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Effects of Beltways on the Location of Residences and Selected Workplaces

FLORENCE MILLS

Beltways have been cited as factors that encourage the decentralization of people and jobs from central cities and thereby contribute to inefficient patterns of urban development. This study compares changes in total population, manufacturing employment, retail employment, and commuting in 24 standard metropolitan statistical areas, half of which had a beltway constructed during the study period. When the data are divided into a prebeltway and either a beltway construction or a postbeltway period, no statistically significant effects on the central cities are found. The study period is 1950-1970 for population and 1958-1977 for employment; the population data represent an advance on prior research because they have been corrected for annexations by the central cities between 1950 and 1970. Comparison with another statistical study by using regression analysis and eight case studies suggests that other forces such as land use regulation or local opportunities for annexation outweigh the beltway's influence on decentralization.

Energy, environmental, and economic factors have recently created new demands for downtown development. This demand in many cities, however, is felt to be fragile and susceptible to erosion if governmental actions favor suburban areas (1,2). Beltways--high-speed, limited-access highways encircling central cities--have been specifically criticized as

factors that may disrupt emerging downtown development markets. In one instance, a research institute concluded on the basis of trends in three beltway and three nonbeltway cities that construction of the Richmond, Virginia, beltway would accelerate the departure of both people and jobs from Richmond and its central business district (CBD) (3). In late 1979, then Secretary of Transportation Neil Goldschmidt refused to authorize completion of the Dayton, Ohio, beltway because of concern that the facility would further weaken the central city by encouraging an exodus of businesses from Dayton (4). This was a particularly difficult and controversial decision, both because of the magnitude of its implications and the dearth of information available on the potential impacts of various courses of action. Little research on the effects of beltways on either suburbanization or central-city vitality has been done. As discussed in the literature review, previous research has either not clearly focused on this area or has suffered from methodological weaknesses.

This paper reports research that examines changes in residential population and two sectors of employment, manufacturing and retail trade, in a sample of 12 beltway and 12 nonbeltway metropolitan areas. The study scope restricted data sources to readily available secondary sources, especially the economic censuses and the Census of Population. The objective of this study was to determine if there is any systematic association between urban decentralization and the presence of a beltway in metropolitan areas. The research also provides some evidence about the use of beltways to influence urban development in efforts to realize societal goals such as revitalization of central cities.

BACKGROUND

Recent economic and demographic trends in U.S. metropolitan areas both explain the concern for the welfare of central cities and assist in interpreting the data in the 24 sample cities. Between 1950 and 1970 the population of central cities of the standard metropolitan statistical areas (SMSAs) as defined in 1970 rose slowly from 54 million to 64 million. At the same time, suburban regions of these SMSAs nearly doubled from 40 million to 76 million. However, between 1970 and 1978, the same central cities are estimated to have lost about 4 million persons while their suburban areas grew by an additional 7 million persons. These census figures include the effects of substantial annexations by the central cities between 1950 and 1970. Correction for annexation would probably result in absolute population losses for the entire period. Such a correction for annexations by the 24 sample cities included in this research had exactly that result. These population changes reflect high suburban birth and in-migration rates compared with the central cities' heavy out-migration rates combined with low in-migration rates.

Central-city jobs also declined while suburban employment rose. Between 1947 and 1963, central-city employment in 90 SMSAs dropped from 7.4 million to 6.7 million. These figures have been corrected for annexations. The corresponding suburban employment rose in the same period from 3.6 million to 6.6 million. Central-city employment has also shifted away from manufacturing and toward services and white-collar jobs. Between 1947 and 1963, manufacturing jobs located in the central city dropped 13 percent while service employment in the central city increased 23 percent (5). Evidence is mixed as to whether the same downward trends in central-city employment have continued in the 1960s and early

1970s, or if employment trends stabilized to a pattern of relatively slow central-city growth of about 1 pecent annually from 1960 to 1975 compared with about 3 percent annually in the suburbs (6,7). The shift from manufacturing clearly continued in the later period.

These shifts in the relative importance of the various central-city and suburban employment sectors indicate changes in the economic function of the central cities as they become office centers supplying administrative and service functions to their metropolitan regions and beyond. At the same time, manufacturing and retail firms are moving to the suburbs where more space and more customers are located. The decline in central-city population and jobs appears related to the size of the metropolitan area and to geographic region. The central-city population losses are most severe in the metropolitan areas with more than 1 million people, and the jobs and people are shifting from the North and Northeast to the South and West (7,8).

Previous Research

Previous studies of beltways comprise four case studies of individual beltways and three largely descriptive statistical studies of groups of beltway and nonbeltway cities. The four case studies analyze Boston's Route 128 (9), the Maryland and Virginia portions of the Capital Beltway in separate studies (10,11), and the Raleigh, North Carolina, Beltway (12). All of these studies found that intensive development sprang up about these roads just as is the case with radial highways. In addition, there was a noticeable increase in multifamily residences in the vicinity of the Capital and Raleigh Beltways. Route 128 quickly attracted industrial development: Several years after its opening, there was a net of $80 million in additional industrial development and 12 000 additional employees in the corridor.

The beltway studies have often noted that many of the businesses and industries locating along these highways are relocating from the CBD; however, a sustained analysis of CBD changes in relationship to the beltway lay outside the scope of these case studies. The Virginia portion of the Capital Beltway was found to promote a more compact, less star-like urban form as residential uses filled in the entire peripheral area instead of following radial routes outward from the center. The distribution of commercial areas was unaffected. Industrial plants also began to appear in peripheral areas associated with the Capital Beltway. However, these areas were previously not easily accessible and it is not clear whether the same development would have occurred if a radial had passed through. Knowledgeable local observers have stated their conclusion that the Raleigh Beltway is a cause of the decline of the commercial core of the city, which is assuming the doughnut form with a comparatively unused center. Based on a review of the highway impact literature down to late 1963, Racster (13) hypothesized that the attractiveness of a beltway location lies in the access it offers to the entire region as contrasted to the more limited access along a radial corridor.

The three descriptive statistical studies were the Urban Institute team's six-city analysis prepared for Richmond, Virginia; an unpublished Federal Highway Administration (FHWA) staff study of seven cities with and seven cities without beltways (14); and a study of office suburbanization along freeway corridors in seven cities (15). Although the study of office sites found that radial routes had a lower percentage increase in office sites than did beltways, this reflects the large, undeveloped areas

Table 1. Regions and SMSA size classes.

Factor	Beltway City	Nonbeltway City
Region		
Northeast/North Central	Washington Minneapolis-St. Paul Indianapolis Columbus Toledo Quad cities	Philadelphia Dayton Grand Rapids Springfield
South/West	Houston Atlanta San Antonio Omaha Sioux Falls	Phoenix Portland Sacramento Birmingham Oklahoma City Knoxville Spokane
Size Class[a]		
<750 000	Omaha Quad cities Sioux Falls	Oklahoma City Grand Rapids Springfield Knoxville Spokane
750 000-2 million	Atlanta Indianapolis Columbus San Antonio Toledo	Portland Sacramento Phoenix Dayton Birmingham
>2 million	Washington Baltimore Houston Minneapolis-St. Paul	Philadelphia Pittsburgh

[a] 1970 SMSA population.

crossed by the beltways rather than network configuration. The beltway routes had lower absolute numbers of sites, and thus the base numbers of sites for the percentages were very small. The Urban Institute's study has already been described. The unpublished FHWA study found that beltway central cities lost population less rapidly than nonbeltway central cities during the 1960s.

Because revitalization was not a major issue when these studies were prepared, the focus was on suburbanization. The case studies, in particular, do not give systematic attention to what happened in the central city. The statistical studies are based on very small numbers of cases and their findings may be of limited general application.

Research Approach

The evidence summarized in this paper is principally from a nationwide study. The findings of this study have been supplemented by a recent statistical study, The Land Use and Urban Development Impacts of Beltways, prepared for the U.S. Department of Transportation, the Department of Housing and Urban Development, and FHWA by the firm of Blayney-Dyett under subcontract to Payne-Maxie. The latter study included eight case studies based on local interviews with officials, developers, and businessmen.

The specific research questions addressed in this study are

1. Do beltway cities show different rates of population change in their central cities, suburban rings, or both, than nonbeltway cities?
2. Do beltways affect patterns of population density? and
3. Do beltway cities now show different rates of average percentage change in manufacturing or retail employment in their central cities, suburban rings, or both, than nonbeltway cities?

The first step in determining if beltways are as-

sociated with decentralization is to show whether any growth rates within a metropolitan area with a beltway differ from those in metropolitan areas without beltways. The first and third research questions focus on differing growth rates. Beltways, by increasing accessibility of suburban areas, may lead to a more tightly clustered suburban development pattern as suggested by study of the Capital Beltway. As a result, a metropolitan area may continue to be centralized but around a new feature—the beltway itself. The second research question investigates this possibility.

DATA

Data on total population, manufacturing employment, and retail employment for the central city and the remainder of the metropolitan area or suburban ring were collected from secondary sources (16-18). The sample is composed of 24 SMSAs divided evenly between beltway and nonbeltway areas.

The sample SMSAs ordered by size are as follows:

Beltway	Nonbeltway
Washington, DC	Philadelphia, PA
Baltimore, MD	Pittsburgh, PA
Houston, TX	Portland, OR
Minneapolis-St. Paul, MN	Sacramento, CA
Atlanta, GA	Phoenix, AZ
Indianapolis, IN	Dayton, OH
Columbus, OH	Birmingham, AL
San Antonio, TX	Oklahoma City, OK
Toledo, OH	Grand Rapids, MI
Omaha, NE	Springfield, MA
Quad cities (Davenport-Bettendorf, IA, and Rock Island, IL)	Knoxville, TN
Sioux Falls, SD	Spokane, WA

The 12 beltway SMSAs comprise most of the SMSAs with beltways essentially completed by 1973. Each beltway forms a continuous loop around at least three-quarters of its SMSA and is no closer than 2 miles to the CBD. The nonbeltway SMSAs have well-developed radial networks but relatively few lateral freeway connectors between suburbs. These SMSAs were selected to match, as closely as possible, the size and geographic distribution of the beltway group. Thus, when comparisons are made in the study between the beltway and nonbeltway groups, the comparison is between two network configurations—radial and beltway or concentric.

The general approach of this study was to compare percentage changes in selected economic and demographic variables for beltway and nonbeltway metropolitan areas between 1950 and 1977. The metropolitan areas were divided into central cities and suburban rings or remainders of SMSAs. Differences between average percentage changes were tested for significance by using the difference-of-means test (19). The SMSAs were disaggregated by geographic region and by SMSA size in 1970, as shown in Table 1, in an effort to make the samples more homogeneous.

Since the estimates of population after 1970 could not be made entirely consistent with the earlier data from the Census of Population, the population data cover the period 1950-1970. The before-beltway period is 1950-1960, while 1960-1970 is the period when the beltways were under construction and opening to traffic. All but three of the beltways were nearly completed by 1973, and all had substantial mileage open by 1970. Employment and commuting data were available for the 1970s; the Census of Retail Trade was available for 1972 and 1977, the Annual Survey of Manufacturing for 1973 and 1976, and the Annual Housing Survey for 1975. Thus, the 1970s are the after-beltway period for the employment and commuting analyses. The Census of Retail

Table 2. Percentage changes in central-city population in 24 beltway and nonbeltway SMSAs excluding annexation.

City Group	Change (%)			Population		
	1950-1960	1960-1970	1950-1970	1950	1960	1970
Beltway	2.9	-8.8	-6.0	5 492 031	5 568 266	5 213 080
Nonbeltway	-0.7	-9.2	-10.5	4 805 446	4 668 455	4 315 315
Total	1.1	-9.0	-8.8	10 297 477	10 236 721	9 528 395

Note: Data based on unweighted averages.

Table 3. Central-city population in beltway and nonbeltway SMSAs by region, 1950-1970.

City Group	Population			Change (%)		
	1950	1960	1970	1950-1960	1960-1970	1950-1970
Northeast-North Central Region						
Beltway	3 852 299	3 799 562	3 528 880	0.6	-9.2	-8.9
Nonbeltway	3 331 197	3 187 525	2 982 163	-2.4	-10.3	-12.5
Total	7 183 496	6 987 087	6 511 043	-0.7	-9.7	-10.4
South-West Region						
Beltway	1 639 732	1 768 704	1 684 200	6.2	-8.2	-2.1
Nonbeltway	1 474 049	1 480 930	1 333 152	0.5	-8.5	-9.0
Total	3 113 781	3 249 634	3 017 352	2.8	-8.4	-6.1

Note: Data based on constant 1950 central-city boundaries and unweighted averages.

Trade was the only economic census available for 1977 at the time that the research was conducted.

For groups of central cities or rings, the percentage changes used were the average of the individual items in each group, not the percentage change of the aggregate population of the group. Use of these unweighted averages focused on changes of individual cities or rings within the beltway or nonbeltway groups rather than on changes in the group populations as a whole. There was a large range in the population size of the individual members of each group, and small percentage changes in the larger ones resulted in large numerical changes. Aggregate percentage changes for each group would be overly responsive to these extreme numerical values.

The data have been corrected for boundary changes during the study period in two ways. Both the employment and population data reflect the SMSAs as defined in 1970 regardless of the date the data themselves refer to. Thus, counties have been added to the SMSA definitions of the 1950s and 1960s. The effects of annexations by the central cities have been corrected only in the population data through comparison of the tract maps of 1950, 1960, and 1970. All population data reflect the central-city boundaries of 1950. It was not possible to make the same correction to the employment data to produce standardized areas for the central cities.

In contrast, the Blayney-Dyett sample is larger (54 SMSAs). It was chosen by using different criteria for the beltway completion date and includes beltways very close to the CBD and beltways around coastal cities where a loop around three-quarters of the city is not possible. Annexations are not corrected in this study, which attempted to isolate the effects of beltways on population and employment through regression analysis.

Population Changes

In all three censuses, the total population (adjusted to exclude annexation) of the beltway central cities as a group was greater than that in the nonbeltway central cities, and the gap has widened as the nonbeltway central cities sustained a greater population loss within their 1950 boundaries than the beltway cities. (See Table 2, which is derived from FHWA and Census of Population data.) When the

20-year period is divided into a prebeltway era (1950-1960) and a beltway construction era (1960-1970), the beltway central cities, on the average, lost fewer persons in the 1960s when their beltways were being constructed and opening than did the nonbeltway central cities. This was also true in the prebeltway decade. Tests of the difference between means show that the differences between the average percentage changes for the beltway versus nonbeltway cities are statistically not significant. It is difficult to relate these changes in levels and rates of changes to the appearance of the beltways in the 1960s, since the trends in population levels and percentage changes favor the beltway cities both before and after the beltways were built.

Since the nationwide sample showed no effects, the analysis was refined by analyzing the data by region and size of SMSA. Many areas of the South and West have been found to be rapidly increasing in population in the 1970s. In contrast to these sunbelt areas, the Northeast or frostbelt has been stagnant or losing population. Such regional trends may obscure trends associated with the presence of a beltway. Also, the Northeast/North Central cities are, in general, older cities that developed before the automobile. Different historical circumstances may have produced different patterns of land and automobile uses that result in different responses to the presence of a beltway. Therefore, the 24 sample cities have been divided into two regions: Northeast/North Central region and the South/West region. The SMSAs by region were noted earlier. The population of the beltway and nonbeltway central cities in the two regions and their average percentage changes appear in Table 3.

These grouped data reveal some influence of overall regional population trends. In both periods, the Northeast/North Central beltway and nonbeltway cities do not fare as well as their South/West counterparts. However, the pattern is most pronounced in the 1950s. During the 1960s, central cities in the fast-growing South/West region lost population nearly as heavily as the Northeast/North Central cities and regional differences appear to fade. Within their respective regions, the beltway central cities continue to gain more or lose less population than nonbeltway central cities in both periods. As in the overall comparison between the regions, differences become very small in the

1960s. This convergence is particularly notable in the South/West region. Statistical tests of these very small samples show no significant differences between the means of the beltway and nonbeltway for either region. It should be noted, however, that there were significant individual variations within each group. Individual cities are discussed below.

Of the seven individual Northeast/North Central beltway cities, only Columbus and Quad cities grew appreciably in the period 1950-1960, and all lost

population between 1960 and 1970 at rates ranging from 1 to 17 percent. This information is presented graphically in Figures 1 and 2. Similarly, the individual nonbeltway cities in this region have two growing cities in the 1950s and none in the 1960s. Percentage changes in the population of the South/West central cities vary more than those in the Northeast/North Central cities for both decades (Table 4). The South/West region has the extreme gainer (Houston) and loser (Atlanta) for 1960-1970,

Figure 1. Percentage change in population in beltway and nonbeltway central cities in North Central-Northeast region, 1950-1970.
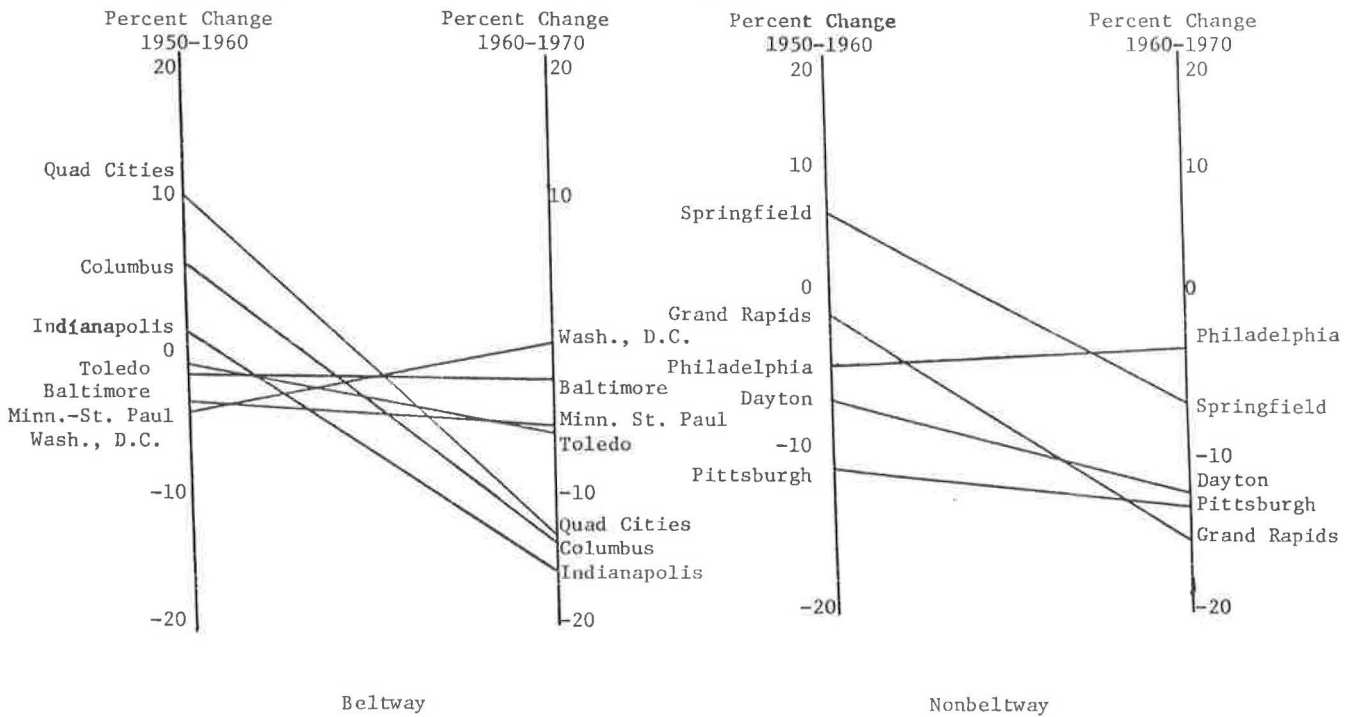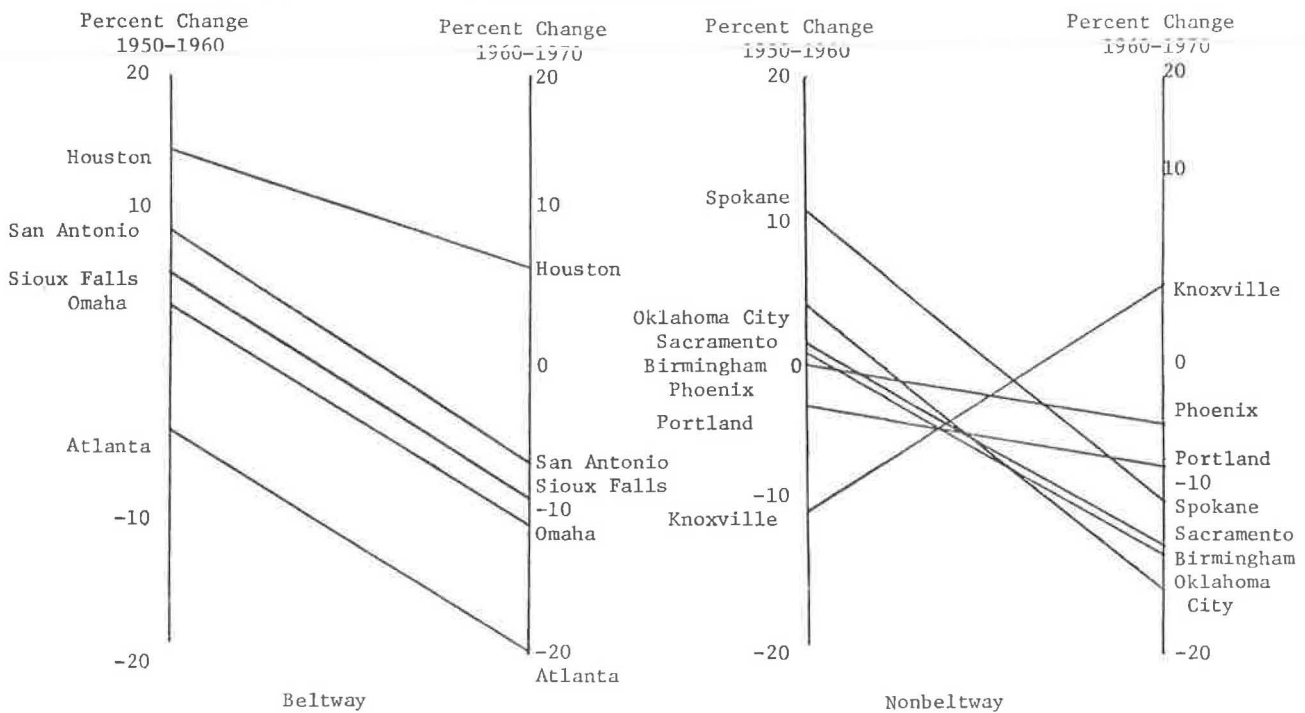

Figure 2. Percentage change in population in beltway and nonbeltway central cities in South-West region, 1950-1970.

and the extreme gainer (Houston) and second most extreme loser (Knoxville) for 1950-1960. There is a group of cities--Washington, D.C., Baltimore, Minneapolis-St. Paul, Toledo, Philadelphia, Phoenix, and Portland--whose population decline has been relatively stable and less than 10 percent since 1950. The larger number of such cities found in the Northeast/North Central region probably is not significant. All of these cities are in the larger SMSAs and the majority are found in SMSAs larger than 2 million in population in 1970. The Northeast/North Central region contains more sample central cities in the larger SMSAs than the South/West region.

Surveys of city dwellers have found that the suburban amenity of low density and large lot sizes are valued (20). This finding suggests that pressures for and against decentralization may be different in central cities of different population densities. Controlling the effect of density may reveal more clearly the role of beltways in decentralization. Density of the 24 sample cities was computed for 1950, 1960, and 1970 by using the 1950 areas and population figures corrected for the 1950 areas.

When the four most-dense beltway and most-dense nonbeltway central cities are compared with the four least-dense beltway and nonbeltway cities, density in the low-density cities fell only 2 percent and the high-density cities fell 13 percent (see Table 5). Within the density classes, beltway cities fell less than nonbeltway cities. However, this cannot be ascribed to the influence of the beltways because the beltway cities resisted decentralization in the 1950s before construction of their beltways as well as in the 1960s.

Trends in the 24 sample cities reflect national demographic trends and indicate that beltways play a minor (if any) role in the growth and distribution of population in metropolitan areas. Analysis of beltway and nonbeltway cities reveals either no statistically significant differences or differences that can be explained just as easily by other factors. Similar conclusions are reached in the

Blayney-Dyett comparative statistical study, which finds only the distribution of higher-density residential development to be apparently sensitive to the presence of a beltway.

The findings do not necessarily preclude the possibility that a beltway would help or harm the central city that it circumscribes. The measured effects may be overwhelmed by

1. The inadequate time between the beltway's completion and the last census (1970) for impacts to be fully consummated;
2. The size of each geographic unit of analysis and boundary distortions, which may wash out localized impacts; and
3. The concurrent existence of other public policies, especially in land use regulation and home finance, which have stronger and more pervasive influences on population distribution.

The last point is emphasized by the Blayney-Dyett case studies in which many competing public actions and market forces are documented. Most importantly, beltways are only one component of the urban transportation network, and their effects cannot be segregated from the presence of other, noncircumferential arteries and transit facilities.

Employment

Since the average distance between workers' homes and their jobs is approximately 10 miles, the population characteristics of a city do not necessarily reflect the economic activities within its boundaries, as is clear from the discussion of national trends. Suburbanization of employment, changes in economic activity in central cities, and suburban congestion coupled with long commuting trips by automobile are widespread phenomena of the 1950s and afterwards. They are not caused by beltways; however, it is not clear if beltways have influenced these trends.

Sample trends for manufacturing employment show no significant differences between beltway and nonbeltway cities in either their central cities or their suburban rings (see Table 6). This is due at least in part to the small sample sizes and high variability. Central cities as a group lost manufacturing employment more heavily than suburban areas. Analysis by region and class size failed to reveal any significant differences.

Results for percentage changes in retail trade employment also do not show significant differences between beltway and nonbeltway cities either for all beltway and nonbeltway cities or for the regional and size class groups. The tendency for retail trade employment to be expanding in suburban areas, in the South and West, and in smaller SMSAs is apparent, but generally the differences are not significant.

Examination of manufacturing and retail trade em-

Table 4. Population change in central cities of beltway and nonbeltway SMSAs by 1975 class size of SMSA, 1950, 1960, 1970.

SMSA Size	Change (%)		
	1950-1960	1960-1970	1950-1970
<750 000	4.1	−9.7	−6.2
Beltway	6.9	−11.6	−5.5
Nonbeltway	2.4	−8.6	−6.7
750 000-2 million	0.2	−11.8	−12.0
Beltway	1.8	−13.2	−11.5
Nonbeltway	−1.4	−10.2	−12.5
>2 million	−1.5	−3.4	−4.5
Beltway	1.2	−1.0	0.4
Nonbeltway	−7.0	−8.2	−14.5

Note: Data derived from FHWA and Census of Population and based on unweighted averages.

Table 5. Average density and average percentage change in density for high and low density central cities, 1950-1970.

Density and City Group	Density (persons/mile^2)			Change (%)		
	1950	1960	1970	1950-1960	1960-1970	1950-1970
High density (N=8)						
Beltway (N=4)	10 928	10 759	9814	−1.3	−9.9	−11.2
Nonbeltway (N=4)	11 569	10 985	9940	−4.7	−10.6	−14.8
Total	11 249	10 872	9877	−3.0	−10.3	−13.0
Low density (N=8)						
Beltway (N=4)	4 493	4 953	4642	10.4	−6.0	4.2
Nonbeltway (N=4)	4 649	4 688	4266	1.4	−8.6	−7.8
Total	4 571	4 820	4454	5.9	−7.3	−1.8

Note: Data based on 1970 central-city boundaries and unweighted averages.

Table 6. Mean percentage changes with standard deviations for manufacturing and retail trade employment for beltway and nonbeltway SMSAs by size of SMSA and region, 1972-1977.

Factor	Manufacturing (1973-1976) Beltway	SD	Non-beltway	SD	Retail Trade (1972-1977) Beltway	SD	Non-beltway	SD
Area								
24 SMSAs	N=10[a]		N=9[b]		N=12		N=12	
Central city	-9.57	8.81	-13.67	6.27	21.77[b]	25.51	8.81	33.32
Ring	1.83	8.48	-3.94	6.54	35.51	19.51	33.32	15.12
North East/North Central	N=6		N=4		N=7		N=5	
Central city	-12.30	3.35	-13.70	5.98	2.70	17.41	-4.14	14.52
Ring	0.25	10.62	-9.08	5.01	27.14	10.27	19.34	6.24
South/West	N=4		N=5		N=5		N=7	
Central city	-5.45	13.68	-13.64	7.20	18.06	26.01	13.74	9.02
Ring	4.20	3.88	0.16	4.41	47.22	24.02	43.14	10.84
Size								
>2 million	N=4		N=2		N=4		N=2	
Central city	-6.58	11.58	-16.30	5.52	1.25	25.49	-0.87	20.14
Ring	6.10	7.93	9.40	1.27	32.03	9.61	26.98	10.80
2 million-750 000					N=5		N=5	
Central city	Classes combined for mfg only {Central city/Ring} N=6		N=6		4.90	18.20	4.52	18.89
Ring	-11.57	6.88	-11.73	6.45	29.20	17.29	44.42	11.70
<750 000					N=3		N=5	
Central city	-1.02	8.20	-3.45	6.59	26.57	18.55	9.14	13.36
Ring					50.67	29.21	28.56	13.20

Note: Data based on Annual Survey of Manufacturing, 1973 and 1976; Geographic Area Services, Census of Retail Trade, 1972 and 1977.

[a] Data unavailable for Sioux Falls and Quad cities.   [b] Data unavailable for Sacramento, Springfield, and Spokane.

Table 7. Percent distribution of workers by place of residence and place of work, 1970-1975.

Place of Residence	Place of Work Central City 1970	1975	Outside Central City 1970	1975	Outside SMSA 1970	1975
Beltway SMSA						
Central city	82	78	17	21	1	1
Outside central city	51	45	46	53	3	3
Nonbeltway SMSA						
Central city	81	81	15	17	4	2
Outside central city	31	30	60	64	9	7

Note: Data based on U.S. Bureau of Census, Census of Population: 1970 Detailed Characteristics; Current Population Reports, Series P-23, Special Studies 86, 89, 98, and unpublished data.

ployment growth in the past for the 24 sample cities reveals that the central city and suburbs of the beltway and nonbeltway cities have not differed significantly in employment growth either as a group or by region or size class for the periods 1958-1963, 1963-1967, and 1967-1972. Employment in both sectors shows a pattern of stagnation in central cities and brisk expansion in the suburban rings. This decentralization appears as early as 1959-1963 and predates all 12 beltways. The pattern is particularly striking in the Northeast/North Central region's SMSAs whose overall loss of manufacturing employment was actually confined to the central cities while their suburbs gained.

Blayney-Dyett, relying on census data, analyzed the suburbanization of manufacturing employment for 1967-1972 and the suburbanization of retail trade for a partial sample for 1972-1977. They did not find any significant relationships between beltways and the other variables that could not be ascribed to other causes.

Commuting

Rather limited data are available on commuting in the 1970s. Data from the 1970 Census of Population reflect patterns during construction of the beltways. However, the Annual Housing Survey for 1975 includes 6 of the 24 sample SMSAs divided evenly between beltway and nonbeltway SMSAs. The cities are Philadelphia; Portland, Oregon; Springfield-Holyoke-Chicopee, Massachusetts; Atlanta; Columbus; and San Antonio. Table 7 suggests that longer commuting may be more common in beltway SMSAs where higher percentages of people live in one jurisdiction and work in another than in the nonbeltway SMSAs. However, significant conclusions cannot be drawn on the basis of such a small sample size and small numerical changes. Blayney-Dyett also found no significant relationships between commuting patterns and beltways that could not more easily be ascribed to other causes.

The sample cities show the decentralization of employment and increase in long-distance commuting across jurisdictional lines characteristic of U.S. cities since at least the late 1940s. This national trend predates the beltways. There is no evidence from either the 24 sample cities examined in this study or from Blayney-Dyett's larger sample that links beltways with a different degree of decentralization or a different commuting pattern than is characteristic of nonbeltway cities. Most U.S. cities suffer to some degree from the fiscal and equity consequences of decentralization; there is no evidence from this study that beltways are a specific cause of decentralization leading to these consequences.

In part, the finding of no significant beltway impact may be due to problems with the research design and availability of data, similar to the problems documented in the population section. The 1972-1977 period used as the "after" period of expected beltway impacts is short and contains a recession. The beltways were actually completed throughout the 1960s and early 1970s. Thus there is no clear-cut "before" or "after" period. The unavailability of major portions of the economic censuses of 1977 limited the analysis for this and the Blayney-Dyett study.

Another problem arising in the research design was the small sample size and high variability within the sample as measured by standard deviations. This problem is not easily corrected since both studies include all beltways that met study criteria. However, examination of the average percentage changes in employment in Table 6 suggests that in many instances the percentages are sufficiently similar between the beltway and nonbeltway cities that a larger sample would not result in significant differences.

CONCLUSIONS

Subject to the caveats raised in the concluding paragraphs of each subject discussion, beltways appear to have no significant effects on overall central-city vitality or on overall suburbanization of people and jobs. Blayney-Dyett's case studies suggest that land use regulation, tax and mortgage policies, and other factors generally outweigh the influences of beltways. These findings based on aggregate data cannot take the place of detailed, project-level analyses that explicitly take into consideration the types of local factors that the case studies found to be important.

The findings of this research, in combination with the case studies, suggest that beltways and probably transportation facilities in general are, at most, one of many influences on the pattern of urban development and that policies to support revitalization of central cities might be better implemented by using beltways or other transportation facilities to support measures such as land use controls that bear more directly on urban development.

ACKNOWLEDGMENT

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Monitoring Traffic Management on Retailing Activities: Problems and Possible Solutions

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A method for objectively measuring the effect of traffic management on retailers' receipts is discussed. It identifies the need for information on these effects and, by considering the impact of traffic management on retailing activities in general terms, highlights the problems in obtaining such information. A checklist of criteria for studies designed to measure effects on trading performance is presented and used as a basis for developing a new method designed