5 Translating Employment Concentration into Land Consumption: some results from the Chicago Metropolitan Area

Daniel Felsenstein

5.1 INTRODUCTION

Large, suburban employment centres are a major feature of contemporary metropolitan growth. While these employment agglomerations have attracted a great deal of attention through the 'edge city' phenomenon that they imply and their impacts on land values (Bingham and Kimble 1995, McMillen and McDonald 1998), rather less attention has been paid to the land consumption implications that arise from this growth. Large employment concentrations do not just engage in the primary consumption of land through absorbing large areas for industrial, commercial or service activity, but they also exert a secondary impact as the result of land absorption through the residential choice of the labour that is employed in these concentrations. Thus a link needs to be made between primary land consumption, which is grounded in place of work, and secondary land consumption that is related to place of residence.

This chapter attempts to forge this link. It offers a methodology for achieving this translation and provides some basic empirical results from a study of two high technology employment concentrations in Chicago. The paper attempts to measure land consumption (primary and secondary) attributable to these two employment agglomerations and also presents a series of simulations as to what would have happened had these two concentrations been located elsewhere in the Chicago metropolitan area. In all the analysis the focus centers on the land consumption effects in the outer metropolitan area (termed here the 'outer suburbs'), which is the area where most land consumption (both primary and secondary) takes place.

The chapter proceeds in the following manner. After a brief description of the context in which this metropolitan growth is taking place, the analytic framework and data requirements for this exercise are described. The method employed is then presented and in turn some empirical results are briefly presented. The costs of his land absorption are also estimated and the paper concludes with some

implications arising from the empirical results with respect to the process of metropolitan expansion and urban sprawl.

5.2 THE CONTEXT

This study is set in the context of two existing, outer suburban high technology employment concentrations in the Chicago metropolitan area. These agglomerations relate to the clusters of high technology activity alongside I-88 in DuPage County and astride the Edens Expressway and I-94 in the south of Lake County (Figure 5.1). The literature on the growth of high technology employment centres tends to stress the increasing returns that entrench high technology locations and cause self-reinforcing growth (Krugman 1991, Anselin et al. 1997, Audretsch 1998). Combined with historical 'lock in', this agglomeration effect can explain why some places develop as high technology concentrations, while other eminently suitable locations seem to 'miss the boat'. Recent work has begun to examine whether concentrations of high technology activity induce more metropolitan expansion and urban sprawl than other forms of economic activity (Felsenstein 2003, Malpezzi 2001). However, the evidence so far, is mixed.

The two present metropolitan concentrations of high technology both only experienced major growth spurts over the last decade. Prior to that, Chicago was never recognized as a major center for high technology despite the fact that on all indices relating to innovation potential, the Chicago SMSA is highly ranked. For example, in the early 1990s it was ranked between 4th and 6th nationally with respect to University R&D funding, nationally ranked science and engineering programs and bachelors degrees in science and engineering (Beeson and Montgomery 1993). In terms of industrial research laboratories, Cook County was ranked second in the nation at the end of the 1980s (375) behind Los Angeles County (481) but ahead of Middlesex County, Massachusetts (367) (Appold 1991).

Considering the existence of infrastructure for innovation, the fact that Chicago did not develop any major high technology concentration akin to Silicon Valley or the clusters developed in Boston, Raleigh-Durham, Salt Lake City or Atlanta (GA), is surprising. Commenting on this situation in the mid-80s, Markusen and McCurdy (1988) pointed to the absence of key military installations in the Chicago area and the disinterest in military markets shown by commercial high tech firms. California's success in 'locking- in' the defense market to the development of a local high technology capacity would have seemed to have simultaneously 'locked-out' all other potential high technology locations.

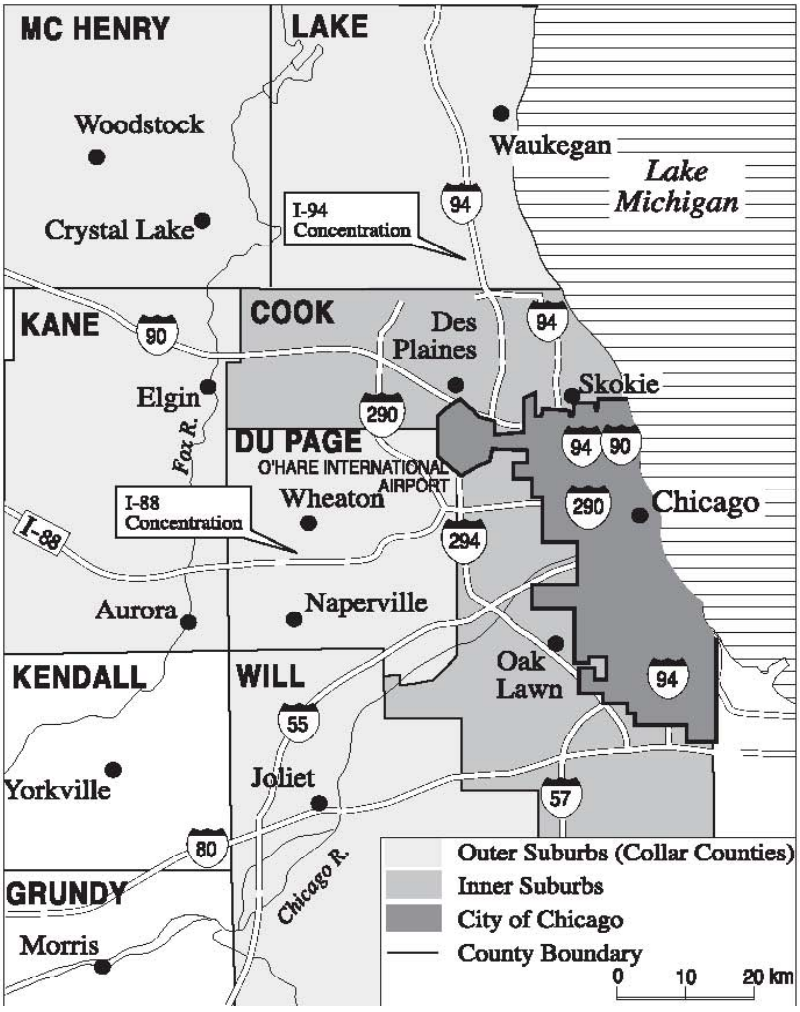

Figure 5.1 High tech employment concentration in the Chicago population area

The present round of high technology development in the metropolitan area has been noticeably devoid of any defense component. Even the existence of Federal installations such as the Fermi National Accelerator Laboratory and the Argonne National Laboratory cannot be considered 'seedbed' factors that have contributed to the growth of the I-88 cluster. Instead, the present development along the I-88 toll-way is a result of mutually complementary public sector and market forces. Federal infrastructure investments in the area at the end of the 1960s (the E-W toll-way, the Lake Michigan water project and the Fermi National Accelerator Laboratory) combined with market forces such as demand for residential development (the birth of Oak Brook as a municipality occurred at the same time) to produce an initial round of residential development alongside I-88. This provided the impetus for a round of office and commercial development and the consequent surge in employment growth that resulted in DuPage adding over 77,000 jobs between 1991 and 1996 (Chicago Sun Times 1998).

The presence of high technology firms along the corridor has been a result of corporate relocation decisions based on the strength and diversified nature of Chicago's employment pool (e.g. Amoco Research came from Iowa, Lucent (Bell Labs) from New Jersey), or relocations from the central city in search of more favorable tax climates. Indigenous, small firm growth has not really been a factor. While spin-off based growth has emanated from some of the large firms (e.g. Lucent Technologies), the existing federal facilities have not been prominent in promoting new firms and their commercial partnering is limited. The present round of industrial office and commercial development has provided the impetus for further residential development and pressure on outer suburban land use to accommodate the growing I-88 employment. Thus, the different forms of land absorption (commercial, industrial, residential etc.) complement each other with lags between phases of development. Residential land consumption in suburban DuPage county accounts for nearly 43% of all available land while industrial and commercial land uses occupy a further 11%. In comparison, the proportions for the city of Chicago are 47% and 20% respectively (NIPC 1998).

A similar picture of self-reinforcing growth has developed in the southern portion of Lake County on both sides of Route I-94 which today includes some large corporate entities such as Abbot Labs, Baxter, Motorola and Hewitt Associates. While the extent of the phenomenon is more limited and the response in Lake County has been less co-ordinated than in DuPage County, the basic pattern of demand for non-residential space reinforcing the demand for residential space in a circular fashion, is similar to that described for DuPage County. The demand generated by re-locating firms from the city of Chicago in search of lower taxes has combined with the suburban residential preferences of the skilled labor

they employ. In addition, S. Lake County is a popular bedroom area for high wage commuters who work in the central city and the inner suburbs. The county as a whole acts as a net 'exporter' of workers with nearly 30,00 more employees leaving the county than entering on a daily basis. Despite the fact that residential land use occupies roughly the same area in both Lake and DuPage counties (over 140 sq. mls.), it accounts for only 31% of all total land coverage in the former (versus 43% in the latter). Similarly, industrial and commercial land occupy a smaller share of total land (7%) than in DuPage County (NIPC 1998).

5.3 THE ANALYTIC FRAMEWORK AND DATA SOURCES

The system used here for analyzing the impacts of employment concentration on land absorption in the outer suburbs is a linear and fairly transparent form of accounting in which employment concentration is translated into land consumption. The approach draws heavily on the work of Persky and Wiewel (2001) who used this form of micro-simulation in order to calculate the costs and benefits of opening a plant at a 'greenfield' location in comparison with an inner city location. It departs however from this approach in that the simulation is presented the level of the industry or employment agglomeration and not at the level of the individual plant.

At the outset, the total employment impacts associated with the agglomeration of high technology activity need to be charted. This step involves counting not just direct employment but also indirect employment arising from inter-sectoral transactions and the induced employment arising from increased household demand (termed here collectively as the 'indirect' effect). Estimating these indirect and induced impacts necessitates the use of a regional econometric model calibrated for the area under investigation. In this instance, we use the REMI model which has the properties of both an input-output model and a policy simulation system (Treyz 1995). This model furnishes us with results for the three basic geographical divisions that are used in this paper: 1. the city of Chicago; 2. the 'inner suburbs'; and 3. the 'outer suburbs'.

The REMI model provides us with estimates of employment by both geographic area and two digit industry classification. The latter is of particular importance as the industry detail acts as the link for translating the employment estimations into patterns of residential development at a later stage. Employment estimates and all further analysis are provided for six cases (or scenarios) as follows:

Case 1 and Case 2: these relate to the land consumption impacts resulting from the actual employment agglomerations along I-88 (Case 1) and in S. Lake county (Case 2).

Case 3 and Case 4: these are simulations relating to the hypothetical case of the present employment concentrations developing in the city of Chicago (instead of in the outer suburbs as at present). Case 3 refers to the I-88 concentration and Case 4 to the Lake County concentration.

Case 5 and Case 6: these simulations relate to a further hypothetical case whereby the present employment concentrations develop in the inner suburbs (instead of in the outer suburbs). As above, Case 5 and Case 6 refer to the I-88 and Lake County concentrations respectively.

Data sources for this exercise are necessarily disparate. The REMI model generates employment estimates. These place of work patterns are translated into place of residence patterns using census data derived from the 1990 PUMS (Public Use Micro Data Sample) data source.

We distribute estimated employment across residential areas, income classes and gender according to the actual proportions derived from the census. In this respect we translate employment change into population change. Once the characteristics of the population are established, census proportions are again used in order to distribute this population across various housing types. On this basis, residential land consumption can be estimated. Non-residential land consumption is estimated on the basis of the sector-by-sector estimates of the distribution of employment as provided by the REMI model.

For identifying the high technology industries that form the basis of the employment concentrations, we follow Acs and Ndikumwami (1998) to delimit a working set of 30 (3-digit) industries that lay the foundations for the present analysis. These 30 industries include all the 'core' activities of the biomedical industries, information technology, aeronautics, high technology instruments, research services and the energy and chemicals sectors. To get a first-cut impression of the employment magnitude of these industries in the Chicago metropolitan area, ES202 data (for 1997) were obtained from the Illinois Department of Unemployment Security relating to employment in Du Page and Lake counties by the 30 designated 3 digit SIC codes. Total employment counts in these industries (excluding suppressed values) yielded 48,800 employees for Du Page and 16,056 for Lake County. These figures represent total county-wide high technology employment. To obtain employment totals for the I-88 and S. Lake county concentrations in particular, we further refined these figures on the basis of establishment level data provided by local planning agencies for all firms in given

SIC codes within geographically defined areas along I-88 and in South Lake county.

This data allowed us to identify the size of the high tech employment concentration on both sides of the I-88 as 36,645 employees in close to 500 establishments, representing 71% of the DuPage County total. For S. Lake County the high tech employment concentration accounts for 10,275 employees (64% of the Lake County total).

5.4 METHODOLOGY

In order to operationalize the approach described above, we derive a sequence of steps for converting place of work estimates into place of residence characteristics. From REMI estimates we can estimate the number of workers (direct and indirect) in each industry, for each of the three places of work (city of Chicago [C], Inner Suburbs [IS] and Outer Suburbs [OS]) in each of our 6 cases, as follows:

$$N_{kw}(1) \tag{1}$$

where N_{kw} = the number of workers at place of work w (w = 1…3) and industry k (k =1…9) under Case 1.

The above expression provides us place of work estimates by geographic area and industry. To convert these into place of residence estimates, we use proportions drawn from the Census relating to place of residence of workers by industry, income group and gender. We assume that the distribution of workers resulting from our employment estimates follows the distribution within the Census. Employment estimates by industry are distributed across the place of residence, income group and gender categories from which these workers are likely to come (i.e across 54 potential categories - three places of work x three places of residence x three income groups x three gender categories). This process is repeated for each of the six cases. Industry affiliation serves as the link in converting the place of work distribution into a place of residence distribution. The conversion is expressed as:

$$N_{kw}(1) * P_{kw}(rys) = N_{w}(rys)(1) \tag{2}$$

where $P_{kw}(rys)$ is the proportion of workers in industry k at place of work w, who live in place of residence r (r= 1…3) and are in come group y (y = 1…3) and gender category s

(s= 1…2). Multiplying this proportion by the number of workers in industry k and place of work w yields $N_w(rys)$ i.e. the number of workers who work in w and live in r for each of the 6 cases.

From this point on, the analysis focuses only on those workers either working or residing in the outer suburbs (i.e. Σw= OS and Σr = OS).
Non- residential land consumption (NRES) is based on place of work in the outer suburbs, i.e. Σw = OS. It is represented by the number of workers in each industry in the outer suburbs for each of the six cases multiplied by the proportion of land consumption in acres, c, for each industry k (P_{kc}). For Case 1, for example, this would be expressed as;

$$N_{kw}(1) * P_{kc} = NRES_c(1) \quad (3)$$

In the outer suburbs, and for the purpose of land consumption, all household formation is assumed to be new: i.e. place of residence in the outer suburbs requires new land consumption via new building and more sprawl or pressures on the land market through housing turnover and filtering. A new household is assumed to form for roughly every two new residents in the outer suburbs.

New household formation (NH) is derived from place of residence, such as that for Case 1, where Σr = OS:

$$NH(1) = N_w(rys)(1)* .53 \quad (4)$$

Residential land consumption (RES) is based on new household formation. Again taking only those households residing in the outer suburbs (Σr = OS) and multiplying them by census-derived proportions for residential land consumption yields residential land consumption for each case. The residential categories used here are multifamily homes, single detached small homes (< 1 acre) and single detached large home (> 1 acre). These housing choices are estimated to consume on average 0.05, 0.25 and 1.5 acres respectively. The proportions of the consumption of these three housing goods are taken from the census data and applied to each outer suburban household according to income level (three categories) and gender (two categories). Thus, each outer suburban household can be assigned to one of these six (3x2) combinations of proportions. For Case 1, therefore, residential land consumption is:

$$RES(1) = NH(1) * P_h(ys) \quad (5)$$

where h = proportion of average acreage consumption by income and gender categories.

5.5 EMPIRICAL RESULTS

The findings reported below give a synoptic view of an application of the previously described method. They do not provide a comprehensive outline of all the mechanics of translating employment concentration into land consumption, but rather help to illustrate, in broad terms, the type of analysis that is possible. The focus of the method is on land consumption at the edge of the metropolitan area (outer suburbs). All workers and households estimated as working or living in the outer suburbs are considered 'new'. While they may not necessarily consume new housing or workspace, they exert pressure for outward expansion on the land market by occupying work or living premises which former occupants will now be looking to replace. In most cases, this replacement will also occur in the outer suburbs thereby contributing to metropolitan expansion.

Table 5.1 Estimated direct and indirect employment impacts: (REMI Estimates)

Employment in	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Chicago	7,057	2,134	53,947	16,605	8,733	2,927
Inner Suburbs	8,742	2,225	10,482	3,548	60,706	19,124
Outer Suburbs	63,427	18,446	8,529	2,871	9,350	3,224
Emp. Multiplier[2]	1.68	1.66	1.56	1.61	1.76	1.86

[1] Estimations based on the following Cases:
Case 1: Employment Concentration in Du Page County (I-88) (actual case).
Case 2: Employment Concentration in S. Lake County (actual case)
Case 3: Chicago gains I-88 (Du Page County) Employment Concentration (hypothetical case)
Case 4: Chicago gains S.Lake County Employment Concentration (hypothetical case)
Case 5: Inner Suburbs gains I-88 (Du Page County) Employment Concentration (hypothetical case)
Case 6: Inner Suburbs gain S. Lake County Employment Concentration (hypothetical case)

[2] Local employment multiplier for the geographic area in which direct employment concentration is located.

Distribution of direct and indirect employment

Table 5.1 presents the spatial distribution of employment. For each case, we can see how the direct stimulus of 34,645 jobs in Cases 1, 3 and 5 and 10, 275 jobs in Cases 2, 4 and 6 stimulate indirect employment. This process, of course, varies across the three different geographic areas, as can be seen from the employment multipliers reported in Table 5.1. These aggregate figures also obscure the sectoral detail that the REMI simulation provides and that acts as the 'bridge' for translating employment patterns into patterns of residence. As expected, the employment distribution under the six scenarios shows the largest direct and indirect impact arising in the location where the direct employment takes place and the 'ripple through' effects other areas. The employment multipliers show that indirect impacts in the outer suburbs are larger when employment concentration develops in the inner suburbs than when it develops in the city of Chicago.

Residential and employment patterns

Once place of work patterns are established, they need to be converted into place of residence. The first column in Table 5.1 for example illustrates that in Case 1 total employment accounts to 79,226. The first column in Table 5.2 shows how these 79,000 workers are distributed by place of residence (Table 5.2), with each column displaying similar information for each of the cases. Thus, for example, in Case 1 (the present situation with 35,000 direct places of employment in the outer suburbs), the vast majority of all workers generated by this concentration reside in the outer suburbs (67%), with 21 % living in the inner suburbs and the remaining 12% in the city of Chicago. When this employment concentration is relocated to the city of Chicago, the resulting residential distribution of total employment changes (Case 3). While 51% of all workers are expected to live in the city itself, a further 30% will reside in the inner suburbs and, more significantly, 19% in the outer suburbs. This finding suggests that even the hypothetical transfer of all outer suburban employment to the city would not curb the pressure for the outward expansion of the metropolitan area. Over 14,000 workers would still be living in the outer suburbs and commuting to work.

Table 5.2 Distribution of all workers (direct and indirect) by place of residence

Place of residence	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Chicago	9,728	2,930	37,075	11,228	17,119	5,875
Inner suburbs	16,726	4,796	21,714	7,028	41,192	12,729
Outer suburbs	52,778	15,100	14,168	4,710	19,478	6,670

When we simulate the scenario of the inner suburbs capturing all the I-88 employment (Case 5), the pressures for metropolitan sprawl through residential expansion are increased. In this case, while 53% of all employees would live in the inner suburbs and 22% in the city, the remaining 25% (nearly 19,500 workers) would be looking for housing in the outer suburbs with all the pressures on metropolitan expansion that this implies.

This simulation exercise is then repeated for the second employment concentration (Cases 2, 4 and 6). Taking the two cases together, we arrive at the interim conclusion that the residential impact on the two outer suburban employment concentrations is of the magnitude of 20-68,000 depending on the scenario. Perhaps the most significant finding relates to the lack of substantial difference between the inner suburbs and the city of Chicago simulations. Whatever the employment location scenario, there would seem to be a core body of 20,000 employees with inelastic demand for outer suburban residence. We need to establish a profile of these outer suburban residents as their residential choice is one of the causes of metropolitan expansion. Once we know how many of the residents also work in the outer suburbs and their basic income groups we can convert this information into a measure of land consumption.

Table 5.3 presents place of employment for outer suburban residents and is purely an expansion of the 'outer suburbs' row in Table 5.2. For example, combining Cases 1 and 2, we see that the two employment concentrations result in nearly 68,00 workers living in the outer suburbs. The overwhelming majority of these residents (96% or 65,000) will also be working in the outer suburbs with less than 2,000 (3%) working in the inner suburbs and less than 1,000 residents working in the city itself (Table 5.3). Once we know the income groups of these residents, we can say something about their housing choices, and subsequently, about their role in demand for land at the metropolitan fringe.

Table 5.3 The distribution of outer suburban residents by place of work

Place of work	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Chicago	717	216	5,412	1,755	894	301
Inner suburbs	1,623	422	1,961	671	11,126	3,800
Outer suburbs	50,437	14,462	6,784	2,282	7,457	2,568
Overall total	52,778	15,100	14,168	4,710	19,478	6,670

Residential and non-residential land consumption in the outer suburbs

Residential land consumption is related to both gender and income characteristics. In addition, land is generally consumed by household units and not by individual

residents. The approach adopted here is to take the estimations of residents in the outer suburbs (attributable to the two employment concentrations) in each of the six cases and convert these figures into households. Using a ratio of workers to households that implies a new household formation for nearly every two workers (Persky and Wiewel 2001), total residents are converted into total households (Table 5.4). However, as gender and income class determines household choice, total households in each of the six cases must be stratified by each of these variables, yielding six (3x2) housing consumption options for each case. The three income groups are converted into housing groups by applying fixed parameter values of acres consumed for each income group, as noted above (section 5.3).

The estimations for non-residential land consumption are presented in summary form in Table 5.4. As expected, Cases 1 and 2 together represent a loss of open space in the outer suburbs of a magnitude close to 11,000 acres. Using actual census proportions of residents of the outer suburbs by income and gender classes, we can ascertain that the majority of this (55-56%) is due to the housing preferences of middle income groups: low density, single family residences that are assumed to consume on average 0.25 acres each. The high income groups whose housing choice is for spacious family dwellings occupying 1.5 acres each, are expected to account for a further 32% of all land absorption in the outer suburbs (3,500 acres). Low income groups are expected to account for the remaining 13 % (1,300 acres) comprised of multi-family housing units occupying 0.05 acres each on average. In the inner suburban and city of Chicago scenarios, the relative weight of the low-income earners on land consumption in the outer suburbs remains constant, around 9%. This figure is slightly surprising, as it does not imply any significant distance decay effect on the commuting patterns of the lower wage suburban residents. Those that do commute are as likely to commute from the city of Chicago as they are from the inner suburbs. Perhaps a decreasing marginal increase in travel costs mitigates against any significant distance decay effect.

In the two scenarios where high tech employment concentrations develop in either the city or the inner suburbs, the impacts on residential land absorption in the outer suburbs are considerably reduced. In the former case, the overall impact is slightly over 3,000 acres and in the latter the estimate is close to 4,400 acres. In both cases, the relative proportions attributable to the different income groups, are roughly similar with the high-income group accounting for 37-39% and the middle-income group for 52-55%. In these two cases, the choice of residence does seem to be conditioned by income group. Thus, when the employment agglomerations are transplanted to the city of Chicago (Cases 3 and 4), the relative

and absolute size of land consumption in the outer suburbs is greater for the high-income groups than when employment is transplanted to the inner suburbs.

Non-residential land consumption refers to the outer suburban open space directly absorbed by the construction of greenfield facilities in the outer suburbs (Cases 1 and 2) and by the indirect consumption of land in commercial and other related activities that are induced by this direct activity. For the other cases (3-6) the question refers to how much non-residential land is consumed in the outer suburbs as a result of employment being relocated to either the city or the inner suburbs.

The REMI-generated employment estimates (direct and indirect) are used as proxy measures for the amount of land absorbed. Using fixed parameter values for land consumption by worker in each sector, we arrive at estimates of land absorption by sector for each of the six cases. These results are presented in summary form in Table 5.4. As expected, the location of the employment concentrations in the outer suburbs exerts the largest pressure on non-residential land use amounting to the absorption of over 4,500 acres of open space at the metropolitan fringe.

A more surprising finding, however, is the relatively small differential impact on the outer suburbs arising from the employment agglomeration developing in the city of Chicago or the inner suburbs. The difference between the two scenarios in terms of non-residential land consumption is only 100 acres.

Table 5.4 Impacts of two Chicago employment concentrations on employment residence

	Employment concentration by case					
Impact on outer suburbs	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Total empl. (Th.)	63.427	18.466	8.529	2.871	9.350	3.224
Total resid. (Th.)	52.778	15.100	14.168	4.710	19.478	6.670
Total households (Th.)	27.633	7.906	7.418	2.466	10.198	3.492
Non-resid. land consumption (Th.acres)	3.437	1.133	0.719	0.240	0.787	0.272
resid. land consumption (Th.acres)	8.509	2.438	2.376	0.792	3.237	1.109
Associated public land uses[1] (Th.acres)	5.97	1.79	1.54	0.52	2.02	0.69
Total land consumption (Th. Acres)	1.792	5.36	4.64	1.55	6.04	2.07

[1] Roads, sidewalks, public areas, estimated to account for a further 50% consumption of land

Table 5.4 also presents total estimated land consumption in the final row. Total estimated land consumption is simply the sum of the residential and non-residential estimates with the addition of associated public land uses (roads, sidewalks, public parking, public open spaces such as parks and other land extensive public facilities). These are estimated as one third of all developed land. Total land consumption at the metropolitan fringe is therefore over 24,000 acres in the case of employment concentration in the outer suburbs (Cases 1 and 2). If these employment concentrations had developed in the city of Chicago the impact on the outer suburbs would have been the consumption of over 6,000 acres. If this development had occurred in the inner suburbs the impact of metropolitan expansion would have been the disappearance of 8,000 acres of open space. To put these estimates in proportion, the amount of land consumption under the present situation is equivalent to three times the area of O'Hare International Airport (7,700 acres). The alternatives would have resulted in land absorption some two thirds less and roughly equivalent to that of the present area of O'Hare airport.

Cost of land consumption at the metropolitan pringe

The above estimates indicate the attractiveness of suburban living and the relatively inflexible housing behavior of the middle and high-income groups when faced with different workplace scenarios. Under present conditions, the outer suburban employment concentrations are responsible (directly and indirectly) for the residential choice of over 35,000 households in the outer suburbs. These households consume nearly 24,000 acres of land through their workplace, residential needs and associated land absorption. If these employment agglomerations were to relocate to the city of Chicago, nearly 10,000 households would still choose to live in the outer suburbs, consuming over 6,000 acres of open space. Had this employment occurred in the inner suburbs, over 13,500 households would still be living in the outer suburbs and would be transforming over 8,000 acres of open land into suburban use.

The ratio of land consumption per household reflects the space requirements of the different income groups. In the case of employment centres in the outer suburbs (Cases 1 and 2), open space consumption per household in the outer suburbs is 0.65 and 0.68 acres respectively. This reflects the absolute size of the high and middle income earners among the labor force employed (directly and indirectly) in high technology production in the outer suburbs.

Under the scenario of employment concentration in the central city, this ratio drops to 0.63 acres consumed per household in the outer suburbs. While the absolute number of the outer suburban households falls considerably in this case, the persistence of the high and middle bracket earners in choosing outer suburban residences still accounts for the relatively high ratio. If the employment concentration were to relocate to the inner suburbs, this would result in an even lower consumption per household of 0.59 acres because of the relative size of the low and middle-income groups residing in the outer suburbs. Employment in the inner suburbs allows the lower income groups the opportunity of outer suburban residence to a greater extent than in the case of employment in the city. Their relatively larger presence in the outer suburbs combined with their less demanding space requirements, serves to moderate the size of the acreage per household ratio.
The loss of open space in the outer suburbs though residential, workplace and associated land uses represents a cost to the metropolitan population. In the case of metropolitan expansion, open areas for the purpose of recreation and enjoyment are forfeited. However, the amenity value of this loss of open space is hard to price. Synthesizing other studies on the amenity benefits of farmland at the metropolitan fringe, Persky and Wiewel (2001) arrive at a cost of $180 per acre. This amount represents the cost of the loss of open space at the perimeter of the Chicago metropolitan area and is based on willingness to pay for the preservation of suburban open land.

Applying this figure to the estimates of total land consumption produces a cost of $4.18m arising from employment concentration in the outer suburbs (the real-world case). This figure represents nearly $3.07m more than the scenario whereby employment agglomerations develop in the city of Chicago (at a total cost in terms of open space forfeited of $1.11m). The estimated cost of the consumption of suburban open land when employment concentrations develop in the inner suburbs is only marginally larger and is estimated at $1.46m. Thus, the differential monetary impact on suburban sprawl resulting from these two scenarios is only about $350,000.

5.6 CONCLUSIONS AND IMPLICATIONS

The analysis presented in this chapter has attempted to estimate the magnitude of land conversion at the metropolitan fringe arising from the development of employment concentrations. In the absence of a full cost-benefit account, it is hard to draw conclusions as to the winners and losers from metropolitan sprawl. While we have tried to price the cost of this expansion in terms of the loss of open space,

this is only a very partial view of reality. Other social costs that need to be addressed include the costs of congestion, pollution and traffic accidents generated by commuters who choose an outer suburban residence and a workplace in the inner suburbs or city. If employers move to the outer suburbs from former inner city locations, a further social cost is the abandonment of structures and the spatial mis-match associated with this move. Public sector costs to be addressed include the cost of servicing low-density suburban development and the cost of the various public infrastructures (highways etc.) that facilitate suburban living.

The benefits associated with suburban expansion are appropriated by residents, firms and land owners. Residents and landowners gain from the rising value of their properties as land is converted at the metropolitan edge. Firms gain from lower land and wage costs and from suburban tax benefits. Thus, private residents, landowners and business owners stand to gain from the unpaid costs of outer suburban location. Whether public costs and private gains cancel out is a matter for further empirical investigation and analysis. This study has shown that considerably less pressure on urban expansion could be expected in the hypothetical instance of the present high technology agglomerations developing in the central city or the inner suburbs. In terms of pure acreage, this theoretical savings amounts to over two times the area of the O'Hare airport complex.

The implications of the study point to severe pressures on land consumption at the metropolitan fringe, whatever the scenario. Even in the hypothetical cases of all suburban employment being transplanted to the city of Chicago or to the inner suburbs, the estimated impact on the outer suburbs arising from the housing choices and ancillary land requirements of the highest income groups result in land absorption equivalent in magnitude to the land area occupied by O'Hare airport.

The policy options arising from these findings would seem to indicate labor force mobility as a key issue. In the case of high technology employment in particular, the supply of high skilled labour is crucial. As this labour seems to generate demand for suburban living unconditional on place of work, the impact on metropolitan extension seems inevitable. As we have seen, the likelihood of low-income labour residing in the outer suburbs falls off when employment concentrations develop in the inner suburbs or the central city. This illustrates the mobility constraints on low-income labour when employment centres are located at outer suburban locations. One policy measure in this direction could be to encourage reverse commuting through the provision of employee transportation to outer suburban employment centres. Reverse commuting would increase employment opportunities for lower income groups without simultaneously increasing pressures on land.

References

Acs, Z.J. and A. Ndikumwami (1998), 'High technology employment growth in major U.S. metropolitan areas', *Small Business Economics*, **10**, 47-59.

Anselin, L., A.. Varga and Z. Acs (1997), 'Local geographic spillovers between university research and high technology innovations', *Journal of Urban Economics*, **42** (3), 422-48.

Appold, S.J. (1991), 'The location process of industrial research laboratories', *Annals of Regional Science*, **25**, 131-44.

Audretsch, D.B. (1998), 'Agglomeration and the location of innovative activity', *Oxford Review of Economic Policy*, **14** (2), 18-29.

Bingham, R.D. and D. Kimble (1995), 'Industrial composition of edge cities and downtowns: The new urban reality', *Economic Development Quarterly*, **9** (3), 259-72.

Beeson, P..and E. Montgomery (1993), 'The effects of colleges and universities on local labor markets', *Review of Economics and Statistics***, 75** (4), 753-61.

Chicago Sun-Times (1998), *Manufacturing jobs still leaving city*, November 25th.

Felsenstein, D. (2003), 'Do high technology agglomerations ecourage urban sprawl?', The Annals of Regional Science, **36** (4), 663-682.

Krugman, P. (1991), *Geography and Trade*, Cambridge, MA.: MIT Press.

Malpezzi, S. (2001) *NIMBYs and Knowledge: Urban Regulation and the 'New Economy'*, The Center for Urban Land Economics research, The University of Wisconsin, Madison, WI.

Markusen, A. and K. McCurdy (1989), 'Chicago's defense-based high technology: A case study of the 'Seedbeds of Innovation' hypothesis'**,** *Economic Development Quarterly***, 3** (1), 15-31.

McMillen, D.P. and J.F. McDonald (1998), 'Suburban subcentres and employment density in metropolitan Chicago', *Journal of Urban Economics*, **43**, 157-80.

NIPC (1998), *1990 Land Use Summary for Northeastern Illinois*, Northeastern Illinois Planning Commisssion <available at http:// www.nipc.cog.il.us/lu-sum.htm>.

Persky, J. and W. Wiewel (2001), *When Corporations Leave Town: The Costs and Benefits of Metropolitan Job Sprawl***,** Wayne State University Press, Detroit, MI.

Treyz, G.I. (1993), *Regional economic modelling: A systematic approach to economic forecasting and policy analysis*, Boston: Kluwer.