A note about this paper:

RCF Economic and Financial Consulting prepared this report with recommendations on this topic for consideration in the *GO TO 2040* plan. The intent is to assist CMAP as it incorporates policies, investments, and other actions to move us towards our regional vision. This report is meant to gather background information, clarify issues, conduct numerical analysis, and present potential recommendations for CMAP's consideration. CMAP Staff has not verified the contents of this report. This report contains the opinions of the authors, and does not represent CMAP policy.

Table of Contents

Executive Summary

This abbreviated version of the full report contains selected sections, as requested by CMAP. The full report covers the following types of infrastructure for the CMAP region:

- Transportation
- Electricity and Natural Gas
- Telecommunications
- Waste Disposal and Recycling
- Water Management
- Public Buildings
- Convention Facilities

This abbreviated report provides a summary of the economic development recommendations for these infrastructure systems, as well as Section 2 from the full report on the economic contributions of infrastructure in general. Two common findings have emerged from this study. First, the responsibility for urban infrastructure is highly fragmented, and some infrastructure systems function at a higher level than do others. Second, some infrastructure systems are in more urgent need of improvement than others, although they all need improvement taking the 2040 horizon. A basic conclusion is that CMAP can usefully serve as advisor and catalyst for all infrastructure systems.

The report makes the following recommendations:

General

Infrastructure Recommendation #1. ***CMAP should consider establishing a permanent Advisory Committee on Infrastructure. Since the responsibility for infrastructure systems is fragmented among numerous agencies and private firms, CMAP can appropriately act as an advisor on infrastructure systems as a whole. A part of the mandate is to help transfer expertise on new infrastructure technologies to CMAP communities.***

Infrastructure Recommendation #2. ***CMAP should commission studies on the impact of financing of infrastructure on communities within the CMAP region, giving attention to internal and external sources of funding.***

Transportation

Infrastructure Recommendation #3. ***CMAP should convene a permanent Deferred Maintenance Task Force. Among the suggested concerns are:***

a) Obtaining annual estimates of maintenance backlogs
b) Costs of achieving minimum acceptable standards
c) Prioritizing according to importance of need

d) Implications of continued deferral both as to added cost and impacts on service quality

e) Ways to set up protected funds for infrastructure maintenance that cannot be raided for other purposes.

Infrastructure Recommendation #4: ***CMAP should set up a committee on programs to enhance transportation amenities that contribute to economic development of member communities.***

Infrastructure Recommendation #5: ***Implementation of the CREATE project to reduce the freight rail bottleneck.***

Infrastructure Recommendation #6: ***Improvements in CTA transit facilities to reduce travel times and expand rush-hour capacity. This report does not discuss specifics of improvements in the mass transit system because CMAP staff has indicated that they are preparing the report on this issue.***

Infrastructure Recommendation #7: ***CMAP should monitor the activity at O'Hare and Midway airports with an emphasis on planning for any eventual need for additional airport capacity or a third airport.***

Electricity and Natural Gas

Infrastructure Recommendation #8 **.** ***CMAP should work with the ICC, FERC, PJM (the RTO that is relevant to the Chicago area), the IPA, and other groups on economic development considerations surrounding the future planning for electricity and natural gas capacity, transmission and distribution delivery infrastructure, generation, and supply. CMAP could form a utilities committee to track developments, regulatory changes, and future supply requirements for the electricity and natural gas industries in Illinois.***

Telecommunications

Infrastructure Recommendation #9: ***In view of the complexity of telecommunications and the many issues to be considered in deciding how best to proceed in this area, CMAP should set up a Task Force on Telecommunications to explore ways that CMAP can help foster growth of telecommunications activities in the Chicago region. The Task Force would include officials from member communities and outside experts on the telecommunications industry and on associated information-based industries.***

Infrastructure Recommendation #10: ***CMAP could provide technical assistance to communities to extend fiber-optic infrastructure to public and educational sites and to reduce the digital divide in the Chicago area in other ways.***

Waste Disposal and Recycling

Infrastructure Recommendation #11. ***CMAP should examine the potential for incentive-based strategies to reduce household and commercial hazardous waste generation including labeling and information and price mechanisms to facilitate market transition to environmentally-friendly products. In addition, CMAP should assess the strategies for encouraging proper disposal of household hazardous waste generating products including deposit-refund systems, additional disposal and recycling facilities and education and information about disposal.***

Infrastructure Recommendation #12. ***CMAP should assess the potential to increase methane capture of landfills as a pollution-reduction strategy, an energy generation market, and as a future stream of revenue generation in regional, domestic and international carbon offset markets.***

Infrastructure Recommendation #13. ***CMAP should examine and assess strategies to incorporate economic redevelopment options for closed landfills into long-term land use planning. Connect the viability of landfills as potential revenue generating site for waste to energy technology development.***

Infrastructure Recommendation #14. ***CMAP should examine the feasibility of large-scale waste to energy facilities including costs, scale and the potential to aggregate waste generators. Further examine the potential to integrate waste generators and energy producers through economic incentives and market-based instruments.***

Water Management

Infrastructure Recommendation #15 . ***Examine the potential to facilitate the transition from flat-rate water pricing to metered pricing. In addition, explore the use of variable pricing including seasonal pricing and block rate pricing based on experiences in other metropolitan areas.***

Infrastructure Recommendation #16. ***Explore the effect of additional incentives for conservation including education and information about water use, grants and tax credits for water-saving appliances and water conservation strategies including rain barrels, green roofs and grey water systems.***

Infrastructure Recommendation #17. ***Assess the potential for economic development of new technology in water treatment and delivery, and reductions in energy use.***

Infrastructure Recommendation #18. ***Examine the potential to improve wastewater treatment technology and energy efficiency to reduce energy use and costs associated with water treatment.***

Infrastructure Recommendation #19. ***Construct a set of ecological indicators based on an ecological assessment of the ecosystem services generated under various land-use and urbanization scenarios for the region as a whole.***

Infrastructure Recommendation #20. ***Estimate the economic values associated with the urbanization scenarios using the market values for economic activity and the non-market values associated with the relevant ecological indicators.***

Infrastructure Recommendation #21. ***Conduct a comprehensive economic analysis of the use of integrated green infrastructure for managing storm water under various climate scenarios. This includes the use of individual building-level systems such as green roofs and rain barrels to broader land use such as compact development and conservation design planning.***

Infrastructure Recommendation #22. ***Assess the scope of green infrastructure recognizing that protected natural areas will appreciate over time unlike man-made infrastructure which depreciates. Assess the capacity of green infrastructure and the extent to which it can reduce the burden on existing and planned physical infrastructure for wastewater and stormwater in the region.***

Public Buildings

Infrastructure Recommendation #23. ***CMAP should issue manuals giving recommendations for modernizing public buildings based partly on directives of energy efficiency programs, LEED, and federal and state guidelines.***

Infrastructure Recommendation #24. ***CMAP can act as a one-stop shop for municipalities applying for funds, giving particular attention to smaller communities with few planning resources, educating local officials, and facilitating collaboration among private and public stakeholders in the building process.***

Convention and Meeting Facilities

Infrastructure Recommendation #25. ***CMAP should set up a task force for enhancing the contribution of the conventions and meetings industry to economic development of the Chicago region. The task force, to be composed of public officials and representatives from the convention and meetings industry, should be charged with developing a white paper on appropriate roles for local governments, to be considered by the CMAP Board. Toward this end, the task force should***

a) Talk with national experts on the convention and meetings industry, with regard to short- and long-term influences at the national level and the competitive position of the major centers of convention and meeting

activity in different parts of the country. Advice should be sought on things that can be done to promote Chicago's competitiveness.

b) Commission studies to quantify the direct and indirect effects of the convention and meetings industry on employment and income in the Chicago region, taking into account hotel, restaurant and other ancillary visitor spending.

c) Deal with public and private financing issues. Attention should be given to overcoming past tendencies to base planning decisions on initial cost estimates that turn out to substantially exceeded when the facilities are built.

1. Introduction

The purpose of this report is to assess the ability of major infrastructure systems to contribute to economic growth and development of the metropolitan area, and thereby contribute economic development considerations to strategies for infrastructure investment. Many topics related to infrastructure have been examined in other CMAP reports. The present report avoids overlap by focusing only on such additional considerations as may be needed to ensure that infrastructure decisions contribute fully to economic development goals.

Major metropolitan areas rely on a large number of infrastructure systems, and many of these systems suffer from deferred maintenance. The Center for American Progress estimated that $1.6 trillion investment would have been needed to fix public infrastructure systems as of 2005.[1] This national figure translates into $52 billion for the Chicago metropolitan area, based on the fact that the metropolitan area produced 3.26% of the Gross Domestic Product. The economic importance of infrastructure has been studied by economists since the 1980s. An influential 1994 survey article by Gramlich summarized the findings up to that time:[2]

- Initial econometric estimates of the productivity of infrastructure using national data were implausibly large,
- Better econometric studies of infrastructure using data from states or metropolitan areas show a large range of possible effects,
- Projects that maintain current urban infrastructure systems (highways, airports, and so on) have the highest rates of return,
- Since most public infrastructure is owned and operated by state and local governments, infrastructure policy should be designed to give them incentives to make efficient infrastructure investments, and
- A recommended approach to infrastructure policy is to have states and localities determine needed public infrastructure investments on a case-by-case basis and to bear a significant share of the cost. (The current system of large federal subsidies for some infrastructure investments gives local authorities an incentive to propose too many projects in the hope that they can win this lottery. In the meantime needed infrastructure projects are not undertaken.)

[1] Center for American Progress, "Failing Infrastructure by the Numbers," Center for American Progress, Washington, DC, 2007.
[2] Edward Gramlich, "Infrastructure Investments: A Review Essay," *Journal of Economic Literature* 32 (1994), pp. 1176-1196.

The best recent study of public infrastructure is Haughwout's examination of public capital in central cities finds substantial marginal benefits, but those marginal benefits are low compared to the willingness of residents to pay for infrastructure.[3] One estimate is that residents are willing to pay 60% of the cost of marginal infrastructure investment. This estimate omits the impact of central city infrastructure on the rest of the metropolitan area, so Haughwout concludes that marginal benefits of infrastructure may roughly equal marginal willingness to pay.

The principal authors of this report are John McDonald (RCF Associate), George Tolley (RCF), Catherine Mertes (RCF), Sabina Shaikh (RCF), and Donald Jones (RCF). Geoffrey Hewings (REAL) contributed the example of long-run effects of infrastructure in the Chicago Metropolitan Area in Section 2.D. Valuable assistance was provided by Mark Grenchik (RCF), Jane Mahoney (RCF), Thomas Defanti (University of Illinois at Chicago), Joe Mambretti (Northwestern University) and CMAP staff.

[3] Andrew Haughwout, "Public Infrastructure Investments, Productivity, and Welfare in Fixed Geographic Areas," *Journal of Public Economics* 83 (2002), pp. 405-428.

2. Economic Contributions of Infrastructure

Infrastructure construction expenditures generate employment and income effects that last as long as the expenditures continue. In addition to these short run impacts, once the construction is completed and the infrastructure is placed in operation, the use of the infrastructure will contribute to the productivity of the economy for a number of years and attract additional firms to an urban area.[4]

2.A. Short-Term Construction Effects

Infrastructure construction expenditures entail the employment of construction workers and expenditures on materials. This employment, through the spending of workers' incomes, supports additional workers in retail, health care, entertainment, and other local service industries. Input-output models calculate the local multiplier effects of expenditures on labor and materials, as workers spend their wages and contribute to the incomes of people in an array of services industries and as the manufacturing of construction materials extends their impacts back up the chain of the raw materials used in their production.

The short-run impacts last only for the duration of construction activity. The magnitude of the impacts depends on such factors as the composition of the construction activity and the proportion of induced expenditures made within or outside the region. Lacking a systematic survey, but from observing input-output results over a number of years, local multipliers tend to be on the order of 1.5 to 2, meaning that the contribution of construction expenditure to the local economy is magnified by 50% to 100% due to the induced effects.

If any unemployment in the regional economy is due to frictional considerations due to normal job changing or to long-term structural problems connected with chronically unemployed people, with the economy close to a state of "full employment," the workers making the effects on the local economy will have to be drawn from those who would otherwise be outside the region. In a state of recession, when the foregoing conditions are not met, more of the workers will be drawn from among those living in the region who are unemployed. The infrastructure construction and its induced effects will serve to relieve distress within the region.

2.B. Implications of the 2009 Federal Stimulus Package

The timeliness of the present report is increased because of recession conditions existing at the time of this writing and by the American Recovery and Reinvestment Act

[4] Andrew F. Haughwout, "Aggregate Production Functions, Interregional Equilibrium, and the Measurement of Infrastructure Productivity," *Journal of Urban Economics* 44 (1998), p. 216.

that has been passed to deal with it. The Act includes $550 billion in spending, including these infrastructure categories:[5]

- Highway and bridge infrastructure $30 billion
- Transit and rail $10 billion
- Clean water, water resources, flood control $19 billion
- Airport improvements $3 billion
- Electricity grid, renewable technology $32 billion
- Wireless/broadband for rural areas $6 billion

Particularly relevant items for metropolitan Chicago are highway and bridge infrastructure, transit and rail, and clean water, water resources, and flood control.

The share of the stimulus funds coming to the Chicago metropolitan area will affect the rapidity with which infrastructure expenditures are put in place that will help achieve *GO TO 2040*. It should ease the burden of ultimately achieving the goals. Meanwhile, it will shift the short-run construction impacts considered in the previous section closer to the present and in the process will help bolster the Chicago area economy.

2.C. The Productivity Effects of Infrastructure

Infrastructure is quite diverse, and the routes by which it makes the economy more productive are correspondingly diverse. For example, highway infrastructure permits cheaper, faster, and more reliable freight transportation. Highway infrastructure also lowers commuting and other road travel costs for workers.

An extensive and varied literature on the productivity of public infrastructure emerged in the late 1980s and has continued to the present.[6] While there is no universal consensus on many empirical issues, several general conclusions have emerged. As a representative example, a 1% increase in the stock of infrastructure could generate an increase in productivity somewhere between 0.04% and 0.08%, which is not negligible. The productivity of public infrastructure investments in the United States has varied over time, with an apparent downward trend from the 1970s through the 1990s and into the 2000s. This effect is particularly noticeable in the case of highway infrastructure. The productivity of much public infrastructure has spill-over benefits between regions. For example, interstate highway located in one state benefits neighboring and even distant states as well as the state where it is located.

[5] House Committee on Appropriations, Jan. 21, 2009.

[6] Bureau of Transportation Statistics, "Transportation Investments and Economic Performance," Chapter 7 of *The Economic Performance of Transportation*, *Transportation Statistics Annual Report 1995* (Washington, D.C.: U.S. Department of Transportation), pp. 161-182. More recent analyses are reported for estimates of quantitative effects on productivity.

The productivity of new public infrastructure in a region depends on the kind of infrastructure, how much of it already exists in an area, and where it is located. Considering the scope for variation in rate of return on infrastructure projects, there is little substitute for cost-benefit evaluation of individual projects. The net benefit to the residents and firms in the region also depends on how it is financed. In light of the potential for spillover of benefits to residents of other regions, the division of financing between lower and higher levels of governments can be an important issue in making regional infrastructure investment decisions. Table 1 provides a summary of productivity effects of various types of infrastructure. Further discussion is provided by type in the sections that follow.

Table 1
Productivity Effects of Various Categories of Public Infrastructure

Public Expenditure	Effects	By	Source
Airport Infrastructure (increase stock by 1%)	Reduces statewide manufacturing costs	.113%	Cohen and Paul (2003)
	Reduces non-production labor costs	.074%	
	Reduces production labor costs	.079%	
	Reduces freight costs	.132%	
	Increases non-production wages	.086%	
	Increases production wages	.108%	
	Increases value of private capital	.606%	
Airport Infrastructure	Reduces cost of delays	113%-367%	Morrison and Winston (2008)
Urban Infrastructure (increase stock 1%)	Increases city aggregate land value	.11%-.23%	Haughwout (2002)
	Increases suburban house value	.61%	Haughwout (1997)
Water Utility Infrastructure (increase volume 1%)	Decreases costsgiven constant size of customer base and service area	.67%-.39%	Torres and Paul (2006)
	Decreases costs given 1% growth in customer base	.09%	
Highway Infrastructure Spending	Rate of Return (highly variable)	1970's: 17%-25%	Shirley and Winston (2004)
		1980's: 4.9%-7%	
		1990's: 1%-1.3%	
Telecommunications Infrastructure	Increase in economic growth rate from 1% increase in mainline penetration	.074%	Röller and Waverman (2001)

2.C.1. Highway Infrastructure

In the 1970s, the rate of return, nationwide, on highway spending was 17%-25%. In the 1980s, it fell to 4.9%-7%, and in the 1990s to 1%-1.3%.[7] To some extent this falling rate of return is attributable to the increasing stock of highway infrastructure, such that later increments to it simply make less difference than earlier increments, and partly to the political influences on the choice of highway projects. A recent study of infrastructure investment in France, a country with a far more centralized government than that in the United States, found little evidence of concern for maximizing productivity in project choice and considerable evidence of playing to electoral concerns.[8] Nonetheless the reduction in the productivity of aggregate highway infrastructure investments in the United States surely masks considerable variation in return across projects, and does not elucidate the potential value of replacing many aging bridges. It does, however, suggest that within a metropolitan region, careful analysis needs to be conducted on potential highway investments.

In outlying areas of the Chicago metropolitan region undergoing residential development, road construction has been estimated to have substantial impacts on agricultural land values, reflecting the anticipation of conversion from agricultural use to residential.[9] In the 1980s, investments in maintaining highway infrastructure had rates of return more than double those of investments in new highways.[10]

2.C.2. Airport Infrastructure

Investments in airport infrastructure have been found to have statistically significant productivity effects. From the national perspective, $1.00 of FAA expenditures to reduce delays has been found to reduce the costs of delay by $2.13, and depending on how efficiently the investment were allocated across the country as high as $4.67.[11]

A more disaggregate analysis has found cost-saving impacts of airports investments in states with large hub airports, such as Illinois with Chicago's O'Hare and Midway Airports. A 1% increase in airport infrastructure causes a 0.113%decrease in manufacturing costs statewide. At an estimated $124 million for a 1% increment to the replacement value of the capital stock in O'Hare and Midway Airports, and $153.8 billion in labor and material costs in manufacturing statewide in Illinois in 2006

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[7] Chad Shirley and Clifford Winston, "Firm Inventory Behavior and the Returns from Highway Infrastructure Investments," *Journal of Urban Economics* 55 (2004), p. 410.
[8] Olivier Cadot, Lars-Hendrik Roller, and Andreas Stephan, "Contribution to Productivity or Pork Barrel? The Two Faces of Infrastructure Investment," *Journal of Public Economics* 90 (2006), pp. 1133-1153.
[9] John F. McDonald and James A. Thorson, "Public Infrastructure Investment and the Market for Farmland," in L. Libby, ed., *Competition for the Land* (DeKalb, Ill.: Center for Agriculture and the Environment, American Farmland Trust, 1997) pp. 91-116.
[10] Edward M. Gramlich, op cit., Table 4, p. 1184.
[11] Steven A. Morrison and Clifford Winston. "The Effect of FAA Expenditures on Air Travel Delays," *Journal of Urban Economics* 63 (2008), pp. 675-676.

(excluding capital and energy costs), the 0.113% cost saving in manufacturing would amount to a present value of $1.17 billion over ten years. The increase in airport infrastructure results in a 0.074%cost saving for non-production labor, a 0.079% reduction in production labor cost statewide, and a 0.132% reduction in freight costs. It increases the value of private capital in the state by 0.606%, enhancing the incentives for private investment.[12]

2.C.3. Infrastructure to Accommodate Urban Living Space

Markets capitalize the productivity effects of urban infrastructure such as streets, bridges and public buildings into land values in a city. An analysis of 33 U.S. cities over a quarter-century, has estimated that a 1% increase in a city's infrastructure stock would raise the city's land values by 0.11% to 0.23%.[13] Across a score of the country's largest cities, the increase in land values in the cities would pay for 46% to 89% of the infrastructure cost. Increases in returns to firms and households could add another 39% to 59% of the infrastructure cost, in total offering a return that could range from negative 15% to a positive 48%. The estimation of these benefits assumed that the infrastructure was financed without raising taxes.

Infrastructure in the central cities of major metropolitan areas provide benefits that spill over beyond city limits to residents of surrounding suburban communities. A study of 30 U.S. metropolitan areas estimated that a 1% increase in central city infrastructure would produce a 0.61% increase in suburban house values. Thus, for an average-sized city, a $1 billion expenditure on infrastructure, with no tax increase, would increase suburban housing values by $3 billion.[14] There is evidence in addition of spill-over of infrastructure benefits to other regions.[15]

2.C.4. Water Utilities

A recent study of scale economies in U.S. water utilities has produced combined estimates of the cost implications of expanding throughput, territory size, number of customers, and types of service (wholesale and retail provision) for utilities of various sizes.[16] Producing a higher volume of water without increasing either the number of customers or the size of the service area could reduce average cost by two-thirds for small utilities (delivery volume under 1,000 Mgal per year), but falling with utility size to

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[12] Jeffrey P. Cohen and Catherine J. Morrison Paul, "Airport Infrastructure Spillovers in a Network System," *Journal of Urban Economics* 54 (2003), pp. 468-469.

[13] Andrew F. Haughwout, "Public Infrastructure Investments, Productivity and Welfare in Fixed Geographic Areas," *Journal of Public Economics* 83 (2002), p. 421-423.

[14] Andrew F. Haughwout, "Central City Infrastructure Investment and Suburban House Values," *Regional Science and Urban Economics* 27 (1997), p. 211.

[15] Alfredo Marvao Pereira and Oriol Roca-Sagales, "Spillover Effects of Public Capital Formation: Evidence from the Spanish Regions," *Journal of Urban Economics* 53 (2002), pp. 238-256, and Cohen and Morrison Paul for airport infrastructure in footnote 24.

[16] Marcello Torres and Catherine J. Morrison Paul, "Driving Forces for Consolidation or Fragmentation of the U.S. Water Utility Industry: A Cost Function Approach with Endogenous Output," Journal of Urban Economics 59 (2006), pp. 104-120.

roughly a 40% reduction for the largest utilities (delivering more than 10,000 Mgal per year). If the higher throughput is provided with proportional increases in customers, with constant customer density, small utilities experience some cost savings, but for larger utilities, higher costs from additional customers outweigh economies of volume. The smaller water utilities that incur lower expansion costs tend to have low throughput per customer and per square mile as low customer density. Such utilities can expand throughput, customers and service area size without increasing unit costs. For larger utilities average cost responds very little to increases in throughput, and the distribution costs of serving more customers and larger service areas are high, eliminating any cost reduction from expansion.

Consolidation is only cost-effective, especially for larger utilities, if the utility can increase its throughput without proportionally increasing the number of its customers and its service area size. It could even be cost-effective to reduce the size of some large systems when the higher costs of lower throughput are offset by the benefits of a smaller network size. Fragmentation may be economically justifiable instead of consolidation for some larger utilities unless sufficient trade-offs between throughput and network size or customer density can be obtained.

2.C.5. Telecommunications Infrastructure

Improving telecommunications infrastructure can increase efficiency and lower the cost of doing business. In contrast to some other forms of public infrastructure, telecommunications infrastructure generates positive network externalities, which are additional benefits that arise when a larger number of users of a good increases the value derived by those users. For contrast, think of highway infrastructure, in which more drivers can lead to congestion. Internet infrastructure has not been in place long enough to generate data on its aggregate productivity effects, but a recent analysis of 21 OECD from 1970 to 1990 found the returns to increasing telephone infrastructure are high, especially for countries that already have a high level of penetration. For such high-penetration countries, this study found that increasing the number of mainlines (a connection to the public, switched telephone network) by 1% would increase economic growth (represented by gross domestic product, or GDP, growth) by 0.074%.[17] For example, if GDP growth were 1.9% per year, a 1% increase in telephone penetration would increase that growth rate to 1.90 x 1.074, or to 2.04%. Considering the wider range of tasks that the Internet permits, the productivity of telephone infrastructure may be a lower-bound estimate of the productivity effect of Internet infrastructure.

2.D. Paying for Public Infrastructure

Public investment, whether local, state or federal, raises the issue of the crowding-out of private investment by public. At the state or local level, the competition between public and private investment is more likely to take the form of deterring investment from

[17] Lars-Hendrik Röller and Leonard Waverman, "Telecommunications Infrastructure and Economic Development: A Simultaneous Approach,"*American Economic Review* 91 (2001), pp. 909-923.

the area. While there is not a consensus on the strength of the deterrent effect on business of state and local taxation, the existence of such effects is well established.[18]

Local areas, including regions the size of the Chicago metropolitan area, can benefit on net from infrastructure investment depending on how the infrastructure is financed—that is, according to the proportions of own-finance and outside financing from state or federal agencies. Particular types of infrastructure are candidates for partial external financing due to spill-overs outside the area, such as interregional highways, bridges and airports. The apportionment of local residents' versus visitors' use of local infrastructure bears empirical investigation beyond what is available in the literature currently.

2.E. Example of Simulated Impacts of a Transportation System Investment

As opposed to the short-run impacts of infrastructure that last only as long as the construction period as considered above, the permanent multiplier effects of infrastructure depend on how it affects productivity in the regional economy. In the following example, the permanent multiplier effects in the Chicago area from investments in infrastructure appear to be on the order of 2, meaning that a $1 billion investment will result in an additional $1 billion in local income over the course of the construction.

The example is for an improvement in the Chicago region's transportation infrastructure. An investment of $2 billion is assumed to reduce commercial trucking costs and household commuting costs by amounts that yield a ratio of benefits to costs of 1.1. Half of the investment cost is assumed to come from federal funding, an inconsequential proportion of which comes from within the Chicago region. One quarter of the remainder is paid with state funds that are raised from tax revenues originating outside the Chicago region, leaving 37.5%, or $750 million, paid by taxes on households within the metropolitan area. In reality, businesses can be expected to share some of the financial burden. Three-quarters of the savings go into increased production. The remainder is divided evenly between increased profits and increased wages and salaries. The multiplier impacts were calculated with the Chicago Regional Economic Impact Model (CREIM), developed by the Regional Economics Applications Laboratory of the University of Illinois at Urbana-Champaign.

The impacts on metropolitan area output shown in Table 2 recur each year for a number of years. Their present value discounted at a 10% discount rate sums to $2.2

[18] Leslie E. Papke, "Interstate Business Tax Differentials and New Firm Location: Evidence from Panel Data," *Journal of Public Economics* 45 (1991), pp. 47-68; James A. Papke and Leslie E. Papke, "Measuring Differential State-Local Tax Liabilities and their Implications for Business Investment Location," *National Tax Journal* 39 (1986), pp. 357-366; Leslie E. Papke, "Subnational Taxation and Capital Mobility: Estimates of Tax-Price Elasticities," *National Tax Journal* 40 (1987), pp. 191-203.

billion. The short-term impacts of the actual construction are not included in these calculations, only the lasting impacts on improved transportation efficiency. If transportation investments yielded a lower rate of return, these impacts would be reduced proportionally, and of course if a higher rate of return were achieved, the impacts would be increased, but either way, their sectoral distribution would not be affected.

Table 2

Annual After-Tax Output Impacts of $2 Billion Investment in Transportation Infrastructure,
in millions of dollars

Sectors Affected	Impacts from Commercial Transportation Industry	Impacts from Reductions in Commuting Times	Total
Resources	$.54	$1.89	$2.44
Construction	$2.27	$13.79	$16.06
Nondurables	$5.82	$27.13	$32.95
Durables	$1.71	$9.21	$10.92
TCU*	$3.55	$12.61	$16.15
Trade	$4.06	$32.78	$36.85
FIRE**	$5.26	$22.22	$27.48
Services	$8.52	$66.08	$74.60
Government	$.34	$2.22	$2.56
Total	**$32.07**	**$187.93**	**$220.00**
Direct	$15.16	$86.16	$101.32
Indirect	$16.91	$101.77	$118.68
(multiplier)	$2.12	$2.18	

*Transportation, telecommunications and public utilities.
**Finance, insurance and real estate.

Table 3 reports the associated increments in employment, a total of nearly 1,900 new jobs in the region. The largest employment impacts are in services and trade.

Table 3

Annual After-Tax Employment Impacts of $2 Billion Investment in Transportation Infrastructure, *in millions of dollars*

Sectors Affected	Impacts from Commercial Transportation Industry	Impacts from Reductions in Commuting Times	Total
Resources	$2	$4	$5
Construction	$18	$106	$124
Nondurables	$7	$38	$45
Durables	$7	$35	$41
TCU*	$13	$39	$52
Trade	$49	$484	$532
FIRE**	$25	$104	$129
Services	$88	$794	$882
Government	$8	$53	$61
Total	**$217**	**$1,655**	**$1,871**
Direct	$99	$923	$1,021
Indirect	$118	$732	$850
(multiplier)	$2.2	$1.79	

*Transportation, telecommunications and public utilities.
**Finance, insurance and real estate.

3. Conclusion

This report has found that economic development needs for some types of infrastructure in the Chicago metropolitan area are already quite thoroughly studied by existing CMAP efforts. Other types of infrastructure require considerable new effort to help improve their contribution to economic development.

Twenty-five recommendations have been made for CMAP to take a more active role in promoting the contribution of infrastructure to economic development. The recommendations range from providing oversight and advice on infrastructure adequacy and financing both for infrastructure as a whole and individual types of infrastructure, to making quantitative projections for some types of infrastructure, to providing technical assistance in the planning of some types of infrastructure.

The recommendations can be found throughout the report, and they are summarized in the Executive Summary.