267

Even though new town development in SMA made a contribution to the stabilization of rising housing prices by supplying a total of 333,000 housing units during that short period of time, Seoul's new town development has been the object of attack in the recent past.

Major criticism includes construction pace, development scale, and location of new towns. Seoul's new town development is an unprecedented event for the construction of more than 300,000 housing units within 6 years. This abrupt increase in construction demand caused serious shortage of construction materials and labor, resulting in unreliable and unsafe construction of new towns. Seoul's new town development has also been criticized of its development density. The average population density of Seoul's new towns is above 20,000 persons per km^2, which is around 5-10 times higher than new town development in Europe.

Another criticism concerns the location of the new towns. Seoul's new towns have been developed in the 20-28km range from the Seoul's CBD, jumping over the greenbelt, they accelerated urban sprawl and made the commuting distance longer. Two important urban land use policies in Seoul, new town development and greenbelt, are contradictory to each other. The greenbelt whose major objective was to prevent urban sprawl kept new town development away from greenbelt and rather forced 'leap-frog' urban sprawl.

The purpose of this paper is to estimate commuting costs of the 'leap-frog' new town development in SMA. In order to measure the commuting costs of the 'leap-frog' new town development, we set up an alternative development scenario of Seoul's new towns: a contiguous new town development to Seoul. The assumed locations of new towns in Figure 1 could be one of possible locations if new town development had been allowed within the greenbelt 10 years ago. When determining the hypothetical location of new towns, we try to follow the same directions from a new town to the CBD as the actual new towns have. We also take the area size and developable land availability into account.

Given the hypothetical locations of new towns, we estimated the average commuting distance and compared the estimated commuting distances with actual distances. We regard commuting distance savings as a measure of the commuting costs of the 'leap-frog' new town development in Seoul.

Previous Research on New Town Development and Commuting

This paper estimates commuting costs of the 'leap-frog' new town development. However, to our knowledge it is not easy to find previous research on this topic. Even though we cannot find exactly the same topics this study examines, there are several previous studies on the commuting patterns of new towns.

Behind the philosophy of new town development in many metropolitan areas such as Paris and London was the idea to achieve a balance between population and employment, enabling high levels of self-containment to be achieved. However, these new towns had good links to the core cities of the metropolitan area. Therefore, high levels of self-containment have not been realized. The British New Towns were 24 percent more self-contained than other towns in 1966, but the margin had declined to 5.4 percent in 1990 (Breheny, 1990).

Jun (2000) examines changes in commuting patterns of the Seoul Metropolitan Area by comparing the before and after of new town development. Average commuting distances of workers residing in cities where new towns are located became significantly longer over the 1990-1996 period, ranging from 12 percent to 70 percent. Moreover, the average commuting distance of new town residents (Bundang) is 18.2km, whereas that of old town residents (Sungnam) is 11.6km. These results strongly indicate that new town development in SMA has resulted in longer commuting trips.

With the same study area Jun and Bae (2000) estimate the commuting costs associated with Seoul's greenbelt. They use a density gradient framework for both workers and residents, and assume that the greenbelt results in a major discontinuity in these gradients that would be eliminated if the greenbelt did not exist. The commuter distance savings from this reallocation form the basis for measuring the commuting costs of the greenbelt. The average saving is 5 percent (a reduction from 7.14 km. to 6.79 km.); Greenbelt workers and residents would achieve substantial savings that are not fully offset by modest increases for those in the non-greenbelt zones. Total commuting costs associated with the current greenbelt are $65.96 million per year for out-of-pocket costs ($12.01 per commuter), or $395.56 million per year ($72.02 per commuter) including the value of travel time.

Estimating Commuting Costs of 'Leap-Frog' Newtown Development

Data

Data used for this analysis include the 1996 Origin-Destination table from the Census Bureau, and distance data (using actual network data) from a GIS (Geographical Information Systems) base. There are 1016 zones (at the Eup (district), Myun (settlement), and Dong (neighborhood) levels). The Dong boundaries and the greenbelt maps are built into the GIS files.

Analytical Methods

This study takes several steps to estimate the commuting cost of "leap-frog" new town development in Seoul. The first step is to assume the location of new towns would be within the greenbelt. Secondly, the jobs and workers in the current new towns would be reallocated into the assumed new towns. The reallocation of jobs and resident workers is quite simple. The number of workers and resident workers subtracted from the actual new towns will be added to the hypothetical new towns. The third step is to analyze changes in commuting patterns of the SMA, given the hypothetical location of the new towns. To do this, we need a trip distribution model. We chose to use the well-known gravity model because the gravity model can generate a new O-D table. The fourth step is to compare actual average commuting distances with estimated average commuting distances, which are derived from the hypothetical locations of new towns. The final step is to convert the distance savings into commuting cost savings in monetary terms.

Changes in Commuting Distances

In order to estimate commuting costs it is necessary to compute the changes in commuting distances associated with the new allocation of jobs and resident workers. We employ the popular gravity model. Its distance decay parameters are derived from actual network distances. The calibration for a distance decay parameter has been made by the TRANPLAN.

The gravity model is represented by the following equation:

$$T_{ij} = A_i * B_j * w_i * J_j f(c_{ij})$$
$$A_i = [\sum_j B_j * J_j * f(c_{ij})]^{-1}$$
$$B_j = [\sum_i A_i * w_i * f(c_{ij})]^{-1}$$

where T_{ij}=number of commuters from zone i to j, W_i=number of resident workers in zone i, J_j=number of jobs in zone j, $f(C_{ij})$ = distance decay function, and A_i and B_j are the balancing factors.

Table 3 presents actual and estimated commuting distances. The first and second columns present the actual number of commuters and average commuting distances. The third and fourth columns show the reallocated commuters and the estimated average commuting distances derived from the gravity model by macro zone, respectively. The fifth column displays percent difference between actual and estimated commuting distances. Averaging over all jobs in the SMA, the distance saving from the "contiguous new town development to Seoul" scenario is 0.16 km., or about 1.5 percent.

As we expect, the biggest benefit goes to the workers who live or work in the new towns with the "contiguous new town development" scenario. The average work trip distance of workers residing in new towns decreases by 27% from 16.68 to 12.17km. The reduction in commuting distance for the workers who work in the new towns is about 17%. However, the contiguous new town development would not always benefit all the commuters in the SMA. There are increases in the commuting distances for intra-Seoul and intra-Kyunggi commuters because new town residents move to the current location to the hypothetical locations that are urban edges of Seoul and

Kyunggi. Increase of commuting distance for intra-Seoul and intra-Kyunggi trips is offset by the reduction of work trip distance for trips from and to new towns, making overall commuting distance saving positive.

Table 3. Actual and Estimated Average Commuting Distances in SMA

		TRIPS	Mean distance		% change
			Actual	estimated	
SMA	SMA	7298216	10.91	10.75	-1.5%
SMA	NEW TOWNS	196471	12.88	10.73	-16.7%
NEW TOWNS	SMA	420613	16.68	12.17	-27.0%
SEOUL	SEOUL	3274419	7.95	8.74	9.9%
	KYUNGGI	312411	24.21	15.20	-37.2%
	NEW TOWNS	49982	23.43	12.39	-47.1%
KYUNGGI	SEOUL	552487	19.22	16.76	-12.8%
	KYUNGGI	1696655	9.20	10.50	14.2%
	NEW TOWNS	71303	12.61	11.28	-10.5%

When the new towns are broken down into Bundang, Ilsan, Jungdong, and Sanbon-Pyungchon (hereafter San-Pyung), more detailed information on average commuting distance gains and losses are found. Workers working or living in Bundang and Ilsan would gain significant average commuting distance reduction by the 22.3-42.7 percent range if there were a contiguous new town development. On the other hand, average commuting distance of workers working in Jungdong increases from 6.3km to 10.1km, while the commuting distance of workers who reside in Jungdong increases modestly from 11.2km to 11.8km. The reason for longer commuting distance in Jundong is due to the location of Jungdong. Jungdong is located between Seoul and Incheon, which has 2.5 million people (see Figure 1). Therefore, relocation of Jungdong toward Seoul presents both good and bad news for the residents in Jungdong. Residents commuting to Seoul can get distance savings, but residents commuting to Incheon suffer from distance increases.

Table 4. Actual and Estimated Mean Commuting Distance in New Towns

Origin	destination	TRIPS	Commuting distance		%
			actual	estimated	
SMA	BUNDANG	66827	14.01	10.89	-22.3%
	ILSAN	69214	16.43	11.44	-30.3%
	JUNGDONG	28423	6.25	10.11	61.8%
	SAN-PYUNG	32007	8.74	9.88	13.0%
BUNDANG	SMA	117495	18.23	10.44	-42.7%
ILSAN		117224	21.10	13.69	-35.1%
JUNGDONG		73663	11.20	11.81	5.5%
SAN-PYUNG		112231	14.03	12.24	-12.7%
SEOUL	BUNDANG	17775	23.20	11.71	-49.5%
	ILSAN	24128	24.82	13.62	-45.1%
	JUNGDONG	2527	19.84	10.55	-46.8%
	SAN-PYUNG	5552	19.74	14.59	-26.1%
KYUNGGI	BUNDANG	28432	13.90	12.16	-12.6%
	ILSAN	17816	18.04	13.15	-27.1%
	JUNGDONG	9810	6.10	9.26	51.7%
	SAN-PYUNG	15245	8.06	10.31	27.9%
BUNDANG	SEOUL	70856	21.12	10.68	-49.4%
ILSAN		75760	25.76	15.18	-41.1%
JUNGDONG		24340	19.07	12.81	-32.8%
SAN-PYUNG		48683	19.81	16.27	-17.9%
BUNDANG	KYUNGGI	26146	19.62	12.82	-34.7%
ILSAN		15301	22.14	14.21	-35.8%
JUNGDONG		27867	7.85	10.21	30.1%
SAN-PYUNG		51405	10.36	9.59	-7.4%

All the workers who live in Seoul and work in new towns gain average commuting distance savings by the 'contiguous new town development', ranging from 26.1 to 49.5 percent. Similar patterns can be found for the workers who live in new towns and work in Seoul.

These results clearly indicate high dependency of new town commuters on Seoul. These results have significant policy implications. Allowing new town development within the greenbelt would make the commuting trips of workers working and/or living in the new towns significantly shorter, while not having much impact on the commuting trips of workers in the other towns, thereby reducing overall mean commuting distance only by 1.5 percent.

Estimating Commuting Costs

The estimates of commuting distance savings from relocating the new towns into the greenbelt are regarded as a measure of the commuting costs of the 'leap-frog' new town development. We convert commuting distances into a monetary estimate by considering both out-of-pocket costs and the value of travel time (an average estimate because of the lack of route-specific travel time data), based on the actual modal split.[3] Via this method, the total

[3] The calculation is based on Lee (1998, p. 49) who computed commuting costs with and without value of time traveled, based on research results from the Seoul Development Institute (SDI). The commuting costs per km. by mode are as follows:

Mode	*Share (%)*	*Out-of-Pocket Cost (Won)*	*Total Cost (Won)*****
Automobile	15.6	315.2	536.4
Regular Bus	33.1	33.9	274.4
High Quality Bus	2.1	36.5	282.5
Subway	11.9	37.1	206.1

Non-motorized modes have a significant commuting share, and in our calculations we assumed zero out-of-pocket costs (ignoring shoe leather, bicycle tires, etc.). The travel time estimates are based on assuming the travel time is valued at 40 percent of the wage rate. The full average cost of a commute in Seoul is comparable with commuting costs of the 'leap-frog' new town development are $39.96 million per year excluding the value of travel time, rising to $239.61 million per year if travel time is included (Table 5). This implies an average saving for each commuter of $5.47 per year in out-of-pocket costs excluding travel time, or $32.83 per year including travel time. But some commuters would save much more; those who live outside new towns and work in new towns, for example, would save 13 times more than the average commuter ($441), while those who live in new towns and work outside new towns would gain even more ($925, or 28 times more than the average). Thus, although the overall regional average gains are modest, both workers and residents in the new towns would gain substantially by the contiguous new towns development to Seoul. In other words, Workers who live or work in the new towns have been paying a substantial amount of the commuting costs everyday because of 'leap-frog' new town development.

Table 5. Commuting Costs of the new towns

		Total Distance Savings (Million km./Day)*	Total Costs ($Million/ Year**)	Commuting Costs per worker ($/Year)
Total Commuters	Out-of-Pocket Costs	2.34	39.96	5.47
	Out-of-Pocket Costs + Value of Travel Time	2.34	239.61	32.83
Commuters to Newtown	Out-of-Pocket Costs	0.84	14.45	73.57
	Out-of-Pocket Costs + Value of Travel Time	0.84	86.68	441.17
Commuters from Newtown	Out-of-Pocket Costs	3.79	64.91	154.32
	Out-of-Pocket Costs + Value of Travel Time	3.79	389.25	925.43

* Number of workers x distance saving x Commuting Frequency per day (2)

** Converted from Wons to dollars at a rate of ($1:1,150 Won)

that in the United States, primarily because of slower speeds (e.g. 13.7 km. per hour for commutes by auto).

Conclusions

Under the assumption of new town development within the greenbelt, the average commuting distance for all commuters in the SMA would fall from 10.91 km. to 10.75 km., a reduction of about 1.5 percent. If we look at work trip distance changes by new town, the commuting distance savings of workers who work or live in Bundang and Ilsan are most substantial, ranging from 12.6-49.5 percent.

These results have significant policy implications. Allowing new town development within the greenbelt will make commuting trips of workers working and/or living in the new towns significantly shorter.

The additional commuting costs imposed by the 'leap-frog' new town development are $39.96 million per year excluding the value of travel time, or $239.61 million per year including the value of travel time. The average commuter pays $5.47 in out-of-pocket costs per year or $32.83 in total costs including the value of travel time.

As expected, workers who live in new towns suffer from the most substantial loss caused by 'leap-frog' new town development. Workers who live in new towns would gain a commuting cost saving of $154/year excluding the value of travel time and of $925/year including the value of travel time by the relocation of new towns toward Seoul.

If greenbelt restrictions had been relaxed and new town development was allowed within the greenbelt in 1989, when the Korean government started to build the five new towns in SMA, a significant level of 'excess' commuting costs of new town residents would have been eliminated.

The results from this study demonstrate the importance of initial location of new town development in terms of urban land use and transportation. The greenbelt and 'leap-frog' new town development have resulted in a significant discontinuity of urban population and employment density gradients. The distortion of urban structure has created a serious jobs-housing imbalance and made longer commuting distances and higher dependency on commuting trips on core cities in the metropolitan area.

In the case of Seoul, the greenbelt affects the location of jobs and population differently. Firms want to stay in the inner city because they are afraid of losing agglomeration economy if they jump over the greenbelt, while leap-frog new town development initiated by the government has been made extensively. Severe jobs-housing mismatch due to the inconsistent land use policies makes trips longer and demands more energy consumption in the transportation sector, which in turn produces a significant level of social costs including commuting costs.

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