



Commuting costs of "leap-frog" newtown development in Seoul

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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.

Total VMT savings from the contiguous new town development to Seoul are 744 million km/year. Average commuting distance would be shortened by 1.5% for every worker of the SMA if 196 thousand workers (2.7% of total jobs) and 420 thousand residents (5.7% of total commuters) in new towns have been relocated into hypothetical new towns. Total commuting costs associated with the leapfrog new town development are \$42.45 million per year for out-of-pocket costs (\$5.82 per commuter), or \$255 million per year (\$34.88 per commuter) including value of travel time.

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 distances of residents and workers of new towns would have substantially decreased by 27% and 17%, if the five new towns had been developed contiguously to Seoul. VKT savings for the residents and workers of the new towns are 1141 million km/year and 256 million km/year, respectively. New town residents would gain commuting cost savings of \$155/year excluding the value of travel time and of \$927/year including the value of travel time by the relocation of new towns towards Seoul. © 2001 Elsevier Science Ltd. All rights reserved

Keywords: Korea, Commuting patterns, Public transportation, Planning process

Seoul's greenbelt and newtown development

Among various urban development and land use policies for Seoul Metropolitan Area¹ (hereafter SMA), new town development and Greenbelt policies have played significant roles in determining the current shape of the city. It is worth noting the history and background of Seoul's greenbelt and new town development for better understanding of those policies.

Greenbelt policy

The Greenbelt was introduced in 1971 as an important component of the 1972-81 National Comprehensive Physical Plan, although its enactment was embodied in the Town Planning Act (TPA) of January 1971, which adopted the term *Gaebal Jehan Guyuk* ("Development Control Zone" or "Development Restricted Zone") rather than the Greenbelt. A Master Plan prepared by the Seoul City Government suggested an approximately 10 kilometers wide Greenbelt beginning 15 kilometers from City Hall (see Fig. 1). However, the boundaries were based more on political decisions than on land use surveys (Bae, 1998).

The chief objectives of Korea's Greenbelt policy were to slow down population and industrial concentration in the Capital; to prevent sprawl and conur-

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¹The SMA consists of the 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 km². Total population of the City of Seoul is 10.5 million and its size is 606 km².

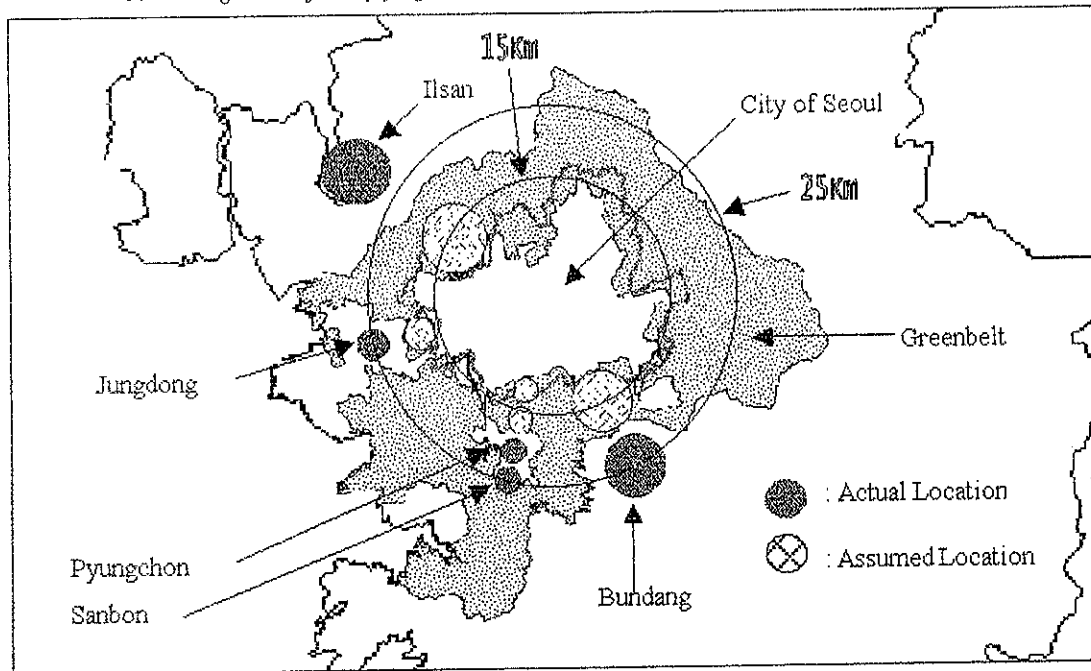


Figure 1 Greenbelt and location of new towns

banization; to reduce air and water pollution; to protect the natural environment; to provide for recreational areas; and to preserve national security (Seoul City Government, 1996, p 784). Interestingly, with the exception of the last, many of these objectives are similar to those of the anti-sprawl movement in the United States.

Although Greenbelt policies were adopted in and around 33 large, medium and small cities in South Korea, controlling urban growth in Seoul became a national obsession. Seoul experienced rapid population concentration with no signs of slowing down. By 1997, more than 21 million (48 percent of the national population) lived in the Seoul Metropolitan Area including Seoul, Incheon, and the rest of Kyunggi Province; however, one-half of the metropolitan population lives in the city of Seoul. Though metropolitan Seoul's greenbelt area is 1450 km² 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. The greenbelt boundaries have remained unchanged since its adoption, until 1999.

After recurrent debates and conflict among land-owners and residents within the Greenbelt, central and local government officials, politicians and environmentalists, Korean government started to deregulate Greenbelt recently. A Greenbelt Reform Committee was formed to review alternatives and significant revisions have been made in 1999. Around 13 km²

of SMA's greenbelt² will be released for residential development at the first stage of deregulation by 2001. In addition, an extensive portion of SMA's greenbelt (approximately 225 km²) will be released after establishing the Seoul Metropolitan Master plan in 2002 (Chosun Ilbo, 2000).

Newtown development

When the new town development plan for the SMA was announced in April 1989, Korea had experienced a serious housing shortage and a great deal of housing market speculation. The housing rent index has increased 3.2 times between 1980 and 1990, while the consumer price index increased around 1.9 times during the same period (Ha, 1997). The Korean government regarded this unprecedented housing rent 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 Fig. 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

²Villages or town in which more than 1000 people (or 300 households) reside within the greenbelt will be released and allowed to urban development.

where land development has been strictly restricted since 1971. These constraints led the 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 over 6 years from 1989 to 1995, accommodating 1.16 million people within 50 km². 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.

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 about its development density. The average population density of Seoul's new towns is above 20,000 persons per km², which is around 5–10 times higher than new town development in England (i.e. 2400 per km² in Milton Keynes, www.mkweb.co.uk).

Another criticism concerns the location of the new towns. Because Seoul's new towns have been developed in the 20–28 km range from the Seoul's CBD, jumping over the greenbelt, they accelerated urban sprawl and created social costs of sprawl such as longer commuting distance, additional infrastructure construction costs, etc.

In summary, 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.

Study objectives

The purpose of this paper is to estimate commuting costs of the "leap-frog" new town development in

SMA, which is caused by Seoul's greenbelt. 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 Fig. 1 could be one of possible locations if new town development had been allowed within the greenbelt 10 years ago. In other words, if the greenbelt had been released 10 years ago, the current location of the new towns would probably have been somewhere within the greenbelt. 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 (ECMT, 1995). 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 (2000a) 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

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	25 km (SE)	1989–1995	20	390,000	372,414
Ilsan	28 km (NW)	1990–1995	16	276,000	356,267
Jungdong	25 km (W)	1994–1995	5	170,000	202,997
Pyungchon	20 km (SW)	1989–1995	5	168,000	159,553
Sanbon	25 km (SW)	1989–1995	4	163,000	164,267

percent to 70 percent. Moreover, the average commuting distance of new town residents (Bundang) is 18.2 km, whereas that of old town residents (Sungnam) is 11.6 km. 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 (Jun and Bae, 2000: 300).

Estimating commuting costs of "leap-frog" newtown development

Data Data used for this analysis include the 1996 Origin-Destination table from the City of Seoul, 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 (see Fig. 2). 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.

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:

$$T_{ij} = A_i * B_j * W_i * J_j f(C_{ij})$$

$$A_i = \left[\sum_j B_j * J_j * f(C_{ij}) \right]^{-1}$$

$$B_j = \left[\sum_i A_i * W_i * f(C_{ij}) \right]^{-1}$$

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 2 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. The last column shows VKT (Vehicle Kilometer of Travel) savings. Total VMT savings associated with the "contiguous new town development" scenario are 744 million km/year. Each commuter would have saved 0.17 km, or about 1.5 percent of average commuting distance if the new towns had been located adjacent to Seoul. Even though 1.5% longer commuting distance looks insignificant in terms of the whole metropolitan commuting pattern, the distance savings are quite substantial if we aggregate commuting distance savings of 7.3 million commuters. That is, relocation of 196 thousand jobs (2.7% of total jobs) and 420 thousand resident workers (5.7% of total commuters) in new towns into hypothetical new towns affects commuting distance of 7.3 million commuters longer by 1.5%.

As we expect, the biggest benefit associated with the contiguous new town development goes to the workers and residents of the new towns. The average work trip distance of workers residing in new towns decreases by 27% from 16.68 to 12.16 km. The reduction in commuting distance for the workers who work in the new towns is about 17%. Total VKT saving for the residents and workers of the new towns is 1141 million km/year and 256 million km/year, respectively. 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 from the current location to the hypothetical locations that are urban edges of Seoul and Kyunggi. Increase of commuting distance for intra-Seoul and intra-

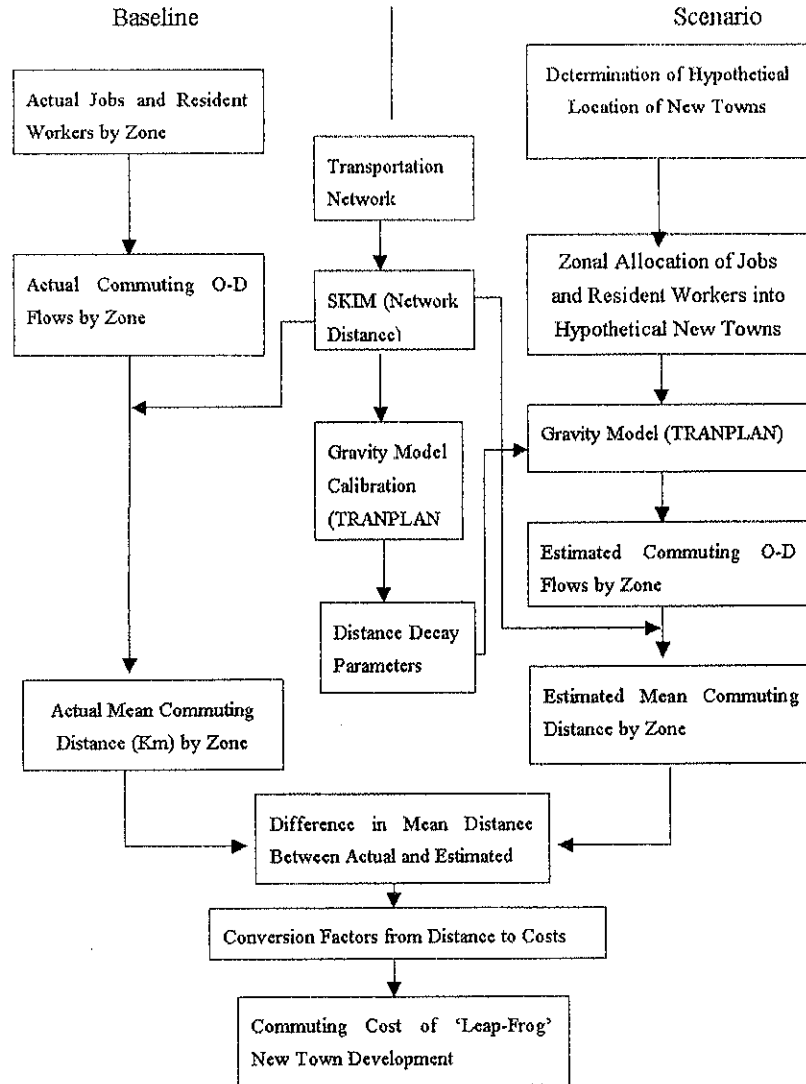


Figure 2 Flow chart of research procedures

Table 2 Actual and estimated average commuting distances in SMA

Origin	Destination	Trips	Mean distance		% change	VKT savings ^a (million/year)
			Actual	Estimated		
SMA	SMA	7298216	10.91	10.74	-1.5%	744.4
SMA New towns	New towns	196471	12.88	10.71	-16.9%	255.8
	SMA	20613	16.68	12.16	-27.1%	1140.7
Seoul	Seoul	3274419	7.95	8.74	9.9%	-1552.1
	Kyunggi	312411	24.21	15.19	-37.2%	1690.8
	New towns	49982	23.43	12.39	-47.1%	331.1
Kyunggi	Seoul	552487	19.22	16.74	-12.9%	822.1
	Kyunggi	1696655	9.20	10.49	14.0%	-1313.2
	New towns	71303	12.61	11.30	-10.4%	56.0

^aVehicle kilometer traveled (VKT)=trips*distance saving*trip frequency per day(2)*300 days.

Table 3 Actual and estimated mean commuting distance in new towns

Origin	Destination	Trips	Commuting distance		%	
			Actual	Estimated		
SMA	Bundang	66827	14.01	10.85	-22.6%	
	Ilsan	69214	16.43	11.39	-30.6%	
	Pyungchon	18632	7.88	10.15	28.8%	
	Sanbon	13375	9.95	9.72	-2.3%	
	Jungdong	28423	6.25	10.11	61.7%	
Bundang	SMA	117495	18.23	10.42	-42.9%	
	Ilsan	117224	21.10	13.66	-35.3%	
	Pyungchon	54542	13.63	12.38	-9.2%	
	Sanbon	57689	14.40	12.18	-15.5%	
	Jungdong	73663	11.20	11.81	5.4%	
Seoul	Bundang	17775	23.20	11.71	-49.5%	
	Ilsan	24128	24.82	13.63	-45.1%	
	Pyungchon	2513	18.83	13.64	-27.6%	
	Sanbon	3039	20.49	15.32	-25.2%	
	Jungdong	2527	19.84	10.53	-46.9%	
Kyunggi	Bundang	28432	13.90	12.14	-12.7%	
	Ilsan	17816	18.04	13.21	-26.8%	
	Pyungchon	9455	6.94	10.42	50.2%	
	Sanbon	5790	9.88	10.28	4.0%	
	Jungdong	9810	6.10	9.28	52.1%	
Bundang	Seoul	70856	21.12	10.68	-49.4%	
	Ilsan	75760	25.76	15.17	-41.1%	
	Pyungchon	26141	18.29	15.61	-14.7%	
	Sanbon	22542	21.57	16.71	-22.6%	
	Jungdong	24340	19.07	12.81	-32.8%	
Bundang	Kyunggi	26146	19.62	12.84	-34.6%	
		Ilsan	15301	22.14	14.32	-35.3%
		Pyungchon	21811	10.53	9.90	-6.0%
		Sanbon	29594	10.23	9.42	-7.9%
		Jungdong	27867	7.85	10.21	30.1%

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

When the new towns are broken down into Bundang, Ilsan, Pyungchon, Sanbon, and Jungdong, more detailed information on average commuting distance gains and losses are found. Workers and residents of Bundang and Ilsan would gain significant average commuting distance reduction by the 22.6-42.9 percent range if there were a contiguous new town development. On the other hand, average commuting distance of workers working in Jungdong increases from 6.3 km to 10.1 km, while the commuting distance of workers who reside in Jungdong increases modestly from 11.2 km to 11.8 km. The reason for longer commuting distance in Jungdong is due to the location of Jungdong. Jungdong is located between Seoul and Incheon, which has 2.5 million people (see Fig. 1). Therefore, relocation of Jungdong towards 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.

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 25.2 to 49.5 percent. Similar patterns can be found for the workers who live in new towns and work in Seoul (Table 3).

Estimating commuting costs

The estimates of commuting distance savings 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 commuting

³The 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

Table 4 Commuting costs of the new towns

		Total distance savings (million km/year) ^a	Total costs (\$million/year ^b)	Commuting costs per worker (\$/year)
Total commuters	Out-of-pocket costs	744	42.45	5.82
	Out-of-pocket costs+value of travel time	744	254.59	34.88
Commuters to newtown	Out-of-pocket costs	256	14.59	74.25
	Out-of-pocket costs+value of travel time	256	87.48	445.27
Commuters from newtown	Out-of-pocket costs	1141	65.05	154.66
	Out-of-pocket costs+value of travel time	1141	390.11	927.48

^aNumber of workers×distance saving×Commuting frequency per day (2)*300 days.

^bConverted from won to dollars at a rate of (\$1:1,150 won).

costs of the "leap-frog" new town development are \$42.45 million per year excluding the value of travel time, rising to \$254.59 million per year if travel time is included (Table 4). This implies new town commuters (only less than 6% of total commuters in the SMA) impose a burden of \$5.82 per year in out-of-pocket costs excluding travel time, or \$34.88 per year including travel time on each of 7.3 million commuters in the SMA. 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 (\$445), while those who live in new towns and work outside new towns would gain even more (\$927, or 27 times more than the average). Thus, workers or 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.

Conclusions

The current locations of the SMA's five new towns are determined mainly by two factors 10 years ago: land shortage for large-scale residential development within Seoul and greenbelt surrounding Seoul. However, it is expected that around 13 km² of the greenbelt will be released by 2001 and more extensive level of release will be made in two or three years. The underlying question of the paper is that if the greenbelt had been released, and new town development had been allowed contiguously to Seoul within the greenbelt a decade ago, how much would the com-

muting cost savings be. In other words, this paper aimed to evaluate the commuting costs of the leapfrog new town development in Seoul and to suggest policy implications for the future new town development in the SMA.

Total VMT savings associated with the contiguous new town development to Seoul are 744 million km/year. Average commuting distance would be shortened by 1.5% for every worker of the SMA if 196 thousand workers (2.7% of total jobs) and 420 thousand residents (5.7% of total commuters) in new towns had been relocated into hypothetical new towns. Total commuting costs of the "leap-frog" new town development are \$42.45 million per year excluding the value of travel time, rising to \$254.59 million per year if travel time is included.

The biggest benefit associated with the contiguous new town development goes to the workers and residents of the new towns. The average work trip distance of new town residents decreases by 27% from 16.68 to 12.16 km, while the reduction in commuting distance for the workers of the new towns is about 17%. Total VKT saving for the residents and workers of the new towns is 1141 million km/year and 256 million km/year, respectively. New town residents suffer from the most substantial loss caused by "leap-frog" new town development. New town residents would gain commuting cost savings of \$155/year excluding the value of travel time and of \$927/year including the value of travel time by the contiguous new town development to Seoul.

However, this analysis seriously underestimated the commuting costs of the leapfrog new town development. Recently hundreds of small-scale "unplanned residential development" by private developers has been made or planned near new towns. The unplanned residential sites adjacent to the five new towns will accommodate around 2.3 million people (two times the current new town population) by the year 2006 (Hur, 2000). Because of a loophole in planning legislation, developers building less than 300 units do not have to provide infrastructure. When new towns (planned communities) are designated, developers

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 that in the United States, primarily because of slower speeds (e.g. 13.7 km per hour for commutes by auto) (Jun and Bae, 2000: 313).

buy up the land immediately around them; build without providing infrastructure, and "free-ride" on the existing infrastructure within the new towns. When we discuss about commuting costs of leapfrog new town development, we should consider the commuting costs of the residents in the unplanned communities because their locations are determined by the initial locations of new towns. The commuting patterns of unplanned community residents adjacent to the new towns are very similar to those of new town residents, highly dependent on Seoul, because they are all residential developments and it is hard to find jobs nearby. Therefore, if we include the commuting costs of residents of unplanned communities adjacent to new towns, the commuting costs of leapfrog new town development will increase substantially.

If the 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 and nearby unplanned community 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 (Jun, 2000b). 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 air pollution.

The analysis results suggest several policy implications. The greenbelt policy imposed on a rapidly growing city like Seoul produces inner-city

densification as well as leapfrog development. According to Jun (2000b) Seoul's greenbelt has significantly shifted the urban edge farther away from the CBD by 19 km and 15 km in terms of population and employment distribution, respectively. In addition, the greenbelt has affected inner-city densification by 9% for population and 15% for employment.

In order to prevent discontinuity of urban development and leapfrog development, the greenbelt boundary in a rapidly growing urban area such as the SMA should be replaced with the US-type Urban Growth Boundary (UGB). Therefore, the greenbelt should accommodate future urban growth, instead of rejecting the growth and pushing it away farther from the central city.

Acknowledgements

This research was supported by the Chung-Ang University Special Research Grants in 1998.

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