Public Infrastructure Investment and the Market for Farmland

by
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Introduction

The purpose of this paper is to summarize what is known about infrastructure investment and the market for farmland at the fringe of an urban area. This purpose will be accomplished according to the following outline.

The first task is to define what is meant by the infrastructure in general, and then to focus on the parts of the infrastructure that are particularly relevant to the land market at the urban fringe. This definition leads to an examination of the trends in infrastructure investment, particularly the decline in the ratio of infrastructure to GNP since the early 1970s. We also examine the studies that summarize the results of cost−benefit analyses of various types of infrastructure investments to determine the probable future course of infrastructure spending.

The next step in the study is to examine briefly the debate that has been taking place concerning the contribution of public infrastructure to economic growth. The work of Aschauer (1989) set off a heated controversy among economists, and no general discussion of public infrastructure is complete without a summary of the current status of this debate. Aschauer found, in a study of the growth of the national economy, that public infrastructure investment had made a very large contribution to the growth of GNP (and to GNP per capita). In fact, we now know that his estimates of this contribution are unbelievably large, and that the fact that the growth rate of GNP fell at the same time that infrastructure investment was being cut back (in the early 1970s) is probably a coincidence with no strong cause and effect implied.

We believe that the effect of infrastructure investment on the land market depends critically upon the method used to finance that investment. The next section of the paper examines the changes that have taken place in the methods of infrastructure finance. In particular, the use of land−use exactions and impact fees has increased greatly in recent years partly to replace declining federal funding. We next develop a model of the value of land at the urban fringe. This model is used to examine the relationship between infrastructure investment and farmland values under alternative infrastructure financing scenarios. A major element of the model is the mechanism through which actors in the market form their expectations that farmland will be converted to urban use.

The next section examines the empirical studies of value of farmland at the urban fringe. The results of previous studies are summarized and presented in Table 1. One important finding is that the proximity to a highway consistently has a positive impact on farmland values. Also, the provision of water and/or sewer service has a very large positive impact on value. This discussion is followed by a new study of land−use allocations and farmland values in McHenry County, Illinois − a county on the fringe of the Chicago metropolitan area. This study finds that an increased provision of roads increases farmland values in areas that are more likely to undergo urban development in the foreseeable future, but not in other areas. The final section provides a summary and conclusions.

Trends in Public Infrastructure Investment

What is the infrastructure? Webster's provides a pretty good definition; a substructure or underlying foundation, especially the basic installations and facilities on which the continuance and growth of a community, state, etc. depend, as roads, schools, power plants, transportation and communication systems, etc. We think that it is useful to divide the infrastructure into four categories based on whether the installations and facilities are owned publicly or privately, and whether they are for the purpose of directly supporting urban activities or supporting other activities (e. g., agriculture, interurban/interstate commerce, etc.). In this discussion we are concentrating on infrastructure that is owned publicly. We recognize that infrastructure that is provided privately (such as electric power, telephone and cable television) may also have important impacts on the land market at the urban fringe. These impacts are good topics for future research.

Data provided by the Bureau of Economic Analysis, U. S. Department of Commerce enumerate the value of the non−defense public infrastructure, defined as the tangible public (non−defense) capital stock, as of 1990 as follows:

	1990 Stock ($ billion)	*Percent of GNP*
Total	2180.4	40.6
Federal	298.1	5.5
Buildings	70.1	1.3
Core Infrastructure	26.3	0.5
Highways Streets	17.2	0.3
Other Structures*	9.1	0.2
Conservation and Development	140.5	2.6
Equipment	61.2	1.1
State and Local	1882.3	35.1
Buildings	575.0	10.6
Core Infrastructure	1143.0	21.5
Highways and Streets	693.6	13.0
Sewer	184.1	3.5
Water Supply	109.6	2.1
Other Structures*	155.7	2.9
Conservation and Development	33.3	0.6
Equipment	131.0	2.5

*Includes mass transit, airports, electric and gas facilities.

Most of the public capital stock (86.3 percent) is owned by state and local governments. But note that the largest item of infrastructure owned by the federal government is the conservation and development category, which consists largely of water resource projects for flood and erosion control, hydroelectric power, etc. Some of these projects, especially ones in the West, have been criticized harshly in the economics literature as having benefit−cost ratios far below 1.0. These projects add value to rural land, and in some instances, make agricultural activity possible.

The infrastructure owned by state and local governments largely supports urban activities. The buildings category includes schools, public office buildings, police and fire stations, public hospitals and so on. The core infrastructure of highways and streets, sewer systems, water supply systems, and other structures supports the towns and cities. The major exceptions are the state highways and county and township roads that support the rural areas, such as the "farm−to−market" roads in Texas.

What are the trends in public infrastructure capital and investment? These trends are discussed in several publications, including Winston and Bosworth (1992), Tatom (1993) and Gramlich (1994). The data on public capital and investment tell an important story − the public infrastructure as a percentage of GNP has declined steadily since 1970. In 1970 the ratio of non−defense public infrastructure of all kinds to GNP was .489, but by 1990 that ratio had dropped to .406, a drop of .083. Much of that drop can be attributed to the decline in the ratio of state and local highway and street infrastructure to GNP from .178 to .130, but other infrastructure categories such as public buildings and flood control projects exhibit declines as well.

The failure to build new urban highways has contributed to a sizable increase in traffic congestion. A recent book by Downs (1992) entitled Stuck in Traffic explains why traffic seems to be getting worse. The growth rate of population in the United States as a whole is not very great, but some urban areas, such as Los Angeles, Phoenix, Atlanta and others in the sunbelt, have experienced big population increases. More important, employment, licensed drivers, and autos and trucks in use have all increased rapidly. In addition, those vehicles are driven more miles per year than before. According to Downs (1992, p. 13), population grew by 9.8 percent from 1980 to 1990, but the number of autos increased by 22.1 percent. In 1990 there were 76.5 registered vehicles per 100 people in the United States. These changes are coupled with a general failure to build new highways. Downs (1992, p. 11) notes that total highway mileage in the United States increased by only 0.6 percent from 1981 to

1989, a time period when autos and trucks increased by 24 percent and total vehicle miles driven jumped by 33.6 percent. Urban highways are not being built at a rate that is fast enough to keep up with the drivers.

The failure of the public infrastructure to grow with the economy stems from a decline in gross investment in infrastructure that began in the late 1960s. According to data in Winston and Bosworth (1992), gross investment in public capital peaked in 1969 at 3.9 percent of GNP and dropped steadily throughout the 1970s and early 1980s to 2.0 percent of GNP in the years 1982−1985. Since then it increased slightly as a percentage of GNP to 2.2 percent in 1991. Winston and Bosworth (1992, p. 271) showed that state and local government spending on one critical component of infrastructure, highways and streets, increased sharply in the 1950s and 1960s to a peak level of $36 billion (1990 dollars) in 1969, and then fell to $19 billion in 1981. Spending on this category recovered to $30 billion in 1990, so there has been an effort in recent years at least to maintain the existing highway and street system and to make some new investments. In contrast, Winston and Bosworth (1992, p. 271) showed that state and local investment spending on water and sewer systems has grown (in 1990 dollars), albeit rather unevenly, from about $10 billion per year in the late 1960s and early 1970s to $16 billion per year in the early 1990s. State and local spending on "other structures" (including mass transit, airports, and electric and gas facilities) has remained stagnant since the late 1960s at around $8 billion per year. Investment in school buildings has declined since the end of the baby boom in the early 1970s.

Some of the spending in recent years has been to replace portions of the urban highway systems that were built in the late 1950s and 1960s. These highways have useful lives of 25 to 30 years in the northern urban areas, and after that they must be replaced from the dirt up. They reach a point where putting patches on patches does no good. Those of you who know the Chicago metropolitan area know that most of the expressway system has been replaced in recent years. Winston and Bosworth (1992) explained that the most important reason for falling infrastructure investment, especially in highways and roads, is a lack of revenues dedicated to the purpose. Highway construction is financed primarily by taxes on gasoline. The federal tax on gasoline remained at four cents per gallon from 1960 to 1982, which meant that the real federal gas tax dropped from four cents per gallon to 1.3 cents per gallon. The federal gas tax has since been raised twice and is now 14 cents per gallon. State taxes on gas also remained flat in nominal terms from 1960 to 1980 at about nine cents per gallon on average. Since then the average state tax has increased to approximately 16 cents per gallon. It seems that the sharp increase in gasoline prices in the 1970s caused by the Organization of Petroleum Exporting Countries deterred governments from raising gas taxes. The price of gasoline dropped in the 1980s; government officials evidently felt that gas taxes could be increased in an era of declining pump prices. The recovery of spending on highways and roads was the result. Much of that spending was financed by rising gas taxes that increased monies in the federal and state highway trust funds. Grants from the U.S. Department of Transportation, the U.S.

Department of Housing and Urban Development (under community block grants) and state governments also played a role.

Given these trends in infrastructure investment, can we predict future investment trends? One approach, adopted by Gramlich (1994) in his survey article, is to make use of alternative methods to determine whether there is a "shortage" of infrastructure investment to which policy makers might respond. By the way, Gramlich does not think that there is a general shortage of infrastructure investment, but he does identify some categories of infrastructure projects with high benefit−cost ratios.

One method for determining an infrastructure shortage is to make an engineering needs assessment. Such studies specify some desired capital stock based on a previous period when capital presumably was adequate, and then compute a gap between the current capital stock and this desired stock. According to Gramlich (1994), these computations make little or no use of economic reasoning and, in the end, generally do not make a compelling case for the proposition that infrastructure capital is significantly out of balance. The strongest evidence in favor of an infrastructure imbalance is in the case of traffic congestion on urban interstate and arterial highways, but Gramlich (1994) argues that more efficient utilization of existing facilities could be accomplished by giving drivers incentives to alter the patterns of urban travel. These suggestions include programs to induce employers to have staggered work hours and to promote car pooling among employees. Also, the idea of peak−period congestion tolls is an idea that economists have promoted for many years. This idea is now being taken seriously by transportation policy makers, and some demonstration projects are being planned as a result of the Intermodal Surface Transportation Efficiency Act of 1991. See McDonald (1997) for a textbook treatment of the economics of urban traffic congestion. However, Gramlich's summary is that there is very little documented need for increasing investments in rural interstate highways, water and sewer systems, aviation, or mass transit.

A second method for examining the possibility that there is an infrastructure shortage is to study the voting on local bond issues, which largely are used to finance infrastructure projects. Gramlich (1994) shows that the rate at which bond issues were approved by voters during the 1968−1978 period was well below the historic average, but that the approval rate was at the historic average (of 70 percent) during the 1980s. This evidence suggests that voters thought that the increases in infrastructure investment that took place during the 1960s were more than sufficient for the period of the 1970s, and that a more normal approval rate returned in the 1980s. The evidence from voting on bond issues thus does not provide evidence of a general infrastructure shortage.

The third method for evaluating a possible infrastructure shortage is to estimate economic rates of return on infrastructure projects of various types. The Congressional Budget Office (1988) has summarized a large number of benefit−cost studies of individual investment projects in the transportation sector. Investments required to maintain the current quality of the urban highway system provide expected annual returns of 30 perent to 40 percent, and selective expansion of the system in congested areas would yield returns of 10 percent to 20 percent. Improvements in airport capacity and air traffic control systems at major airports also yield high returns. However, other infrastructure projects yield low returns. Investments in inland waterway projects, new rural highways, upgrades of rural highways, and public and rail transit in smaller cities all have very low estimated returns.

It may well be that future trends in infrastructure investment depend more on political factors than on economic returns. Infrastructure traditionally is part of the pork barrel. Nevertheless, the best economic evidence that can be mustered by the experts cited above is that infrastructure investment in the future is likely to focus on maintenance and highly selective expansion of urban highway systems and on airports and air traffic control. There appears to be little economic need for an expansion of infrastructure investments in rural areas. Indeed, many economists have argued that there has been overinvestment in rural water resources projects. Also, growing urban areas will continue to make infrastructure investments at the urban−rural fringe − highways and streets, water and sewer systems, schools and other public buildings, and so on. The future of infrastructure investments for urban areas that are not growing very rapidly is less certain. Many of these urban areas, such as metropolitan Chicago, expanded their land areas greatly during the 1970s and 1980s after the completion of the interstate highway system. However, at this point it is not clear how rapidly infrastructure investment will be made and how much land will be converted from rural to urban use. Indeed, there is a political movement within the urban area that argues for a significant slowdown in the expansion of the land area taken up by urban areas. One important reason for this political movement is concern over the fact that residents of the inner city are becoming increasingly isolated from areas of employment growth in the suburbs. See McDonald (1997) for an extensive textbook treatment of this topic. Planning authorities are taking this view into account, but the future remains cloudy.

Infrastructure and Economic Growth: A Summary of the Debate

As we stated in the introduction, no discussion of the public infrastructure is complete without at least a brief examination of the heated debate over the role of infrastructure in the growth of the overall economy. Aschauer's initial study (1989) was followed by a large number of studies, some of which confirmed his results and others that were highly critical of his methods and findings.

The fundamental idea is pretty simple − include the public capital stock in a production function for the aggregate economy. The basic equation is: $Q = A F(L,K,G)$, where Q (aggregate output) is a function F of labor (L), private capital (K) and public capital (G). The variable A is an index for the productivity of the inputs. For purposes of empirical study this equation is usually written in logarithmic form as: $\ln Q = \ln A + a\ln L + b\ln K + c\ln G$, where ln denotes natural log (log to base e), and a, b and c are the coefficients of the inputs. Aschauer used aggregate time series data for the

United States economy to estimate this equation, and found c to be .38 to .56. Such estimates for c are implausibly large because they imply that a 1 percent increase in public capital will increase aggregate output by .38 percent to .56 percent. Aschauer's estimates of c mean that a good solution to the problem of sluggish economic growth is simply to increase the rate of growth of the public capital stock by two or three percentage points − a task that should not be terribly difficult. If only it were so easy!

Criticisms of Aschauer's results can be made on logical grounds. First of all, how exactly does the public capital stock contribute to aggregate output (as measured by GNP)? The single largest component of the public capital stock is highways and streets. Clearly better highways and streets make transportation (especially trucking) more efficient, but it is difficult to see how the impact of highways and streets can be as pervasive as Aschauer's estimates suggest. The second−largest component of public capital is public buildings, and it is difficult to see how school buildings, police and fire stations, etc. contribute to current GNP beyond providing places for public services to be performed. Secondly, Aschauer's estimates imply that the rate of return to public capital investment is greater than the rate of return to private investment. If that were true, then private businesses would be calling for a great deal more public investment. And lastly, even if past investments in public capital were very productive, the productivity of future investments can be in doubt.

Aschauer's research can also be criticized on more technical grounds. The causation may run in the opposite direction − greater output may cause greater public capital. A richer nation spends some of those riches by providing more of the amenities associated with the public capital stock. A related point is that the trends in aggregate output and public capital may have moved together for reasons that have little or nothing to do with the productivity of public capital. We know that investment in public capital slowed down in the early 1970s for a variety of reasons; the interstate highways system had been completed, construction of the generation of airports needed for jet planes had also been completed, and the construction of school buildings declined because the last of the baby boomers had already entered school. These reasons are largely unrelated to the slowdown in the rate of overall productivity growth.

The growth of GNP slowed down at roughly the same time for a whole host of reasons that we still do not fully understand. Some economists blame slower growth in private capital. Many economists cite a decline in the average quality of workers because of the increase in the labor force participation of teenagers and women since 1973. Others point out that we are running out of raw materials; it costs more to recover the same amount of oil, natural gas and other natural resources. The impacts of government rules and regulations, particularly environmental and safety rules, are blamed by some. The slowdown in public capital investment is also included in this list. All of these arguments have merit, but at this point we do not know enough to determine how much of the decline in GNP growth can be attributed to each. This situation creates the opportunity for a lot of people to make a lot of suggestions, many of which have little solid research to back them up.

Several researchers have attacked Aschauer's findings with findings of their own, and most of that research has found that public capital has only a modest impact (or zero impact) on output. Gramlich (1994) provides a summary of these studies. The bottom line seems to be that we should not ignore the public infrastructure as a possible contributor to economic growth, but that there is no reason to initiate a large increase in public infrastructure investment. The excitement caused by Aschauer's study (and others) has subsided, and we are back to considering each proposed public investment project on its individual merits.

In contrast to studies of aggregate economic growth, some studies have examined the effects of infrastructure provision on the business location decisions in rural areas. For example, a recent study of location choice by manufacturers in rural New England and Wisconsin by Halstead, Deller, and Draper (1996) found that proximity to four−lane highways, freight rail lines and lower solid waste disposal and waste water treatment costs attract manufacturing plants. Proximity to airports did not exhibit a statistically significant effect on manufacturers' location choices in their survey. These results suggest that a rural area can use infrastructure investments to attract economic activity. However, the larger issue is whether such infrastructure investments simply bring about a somewhat different location pattern for a given amount economic activity. It is not clear that "rearranging the furniture" yields a net gain for society as a whole.

In spite of the finding by the Congressional Budget Office that new highway construction projects do not generally exhibit high economic rates of return, there are quite a few projects on the drawing boards. A report by Novins, Subramanian, and Hirsch (1996) provides some details on 22 proposed highway projects that would use federal funds to build highways of doubtful usefulness. The largest of these 22 projects are:

- Outer Perimeter Highway in the Atlanta metropolitan area (cost of $5 billion),
- Grand Parkway project, an outer freeway loop for Houston (cost of $1.8 billion),
- Appalachian Corridor H Highway, to run from Strasburg, VA to Elkins, WV (cost of $1.1 billion),
- Inter−County Connector, to run from Laurel to Gaithersburg, MD (cost of $1 billion) and
- I−69 Highway Extension to run from Indianapolis to Evansville, Indiana (cost $800 million).

At this point it is not clear whether any of these projects will actually be built. However, each one has managed to generate some fairly sophisticated opposition. As we said, the selection of infrastructure projects often turns on political factors rather than on economic analysis. It is also true that, as long as the federal government is willing to pay a substantial portion of the costs of infrastructure projects (up to 90 percent in some cases), state and local governments are foolish not to propose projects. Often it is up to the federal officials to sort the good ideas from the bad ones. Citizens' groups now recognize that they can play a role in this process as well.

The Financing of Infrastructure

Both the buildup in public infrastructure investment in the 1950s and 1960s and the decline in the 1970s and 1980s are the result of federal policy. For example, Altshuler and Gomez−Ibanez (1993, p. 29) note that federal spending for five major infrastructure categories − highways, aviation, mass transit, water supply and waste water treatment − nearly quadrupled in real terms from 1956 to 1965, then dropped by two−thirds from 1965 to 1989. In 1965 federal funds paid for 50 percent of these expenditures, but the federal share was only 16 percent in 1989. The dollar amounts (in 1987 dollars) of federal spending for these five categories were $14.0 billion in 1965, $15.2 billion in 1980 and $5.3 billion in 1989. It has been up to state and local governments to replace the federal dollars.

Prior to the mid 1950s, state and local governments were responsible for financing infrastructure investment, and they used a combination of state and local taxes (property taxes, sales taxes, etc.), bond issues (backed by the power to tax), special assessments, and land dedication for streets, sewers, and so on. According to Altshuler and Gomez−Ibanez (1993, p. 28), the per capita stock of state and local fixed capital was growing at a rate of 2.0 percent per year in the early 1950s. The federal government got into the business of funding infrastructure investment in the mid 1950s with the initiation of the Interstate Highway System and other projects, and the growth rate of the per capital stock of state and local fixed capital was 3.6 percent per year for the 1955−1970 period. This growth rate dropped to 0.7 percent for 1970 to 1990 as the federal government cut back on funding.

The decline in federal funds for infrastructure investment is one primary cause of the greatly increased use of what Altshuler and Gomez−Ibanez (1993, p. 3) call land use exactions: "Exactions may be in−kind or financial. In−kind exactions require developers to contribute land, to construct public facilities, or to provide public services. Financial exactions, most commonly known as 'impact' or 'development' fees, require monetary payments to the public coffers." The legal basis of in−kind exactions and impact fees is that governments have found that various public needs can be attributed to the new development, and therefore require that these costs be assessed as part of the development process. Land−use exactions are "user fees" rather than taxes because a direct connection exists between the user and the fee. Altshuler and Gomez−Ibanez argue that the increased use of land use exactions has also been caused by the rise in neighborhood−based citizens groups, the growing influence of environmental groups, slow growth in income for many households and the resulting resistance to taxes and new federal and state mandates.

Altshuler and Gomez−Ibanez (1993, p. 34) state that, "A virtual revolution in exaction utilization took place in the 1970s and 1980s, according to several measures: the number of localities involved, the purpose for which exactions were considered appropriate, and the significance of exactions as an element of both local government revenue and real estate development cost."

Purdum and Frank (1987) provide information about the use of exactions up to 1985 as follows:

Exaction purpose	*Period of rapid adoption*	*Exaction types used by 40 percent or more localities*
police stations	1970−84	build, land, cash
parks	1970−84	build, land
roads	1970−84	build, cash, land
schools	1970−79	build, land
water lines	1960−64	build, cash, land
water treatment	1960−74	build, cash, land
sewage treatment	1960−74	build, land
solid waste	1960−64	build, land, cash
sewer lines	1970−79	build, cash, land
open space	1970−84	cash, land
fire stations	1970−84	build, land, cash
affordable housing	1980−84	build, cash, land

Other studies cited by Altshuler and Gomez−Ibanez (1993) found that the use of exactions is more prevalent in California than in the East, and that growing communities are much more likely to use exactions.

The dollar amounts of the land−use exactions vary widely, in part because some of the exactions are in kind. The magnitudes of impact fees vary widely, and there is no general study that can be cited. One study of impact fees in Loveland, Colorado by Singell and Lillydall (1990) found that actual incremental costs per dwelling were $5,000 to $7,000 in the mid 1980s. Another study of local governments located primarily in California [Altshuler and Gomez−Ibanez, 1993, pp. 39−40] found that the average impact fee in 1991 was $12,000 per typical single−family house. The average impact fee on nonresidential development was $6 per square foot. These fees varied enormously across local jurisdictions. Most impact fees are negotiated rather than set by some formula, so the huge variation is not surprising. Indeed, Altshuler and Gomez−Ibanez do not say so, but it is likely that impact fees vary substantially within the same jurisdiction. There is no study of the issue of corruption, but clearly the potential for illegality is there.

Altshuler and Gomez−Ibanez (1993) conclude that land−use exactions are here to stay, and that they are probably preferable to the alternatives that are available to local governments in need of funds for infrastructure investment. The alternative that is most easily available to local governments is simply to prohibit (or sharply control) growth. Altshuler and Gomez−Ibanez argue that land−use exactions are better than growth controls because they permit growth to take place provided that the developer pays for the needed infrastructure. However, many impact fees and in−kind contributions are not accurate estimates of the true costs generated by the development. Given that land−use exactions are here to stay, a goal is to make those exactions into reasonably accurate estimates of the marginal costs to society of additional urban fringe development. Those marginal costs should include the costs to society of giving up farmland.

It is clear that the use of land−use exactions has an impact on the rate of urban development, the location pattern of development, and the value of the land that is developed. Professor Peddle argues that the use of land−use exactions may actually stimulate development at the urban fringe, especially if the alternative scenario includes local governments with little or no ability to finance infrastructure investment. We would add that land−use exactions can be seen partly as a substitute for federal funds that once provided infrastructure at the urban fringe at reduced prices to local governments. Holding other factors constant, this substitution in funding for infrastructure will slow down the rate of urban development.

A Model of Urban Fringe Farmland Value

So far this paper has been concerned with defining what is meant by public infrastructure and documenting general trends in infrastructure investment and finance. With these sections of the paper as background, the task now is to concentrate on the impacts of public infrastructure capital on the market for farmland at or near the fringe of urban areas. The first task is to formulate a reasonably simple model of urban fringe land values that can be used to study the questions at hand. What are the effects of various types of infrastructure investments on farmland values at or near the urban fringe?

What are the effects of the various means for financing that infrastructure investment on the value of the land? As we noted in the introduction, a critical element in the model pertains to the formation of the expectation that land will be converted to urban use.

The empirical research on land values at the urban fringe is based on the hedonic model of land values − the idea that a parcel of land has a value that reflects its many characteristics. Use of this model means that implicit prices for characteristics that differentiate parcels can be estimated. Chicoine (1981 p. 354), for example, classifies those characteristics as:

- access to points of economic and social attraction
- amenity and physical properties of the land itself
- public services (and associated taxes)
- institutional factors that influence the land market

In addition to these types of characteristics, Dunford, Marti, and Mittelhammer (1985) argue persuasively that *subjective expectations* about the timing and nature of future development are also potentially an important determinant of land values − especially urban fringe land values. The specific variables used in various studies to measure these characteristics are discussed in the next section. But first we wish to consider the role of public infrastructure in the determination of land values at the urban fringe.

We shall consider each of the major forms of public infrastructure in turn. It is logical first to consider highways, roads and streets. The value of farmland in virtually any location is enhanced directly by the provision of highways and roads because they provide accessibility for the farmers and their products. However, this is not the issue. Farmland that is located at or near the fringe of an urban area generally is provided with highways and roads that are sufficient for farming purposes. The provision of high−performance highways and/or roads that signals reasonably imminent conversion to urban use can be expected to have a sizable impact on land values. Given the relatively low population density in farming areas, farmers do not really need superhighways to get into town. Rather, the provision of highways and roads beyond the needs of farmers can create the (entirely reasonable) expectation that buyers will find the land near those facilities to be attractive for urban uses. However, the provision of such highways and roads by itself may not create the expectation that urban development is imminent.

Next, consider public infrastructure that provides basic services directly to the land parcel; water lines, sewer lines, water treatment facilities and sewage treatment plants. A certain minimal amount of development for residential or commercial purposes can take place at the urban fringe without these features. [The first author grew up on the urban fringe of Decatur, Illinois. In the 1950s we had our own well and septic tank and field of tile. The road in front of our house was gravel and pretty dusty. The area behind our back fence was a pasture, and he literally walked a mile through corn fields to get to the elementary school, which had four rooms. Standards for urban fringe development are higher now.] Normally the provision of water and sewer lines takes place as a plot of land is being developed for fairly dense urban use. Farmland that has access to water and sewer services can be expected to undergo urban development in the not−too−distant future.

Finally, consider off−site facilities such as school buildings, police and fire stations, and parks that provide services for a neighborhood. Holding other things equal, proximity of farmland to these facilities adds to land value both because they mean that better services are being provided to the residents of the farmland and because they raise the expectation that urban development will follow.

The method used to pay for the infrastructure investment will also affect the value of the land. Professor Featherstone's paper examines the general issue of tax policy and the market for farmland, so we restrict our comments to the matter of infrastructure finance. As we discussed in the previous section, the cutbacks in federal funds for infrastructure mean that state and local governments have shifted to the use of land−use exactions to finance infrastructure investment. This shift means that the provision of infrastructure at the urban fringe will be accompanied by the obligation to pay an amount that could even exceed the cost of that investment. Developers will agree to pay as long as they can make money at the business of developing urban fringe land. Some (or perhaps even all) of the land−use exaction cost can be shifted forward to the developer's customers in the form of higher prices for developed parcels, but this increase in price will mean that fewer developed parcels will be demanded. See Singell and Lillydall (1990) for a reasonably simple economic model of housing supply and demand with these implications.

Altshuler and Gomez−Ibanez (1993) reach the conclusion that land−use exactions can be thought of as rough and ready user charges for public facilities. The widespread use of land−use exactions will tend to slow down the rate at which land is developed and converted to urban use compared to a regime in which others (e.g., the federal government or other state and local taxpayers) pay for the infrastructure. As a practical matter, we can expect that the rate at which land is developed for urban use in the proximity of a new high−performance highway will now be slower than it was in the old days of generous federal support of infrastructure investment. This expected delay in development means that the current value of farmland at or near the urban fringe is reduced in comparison to the scenario in which developers do not pay sizable land−use exactions. As far as we know, no one has conducted an empirical test of this hypothesis − that urban fringe farmland values have been reduced by the increase in land−use exactions. We turn now to the empirical tests that have been conducted.

Empirical Studies of Urban Fringe Farmland Values

The empirical studies of the urban fringe land market typically were not designed specifically to determine the effect of all of the various infrastructure investments on the value of land. Some were designed to examine the impact of highways on land values, but most had some other purpose. Nevertheless, most of the studies include some measure of the infrastructure because important variables must not be omitted from statistical studies. In this section we review the findings pertaining to infrastructure capital of the main published empirical studies of urban fringe land values. A summary of these findings is shown in Table 1.

The empirical findings are actually reasonably consistent. The studies show that distance to a highway has a negative effect on farmland value, and three of the six studies that include this variable found that the effect is 2.0 percent to 2.6 percent per mile. One study found that the effect was −3.1 percent to −6.9 percent per mile, another estimated the effect be −$9 to −$13 per mile per acre in 1970 (but not enough information was included to convert to percentage terms), and one study found no effect.

Two studies included water and/or sewer service, and found very large effects. The provision of both water and sewer service increased land value by 98.4 percent, and a location within the sewer service area increased land value by 84.2 percent. As we discussed in the previous section, the provision of water and sewer service to an area that currently is in agricultural use usually means that conversion to urban development is imminent. The other infrastructure variables included in the studies listed in Table 1 are:

- parcel has road frontage
- frontage road quality (non−township)
- parcel abuts a town

All of these variables have the expected positive effect on farmland values. One recent study by Henneberry and Barrows (1990) found that frontage on a highway had no statistically significant effect on farmland value, but this study was restricted to parcels with little potential for conversion to urban use. Henneberry and Barrows used an elaborate statistical method to define such a subsample in their data, and their finding is consistent with our hypothesis that highway access increases the value of farmland if it signals conversion to urban use in the near future.

Finally, the study by Dunford, et al. (1985) included a variable to indicate that the buyer of the parcel expects that the area surrounding his/her parcel will be developed more intensively in the subsequent five years. A "yes" response to this question adds 34.2 percent to market value.

An empirical study by McMillen (1989) that is not listed in Table 1 takes a direct look at land−use at the urban fringe. He divided land−use into three categories; residential, vacant and agricultural. (The other uses of land in the area under study were a small fraction of total land.) The probability that a land parcel that was sold is in one of these categories was hypothesized to be a function of several variables that measure location and the nature of land−use in the surrounding area. The results of this study are that:

- lot sizes are smallest for residential land−use and largest for agriculture

- farmland tends to be located at greater distances from larger towns in the area
- railroads are a strong disamenity for residential users
- the probability that a parcel is sold for agricultural use declines over time in the area studied

Also, McMillen (1989) found that his model predicts that a vacant parcel is residential as often as vacant. This finding suggests that vacant land is ripe for conversion to residential use; the conversion of land from agricultural use to vacant is an intermediate step in the conversion to urban residential use. Future research might focus on the possibility that the existence of vacant land at the urban fringe signals conversion to urban use in the near future.

As the previous sections of this paper suggest, there are several more public and private infrastructure variables that could be investigated in future research projects. In addition, none of the studies listed in Table 1 included any variable to control for the use of land−use exactions. This omission may mean that some of the results shown in Table 1 are out of date and that more research is needed. An empirical study by Singell and Lillydall (1990) found that an increase in impact fees in Loveland, Colorado was associated with higher prices for both new and old houses. The increase in the price of old houses stems from a reduction in the construction of new houses.

New Estimates from McHenry County

The literature has not examined the effect of infrastructure investment on farmland values in great detail, so this section will provide a new study for McHenry County, Illinois. McHenry County is located on the northwestern fringe of the Chicago metropolitan area. The county is particularly important in the market for farmland on the urban fringe because in 1979 it increased the minimum lot size for agricultural land from 5 to 160 acres. Given the significance of McHenry County in the farmland preservation debate, it is a particularly attractive area for analysis.

The first question that will be addressed is how the presence of public infrastructure affects the use of land. Second, the effect of infrastructure on farmland values will be studied. The data consist of unimproved property sales in McHenry County between 1979 and 1987 which were obtained from the Illinois Department of Revenue. The data set was used in Thorson (1994a, 1994b), and is similar to those used by Chicoine (1981) and McMillen (1989). The explanatory variables fall into two categories; variables which represent the location of the parcel of land (distance to the Chicago CBD and distance to the nearest town), and variables that describe the land−use characteristics in the square−mile section which surrounds the parcel of land. These land−use variables include the proportions of the land allocated to residential use, manufacturing, rail lines, airports, roads and streets, mining, open space and water. Two final variables included are parcel size (in acres) and a monthly time trend.

The descriptive statistics for the agricultural land sales are shown in Table 2. There were 476 parcels of agricultural land that were sold during this period. The price per acre averaged $4883.48, and the average parcel size was 18.44 acres. The average parcel of land was located 54 miles from the Chicago CBD and two miles from the nearest town. Approximately 3 percent of a section was used for streets on average, but this value ranged from a low of zero to a high of almost 16 percent. The proportion of a section used for rail lines averaged 0.3 percent and ranged from zero to 3 percent.

The first step in our analysis is to estimate equations for land−use. The data set used to estimate these equations consists of 3814 unimproved properties in McHenry County. These parcels are divided into three different classifications; agricultural land which includes parcels greater than five acres in size, estate land which includes parcels between one and five acres and residential land of one acre or less. How does the existence of infrastructure investment influence the allocation of land among these three uses?

The model used here is similar to that used by McMillen (1989) in that it is assumed that land is allocated to its most profitable use. Public infrastructure investment is likely to decrease the probability that a parcel of land will be allocated to agricultural use. A multinomial logit model with three choices will be used to predict land−use. A two−equation model is required to describe the situation with three choices; the first equation models the choice between estate and agricultural land, and the second equation models the choice between residential and agricultural land. The two equations to be estimated are:

$$\log(P_{est}/P_{ag}) = a_0 + a_1X_1 + a_2X_2 + ..., \text{ and}$$
$$\log(P_{res}/P_{ag}) = b_0 + b_1X_1 + b_2X_2 + ...,$$

where P_{est}, P_{ag}, and P_{res} are the probabilities that the parcel is devoted to estate, agricultural, or residential use. Independent variables are denoted X_1, X_2, etc., and a_0, a_1, a_2, b_0, b_1, b_2, etc. are coefficients to be estimated. Suppose that a variable (such as use of land for streets) has a positive effect in both equations. The equations will indicate that an increase in this variable will increase both estate and residential land−use relative to agricultural use, and (by inference) whether estate land increases relative to residential use.

The estimated multinomial logit equations are shown in Table 3. The results are consistent with expectations. A parcel is more likely to be in agricultural use (relative to estate or residential) as the distance to the Chicago CBD increases. The result is the same for distance to the nearest town. The proportion of land used for rail lines increases the probability that the parcel is used for agriculture, but the results for the proportion of roads in a section are mixed. A higher proportion of land used for roads increases the probability that land will be classified as agricultural relative to estate, but also increases the probability that land will be allocated to residential use relative to agriculture. The estimated coefficients indicate that the latter effect is dominant; residential use increases, but agricultural use declines by a smaller amount than does estate use.

A related question that can be asked is whether infrastructure will affect land−use equally in all areas of the county. That is, we hypothesize that infrastructure investment may be more valuable to developers in the more urbanized parts of the county. Therefore, the data are split into two parts − urban parcels located within 54 miles of the Chicago CBD and rural parcels located beyond 54 miles of the Chicago CBD. The multinomial logit equations for the two subsamples are shown in Table 4. Three differences emerge clearly in these results. First, the presence of a rail line only has a significant effect in the rural areas of the county. Second, the proportion of land allocated for roads has a significant effect only for the urban parcels. Finally, in the rural equation the probability that a parcel of land is allocated to residential use increases with distance to the Chicago CBD.

Taken together, the logit equations have provided the following insights. As the proportion of land used for rail lines in rural areas (as here defined) increases, and as the proportion of land devoted to roads in urban areas decreases, the probability that land will be used for agriculture increases.

The final step is to determine how infrastructure affects the value of agricultural land in McHenry County. The land value equations are shown in Table 5. As with the land−use equations, land−value equations are estimated for the entire county, and then the sample is split into urban and rural subsamples based on a distance of 54 miles from the Chicago CBD.

The results for the entire sample show that the price per acre decreases by approximately 0.32 percent for a one acre increase in parcel size, and the price per acre decreases by 4 percent with each mile to the Chicago CBD. The railroad variable is insignificant, but additional land used for roads does increase the value of agricultural land. The results change significantly when the sample is split into the urban and rural portions. In the urban area of the county agricultural land values decrease with distance to the Chicago CBD, while in the rural areas of the county the coefficient of the variable is not statistically significant. This is precisely what one would expect if the value of agricultural land within 54 miles of the Chicago CBD partly reflects the expectation that this land will be converted to urban use in the foreseeable future. In addition, additional land allocated to roads strongly increases land values in the urban areas of the county. For parcels located within 54 miles of the Chicago CBD, an increase in the proportion of land devoted to roads of one percent increases land value by 7.1 percent. In the rural areas the coefficient of this variable is statistically insignificant (and negative in sign). Once again, this is the result that would be anticipated based on the expectation of conversion to urban use.

This section has shown that infrastructure investment in the form of roads does significantly affect both the use of land and the value of land currently in agricultural use. However, the effects of this form of infrastructure appear only in the subsample of the data containing parcels located within 54 miles of the Chicago CBD. The provision of roads has no impact on land−use or agricultural land value beyond this distance.

Summary and Conclusions
In this paper we have argued that the value of farmland at the urban fringe is influenced strongly by the *expectation* that it will be developed for more intensive, urban use. The provision of public infrastructure, usually in the form of a highway that provides improved access to the urban area, sometimes (but not always) signals that this more intensive development is now more likely to take place. The provision of water and sewer service signals that urban development is imminent, and McMillen's (1989) findings on land−use at the urban fringe suggest that the existence of vacant land is an indicator that conversion to urban use will take place. Also, the new econometric results for McHenry County presented in Section 7 show that an increase in the amount of land used for roads both reduces the probability that a parcel is in agricultural use and increases the value of agricultural parcels. However, these findings apply only to parcels located closer to the Chicago CBD (i.e., within 54 miles of the CBD).

On the other side of the coin, the shift in the financing of public infrastructure from federal funds to land−use exactions will tend to slow down the rate at which urban development will occur. There are some highway projects on the drawing boards that are projected to use federal funds, but a good number of these projects are meeting organized opposition from a variety of quarters. The widespread use, and continued growth, of land−use exactions can be expected. This major change in policy may actually mean that the empirical studies listed in Table 1 need to be updated.

Finally, a review of the controversy over the contribution of public capital to overall economic growth revealed that this contribution was badly overstated by some early studies. The consensus now seems to be that there is no need for a major increase in public infrastructure investment. At the same time, some investments, such as urban highway maintenance, airport capacity and air traffic control, and selected urban highway improvements, have high payoffs. There appears to be no coming "boom" in public infrastructure investment. Indeed, there is now an increasing organized opposition to further investments in highways at the urban fringe.

Table 1

Summary of Empirical Studies of Infrastructure
and Urban Fringe Farmland Values

Study	***Infrastructure Variables Included***	***Estimated Effect***
Clonts (1970)	Distance to highway	−$9 to −$13/acre per mile
Husak (1975)	Distance to highway	not significant
Husak and Sadr (1979)	Distance to highway	−3.1% to −6.9% per mile
	Distance to freeway interchange	−2.0% per mile
Chicoine (1981)	Frontage road type non−township	13.3%
	Abuts a town	40.9%
	Septic tank soil limitations	−17.1%
Vaillancourt and Monty (1985)	Water service	29.0%
	Water and sewer	98.4%
Shonkwiler and Reynolds (1985)	Distance to highway	−2.0% per mile
Dunford, et al. (1985)	distance to highway	−2.6% per mile
	Has road frontage	18.6%
	In sewer service area	84.2%
	Intensive development expected (5 years)	34.2%
Henneberry and Barrows (1990)	Highway frontage for parcels without high development potential	not significant

Table 2

Agricultural Land Sales in McHenry County: 1979−1987

Variable	***Mean***	***Standard Deviation***	***Minimum***	***Maximum***
Price per acre	$4883.48	6649.41	71.43	107,143.00
Acres	18.44	30.80	5.00	240.00
Distance to Chicago CBD	53.72 mi.	6.51	29.75	68.50
Distance to town	2.07 mi.	1.48	0.00	6.25
Proportion of land use				
Residential	0.0745	0.0632	0.00	0.3659
Manufacturing	0.0012	0.0063	0.00	0.0914
Railroad	0.0027	0.0066	0.00	0.0331
Airport	0.0008	0.0086	0.00	0.1448
Roads	0.0313	0.0229	0.00	0.1581
Mining	0.0119	0.0459	0.00	0.4214
Open space	0.0052	0.0298	0.00	0.4091
Water	0.0197	0.0830	0.00	0.4625

Table 3

Multinomial Logit Results

Variable	**Estate vs. Atricultural**	**Residential vs. Agricultural**
Constant	1.826* (2.52)	2.692* (3.46)
Distance to Chicago CBD	−0.031* (2.40)	−0.074* (5.17)
Distance to nearest town	−0.311* (5.39)	−0.707* (9.75)
Time trend (months)	0.002 (1.30)	0.001 (0.48)
Proportion of land use in section		
Residential	12.459* (8.33)	4.812* (3.12)
Manufacturing	0.793 (0.07)	−0.495 (0.047)
Railroad	−19.262** (1.76)	−34.011* (3.04)
Airport	−6.554 (0.71)	−17.375 (0.81)
Roads	−14.395* (3.18)	40.949* (9.26)
Open space	2.028 (1.09>	2.381 (1.37)

Water	−1.612	5.585*
	(1.35)	(5.35)

Note: absolute t values are in parentheses.

Table 4

Multinomial Logit Results by Location

	Urban		***Rural***	
Constant	3.758*	4.934*	4.236*	−7.687*
	(3.11)	(4.18)	(2.07)	(2.23)
Distance to Chicago CBD	−0.070*	−0.119*	−0.084*	0.102**
	(2.94)	(5.13)	(2.38)	(1.82)
Distance to nearest town	−0.286*	−0.605*	−0.294*	−1.154*
	(3.82)	(7.13)	(2.86)	(5.42)
Time trend (months)	0.002	0.000	0.004	0.001
	(0.77)	(0.05)	(1.10)	(0.14)
Proportion of land use in section				
Residential	11.054*	1.948	21.340*	33.282*
	(6.52)	(1.15)	(5.49)	(6.08
Manufacturing	−6.405	−12.362	33.370	−3.514
	(0.53)	(1.07)	(0.96)	(0.08)
Railroad	−6.958	−20.684	−47.363*	−92.730*
	(0.48)	(1.50)	(2.46)	(2.52)
Airport	−4.065	−135.689	984.773	1207.790
	(0.45)	(1.59)	(0.00)	(0.00
Roads	−14.780*	45.474*	−7.942	4.330
	(2.75)	(8.94)	(0.84)	(0.35)
Open space	1.809	1.843	−62.203*	−60.875**
	(0.93)	(1.01)	(2.92)	(1.91)
Water	−2.177**	4.611*	19.587**	39.543*
	(1.79)	(4.40)	(1.76)	(2.11)

Note: absolute t values are in parentheses.

Table 5

Agricultural Land Value Equations
Dependent Variable: ln(price per acre)

Variable	***Total Sample***	***Urban***	***Rural***
Constant	10.971*	11.683*	9.096*
	(35.84)	(21.09)	(16.97)
Parcel size (acres)	−0.322*	−0.376*	−0.283*
	(11.09)	(8.44)	(8.11)
Distance to Chicago CBD	−0.041*	−0.051*	−0.011
	(7.74)	(4.82)	(1.19)
Distance to nearest town	0.027	−0.025	0.064*
	(1.24)	(0.69)	(2.49)
Time trend (months)	0.000	0.000	−0.001
	(0.18)	(0.19)	(1.09)
Proportion of land use in section			
Residential			

	0.049	−0.943	1.353
	(0.07)	(1.08)	(1.23)
Manufacturing	13.700*	16.559*	−8.786
	(2.51)	(2.44)	(0.75)
Railroad	2.566	−0.842	1.507
	(0.59)	(0.11)	(0.32)
Airport	−0.896	−0.233	−−
	(0.30)	(0.07)	
Roads	4.314*	7.137*	−1.163
	(2.42)	(2.96)	(0.44)
Open space	−0.195	−0.752	0.252
	(0.21)	(0.72)	(0.05)
Water	−0.504	−0.765**	−5.304
	(1.32)	(1.77)	(1.38)
R^2 (adj.)	.361	.346	.247
Sample size	476	248	228

Note: absolute t values are in parentheses
* significant at the 5% level
** significant at the 10% level

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