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Highway capital is a major component of public capital, both in terms of impact on productivity and magnitude of expenditures. The role of highway capital seems especially important in Minnesota, because the per capita investment in streets and highways is significantly higher than the national average. Compared to the national average, per capita spending on construction and maintenance was 58% higher in Minnesota from 1992 to 1996.

This study focuses on the benefits of highway capital, especially through its effects on the productivity of Minnesota firms but also on through the benefits Minnesota consumers receive because of increased accessibility. Traditional methods of assessing the significance of investments in roads examine the costs or the use of roads, and not the benefits derived from them. Measures of costs include the size of construction and maintenance expenditure or the cost of replacing roads. Measures of use include vehicle-miles traveled or ton-miles of freight hauled. Quantifying the economic benefits derived from roads is more difficult because benefits must be inferred from macroeconomic effects or choices made by individual firms.

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Executive Summary

This study attempted to determine the effects of investments in highway capital on economic productivity in Minnesota. Per capita investment in streets and highways in Minnesota was 58% higher than the national average from 1992 to 1996. Researchers have disagreed over the magnitude of the effects public capital can have on productivity, and whether or not the effects indicate that more investment in public capital is needed. Traditional methods of measuring the importance of investments in roads use only costs and use of roads. This study focuses on the benefits of highway capital, both through effects on productivity and the benefits consumers receive from increased accessibility to products. Quantifying the economic benefits derived from roads is difficult, because benefits must be inferred from macroeconomic effects or choices made by individual firms.

Results of the study indicate that the economic return on investments in highway capital is high. These findings do not determine an optimum level of roadway investment. Investments in individual highway projects must create economic benefits in excess of cost in order to assure that highway expenditures continue to create productivity gains. Researchers conclude that a one percent increase in the amount of highway capital in Minnesota will lead to a significant increase in the value of goods and services produced in the state. This finding is consistent with the findings of researchers studying the productivity of highway capital in other regions. Differences in returns across projects mean that evaluating individual projects is critical, and only by investing in the best projects available can high returns be maintained.

1 Introduction

Over the long run, increases in productivity drive economic growth and improvements in living standards. Investments in both public capital and private capital contribute to increased productivity. This report attempts to determine how much investments in Minnesota highway capital contribute to productivity increases.

Highway capital is a major component of public capital, both in terms of impact on productivity and magnitude of expenditures. The role of highway capital seems especially important in Minnesota, because the per capita investment in streets and highways is significantly higher than the national average. Compared to the national average, per capita spending on construction and maintenance was 58% higher in Minnesota from 1992 to 1996.

Since the early 1990s the adequacy of public capital investments has been the subject of interest to economists and policymakers. We do not feel this debate has been resolved. Most studies agree that public capital can have important effects on productivity, but disagree over the magnitude of these effects and whether or not the effects indicate that more investment in public capital is needed. One of our main results is that the return on investments in roads is high. The result suggests that investments in public capital, and investments in highway capital in particular, may produce significant economic payoffs. The findings do not, however, determine an optimum level of roadway investment. In addition, investments in individual highway projects must create economic benefits in excess of cost in order to assure that highway expenditures continue to create productivity gains.

This study focuses on the *benefits* of highway capital, especially through its effects on the productivity of Minnesota firms but also on through the benefits Minnesota consumers receive because of increased accessibility. Traditional methods of assessing the significance of investments in roads examine the *costs* or the *use* of roads, and not the benefits derived from them. Measures of costs include the size of construction and maintenance expenditure or the cost of replacing roads. Measures of use include vehicle-miles traveled or ton-miles of freight hauled. Quantifying the economic benefits derived from roads is more difficult because benefits must be inferred from macroeconomic effects or choices made by individual firms.

The main goal of this study is to infer the benefits of road infrastructure by examining the relationship between the value of the road infrastructure and the output of the state's economy. Section 3 presents the economic model we use, Section 4 presents results, and Section 5 contains conclusions. Appendix A discusses the benefits that consumers derive from streets and highways. Appendices B and C contain data and explain how the data was assembled. The following section provides background on the debate over the adequacy of public investment in infrastructure.

2 Research on Public Capital Investment

For many years the stock of public capital has been identified as an important contributor to total output. However, it was not until a series of articles by Aschauer (1989a, 1989b) that public capital investment was brought into the forefront as a political and economic issue. Aschauer argued that a decline in investment in public infrastructure was a major factor contributing to an observed decrease in productivity growth. He pointed to previous studies that show a positive relationship between public capital stock and output. Aschauer examined the impact that public sector capital has on private sector productivity by assuming that economic output was a function of labor, the stock of public capital, and the stock of private capital. Aschauer inferred the mathematical form of the function by examining data on output, labor, and public and private capital from different states over time. He found each additional dollar of public capital investment would lead to an increase in output of more than two dollars. Another conclusion that Aschauer drew from analyzing the impact of public capital investment was that greater investment leads to a larger rate of return to private capital investment. This suggests that increasing public capital investment not only increases output, it also makes other capital more efficient.

Munnell (1992) strengthened Aschauer's results by examining a variety of potential causes for the slowdown in productivity growth such as changes in energy prices or a decline in growth of spending on research and development. After identifying the main theories to explain the slowdown in productivity growth, Munnell examined relevant trends and concluded that the decline in public capital is the sole explanation for the decline in productivity. She recommended increased government spending on new capital as well as maintenance and repair of the existing capital stock.

Since these findings, public capital productivity has come under close scrutiny. Holtz-Eakin (1994) offered a strong critique of previous work and pointed to several difficulties that occur when analyzing public capital productivity. He argued that it is necessary to use more disaggregated data to find the relationship between public capital stock and private sector productivity. Holtz-Eakin pointed out a potential pitfall in using state data—more prosperous states (with higher productivity) are likely to spend more on public capital. This guarantees that researchers will find a high correlation between productivity and public capital, but it does not necessarily imply that higher public capital causes higher productivity. After adjusting for these state-specific effects, Holtz-Eakin estimated state level data and found no correlation between public sector capital and private sector productivity.

Recent research continues to refine previous work. Nadiri and Mamuneas (1996) conducted a comprehensive study of the contribution of highway capital to US productivity. They examined questions similar to Aschauer and Munnell, and also

estimated the contribution of highway capital to productivity for specific industries. Bedi and Gillen (1999) examined the benefits of Ontario's highway capital. They estimated the economic benefits to firms in Ontario and extended previous work by also estimating the value consumers in Ontario place on highway capital.

Gramlich (1994) provides an excellent overview of the ongoing methodological debate on the effects of public capital investments on productivity. He acknowledges the importance of public capital, providing a table showing the levels of public infrastructure capital in 1991. A version updated to year 2000 prices, shown in Table 1, demonstrates that highway capital makes up the largest portion of all public infrastructure capital. However, Gramlich identifies a number of technical problems with estimating the productivity of highway capital. These include difficulties (i) measuring public and private capital, (ii) determining the correct way to specify returns to scale in the production function, (iii) the effect of common trends in the data, (iv) accounting for missing variables, (v) interpreting causality, and (vi) adjusting for differences across states. Gramlich feels that researchers should focus on whether government policies on investment should be changed. He concluded that setting up institutional structures that allow for state and local governments to determine their own levels of capital stock would help to limit any under-investment in public capital that might otherwise occur. Lastly, he asserted that more attention needs to be placed on studies that examine the productivity benefits of individual projects, and less on studies that examine aggregate productivity benefits.

Overall we feel that the debate over the adequacy of investment in public capital has not been resolved. Most studies agree that highway capital is a major component of public capital and an especially important factor affecting productivity. (The stock of public capital for education, for example, probably has longer-term effects on productivity while the stock of water and sewer capital may act more as a constraint of development than a factor to increase productivity.) However, the conclusions of Aschauer and Munnell, that there are large returns to investment in public capital and that a slowdown in public capital investment led to a decline in productivity in the US, continue to generate debate. Studies such as the one by Holtz-Eakin, which try to control for factors that Aschauer and Munnell did not account for, have not been accepted as conclusive either. Gramlich offers an interesting argument to support the view that the returns to public investment are not much higher than the returns to private investment. He says that if public investment was very profitable, then private investors would encourage taxation on businesses to fund public capital investment, which would then lead to higher profits at a much lower cost. We do not find this argument conclusive, however. Overall, we feel that studies that examine the effect of public capital on productivity can be useful for providing perspective on the effects of highway investment on productivity. Given all of the methodological questions about which are the best ways to estimate productivity, however, we also feel that researchers cannot at this time be certain of accurately measuring the exact size of the effects of aggregate highway investments on productivity.

Note: Three arguments seem especially important. First, lobbying for taxation on businesses would be a public good because most of the profits gained from new public policies would go to other firms. Second, firms may doubt that tax revenue will be spent on public capital. Third, it is not clear that higher public capital investments will lead to higher profits. An increase in productivity is not enough to insure that firms' profits increase. Investments in transportation, in particular, may reduce market firms' market power and hence their profits.

Table 2.1: US Public Capital in 1991 from Gramlich

(Billions of Year 2000 Dollars Based on the Price Deflator for Private Fixed Investment)

Type of Capital	Federal	State & Local	Total
Streets & Highways	18.8	788.9	807.7
Water & Sewer	0.0	329.3	329.3
Education	1.3	355.2	356.6
Conservation	159.8	40.0	199.8
Other Non-military	90.5	645.8	736.3
Military	572.9	0.0	572.9
Total	843.3	2159.3	3002.6

3 An Econometric Model of Production in Minnesota

Our approach to estimating the productivity of highway capital is similar to the studies discussed previously [See especially (Aschauer 1989a), (Munnell 1990), and (Bedi and Gillen 1999).] and the caveats expressed by Holtz-Eakin and Gramlich apply. Effects on productivity are measured by examining the relationship between labor, private capital, highway infrastructure, and state output. The relationship between these variables is summed up by a production function.

Specifically, we assume that

$$\text{Output} = f(\text{Labor, Private Capital, Highway Capital})$$

where f represents the production function.

Note: We use a Cobb-Douglas production function, which is common for this type of analysis, and allow for increasing or decreasing returns. We assume that $Y = A\, L^{\alpha} (PK)^{\beta} (HK)^{\delta}$ where Y is output, L is labor, PK is private capital, HK is highway capital, and A, α, β, and δ are free parameters. Note that we do not assume constant returns to scale (i.e., an equal proportional increase in each input will *not* necessarily lead to a proportionate increase in output). Technically, this means that we do not restrict the sum $\alpha + \beta + \delta$ to equal one.

By examining the way the levels of the inputs (i.e., labor, private capital, and highway capital) change over time and the effects of these changes on output, the contribution of each input to productivity can be estimated. Most importantly, we will obtain coefficients that estimate the percent that output that would change if there were an increase of one percent increase in a particular input. It should be noted that these are marginal values so they only apply for small changes in an input. A large increase in one input, say a 50 or 60 percent increase, might not result in the same proportionate increase.

To obtain results we need to know state output, labor, private capital, and highway capital for a number of periods. We acquired data for each year from 1957 to 1996. Our measure of output is gross state product (GSP). Our measure of the labor input is labor-hours of work. Our measure of both private and highway capital is "replacement value." The replacement value of a piece of capital is the cost, in current dollars, of purchasing the capital adjusting for the condition of the capital. Condition is accounted for by the depreciation rate. This depreciation rate determines the portion by which the capital's function decreases each year due to wear and tear.

Gross state product (GSP) is a measure of the total value of all production in the state. Collected by the Bureau of Economic Analysis (BEA), data on gross state product was only available from 1977 to 1996, so it was necessary to adjust another series to expand the data for the length of the study. To accomplish this, personal income data for the state

was used. Over the years where the data overlapped, the two series were highly correlated making it an obvious choice to extend the data. (The correlation coefficient was over 0.999.)

Data for the labor force in Minnesota was taken from the Minnesota Department of Economic Security current employment statistics. The series for number of people employed each year was multiplied by the average number of hours worked in a year, to come up with the number of labor hours in the state for each year.

The data collection for the capital series was a much more involved process. Data for private capital is estimated by the BEA at the national level and is not available for individual states. Previous studies have used a method of estimating the share of the capital stock that is attributable to each state based on proxy ratios in each of the sectors. For example, the capital stock in the agriculture sector was distributed for each state based on its share of the total value of land, buildings, and equipment (obtained from the *Census of Agriculture*). This procedure, which is similar to the one employed by Costa, Ellson and Martin (1987) was employed here. Ratios of Minnesota's share of national values were based on a number of different sources that approximated Minnesota's share of capital. The BEA breaks down the national capital stock into a number of categories including: agriculture, manufacturing, construction, retail trade, and financial. Of the twelve categories of capital stock data collected by the BEA, this model uses the eleven largest categories. Some of the smaller subcategories of capital stock data were omitted because they were deemed too small or ratios could not be found. For example, the oil and gas extraction capital ratio (a subcategory of the mining capital stock) was left out because the ratio was inconsequential for the state. Ratios of Minnesota's share of national values are based on a number of different sources that approximate Minnesota's share of capital. Though data for these ratios was not available for every year, the year's ratios that were missing were linearly interpolated.

Because this part of our study focuses on the impact of roads on the economy, it was crucial to obtain accurate measures of the stock of highway capital. Fortunately, state-specific investment numbers were available for highway capital. We used these numbers to obtain our estimate of the replacement value of Minnesota's roads. The first step was to estimate the depreciation rate for highway capital. Our estimate was based on Fraumeni's estimate of the productive highway capital stock for the US and Federal Highway Administration (FHWA) data on yearly US capital and maintenance expenditures. The second step was to determine how much highway capital was accumulated in Minnesota and the US from 1957 to 1996. This was done using our estimate of depreciation and the FHWA's data on US and Minnesota investment. Our third step was to determine the amount of highway capital in Minnesota in 1996. This was done by assuming the ratio of Minnesota to US road capital at the end of 1996 was equal to the ratio of capital accumulated from 1957 to 1996. (This is similar to the approach used by Munnell. We estimate that 98.4 percent of the value of US roadway capital was accumulated since 1957 so using the ratio seems reasonable.)The fourth step

was to work backwards from 1996 to obtain estimates of Minnesota highway capital stock for previous years. This was done using our estimate of the rate of depreciation and the FHWA data on statewide construction and maintenance spending.

4 Findings

The replacement value of the stock of roadway capital in Minnesota is useful for understanding the role of roads in Minnesota's economy. It gives us one measure of the value of roads. It also provides information about whether or not maintenance expenditures are high enough to keep the quality of roads and bridges from deteriorating. Figure 1 shows the replacement value of, and investment in, Minnesota roads from 1957 to 1996. The rate of capital accumulation was approximately four percent per year for the last 40 years, with a slight slowdown occurring in the 1970s. The ratio of capital to the gross state product has also been approximately constant. Except for rising rather rapidly from 16 percent in 1958 to 21 percent in 1963, the ratio has not changed much. It rose slowly to 24 percent in the early 1970s and then declined to 22 percent in the early 1980s. From 1984 to 1997 it was between 20 and 22 percent. These results are consistent with Bedi and Gillen's findings for roadways in Ontario.

The replacement value of highway capital was used to estimate the effects of highway capital investment on productivity. That is, we estimate how an increase in highway capital affects economic output. We should emphasize again that, given the caveats that apply to this and similar studies, and due to time and data limitations, we do not offer these results as final or definitive conclusions. Instead, the results are offered as a basis for discussion—providing evidence that highway capital in Minnesota contributes significantly to productivity growth. The coefficients for the inputs in the production function are similar to those found in other studies. Highway capital has a coefficient of 0.26 meaning that a one percent increase in the amount of highway capital would be expected to bring about a 0.26% increase in the gross state product. This finding suggests that the returns to investments in highway capital are high and it is consistent with other studies of the productivity of highway capital. We also find that labor has a coefficient of 0.81 and private capital a coefficient of 0.08. This means a one percent increase in labor or private capital would be expected to increase GSP by 0.81% or 0.08%, respectively. The coefficients for labor and highway capital were statistically significant meaning that, given the assumptions of our model, it is highly unlikely that their values are zero. The values of the coefficients are shown in Table 2.

Figure 4.1: Roadway Investment and Replacement Value (Millions of 1992 Dollars)

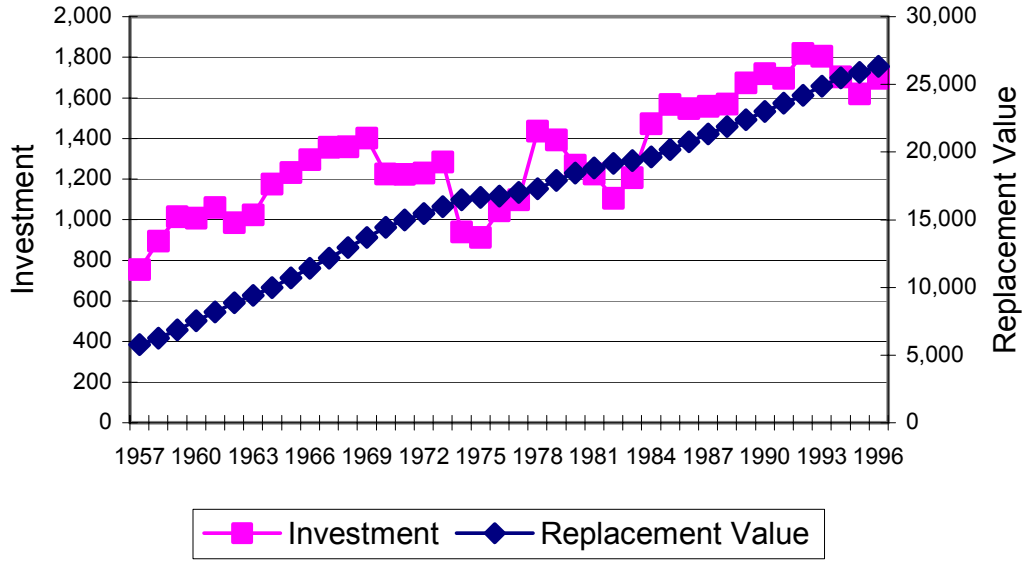
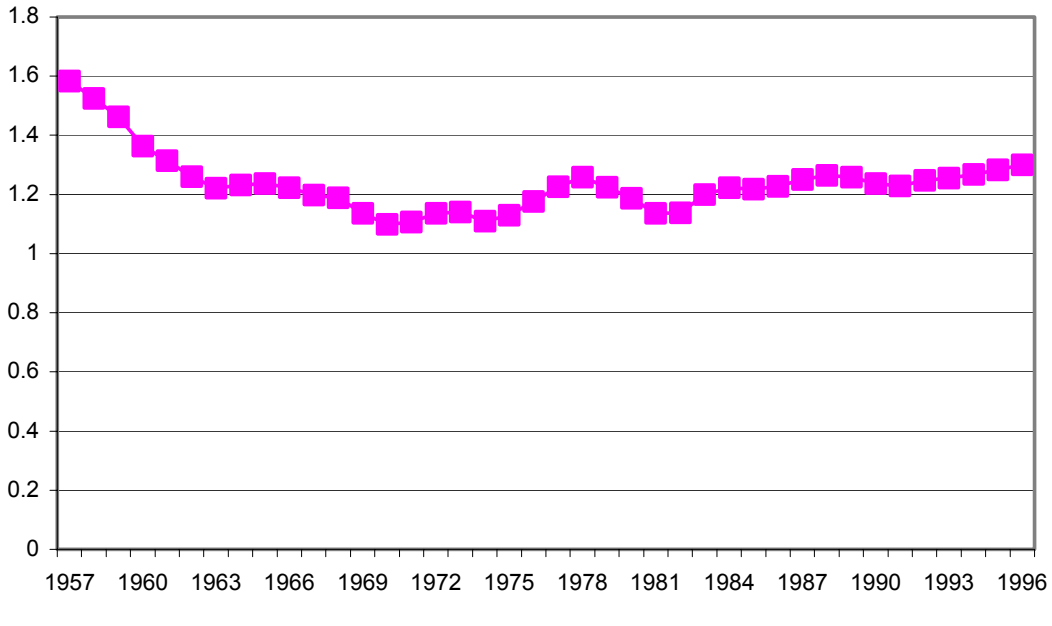


Figure 4.2: The Marginal Product of Highway Capital



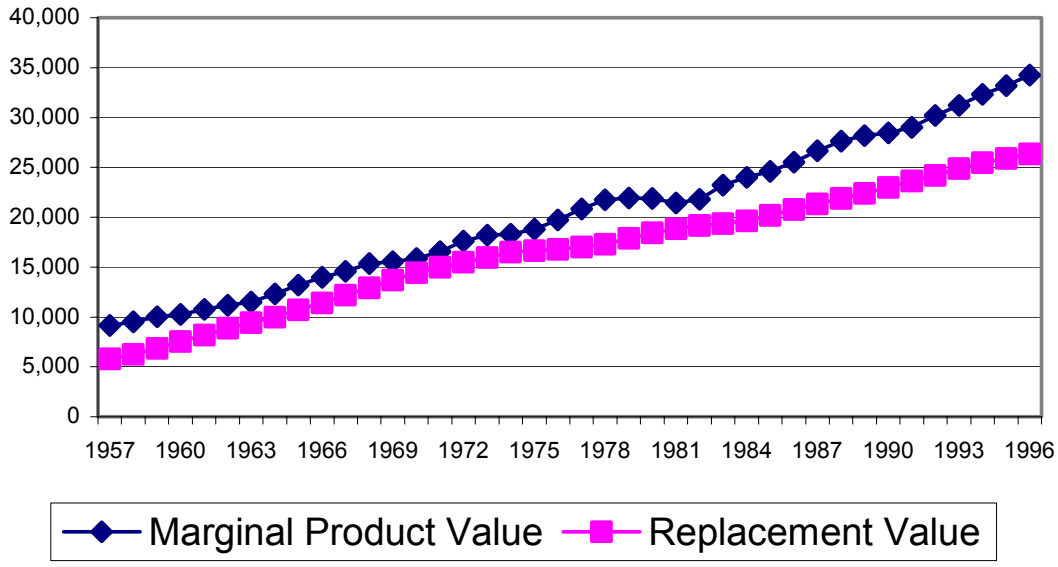
Our parameter estimates can be used to approximate the marginal product of highway capital in each year of the sample. This value is defined as the amount that one additional unit of capital would add to output and is shown in Figure 2. We find that the marginal product of highway capital fell from the early years of our sample, from about 1.6 in 1957 to about 1.2 in the mid-1960s. Since then, the marginal product of capital has remained nearly constant. This is not surprising given the evolution of the highway system in Minnesota. As the highway system, and especially the interstate system, was built, early improvements made the greatest contribution to the productivity of the economy. As the highway system matured, additions to the system contributed less to the overall productivity of the economy. The decline in the marginal productivity of highway capital coincides with the increase in highway capital stock noted earlier. Starting in the early 1990s, there have been small annual increases in the marginal product of highway capital. This may be a reflection of increasing economic activity, a sign of an increase in the demand for transportation, or a sign of a relatively low amount of highway capital.

Some perspective on the value of highway capital can be gained by examining its "marginal product value." The marginal product value is a measure of the total value of the highway system to producers. It equals the amount that producers would pay for roads if roads were paid as they would be in a competitive environment. The resulting series is shown in Figure 3. Note that this value is consistently higher than the replacement value of roads for the years examined and the difference has been growing in recent years.

Table 4.1: Estimates of Parameters

	Coefficient	**Standard Error**	**t Statistic**
Intercept	4.41	0.27	16.23
Labor	0.81	0.09	9.56
Private Capital	0.08	0.05	1.66
Highway Capital	0.26	0.03	8.75

Figure 4.3: A Measure of the Value of Minnesota's Highway Capital (Millions of 1992 Dollars)



5 Conclusions

The productivity of highway capital in Minnesota appears to be very high. Our main finding is that a one percent increase in the amount of highway capital will lead to a significant increase in the value of good and services produced in the state. While there are no other studies of the value of Minnesota's highway capital, this finding is consistent with the findings of researchers studying the productivity of highway capital in other regions. It should also be noted that our findings do not necessarily mean that all new highway investments will lead to gains in productivity. Differences in returns across projects mean that evaluating individual projects is critical, and only by investing in the best projects available can high returns be maintained.

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Appendix A: On the Value of Minnesota's Road Network to Consumers

This appendix describes the work we did to estimate the value of Minnesota's road network to consumers. Our basic approach followed that of Bedi and Gillen (1999). We used data on consumer expenditures from a number of cities to estimate a demand function for transportation. Given this function, we calculated the maximum value consumers would pay for transportation. This total is the benefit consumers derive from transportation and can be much larger than the amount consumers actually pay for transportation because many consumers may receive benefits from transportation in that are larger than what they pay for transportation.[1]

While measuring benefits to consumers is not difficult conceptually, it is difficult in practice. We do not actually observe the demand function for transportation. We can observe expenditures at a variety of price levels, but we cannot observe them at all price levels. Especially problematic is that we do not usually observe behavior at very high price levels. We would like to know how expenditures would vary if the price of transportation increased by 200 or 300 percent, but usually we only observe changes of 20 or 30 percent.

We proceed by outlining the approach of Bedi and Gillen. We felt that there were problems with their approach, which we felt were significant enough that we adopted a different approach to measuring value to consumers. Still, we ran into technical difficulties and this limits the results we were able to obtain.

Bedi and Gillen's Approach

Bedi and Gillen attempt to measure the value to consumers by estimating an aggregate consumer demand function. They use data for seven types of goods over for eight different years in 17 Canadian cities. The data is then fitted to a translog utility function. Once the parameters of the utility function are obtained, the value consumers place on transportation is calculated.

We feel that there are two important problems with their approach.[2] The first is that there is no data available when prices are significantly higher than average.

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[1] If a consumer buys an apple for $2, we can assume that the benefit the consumer derives from the apple will be at least $2. Otherwise, why would he or she buy the apple? The benefit, which equals the maximum amount the consumer would pay for the apple, could be $3 or $4 or more.

[2] Similar problems apply to Bedi and Gillen's measure of the value of transportation to firms. For this reason, we focused on the marginal product and the marginal product value of transportation to firms and not on the total value of transportation to firms.

This means that we have no evidence of how people would behave if prices were high. This may seem to be a technical distinction, but it depends entirely on the form of the demand function. For some demand functions, most of the benefits to consumers are derived for low levels of output. To accurately calculate benefits, we may need to know precisely how much consumers would buy at high prices.[3] Unfortunately, transport prices do not vary a great deal and we only observe prices "locally" (i.e., near one price and quantity level). Bedi and Gillen infer demand at high price levels by assuming the indirect utility function has a specific form. We see no reason, however, to assume that the indirect utility function should have this specific form.[4]

The second problem is that the function they choose as an indirect utility function does not have reasonable "global" properties. Their indirect utility function does not satisfy the properties of an indirect utility function globally.[5] In addition, their functional form implies that consumer surplus is infinite and this result is not particularly useful.[6] We can't use consumer surplus to compare the relative benefits from different types of goods. In Bedi and Gillen's model, *all* goods produce infinite consumer surplus. The fact that consumer surplus is infinite seems to be an artifact of the mathematical form of the demand function and it is not clear it says anything about the actual benefits derived from transportation.

Our Approach

We make three observations about consumer demand and the usefulness of information on the benefits of transportation.

1. The marginal benefits that consumers derive from a transportation investment are often an important factor in determining whether or not transportation investments would increase social welfare.
2. The elasticity of demand for transportation can be an important factor in determining whether or not major transportation investments would increase social welfare.

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[3] Consider a simple example. The first unit consumed is valued at $100, the next four units consumed are valued at $1, and no other units are desired. Maximum possible consumer surplus is $104, but $100 units of this surplus is received by the consumer who buys the first unit.

[4] The functional form they use is the translog and a strength of this form is that it's flexibility makes it good for making *local* approximations. We are not aware of any literature that supports the view that the translog is a good form for globally fitting demand functions.

[5] See Varian (1984), page 185.

[6] The results are also made suspect because they show that the case considered above is relevant. Consumers place very high values on the first few units of the good, so we need to know demand at high price levels.

3. The total benefits that consumers derive from transportation may be useful for gaining perspective on a transportation system as a whole, but is not useful for analyzing individual transportation projects.

For small investments, it is useful to know marginal benefits. For fairly large investments, one should know marginal benefits and the elasticity of demand. Total benefits are only needed if large changes are made, e.g., reducing bus service by 75 percent or increasing vehicle-miles traveled by 200 percent.

We attempt to measure the marginal benefits that consumers derive from transportation and the elasticity of demand for transportation by simultaneously estimating the demand for transportation and for other goods and services. We do not try to estimate total benefits to consumers because we face the same data limitations that Bedi and Gillen faced. We are able, however, to place a lower bound on benefits to consumers.

Our approach is somewhat unusual because it attempts to infer characteristics of the demand for transportation from aggregate expenditures and not by examining the transportation market in isolation.[7] Three technical issues complicate the interpretation of out results. Two of the issues tend to make our results overestimate the value of Minnesota's road network. The first is that, while we wish to measure the value of Minnesota's road network, our data on transportation expenditures are divided only into public and private transportation. We do not have data on different modes of transportation, for example, air transport and ground transport. To the extent that travel is by air, water, or rail, our results will overestimate the value of Minnesota's road network. Most consumer expenditures are on ground transport, however, so we may not be overestimating by too much. The second issue is that there is probably some overlap between the value of the road network to consumers and the value to firms. Most expenditures by consumers are probably for non-work activities, but some may be work related. Work-related expenditures would include money spent on operating vehicles for running errands while at work.[8] Even more important some of the expenditures made by commuters may make them more productive at work. Buying a car, for example, may allow someone to travel faster and either do more work or get to a job where the person is more productive. The value of these consumer expenditures has already been measured as a benefit to

[7] The more standard method assumes that the marginal benefit to drivers equals the marginal cost to drivers. Marginal cost is then calculated, often as the sum of time costs, vehicle operating costs, and crash costs. This method can potentially provide more accurate estimates of the benefits of individual transportation projects.

[8] Technically, this should not be included as part of consumer expenditures by the Consumer Expenditure Survey, but in many cases we expect that people will report these expenditures on personal vehicles as consumer expenditures, even if they are incurred while at work.

firms, however, and should not be counted twice. A third issue is that we measure only out-of-pocket (i.e., cash) expenditures. People also invest significant amounts of time in travel, however, and there is no theoretic reason to treat time costs differently than other expenditures. That consumers spend significant amounts of time on travel is important evidence that consumers value travel. We do not account for time costs because we do not have data on these costs for the different regions in our study.

Problems with Econometrics

Our estimates are based on data from 25 US Metropolitan Statistical Areas (MSAs). We have data on nominal expenditures for seven types of goods, including public and private transportation. The data is for each MSA from the years from 1986 to 1997, except for the year 1995 when no data was collected. Real expenditures are calculated using price data for different years, and for the housing and non-housing sectors in each MSA.

Demand functions were estimated using an Almost Ideal Demand System (see Deaton and Muellbauer, 1980). The results of these estimates did not seem strong enough for us to use them to confidently make predictions about marginal benefits or the elasticity of demand. Some of the estimated coefficients for the demand system were not statistically significant, and they seemed sensitive to the way the demand system was specified. Overall, we feel that better data is needed to draw firm conclusions about the elasticity of demand for transportation or the marginal benefit of the road network to consumers.

We think there were three main shortcomings with our data, but that these might be overcome with further research. The first is that the data may not be heterogeneous enough—both across Metropolitan Statistical Areas (MSAs) and over time. If expenditure shares are nearly the same across cities and time, then we will not be able to accurately estimate demand. International data and data for a wider range of years might help. A second problem involves expenditures on housing. There are two issues here—expenditures on housing vary more than expenditures on other goods and theory predicts that expenditures on housing and transportation are related in a special way. If housing expenditures vary significantly more than expenditures on other goods, then our econometric methods may not do a good job of estimating demand for other goods. This problem might be remedied by an econometric technique that accounts for the fact that expenditures on different goods may vary systematically in different ways. Urban economic theory predicts that transportation costs vary inversely with housing costs. This special relationship between transportation and housing is not accounted for in our model of demand. Structuring our model to account for this relationship might change our results. The third problem is that time costs are not included with expenditures. These costs can account for a large share of all costs

that consumers incur to travel, however. Including time costs might significantly improve our results.

Summary

We estimated aggregate demand functions for public and private transportation, but our initial results did not seem strong enough for us to use them to confidently make predictions about marginal benefits or the elasticity of demand. We are able to place a lower bound on the value that consumers place on transportation based on consumers' expenditures. We estimate that consumers in Minnesota spent 17.6 billion dollars on transportation in 1997. This suggests that consumers receive benefits from transportation that are worth more than 17.6 billion dollars. Most of these benefits come from using the road network although some come from air travel. Total benefits received by using the road network are probably higher than 17.6 billion dollars because travelers incur high time costs to use the road network and because some travelers probably place a much higher value on using the network than the amount they pay.

Appendix B:
Summary of Production Model Data Sets

This appendix provides an overview of the data sets used to estimate the value of Minnesota's highway network to firms. The data is contained in two Excel spreadsheets "Production Model Data (v 100).xls" and "Private Capital Data (v 100).xls." Comments within the actual spreadsheets provide more detailed information on individual data series. The main spreadsheet is "Production Model Data (v 100).xls." It contains all of the final data series used to estimate the value of the road network to firms. The spreadsheet "Private Capital Data (v 100).xls" contains the raw data that we used to construct estimates of the stock of private capital in Minnesota.

The Production Model Data Spreadsheet

The Production Model Data Spreadsheet contains four parts or worksheets. The first contains estimates of labor hours in Minnesota, Minnesota's real GSP and Minnesota's real stock of private capital. The stock of private capital was taken directly from the Private Capital Data Spreadsheet which is discussed below.

Labor hours were calculated based on Minnesota employment and average US hours worked.

Real GSP was calculated from data on nominal GSP and nominal personal income (PI). Nominal GSP data was only available for the years after 1977 so before that personal income data was used. The personal income data was inflated by a factor of 1.208. This factor was the ratio of GSP to PI in the years for which we had data on both. Real GSP in 1992 was determined based on the US GDP deflator.

The second worksheet contains the data used to calculate the replacement value of Minnesota's roadway capital. Raw data series included are: US and Minnesota nominal expenditures on road construction and maintenance, a highway construction price deflator, and the replacement value of US highway capital. We examined highway capital stock estimates from Fraumeni and the US Bureau of Economic Analysis, and used Fraumeni's estimates for constructing the stock of capital in Minnesota. Our method of estimating highway capital stock is described in our main report.

The third worksheet contains the four data series that were used to estimate the productivity of highway capital. This data is shown in Table 3. The data series are given from 1958 to 1997. They are the natural logarithm of GSP, labor hours, the stock of private capital and the stock of highway capital. The fourth spreadsheet

contains the output from a linear regression of the logarithm of GSP on the other series.

The Private Capital Data Spreadsheet

The Private Capital Data Spreadsheet contains seven worksheets. The first contains raw data on US and Minnesota capital stocks for sixteen sectors of the economy.

The second worksheet is divided into three parts. The first contains ratios of US to Minnesota capital stocks for the sixteen sectors. The second contains information on whether data was available for each year and sector. The third part contains the ratios when data is available and zeros in columns where data is not available.

The third worksheet contains interpolations of the capital ratios for the years 1945 to 1997. This gives us estimates of the ratio of Minnesota to US capital stocks for each sector for all of the years from 1945 to 1997.

The fourth worksheet contains nominal US capital stocks.

The fifth worksheet contains price indices.

The sixth worksheet contains real US capital stocks. These were calculated from the fourth and fifth spreadsheet. The price index that was used was the one for total nonresidential private fixed investment.

The seventh worksheet contains real Minnesota capital stock. This was calculated by applying the shares from the third spreadsheet to the capital stocks given in the sixth spreadsheet. This data is shown in Table 4.

Table 3: Regression Data
(All Data in Millions of 1992 Dollars. Data is from 1958 to 1995)

Ln(GSP)	Date	Time	Ln(L)	Ln(PK)	Ln(HK)
10.4812	1958	1	3.5947	10.4631	8.6606
10.5100	1959	2	3.6186	10.4827	8.7404
10.5550	1960	3	3.6482	10.5031	8.8317
10.5927	1961	4	3.6468	10.5178	8.9273
10.6331	1962	5	3.6756	10.5358	9.0100
10.6805	1963	6	3.6916	10.5619	9.0886
10.7053	1964	7	3.7085	10.5721	9.1503
10.7873	1965	8	3.7699	10.6083	9.2095
10.8401	1966	9	3.8303	10.6572	9.2771
10.8811	1967	10	3.8709	10.7116	9.3425
10.9343	1968	11	3.8988	10.7556	9.4062
10.9837	1969	12	3.9398	10.8040	9.4680
11.0138	1970	13	3.9306	10.8556	9.5236
11.0264	1971	14	3.9323	10.9046	9.5770
11.0675	1972	15	3.9698	10.9483	9.6135
11.1761	1973	16	4.0270	11.0111	9.6470
11.1659	1974	17	4.0498	11.1097	9.6783
11.1446	1975	18	4.0359	11.1940	9.7104
11.1739	1976	19	4.0676	11.1801	9.7197
11.2420	1977	20	4.1203	11.2223	9.7269
11.2963	1978	21	4.1803	11.2557	9.7414
11.3360	1979	22	4.2223	11.3063	9.7581
11.3166	1980	23	4.2161	11.3466	9.7928
11.3215	1981	24	4.2001	11.3971	9.8225
11.2923	1982	25	4.1659	11.3982	9.8433
11.3199	1983	26	4.1816	11.4044	9.8605
11.4295	1984	27	4.2520	11.4486	9.8704
11.4565	1985	28	4.2835	11.5000	9.8850
11.4788	1986	29	4.2995	11.5361	9.9118
11.5195	1987	30	4.3337	11.5558	9.9414
11.5483	1988	31	4.3777	11.5868	9.9678
11.5749	1989	32	4.4098	11.6169	9.9928
11.5737	1990	33	4.4248	11.6322	10.0165
11.5667	1991	34	4.4250	11.6512	10.0432
11.6142	1992	35	4.4409	11.6560	10.0699
11.6235	1993	36	4.4789	11.6826	10.0937
11.6834	1994	37	4.5038	11.7565	10.1208
11.7133	1995	38	4.5343	11.7957	10.1455
11.7695	1996	39	4.5575	11.8447	10.1612
11.7995	1997	40	4.5860	11.8877	10.1788

Table 4: MN Non-residential Private Capital Stocks

(Real, Millions of 1992 Dollars)

Agriculture, Forestry, and Fishing	Metal Mining	NMMEF	Construction	Manufacturing	RR	Trucking & Warehousing	Telephone & Telegraph
2,784	1,284	37	393	2,913	12,074	764	733
3,153	1,235	37	446	2,950	11,759	794	790
3,445	1,182	37	472	2,942	11,833	818	848
3,655	1,245	40	524	3,125	12,302	908	931
3,642	1,234	40	534	3,175	11,806	929	929
3,808	1,251	40	549	3,290	11,908	913	977
3,888	1,290	41	563	3,400	12,002	902	1,052
3,849	1,310	41	569	3,488	11,979	892	1,113
3,944	1,396	43	619	3,735	12,274	971	1,209
3,824	1,406	44	606	3,865	11,834	995	1,247
3,875	1,382	44	625	3,964	11,687	1,010	1,289
4,142	1,365	43	651	3,991	11,630	1,032	1,343
4,296	1,348	42	673	4,000	11,519	1,060	1,423
4,420	1,384	42	691	4,078	11,160	1,087	1,535
4,412	1,437	43	698	4,174	11,049	1,140	1,622
4,451	1,510	46	722	4,331	10,944	1,206	1,723
4,508	1,563	49	775	4,485	10,861	590	1,879
4,568	1,643	53	837	4,723	10,820	620	2,001
4,808	1,773	59	895	5,049	10,765	641	2,167
5,053	1,878	65	962	5,561	10,674	673	2,369
5,258	1,971	70	1,007	5,873	10,783	680	2,541
5,476	2,091	75	1,063	6,200	10,983	711	2,688
5,701	2,211	79	1,123	6,583	11,104	763	2,956
6,168	2,319	81	1,186	7,101	11,232	808	3,277
6,561	2,454	84	1,222	7,353	11,376	842	3,415
7,509	2,692	103	1,335	7,750	11,599	890	3,599
8,380	2,937	103	1,484	8,350	12,792	1,015	3,988
9,279	3,181	106	1,728	9,227	14,045	1,102	4,376
9,238	3,231	101	1,731	9,249	13,738	1,031	4,124
10,000	3,443	99	1,770	9,691	13,894	1,077	4,293
10,789	3,683	98	1,852	10,243	13,180	1,160	4,414
11,775	4,119	105	1,978	10,836	12,719	1,234	4,684
12,786	4,566	115	2,082	10,704	12,544	1,293	4,965
13,308	4,702	125	2,091	11,276	13,175	1,272	5,383
13,370	4,529	131	2,018	11,353	12,812	1,215	5,388
13,178	4,345	129	1,871	11,347	12,757	1,157	5,416
13,108	4,334	128	1,821	11,684	13,285	1,199	5,642
13,042	4,408	137	1,814	12,085	13,577	1,294	5,893
12,626	4,356	149	1,819	12,632	13,234	1,354	6,081
12,270	4,215	156	1,810	12,980	12,612	1,372	6,285
12,012	4,119	165	1,816	13,400	12,769	1,395	6,463
11,779	4,014	181	1,819	13,632	12,547	1,466	6,697
11,601	3,854	192	1,842	13,976	12,511	1,470	6,906
11,439	3,732	201	1,852	14,436	12,274	1,446	6,961
11,139	3,602	206	1,776	14,554	12,041	1,419	7,049
10,995	3,618	209	1,760	14,919	12,197	1,435	7,232
11,326	4,556	161	1,925	15,290	12,825	3,717	7,404
11,724	4,796	167	1,998	15,783	12,877	4,184	7,572
12,099	4,963	172	2,079	16,455	13,128	4,631	7,834
12,634	5,142	177	2,188	17,239	13,686	5,106	8,341
13,309	5,514	188	2,343	18,072	14,009	5,408	8,894

Table 4 (continued)

Radio & Television	Electric Services	Gas Services	Wholesale Trade	Retail Trade	Financial, Non-Insurance	Insurance	Services	Total
57	1,031	769	387	1,303	3,014	61	736	28,340
60	1,081	830	483	1,526	2,964	64	757	28,930
61	1,186	903	487	1,506	2,899	64	751	29,433
63	1,343	1,013	522	1,604	3,139	70	821	31,304
64	1,367	1,041	519	1,572	3,241	75	849	31,017
66	1,468	1,108	511	1,538	3,315	79	892	31,711
68	1,618	1,200	516	1,545	3,404	79	942	32,511
69	1,736	1,239	515	1,539	3,496	80	982	32,898
75	1,899	1,351	565	1,640	3,820	88	1,106	34,736
82	1,977	1,421	577	1,622	3,917	96	1,171	34,683
89	2,068	1,480	591	1,589	3,966	101	1,241	35,002
94	2,191	1,548	599	1,585	4,052	105	1,319	35,691
99	2,415	1,636	627	1,616	4,190	114	1,370	36,430
108	2,542	1,685	664	1,645	4,374	119	1,435	36,966
116	2,556	1,732	703	1,693	4,629	125	1,511	37,639
128	2,600	1,748	773	1,757	4,953	134	1,607	38,634
143	2,659	1,725	858	1,832	5,249	139	1,716	39,031
154	2,739	1,762	951	1,959	5,650	152	1,837	40,469
167	2,815	1,850	1,070	2,125	6,167	166	1,977	42,496
184	2,948	1,939	1,198	2,326	6,715	178	2,150	44,875
206	3,065	2,010	1,295	2,485	7,160	194	2,290	46,890
224	3,109	2,104	1,396	2,637	7,748	209	2,501	49,216
241	3,202	2,159	1,497	2,795	8,430	223	2,755	51,823
222	3,388	1,930	1,571	2,913	9,034	226	2,971	54,427
249	3,678	1,982	1,630	3,030	9,563	245	3,174	56,858
283	4,007	2,060	1,764	3,214	9,983	272	3,480	60,542
325	4,392	2,186	2,049	3,545	11,070	310	3,888	66,815
364	4,796	2,294	2,265	3,791	11,629	335	4,172	72,690
379	5,169	2,197	2,219	3,683	11,230	348	4,021	71,689
412	5,623	2,183	2,356	3,819	11,575	377	4,171	74,783
450	5,931	2,187	2,536	3,990	12,027	401	4,380	77,320
499	6,225	2,249	2,837	4,213	12,751	447	4,662	81,332
491	6,148	2,306	3,121	4,456	13,687	512	4,901	84,678
488	6,664	2,401	3,399	4,593	14,516	579	5,089	89,060
550	6,358	2,512	3,603	4,590	15,000	646	5,091	89,164
626	6,155	2,608	3,875	4,622	15,773	721	5,139	89,718
712	6,247	2,723	4,370	4,946	17,212	839	5,515	93,766
802	6,628	2,904	4,937	5,307	18,951	983	5,954	98,714
883	7,026	2,968	5,319	5,603	20,823	1,131	6,342	102,346
934	7,328	3,050	5,602	5,920	21,814	1,326	6,709	104,384
992	7,818	3,274	5,746	6,272	22,797	1,532	7,094	107,666
1,083	8,789	3,537	5,991	6,619	23,596	1,691	7,519	110,958
1,191	8,420	3,686	6,180	6,873	24,224	1,880	7,861	112,664
1,295	8,457	3,757	6,312	7,179	25,267	2,059	8,166	114,832
1,389	8,394	3,955	6,407	7,399	25,486	2,137	8,427	115,379
1,453	8,536	4,293	6,675	7,769	26,145	2,398	8,858	118,493
1,539	9,367	4,698	7,356	8,349	27,176	2,563	9,333	127,585
1,621	9,378	4,976	7,877	8,860	28,066	2,828	9,981	132,686
1,852	9,757	5,400	8,368	9,431	29,624	3,055	10,493	139,344
2,085	9,502	5,776	9,105	10,209	29,746	3,274	11,253	145,465
2,395	9,304	6,501	9,955	11,093	54,141	3,514	12,202	176,843

Appendix C:
Summary of Consumer Model Data Sets

This appendix provides an overview of the data sets used to estimate the value of Minnesota's highway network to consumers. The data is contained in the Excel spreadsheets "Expenditure Model Data (v 100).xls". Comments within the actual spreadsheet provide more detailed information on individual data series. The main spreadsheet is divided into five parts, or worksheets that are described below.

The goal of the first four worksheets is to calculate real, per capita expenditures for seven types of goods by the residents of 25 metropolitan areas. The first worksheet contains per capita nominal expenditures for each year, type of good, and area. The second worksheet contains raw price index data The third worksheet contains price inflators for each year, type of good, and area. The fourth worksheet contains real per capita expenditures. The data contained in this worksheet is shown in Table 5. Real per capita expenditures were calculated by multiplying each expenditure entry in the first worksheet by the corresponding price index in the third worksheet.

The second worksheet contains five tables. The first table contains raw data was on price indices for all urban consumers for each year and for six expenditure categories. The second table contains "mid-year" or two-year average price indices that we thought would be more reliable than the original one-year price indices. The third table converts the price indices into price inflators for the year 1992. The fourth table adds in a price indices for the entertainment category (entertainment is a separate category in the expenditure data, but not in the price index data). The fifth table contains area-specific price data for housing and non-housing goods. The fourth and fifth tables are then combined to construct the third worksheet, which contains an individual price inflator for each nominal expenditure entry.

The fifth worksheet contains income data. Originally, data was obtained on the number of households in each of nine income categories in each area. This data was adjusted to calculate shares of the population in different income categories. A final table calculates some summary statistics that were needed for our econometric work.

Table 5: Real Expenditures by MSA and Year (1992 Dollars)

MSA	Start Year	Housing	Food	Apparel & Services	Ent.	Private Transport	Public Transport	Other Exp.	Total
Anchorage	1986	18,464	6,694	2,921	3,838	7,167	1,453	15,438	53,981
	1987	18,754	6,300	2,774	4,118	7,433	1,436	14,695	53,794
	1988	19,336	6,789	2,720	4,375	9,100	1,447	15,369	57,699
	1989	19,174	7,283	2,683	4,572	10,152	1,226	15,708	59,718
	1990	18,544	7,008	2,904	4,306	8,439	1,110	16,204	57,719
	1991	18,324	6,419	2,740	3,729	7,312	958	14,510	53,612
	1992	16,925	6,288	2,316	3,292	7,014	862	12,298	48,943
	1993	16,526	6,544	2,515	3,853	6,466	911	12,063	48,977
	1994	16,515	6,836	2,609	3,430	6,504	1,076	12,488	49,652
	1996	18,921	7,373	1,981	4,818	10,068	1,193	11,638	56,573
	1997	18,505	6,869	2,422	3,369	9,328	1,072	11,307	53,595
Atlanta	1986	11,579	4,231	2,183	2,575	7,127	345	8,880	36,004
	1987	11,137	4,122	2,127	2,164	6,215	348	9,045	34,355
	1988	11,579	4,136	1,995	2,099	5,479	429	10,122	35,072
	1989	11,735	4,442	2,285	1,938	5,555	405	10,193	35,983
	1990	11,274	4,286	2,400	1,541	5,586	411	10,708	35,809
	1991	12,537	4,250	2,248	1,820	5,826	391	10,270	37,207
	1992	12,471	4,154	2,083	1,886	5,930	335	9,313	36,240
	1993	11,920	4,291	1,953	1,804	6,696	370	9,342	36,511
	1994	11,495	4,436	2,430	1,935	7,337	376	9,284	37,463
	1996	12,088	3,570	2,028	1,706	6,374	325	8,292	34,704
	1997	11,641	3,469	1,698	1,398	7,499	298	7,552	33,999
Baltimore	1986	9,756	4,584	1,892	1,563	5,161	288	8,012	30,425
	1987	9,809	4,938	1,860	1,637	5,477	277	7,832	31,146
	1988	10,052	5,115	2,059	1,518	5,453	244	8,512	32,370
	1989	11,187	4,800	2,128	1,471	5,227	208	9,489	33,965
	1990	12,004	4,583	2,001	1,646	5,446	187	9,541	34,982
	1991	11,917	4,633	1,928	1,523	4,887	165	8,447	33,298
	1992	10,907	4,478	1,723	1,545	3,753	216	7,844	30,426
	1993	10,776	4,153	1,438	1,465	4,191	247	8,060	30,361
	1994	11,890	4,180	1,435	1,293	4,902	286	8,680	32,740
	1996	10,340	4,557	1,806	1,283	4,591	236	7,715	30,752
	1997	10,712	4,114	1,620	1,435	4,548	277	7,716	30,899
Boston	1986	13,253	5,304	2,351	2,292	7,807	478	9,560	46,591
	1987	14,920	4,860	1,913	1,672	6,145	340	8,420	37,284
	1988	14,479	4,842	1,921	1,672	5,614	312	8,594	36,630
	1989	18,645	4,583	2,097	1,867	6,921	418	7,789	40,829
	1990	18,015	5,490	2,361	1,972	5,487	351	9,310	41,893
	1991	16,093	5,279	2,452	1,613	5,494	338	9,002	39,804
	1992	16,017	5,313	2,604	1,595	5,554	340	8,609	39,740
	1993	16,526	4,742	2,320	1,518	6,107	416	8,490	39,685
	1994	15,593	4,396	1,839	1,420	4,925	399	7,937	35,945
	1996	22,810	4,578	2,340	1,994	6,432	644	23,037	63,519
	1997	24,198	4,727	2,042	1,740	5,904	615	8,558	45,916

MSA	Start Year	Housing	Food	Apparel & Services	Ent.	Private Transport	Public Transport	Other Exp.	Total
Chicago	1986	12,720	6,471	2,949	2,314	7,584	614	12,207	43,739
	1987	13,095	6,588	2,928	2,305	7,280	756	11,852	43,929
	1988	13,630	6,707	3,201	2,184	7,526	770	12,923	46,191
	1989	13,619	6,957	2,993	2,211	6,499	714	12,147	44,677
	1990	12,834	6,613	3,034	2,289	5,773	698	11,221	42,218
	1991	13,143	6,173	3,148	2,025	6,671	659	10,819	42,675
	1992	13,413	6,312	2,862	1,815	7,354	595	10,376	42,968
	1993	13,574	6,287	2,914	1,870	7,638	589	10,383	43,552
	1994	14,221	6,059	3,164	2,055	7,435	616	9,757	43,668
	1996	13,290	5,756	3,036	1,968	6,000	833	15,461	47,099
	1997	13,157	5,444	2,511	1,827	5,977	561	8,750	39,033
Cincinnati	1986	8,516	4,453	2,004	1,779	5,761	265	8,068	29,947
	1987	8,850	4,825	1,796	1,708	5,633	268	7,797	30,218
	1988	9,187	5,114	1,744	1,812	6,131	218	7,470	31,205
	1989	8,619	4,967	1,871	1,868	5,574	221	7,546	30,296
	1990	8,420	4,761	1,884	1,647	4,785	190	7,383	28,827
	1991	9,092	4,639	1,821	1,677	5,106	202	7,362	29,818
	1992	9,622	4,699	1,968	1,873	5,631	247	7,754	31,849
	1993	9,794	4,541	1,900	1,914	5,645	294	7,639	31,834
	1994	9,624	4,049	1,469	1,799	5,864	332	6,929	30,228
	1996	10,083	4,308	1,601	2,047	5,715	371	13,780	38,636
	1997	10,283	4,337	1,797	1,478	5,339	350	7,394	31,481
Cleveland	1986	10,582	4,862	2,193	2,100	6,606	362	11,888	37,273
	1987	10,379	5,283	2,301	2,088	7,589	347	10,730	37,784
	1988	10,355	5,116	2,555	2,092	6,773	314	9,710	36,246
	1989	9,611	4,936	2,456	1,727	5,092	273	9,086	32,696
	1990	9,576	4,806	2,565	1,559	5,028	190	8,494	31,915
	1991	9,986	4,843	2,228	1,592	5,100	215	7,881	31,711
	1992	9,513	4,780	1,651	1,460	5,486	262	7,540	30,705
	1993	9,619	4,486	1,547	1,398	5,479	284	6,827	29,663
	1994	10,455	4,358	1,476	1,449	5,052	273	6,553	29,627
	1996	12,000	4,467	1,843	2,111	6,195	296	13,758	41,375
	1997	11,960	4,823	2,187	1,993	6,226	319	7,697	35,600
Dallas-Fort Worth	1986	9,065	4,641	2,388	2,084	7,552	444	11,050	36,050
	1987	9,596	4,967	2,511	1,837	7,435	410	11,583	37,342
	1988	10,456	5,099	2,499	2,095	7,166	488	12,242	39,225
	1989	10,211	5,054	2,244	2,133	7,333	467	11,288	38,198
	1990	9,609	5,069	2,173	1,743	6,582	335	10,097	35,360
	1991	9,960	5,102	2,127	1,750	7,008	324	9,567	35,855
	1992	10,203	5,047	1,901	1,760	7,368	286	10,095	36,855
	1993	10,154	4,874	2,069	1,761	7,034	288	10,874	37,312
	1994	9,839	5,201	2,226	1,844	7,214	366	9,387	36,349
	1996	10,036	5,154	2,139	1,438	9,129	262	9,040	37,594
	1997	10,470	5,415	2,493	1,481	8,024	305	9,647	38,476
Detroit	1986	12,838	4,690	2,179	1,514	6,051	293	8,682	35,201

MSA	Start Year	Housing	Food	Apparel & Services	Ent.	Private Transport	Public Transport	Other Exp.	Total
Detroit	1987	13,248	4,691	2,421	1,494	6,415	311	8,206	35,902
	1988	14,064	4,255	2,052	1,612	6,598	388	8,057	36,089
	1989	13,940	4,106	1,399	1,737	6,077	387	8,296	35,014
	1990	13,625	4,315	1,674	1,786	5,737	331	7,925	34,665
	1991	13,795	4,441	1,895	1,710	5,743	273	7,011	34,261
	1992	14,161	4,344	1,960	1,611	6,622	253	7,082	35,557
	1993	14,374	4,513	2,151	1,435	7,074	303	7,158	36,591
	1994	13,838	4,359	1,779	1,339	6,778	330	7,212	35,302
	1996	13,251	4,936	2,574	1,703	5,673	346	11,814	40,915
	1997	13,685	4,472	1,671	1,855	6,012	385	6,300	34,301
Honolulu	1986	29,884	7,814	2,704	2,827	5,925	884	14,340	61,843
	1987	31,513	8,021	2,957	2,997	8,278	1,093	14,614	67,796
	1988	33,211	7,791	2,579	2,597	7,698	1,121	14,836	67,430
	1989	32,180	7,681	2,110	2,486	6,421	964	14,530	63,946
	1990	33,373	7,602	2,370	2,359	7,068	1,173	14,820	66,653
	1991	34,188	8,374	2,882	2,083	6,367	1,109	13,239	65,892
	1992	34,371	9,239	2,724	2,116	6,121	975	13,328	66,931
	1993	39,066	8,664	2,223	2,303	6,887	1,106	14,935	72,163
	1994	37,740	7,331	1,940	2,328	6,695	1,006	13,219	66,668
	1996	34,415	6,621	2,903	2,235	8,071	1,114	11,464	64,669
	1997	36,391	7,076	2,447	1,986	6,968	964	11,491	64,423
Houston	1986	10,069	4,698	1,891	2,460	6,019	349	10,058	34,611
	1987	9,423	5,046	2,206	2,286	5,331	479	10,784	34,591
	1988	9,156	4,614	2,018	2,013	5,280	585	9,939	32,958
	1989	8,592	4,451	1,711	1,750	6,275	428	9,016	31,825
	1990	8,273	4,760	2,133	1,743	6,593	272	8,987	32,462
	1991	8,247	4,869	2,176	1,766	6,225	239	8,399	31,844
	1992	8,606	4,611	1,790	1,840	5,898	344	8,866	32,083
	1993	8,743	4,867	2,037	1,614	6,300	365	9,104	33,196
	1994	8,675	5,329	2,376	1,452	7,149	358	8,740	34,213
	1996	9,095	4,249	1,844	1,388	7,217	305	7,779	32,292
	1997	9,193	4,215	1,846	1,417	7,736	301	7,915	33,183
Kansas City	1986	8,901	4,346	1,890	2,042	7,043	303	10,734	34,107
	1987	9,069	4,392	1,730	2,094	6,488	312	10,182	33,361
	1988	8,760	4,646	1,659	1,859	5,527	251	9,096	31,222
	1989	8,359	4,759	1,478	1,621	5,024	197	8,503	29,583
	1990	8,232	4,600	1,569	1,509	4,664	222	8,524	29,102
	1991	8,265	4,564	1,991	1,757	5,704	248	8,663	31,111
	1992	8,819	4,498	2,027	1,775	6,250	270	8,256	32,014
	1993	8,926	4,507	1,868	1,525	5,773	295	8,458	31,556
	1994	8,488	4,317	1,825	1,553	5,784	381	8,806	31,386
	1996	8,540	4,823	1,885	1,420	5,212	258	13,154	35,830
	1997	8,883	4,820	1,666	1,180	5,814	210	7,422	30,570
Los Angeles	1986	16,615	5,420	2,221	2,095	6,431	500	10,502	42,186

MSA	Start Year	Housing	Food	Apparel & Services	Ent.	Private Transport	Public Transport	Other Exp.	Total
Los Angeles	1987	17,607	5,555	2,186	2,224	6,110	584	10,383	43,065
	1988	18,263	6,170	2,319	2,267	6,731	619	10,716	45,715
	1989	18,959	6,195	2,887	2,393	6,653	498	10,496	46,839
	1990	18,635	5,719	2,831	2,323	5,791	355	9,728	44,217
	1991	17,972	5,342	2,265	2,135	5,679	410	9,066	41,918
	1992	17,236	5,164	2,173	1,980	5,974	462	8,735	41,027
	1993	17,074	5,054	2,231	1,727	5,799	366	8,526	40,091
	1994	17,548	4,841	2,210	1,691	5,863	397	8,143	39,932
	1996	18,193	4,858	1,987	1,666	6,164	575	8,241	41,067
	1997	18,484	4,848	1,851	1,605	6,997	539	8,544	42,539
Miami	1986	11,685	5,848	1,916	1,765	6,883	768	9,345	37,278
	1987	12,443	6,196	1,745	1,991	7,073	758	8,656	38,098
	1988	13,219	5,436	1,631	2,831	7,341	502	8,951	39,159
	1989	12,994	5,637	1,843	2,457	6,765	1,131	9,525	39,764
	1990	12,048	5,694	2,031	1,719	5,367	1,039	9,101	36,630
	1991	11,354	5,309	1,724	1,501	5,038	412	7,943	33,096
	1992	11,219	5,214	1,724	1,350	5,443	449	7,573	32,926
	1993	11,918	5,147	1,725	1,464	5,596	532	7,406	33,764
	1994	11,559	4,731	1,660	1,358	5,571	497	6,849	32,223
	1996	11,414	4,793	1,694	1,016	4,470	287	6,872	30,632
	1997	12,704	4,000	1,583	1,258	6,281	337	6,732	33,123
Milwaukee	1986	11,039	3,901	1,477	1,898	4,935	304	7,217	29,759
	1987	11,776	4,696	1,842	1,706	4,813	263	7,331	31,536
	1988	10,923	4,188	1,673	1,556	4,392	249	6,880	29,135
	1989	11,199	4,208	1,663	1,638	4,398	295	7,114	29,871
	1990	11,188	4,160	1,708	1,870	4,445	296	7,353	30,502
	1991	11,355	4,253	1,677	1,784	5,314	396	7,548	32,037
	1992	11,772	4,355	1,903	1,464	5,641	371	8,186	33,561
	1993	11,846	3,903	1,901	1,438	6,175	402	7,988	33,564
	1994	12,324	3,765	1,612	1,720	6,313	410	7,866	33,935
	1996	12,274	3,993	1,722	1,869	4,208	375	17,512	43,107
	1997	13,570	3,898	1,348	1,307	5,030	392	7,246	32,818
MSP	1986	9,990	4,548	1,959	2,178	5,233	499	9,668	33,140
	1987	10,043	4,516	1,919	1,789	5,548	501	9,053	32,728
	1988	10,858	4,811	2,239	1,914	5,761	503	10,027	35,557
	1989	10,413	5,005	1,996	1,984	5,386	386	11,017	35,659
	1990	10,165	5,069	2,049	1,800	5,602	330	11,424	36,075
	1991	11,255	4,920	2,301	1,802	5,941	349	12,407	38,911
	1992	11,267	4,900	2,023	1,865	5,551	350	11,487	37,668
	1993	10,545	5,003	1,891	2,003	5,470	434	9,806	35,433
	1994	10,611	4,667	1,793	2,064	5,993	452	10,422	36,358
	1996	10,582	5,003	1,959	2,148	7,133	506	15,068	43,106
	1997	11,790	4,918	1,933	1,927	7,720	475	10,713	40,366
New York	1986	20,359	7,152	3,359	2,367	6,502	1,124	12,462	51,376

MSA	Start Year	Housing	Food	Apparel & Services	Ent.	Private Transport	Public Transport	Other Exp.	Total
New York	1987	18,313	6,833	2,932	2,276	7,041	429	12,421	48,718
	1988	19,087	6,744	2,893	2,310	7,145	421	12,631	49,815
	1989	18,222	6,180	2,997	1,929	5,764	983	10,154	45,022
	1990	18,819	6,257	2,956	2,169	6,321	418	12,743	48,636
	1991	18,819	6,226	2,862	2,031	5,417	372	12,345	47,228
	1992	20,828	6,262	3,240	2,139	5,977	473	11,551	49,588
	1993	19,280	6,089	2,871	2,045	6,260	532	10,741	47,159
	1994	16,699	5,899	2,230	1,670	6,305	456	10,210	43,140
	1996	21,911	7,089	2,969	2,009	5,185	953	18,521	59,012
	1997	22,767	7,114	2,974	1,959	6,417	1,040	10,149	51,874
Philadelphia	1986	14,175	6,039	2,411	1,987	6,382	466	10,722	40,916
	1987	17,387	5,703	2,770	2,546	7,855	642	10,165	45,751
	1988	18,356	5,501	2,155	2,803	7,179	696	9,927	45,216
	1989	12,687	5,218	2,151	1,619	5,657	408	8,736	35,856
	1990	17,754	5,178	2,334	1,793	5,413	451	9,921	41,689
	1991	17,096	5,302	2,523	1,988	5,846	428	9,152	41,533
	1992	18,164	5,164	2,383	2,263	6,121	447	8,840	42,612
	1993	18,951	5,135	2,380	2,319	5,833	659	9,113	43,604
	1994	17,910	5,198	2,391	2,065	5,745	669	9,256	42,628
	1996	16,823	4,154	2,361	1,946	5,634	460	19,345	51,695
	1997	19,031	4,324	1,883	1,693	7,221	443	8,392	42,534
Pittsburgh	1986	8,756	5,037	1,946	1,723	5,302	284	8,107	30,328
	1987	7,769	5,112	1,680	1,306	4,911	273	5,634	26,295
	1988	8,334	5,304	1,493	1,237	5,498	348	6,069	27,973
	1989	7,837	4,352	1,736	1,404	4,701	249	6,606	26,578
	1990	9,072	5,076	1,530	1,312	4,819	263	6,735	28,627
	1991	8,832	4,954	1,478	1,278	4,540	258	5,889	27,182
	1992	8,381	5,007	1,416	1,274	3,912	324	5,598	25,950
	1993	8,892	4,657	1,308	1,140	3,859	240	5,055	25,203
	1994	9,268	4,394	1,622	1,280	3,476	184	4,879	25,156
	1996	10,521	4,729	1,921	1,651	6,093	392	11,659	37,508
	1997	10,459	4,735	2,375	1,557	5,956	377	8,134	34,074
Portland	1986	11,938	4,947	1,300	1,923	5,337	414	8,840	33,538
	1987	11,741	4,829	1,439	1,769	4,725	424	8,332	32,252
	1988	11,167	4,349	1,608	1,700	4,721	358	8,353	31,452
	1989	11,972	4,265	1,612	1,751	4,921	362	8,874	33,014
	1990	11,751	4,314	1,555	1,836	5,299	327	8,957	33,525
	1991	11,859	4,659	1,688	1,942	5,607	293	8,163	33,934
	1992	12,914	4,518	1,692	1,792	5,545	373	7,869	34,426
	1993	13,650	4,275	1,725	1,715	5,782	443	7,837	35,120
	1994	13,689	4,284	1,817	1,675	5,385	425	8,443	35,484
	1996	14,341	4,605	2,195	1,740	6,289	443	9,008	38,629
	1997	14,406	5,045	2,013	1,482	6,192	445	8,712	38,501
San Diego	1986	17,485	4,986	2,425	2,155	6,740	524	10,183	42,833

MSA	Start Year	Housing	Food	Apparel & Services	Ent.	Private Transport	Public Transport	Other Exp.	Total
San Diego	1987	19,047	4,998	2,426	3,280	7,041	463	9,575	45,040
	1988	20,896	4,909	2,100	3,241	6,899	494	9,675	46,154
	1989	19,553	4,951	2,135	2,075	5,311	439	9,561	42,160
	1990	18,316	4,860	2,004	1,813	6,123	562	9,116	41,438
	1991	19,504	4,902	1,782	1,783	7,105	588	8,910	43,258
	1992	18,813	4,980	1,849	1,844	5,817	451	8,955	41,585
	1993	18,218	4,449	1,719	1,825	5,755	446	8,100	39,380
	1994	17,599	4,084	1,573	1,642	5,867	428	7,839	37,987
	1996	20,554	4,402	1,782	1,725	5,132	389	7,713	40,118
	1997	20,491	4,588	2,046	1,632	5,891	433	7,544	41,375
San Francisco	1986	39,674	6,413	2,388	2,815	6,428	940	12,844	65,371
	1987	38,044	6,348	2,552	3,007	7,112	879	12,284	65,245
	1988	40,896	6,599	3,373	3,044	8,025	854	12,228	70,000
	1989	43,243	6,836	3,351	3,118	7,554	867	12,569	71,833
	1990	41,965	6,541	3,037	2,869	6,952	687	13,194	69,923
	1991	40,970	6,322	2,782	2,397	7,382	760	11,797	67,286
	1992	40,239	6,367	2,215	2,486	7,544	790	12,335	67,611
	1993	40,049	6,238	2,074	2,400	7,151	667	12,398	66,522
	1994	43,187	5,932	2,456	2,248	6,617	592	11,093	65,588
	1996	38,575	6,612	2,430	2,229	7,065	689	11,931	66,144
	1997	40,093	6,670	2,387	2,214	7,518	753	12,393	68,951
Seattle	1986	13,426	5,636	2,008	3,193	6,211	593	10,965	40,603
	1987	13,723	5,534	1,917	3,513	6,291	529	10,563	40,802
	1988	14,496	5,478	1,948	2,671	6,411	596	10,855	41,387
	1989	15,352	5,586	1,990	2,570	6,175	650	11,197	42,570
	1990	15,778	5,183	2,026	2,362	5,901	582	11,634	42,641
	1991	15,767	4,959	2,064	1,877	6,528	495	10,825	41,981
	1992	15,211	5,129	2,097	1,947	6,824	444	9,867	41,243
	1993	14,448	4,721	1,756	2,367	6,167	472	9,275	39,025
	1994	14,598	4,651	1,601	2,405	6,215	667	9,202	39,236
	1996	16,490	5,110	2,137	2,111	6,979	492	8,231	41,329
	1997	17,321	5,201	2,237	2,385	7,108	560	8,536	43,368
St. Louis	1986	8,572	4,445	1,531	1,711	5,918	268	8,888	30,394
	1987	8,604	4,349	1,696	1,768	5,011	254	8,644	29,522
	1988	9,129	4,141	1,509	1,668	5,038	249	8,450	29,581
	1989	9,230	3,972	1,416	1,602	4,890	231	8,461	29,348
	1990	8,619	3,685	1,406	2,087	4,587	269	7,928	28,263
	1991	8,128	3,906	1,221	2,220	4,725	275	7,499	27,870
	1992	7,859	4,029	1,170	1,618	4,409	228	7,033	26,403
	1993	8,060	3,739	1,247	1,196	5,248	306	6,787	26,687
	1994	8,492	3,855	1,515	1,105	5,915	350	6,956	28,332
	1996	9,153	4,198	1,848	1,605	5,114	218	15,412	38,305
	1997	9,286	4,479	2,119	1,351	5,583	209	7,600	31,072
Washington D.C.	1986	21,497	5,363	3,025	2,648	7,499	757	15,592	53,913

MSA	Start Year	Housing	Food	Apparel & Services	Ent.	Private Transport	Public Transport	Other Exp.	Total
Washington D.C.	1987	21,965	5,911	2,777	2,947	8,302	723	14,156	54,660
	1988	22,231	6,042	2,928	2,498	7,846	735	13,325	53,702
	1989	21,731	5,848	3,037	1,991	6,558	672	13,408	51,483
	1990	19,910	5,520	3,025	2,151	6,573	684	13,826	50,512
	1991	21,259	5,365	2,667	2,039	6,077	634	13,423	50,257
	1992	21,628	5,632	2,278	1,981	5,892	523	12,866	49,727
	1993	20,412	5,372	1,991	1,958	6,735	588	12,301	48,606
	1994	20,856	5,278	2,349	2,186	6,433	654	11,701	48,644
	1996	23,808	5,729	2,577	2,118	7,077	862	11,610	52,802
	1997	22,869	5,198	2,501	2,029	7,101	634	10,803	50,449