ECONOMICS OF TRANSPORTATION CORRIDORS: FURTHER EMPIRICAL ANALYSIS

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This paper poses the question: Do transportation corridors make economic sense? The answer yielded in earlier work and supported more rigorously here is No. A sample of 325 randomly selected properties were chosen from the assessment roles of the city of Burnaby, in the Vancouver, British Columbia, metropolitan region. Two relationships were explored. First, we examined the rate of increase of real property values during a 19-year period for which consistent assessment data were available. A deflated price index was developed for all 325 properties and for a smaller sample of some 24 properties within 0.2 mile of the Trans-Canada Highway. In both instances the rate of appreciation of the property fell considerably short of the 8 percent opportunity cost of purchasing and holding the property. Second, an estimate of the rental value of the acquired property was included in the previous calculations. Here again, when management and operating costs, foregone property and income taxes, and depreciation are taken into account, the net revenue resulting from leasing the property plus the appreciation of the property still does not cover the opportunity cost. From a strictly economic viewpoint, therefore, the corridor concept does not pay even when we allow for leasing of acquired property. These findings confirm the previous results and appear quite sound. However, I would not conclude that the corridor concept should not be applied to transportation planning. Particularly with the present concern for social and environmental factors, the concept has much to recommend itself. I would urge, however, that these strengths be noted and not its dubious economies.

• THIS is the last phase of a series of studies begun almost 3 years ago by the author and Heaver (1, 2). This paper builds directly on the previous work with two refinements. First, the economic framework developed in the first study and tested in the second is subjected to further empirical testing in a different area of the Vancouver region. This provides further support to the findings to date. The second refinement reported on relates to the inclusion of the rental value of property acquired in advance of need. This rental value was excluded in our earlier work and assumed to be balanced by lost tax revenues and the cost of operating rental property. The present paper probes this area more deeply inasmuch as data that allowed the calculation of rents and their relationship to assessed values were provided. The data base and the empirical work are described in more detail below.

The next two sections bring the reader up to date by summarizing the two previous papers and their findings. New data are presented to complement the earlier empirical work and to examine the inclusion of rents in the economic analysis of transportation corridors. The concluding section summarizes the progression of studies, gives conclusions, and points the way for further study and expansion of the corridor concept in the transportation planning process.

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ANALYTICAL FRAMEWORK

Transportation corridors and related ideas have been espoused over the past half century. By the 1960s urban freeway development was nearing its peak, and the high costs of acquisition, urban sprawl, and inadequate planning were becoming painfully apparent. It is against this background that the renewed interest in transportation corridors should be viewed.

Accordingly, the first task we undertook was to define the transportation corridor concept in a reasonably rigorous and operational manner. Having done this, our first paper went on to delineate an economic framework for the evaluation of corridor projects.

After reviewing existing literature, we identified three elements that differentiate, and therefore serve to define, transportation corridors from the standard right-of-way. These elements are as follows:

1. Buying early (advance acquisition of the right-of-way),
2. Buying more (more than short-run needs dictate), and
3. Designing for multipurpose use of the land.

The economic framework that evolved was that of cost-benefit analysis. We attempted to define the various kinds of costs encountered in such an analysis, including the following:

1. Economic costs—opportunity costs,
2. Financial costs—monetary outlays,
3. Direct costs—those incurred in acquiring and holding land,
4. Indirect costs—those costs that are induced in adjacent areas and activities, and
5. Tangible costs—costs that are easily measured in monetary terms (e.g., quality of environment and noise).

These costs provided a basis for analyzing the specific costs involved in acquiring more land than is needed immediately (i.e., corridors). There were two primary sets of costs involved: acquisition costs and holding costs. Each in turn was subjected to analysis. The benefits were treated in an entirely analogous manner.

The substance of the argument, and the conclusions, can easily be illustrated as shown in Figure 1. In the future there are two curves. The curve C_e represents the cumulative costs of buying the land at time t_A and holding it, thus incurring holding costs each year. The second and more curvilinear function, C_l, represents the cost of buying at some later date. This curve illustrates the great appreciation of rural fringe land as it is developed for urban uses, roughly near the point C. This curve depicts the progress of land values over time and represents the actual purchase price of property at any point of time.

The curves shown in Figure 1 demonstrate that it is not always economically wise to purchase land in advance of need. The early purchase plus holding cost curve is above the late purchase curve at all points to the left of B. To the right of B, land values accelerate to such an extent that early purchase plus holding cost represents an economic saving. It is doubtless that this situation is in most people's minds when they state that early purchase is a method of saving on acquisition costs. The more usual situation, in which a corridor is planned to stretch out into some as yet undeveloped suburb, is represented by the acquisition points to the left of B.

Employing the usual methods of microeconomic analysis shows that the optimum time to buy is where the slopes of the early and late purchase curves are parallel and where the late purchase curve is rising more rapidly for successive points to the right. Point C in Figure 1 is such a point and represents the maximum saving possible from buying early and the maximum vertical distance between the two curves. A straightforward proof of this proposition concludes our original argument.

INITIAL EMPIRICAL ANALYSIS AND FINDINGS

With the framework established, we next set out to investigate the economics of corridor acquisition (2). A sample of some 200 properties were selected from assessment rolls. We looked at real property values and land values. Real property values were

selected as our focus inasmuch as acquisition costs are based on this figure and not simply land costs.

The area selected to test the corridor concept is typical of a zone in which property acquisition for a corridor might take place. Richmond, B.C., is a part of a rapidly growing metropolitan area. The municipality enjoys good access to the Vancouver CBD and satellite commercial cores, and its population is increasing rapidly.

Two characteristics of the area are likely to be particularly favorable to rapid increases in values. First, a freeway was completed through the area in 1959, which accelerated the process of development (3). Second, a significant amount of land is undeveloped, and it is land in this state that normally shows the greatest percentage of appreciation in value (4, 5).

However, data show that even the properties closest to the freeway only increased at a compound annual rate of 2.85 percent net inflation. Properties in Richmond as a whole only increased at a compound annual rate of 5.23 percent net inflation. Although the data have the usual problems characteristic of land and property value samples, the statistical reliability of the data is very good.

If it is supposed that holding costs are only 8 percent per annum, the results show that the increase in value of suburban properties is not sufficient to make advance acquisition attractive. The cost savings possible from buying very wide corridors in advance of expansion requirements also appear to be very limited. These results are consistent with the evidence available in other studies that have examined property values over time.

These studies all report average rates of increase in excess of those recorded in Richmond. It may be questioned, therefore, whether the experience in Richmond is typical of other rural-urban fringe areas. We think it is. The differences between our estimates and those of other studies can largely be accounted for by use of real property values and not simply land values. When land values are substituted for real property values, for all the properties in our Richmond sample, we get a regression equation of

$$V_L = 0.0740\, e^{0.0872t}_{0.0141} \quad R^2 = 0.7767 \quad F(1,11) = 38.3094$$

which implies a growth rate of 8.72 percent per annum and is significant at the 0.001 level.

To conclude that the rate of increase in suburban property values is modest is surprising at first sight. We are accustomed to reading of substantial changes over a number of years and certain cases of spectacular increases over a very short period. In reality, however, the effect of urbanization is gradual. Proportional changes in the radius of the city result in geometric increases in the supply of land (6). It takes considerable time, therefore, for a zone to experience an acceleration in the rate at which land values increase as urbanization approaches. The creeping process of urbanization consumes land lot by lot and results in gradual changes in the growth rate of wide bands.

To go several miles from the suburbs to acquire land for transportation corridors is not warranted on the basis of an analysis of tangible acquisition costs. Even as urbanization proceeds, the high level of holding costs demands that the rate of increase be in excess of 10 percent per annum before advance acquisition is warranted (7, 8). Drachman's rule (with the then prevailing interest rate of 7½ percent) was that land must double in value every 6 years to be a worthwhile investment. This implies a growth rate of 12 percent.

The high rate of appreciation necessary for an entrepreneur to make a profit by speculating in land was observed by Drachman (8). It should be noted that he assumed an interest rate of 7½ percent and an inflation rate of 4 percent. Current financial costs would run 2 percent above each figure, boosting Drachman's carrying charges to nearly 18 percent, which implies a doubling of land value every 4 years instead of the previous 6. It should be noted that Drachman is concerned (as are others who talk of speculation) with the appreciation of raw land. The question of speculation (and urban sprawl) is not posed in terms of real property appreciation (i.e., land plus improvements). This follows because land alone is cheaper and thus provides a lower

base on which appreciation can accrue, as well as being easier to speculate in because of its lower price. Finally, raw land is more liquid because it is not constrained in use, nor by sunk capital costs, by the existence of improvements. Our results point this out: Raw land appreciates much more rapidly than does real property (8.76 versus 5.23 percent). The lack of liquidity depresses real property appreciation and thus makes the economics of corridors even more unattractive.

We observed that, although our conclusions were tentative and assumed away such things as rental value of acquired property, they did appear to reduce the apparent economic justifications for the concept. We went on to stress, however, that even a completely satisfactory economic repudiation of the corridor idea should not obviate it. There are doubtless substantial intangible benefits associated with corridors. Integrated land use and transportation planning and better treatment of environmental problems such as air and noise pollution would seem to be intangible benefits of corridors. We concluded therefore that too much stress on cost savings of advance acquisition may actually detract from the inherent strengths of the concept.

Our final observation was that additional empirical work should be undertaken to verify the initial findings. We noted (2) that "...time series studies of land values in other rural-urban fringe regions are desirable to substantiate the generality of the conclusions." This is the role of the present paper.

FURTHER EMPIRICAL ANALYSIS AND FINDINGS

To ensure comparability with the previous study, we again collected data for a suburban municipality in the Vancouver region (Table 1), this time from the municipality of Burnaby, the immediate eastern neighbor of Vancouver, as well as the location of the freeway in 1961 (Fig. 2). The present sample also comes from assessment records but is somewhat larger than the previous sample (325 properties compared with 200). Unlike the initial sample, which was random with respect to a preselected subarea of the study region (Richmond), the present one was completely randomly selected. The analysis begins with a test of the initial work; it then goes on to consider the rental value of acquired property and its effect on the economics of buying early.

Retesting the Economics of Corridors

Testing the economics of transportation corridors is at best hazardous. For purposes of comparability, this paper follows the same procedure, albeit imperfect, as the earlier one. First we need to derive what the actual deflated rate of real property appreciation in the test area is. Knowing this, we can then compare this rate of appreciation to the social opportunity cost of capital and determine whether the cost of capital was exceeded. If it was, then it pays in an economic sense to purchase early; otherwise, it does not.

Accordingly, a regression was fitted to the sample with time as the independent variable and real property value and land value as the dependent variables. The results are given in Eq. 1, real property, and Eq. 2, land values only. Figure 3 shows this information graphically.

$$V_p(t) = 1.00315\ e^{0.02513t}_{0.004506} \qquad \begin{aligned} R^2 &= 0.6467 \\ F(1, 17) &= 31.122 \\ \text{t-statistic} &= 5.579 \end{aligned} \qquad (1)$$

$$V_L(t) = 1.07928\ e^{0.08510t}_{0.00525} \qquad \begin{aligned} R^2 &= 0.9392 \\ F(1, 17) &= 262.517 \\ \text{t-statistic} &= 16.202 \end{aligned} \qquad (2)$$

where

$V_p(t)$ = assessed real property value,
$V_L(t)$ = assessed land value, and
t = time in years.

Figure 1. Acquisition, holding, and development costs.

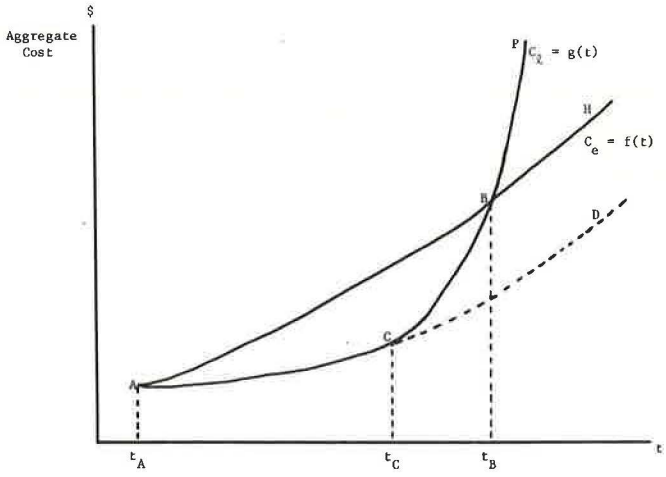
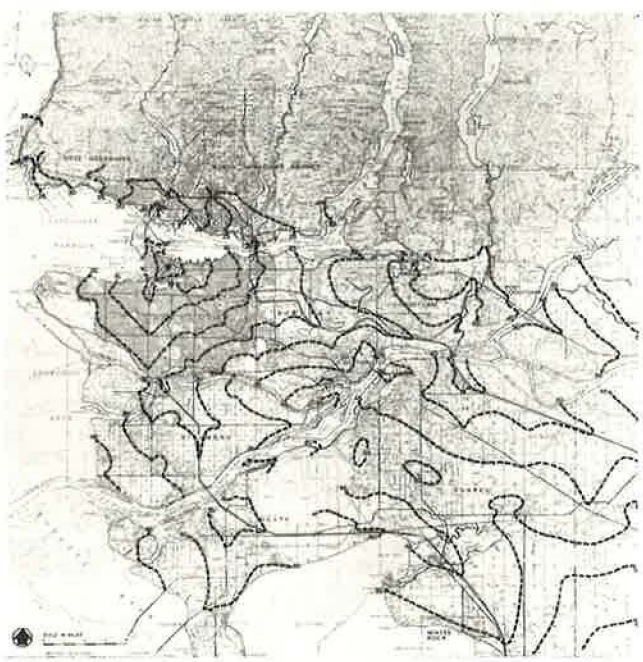


Table1. Deflated price index of assessed land and property values.

Date	Land	Improvements	Land and Improvements	Fitted Values: Land and Improvements	Fitted Values: Land
1953	1.00	1.00	1.00	1.03	1.12
1954	1.08	0.96	0.98	1.05	1.24
1955	1.26	0.97	1.02	1.08	1.35
1956	1.39	1.00	1.06	1.11	1.47
1957	1.69	1.04	1.19	1.12	1.61
1958	2.21	1.06	1.28	1.17	1.75
1959	2.09	1.07	1.26	1.19	1.91
1960	2.20	1.05	1.27	1.21	2.09
1961	2.37	1.07	1.32	1.24	2.24
1962	2.97	1.05	1.32	1.27	2.48
1963	3.02	1.04	1.28	1.31	2.71
1964	2.99	1.03	1.51	1.34	2.97
1965	2.98	1.27	1.26	1.37	3.22
1966	3.05	0.85	1.35	1.41	3.51
1967	3.18	1.05	1.36	1.44	3.77
1968	3.99	0.87	1.43	1.48	4.18
1969	4.49	0.86	1.57	1.51	4.56
1970	5.18	0.87	1.61	1.54	4.97
1971	5.53	0.84	1.63	1.57	5.45

Source: Burnaby Assessor's Office.

Figure 2. Vancouver area.



SOURCE: GREATER VANCOUVER REGIONAL DISTRICT, 1970

From these equations we see that land alone appreciated at 8.51 percent annually compounded and real property at the much slower rate of 2.51 percent. In each instance the constant term of the regression is not significantly different from unity. Time, therefore, explains some 65 and 94 percent of the variance respectively. All the statistics are significant at the 0.001 level. Similar regression equations reducing both land and property values on a basis of square feet of land yielded the following:

$$V_p(t) = e^{0.02433t}_{0.00395} \qquad \begin{aligned} R^2 &= 0.8001 \\ F(1, 17) &= 68.04 \\ \text{t-statistic} &= 8.25 \end{aligned} \qquad (1a)$$

$$V_L(t) = e^{0.08706t}_{0.00477} \qquad \begin{aligned} R^2 &= 0.9514 \\ F(1, 17) &= 333.09 \\ \text{t-statistic} &= 18.25 \end{aligned} \qquad (2a)$$

These results are very similar to those in Eqs. 1 and 2.

The more modest increase in real property is accounted for by the depreciation of the improvements on the land relative to the land values inasmuch as acquisition costs cover real property and not just the land itself. The 2.51 percent rate of appreciation certainly does not warrant early purchase in light of an assumed 8 percent opportunity cost. We arrived at this 8 percent figure after reading over the various estimates of other authors and noting that their estimates fell in the 6 to 10 percent range. The mean of 8 percent seemed reasonable. However, even if the lower estimate is taken, early purchase is still not warranted in light of the low rate of property appreciation.

These results imply that, were a corridor purchased in 1953 for construction in 1971, society would suffer a net loss of from 3.5 to 7.5 percent per year on its investment. This is quite a strong finding statistically. (One question that has not been looked at is the relationship between assessed value and actual sales value. A sample of 225 record sales and assessment yielded a correlation coefficient equal to 0.4764, which is significant at the 0.001 level.) In addition, Burnaby is precisely the kind of suburban area that is ripe for such freeway development. In fact, to date there has already been one freeway constructed through the municipality (in 1961). To the extent that Burnaby has already received increased accessibility from the freeway, the growth rate of property values is in fact higher than it would have been had the land been purchased before such improvements were made in the transportation system.

It can be argued that taking an average property appreciation figure over the entire municipality avoids the question of expansion of an existing right-of-way, since to answer such a question one would be interested in those properties that fell within 0.1 or 0.2 mile of a freeway. It has been argued in the past that it is these properties that appreciate so greatly due to their access to the freeway. Such an assertion can be tested in Burnaby by looking at those properties falling within a band 0.1 or 0.2 mile of the Trans-Canada Highway. This effectively looks at the economics of buying more land as well as buying it early.

Regressions analogous to Eqs. 1 and 2 were fitted to properties falling within 0.2 mile of the Trans-Canada Highway. They are given in Table 2 as Eqs. 3 and 4. Equations 5 and 6 present the same information for properties falling between 0.1 and 0.2 mile of the freeway. They are all significant at the 0.001 level.

The results show that the effect of the freeway is very localized, a significantly higher rate of appreciation of both land and property values being within 0.1 mile of the freeway. However, as we move out to the next band between 0.1 and 0.2 mile we see that appreciation falls off sharply from 11.01 to 6.86 percent for land and from 4.11 to 2.98 percent for land plus improvements. Even the 4.11 percent growth rate falls below the lower range of the cost of capital of 6 percent.

From these findings, it seems not to be economically sensible to acquire excess land for right-of-way expansion. The evidence presented in Eqs. 1 through 6 supports the previous findings and presents no support for the assertion that buying more and buying early will result in economic savings.

Testing the Concept With Leasing of Acquired Property

In the preceding section, as well as in the previous empirical study, it was assumed that the only holding costs were opportunity costs of the social capital used to purchase the corridor. The assumption was made that renting the acquired property would be balanced by lost taxes (both property and income taxes), operating expenses, and maintenance costs.

Obtaining accurate information on the rental value of real property is very difficult. Even with data in hand it is trying to compare such information with the data on property appreciation. Accordingly, assessed rental value information was obtained. These data are consistent with the assessed value data on which the previous findings are based and have stood the test of time and consistency of assessment practice.

The goal of this section is to provide an estimate of the net annual addition to cost savings that results from leasing acquired property. Equation 7 sets out the cost savings calculation.

$$S = GAR - OE - DEP - LIT - LPT \tag{7}$$

where

S = addition to cost savings (as a percentage of acquisition cost, i.e., assessed value),
GAR = gross assessed rental value,
OE = operating expenses excluding property taxes,
DEP = physical depreciation,
LIT = lost income taxes from developer, and
LPT = lost property taxes.

Data were collected to estimate each of the terms in Eq. 7. Thus, GAR was found to be equal to roughly 7 percent of the assessed value of the property. A regression between GAR and AV (assessed value) yielded

$$\begin{array}{rl} GAR = 1{,}492.7 + 0.0675AV & R^2 = 0.6507 \\ \quad\quad (419.0) \quad\; (0.0039) & F(1, 159) = 296.17 \\ & \text{t-statistic} = 17.21 \end{array}$$

Information from the Greater Vancouver Real Estate Board (9) established that operating expenses net of property taxes constituted from 21.8 to 34.1 percent of gross rent for frame buildings depending on age. Property taxes varied from 11.2 to 13.5 percent of gross rent for these structures. For office buildings the operating expenses were 23.5 percent of gross rent, whereas property taxes represented 13.0 percent.

To estimate depreciation of the improvements required an estimate of improvements as a percentage of assessed value. Using the assessment information yielded improvements equal to 52 percent of the property value. A regression showed

$$\begin{array}{rl} \text{Improvements} = 0.521AV & R^2 = 0.7065 \\ \quad\quad\quad\quad (0.026) & F(1, 159) = 382.75 \\ & \text{t-statistic} = 19.56 \end{array}$$

Assuming a 50-year life and straight-line physical depreciation yields annual depreciation equal to 1 percent of the assessed value.

Finally, lost income taxes were calculated from information on the average return on investment in real property (10). The average return was 5.5 percent after taxes. This implies a before-tax return of 10.0 percent, which further implies lost income taxes roughly equal to 4.5 percent of the capitalized value of the property (assessed value in our terms).

With this information we can then calculate S as follows:

$$\begin{aligned} S &= 0.07AV - 0.20(0.07AV) - 0.01AV - 0.045AV - 0.010AV \\ &= 0.07AV - 0.014AV - 0.01AV - 0.045AV - 0.010AV \\ &= -0.010AV \end{aligned} \tag{8}$$

Upon closer scrutiny, it appears that our assumption was correct and that costs of holding, maintaining, and renting the property do offset the rental income. The calculation given in Eq. 8, rough as it is, shows in fact that the saving is negative. Even if we assume away depreciation on the argument that the structures will be demolished for the corridor, the saving is still -0.009AV.

Even if we acknowledge the weakness of data and the assumptions made in the calculation of S, it still appears that allowing for leasing of acquired property does not improve the economics of transportation corridors.

CONCLUSIONS

The present study confirms the findings of the previous one. Moreover, the statistical results being more conclusive and the sample being more complete allow stronger conclusions to be drawn.

Under the assumption that rental revenue will be offset by holding costs and lost taxes, the findings show clearly that there is no economic justification for early acquisition of large corridors. Calculating the likely effect of rental income showed that there would be little effect, thus validating the previous assumption.

One might draw the conclusion therefore that both corridor planning and leasing until need should be discouraged. Quite the contrary. Previous papers by the author and others have pointed out the need for flexibility in transportation planning as well as integrating transportation planning with land use and more recently environmental planning. Wide transportation corridors (up to ½ mile in width) would seem to be very effective in achieving such integration and flexibility. We would not like to see these strengths ignored by discrediting corridors because of overly enthusiastic claims of economic savings. One point should be stressed. This relates to interinstitutional differences between British Columbia and the rest of Canada and the United States. One of the significant elements in the land development process in British Columbia is the absence of large-scale builders. There are currently no builders who construct more than 100 private single-family homes a year. Thus, the average developer is small, and the development process proceeds in a checkerboard but relatively small incremental pattern. Urban sprawl has taken place, but it has been the result of the development of a large number of very small subdivisions. The absence of large-scale community builders in British Columbia means that growth takes place in a reasonably smooth way.

Land prices tend to rise continuously over time rather than by large discrete jumps, which would correspond to large discrete developments. Thus, one of the claims of proponents of the corridor concepts—that corridors save large amounts of capital by preventing large-scale subdivisions—does not apply in British Columbia inasmuch as there are no large-scale subdivisions. The situation is likely to be quite different in the United States, and it is entirely conceivable that significant savings might result from advance acquisition by preventing the large-scale builder from building in the path of a corridor. Related questions were touched on in our earliest paper.

It is hoped that future studies of the corridor concept will cloak that concept in a broader context, where it can be viewed as one of a small variety of tools available to the regional planner, tools that have social, environmental, transportation, and land use implications on a large scale. It is my strong feeling, therefore, that corridors should be brought into the family of planning tools. They do make sense but not cents.

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DISCUSSION

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I do not disagree with Goldberg's conclusions, only with his method of arriving at them. I refer here to his implicit definition of "benefits" as the difference between the costs of acquisition when the corridor is identified and the costs of acquisition when the land is actually needed. If he were considering private investment he would be correct, but highway corridors are public investments that require consideration of total societal welfare. When viewed from this broader perspective it becomes quite clear that, without knowledge of the gainers and the losers, we can say only that a transfer results. We cannot say we have increased economic benefits and thus societal welfare.

Indeed, the "benefits" derived from a program like advance acquisition of corridors considered in Goldberg's context meet neither the Pareto criteria nor the less stringent Hicks-Kaldor criteria for optimal resource allocation. [The Pareto criterion says that the welfare of society is increased if one is made better off, given no one else is made worse off. The Hicks-Kaldor criterion extends this by saying that societal welfare is increased if the gainers of a resource reallocation gain more than the losers lose (11).]

Unless we can identify and are willing to make utility decisions concerning the landholders from whom the windfall gains will be taken we can make no pronouncements either positive or negative about the economic desirability of such redistributive programs. We may be quite willing to do so, but I dare say our decisions may be quite different in each case. (Consider the poor farmer's widow whose only asset is land, whose income is $5,000 a year below the median income of the gasoline taxpayer, and whose farm happens to lie adjacent to a new highway. Then consider the moneyed land speculator whose business it is to foreclose on mortgages of poor old farmers' widows, knowing full well where the location of the new highway corridor is.) We can say, however, that there are considerably more efficient programs for causing redistributions if that be our objective.

Having made this unequivocal statement, let me elaborate slightly. If we know the appropriate social rate of discount, the rate of return of the landholders in their best

alternative investment (other than in the land), and if we assume the utility of money to be constant, we can determine under the Hicks-Kaldor criterion whether the social welfare has increased. But those are a lot of ifs.

However, let us assume for a moment that we do know all these things. Then social welfare has increased by

$$W = Po\left[(1 + b)^n - (1 + r)^n\right]$$

where

Po = cost of a specific piece of property when the corridor is identified,
b = private rate of return on best alternative investment,
r = government's rate of discount, and
n = number of years until property is needed.

Notice first that this function does not depend on the rate at which land is appreciating in value and second that it is positive when $b > r$. However, without a case-by-case comparison of r with b, we still cannot make a categorical statement about welfare, for if $r > b$, which is not unlikely (although Goldberg's work shows that this is so; i.e., he shows that $r > a$, but $a > b$ to cause the landholder to invest in land instead of his alternative investment; therefore, $r > b$), welfare is decreased.

I must admit that the foregoing analysis does not consider improvements to the land made during the period between corridor identification and purchase. But neither does Goldberg's. That is a broader question for which we would need to examine the economics of such in-between alternatives as land use controls.

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The purpose of this discussion is to raise some questions about the approach proposed by Goldberg for the economic evaluation of transportation corridors. It is suggested that the following questions be carefully considered before the approach is used in making decisions on transportation corridors.

IS AN ECONOMIC OR A FINANCIAL APPROACH PREFERRED?

The paper purports to deal with "the economics of transportation corridors," "measuring the impact of transportation corridors," and "testing the economics of transportation corridors." From such captions, one might expect to find evaluations that could be used as a guide if one wished to make decisions from the point of view of the overall economic good of the community. The information presented by Goldberg, however, establishes only that, if an agency desired to acquire a corridor traversing the entire municipality of Richmond, B.C., it would be farther ahead financially to acquire near the end of the 1958-1969 period rather than earlier in that period. In reaching this conclusion, it is assumed that (a) money costs more than 5 to 6 percent, (b) the agency is able to purchase land at the assessed value at any time, and (c) land values increase gradually under the impact of urban development.

What perspective is required for an economic assessment in the broad interest of the whole community? Should it be the point of view of an agency, assumed to hold all of the land, wishing to maximize the economic good of the community?

SHOULD ONE CONSIDER THE WAVE OF RESOURCE INVESTMENT DURING DEVELOPMENT?

One of the most significant characteristics of the data given in Table 1 and shown in Figure 3 is the jump. Goldberg explains this by saying that the completion of several large developments account for a jump in the value of land and completions. One must ask, however, if such jumps are important to the economics of corridors. Urban development occurs when raw land is subdivided and serviced and when improvements are constructed. This phenomenon is reflected in property prices by a jump. This price jump reflects the investment of real resources such as the labor and materials for the

construction of services. The amount of the jump is some indication of the quantity of resources consumed and thus of the economic value.

For any particular radial corridor extending through the zone of land development, the price jump will tend to move outward from the center like a wave. The obvious time for corridor acquisition, or reservation, at each particular point is just before the price wave hits that point. Therefore, should not any analysis aimed at determining the optimal time of corridor acquisition, or reservation (whether economic or financial), of necessity be an analysis of this wave propagation?

Possibly the surprising conclusion that "the rate of increase in suburban property value is modest" is a result of the author's curve-fitting methodology, which obscures the jump. Goldberg states that "the creeping process of urbanization consumes land lot by lot and results in gradual changes in the growth rate of wide bands." It should be clear that the rate of the price change depends directly on the width of the band selected. A narrow, CBD-concentric band will show an abrupt jump, whereas a wide band will show a gradual increase. If the band is chosen wide enough, let's say to include the entire nation, then the rate of increase may only be the rate of inflation plus appreciation due to population growth.

IS MARKET PRICE A USEFUL INDICATOR OF "THE VALUE OF REAL PROPERTY"?

For an economic evaluation of corridors from the community viewpoint, it is important to penetrate the meaning of the value of real property. The author uses assessed value to quantify the value of real property. He defends this by showing a correlation with actual sale price. The linearity of this correlation is not surprising because assessed values are usually established to bear some consistent relationship to market price. The question remains, therefore, whether market prices are a good indicator of the economic value of the real property used for corridors.

The importance and difficulty of this question are underlined by the fact that there is really no market for corridor land. Land price is related to zoned use. The market price varies greatly when the zoning is changed, as, for example, if single-family land is rezoned to multiple-family land. There is a market price for residential land of a particular type and location, but how can one determine a market price for street land that the developer is required to dedicate to the municipality when the land is subdivided? What is the market price for corridor land?

Market price is of doubtful usefulness, not only because of the absence of a suitable market but also because, for an economic evaluation from a community point of view, we should be interested in the entire community. If a city with corridors were better or worse than a city without corridors, this theoretically might be determined in a marketplace where cities were bought and sold. Inasmuch as there is no such market, the market price approach seems a blind alley.

Consider a theory of the relationship between land price and the quality of the transportation, a theory stating that "the sum of the land price of all parcels in an urbanized region, less the replacement cost of useful services and improvements, is an inverse measure of the quality of the transportation system." At least one extreme of this theory seems valid: If transportation were perfect, i.e., speed infinite and cost zero, then the total land price less improvements is likely to be low. At the other extreme, the theory also checks because the highest land prices in the world come at the center of cities, such as Hong Kong, with very poor transportation systems. This theory has not been proved, but it cannot easily be disproved. The very difficulty of disproving such a theory demonstrates that it is dangerous and possibly misleading to sum up micro land prices determined in the market and to use the result to draw macrolevel conclusions concerning the benefit of corridors to a metropolitan region.

SHOULD REAL PROPERTY VALUE BE APPROACHED THROUGH MEASURING OUTPUT?

Economic value may, in general, be thought of as the present worth of future production potential. In the case of rural agricultural land remote from urban development,

the market price gives some indication of productive potential. Land that is more productive agriculturally and better located with respect to markets sells at a higher price, representing the benefit bestowed on the owner because he will be able to produce more agricultural products and to sell them at a better price. Under these conditions, one might consider using market prices for agricultural land as a measure of economic value.

The market conditions are much different, however, within urbanized areas and close to urbanized areas where land speculation occurs. Urban land prices are responsive to governmental and community actions that do not change the community's productivity, at least not in the way the land price changes it. Indeed, the land price may even vary inversely with the productivity. In each urban area there is a unique market for each category of land, e.g., desirable, easily accessible, or high-rise apartment land. Such land is a scarce commodity. The price is some indication of the degree of scarcity. The scarcity is increased by poor planning, zoning, and supply of transport facilities. If the planning is poor and the transport poor, such land might be very scarce indeed and thus very expensive. Comparing two similar cities that differ in the average price for high-rise land, we might expect the one with the higher land prices to have the inferior transport system and thus the inferior efficiency and productivity.

Urban land prices, therefore, cannot be used as a measure of production potential, and we must seek elsewhere for such a measure. In searching for such a measure, we must bear in mind the object. This can be illustrated as shown in Figures 4 and 5. We are not concerned so much with the production of particular parcels of land within these cities as with the productivity of the total city region and its variation between the two cases, without the corridors and with them. In both cases, the total area that we are considering is exactly the same, that is, πR^2. We are interested in some measure that would determine whether city A or city B is better, that is to say, which has a higher production potential. Market prices could mislead us, but how else can we get an indication?

One might suggest that the arrangement that gives the ability to produce a given output at a lower cost (i.e., at a lower consumption of resources) will also be the arrangement that gives the higher output. This assumes that there is some positive elasticity of output to price. If the city can produce television sets at a lower price, it will be able to sell more of them.

If the use of transportation corridors results in some rearrangement of the activities of a community on the land available to it, then the crucial question of the economics of corridors appears to be "What effect will this rearrangement of activities have on the cost of production?"

The net benefit from transportation corridors might thus be expressed in the following equation:

$$\text{Net benefit} = S - A - T_c + T_t$$

where

- S = present worth of saving in the cost of services, buildings, and roads, which results from the avoidance of reconstruction and of inefficiency that would be caused by rearrangement sometime after construction;
- A = loss of agricultural production, inasmuch as it is more difficult to use the corridor land, which is represented in Figure 5 by LW, for agricultural production than it is to use an equivalent amount of land at the perimeter of the city;
- T_c = present worth of the increased transportation cost necessitated because all trips crossing a corridor are made longer by the amount that the corridor is wider than necessary for the facility; and
- T_t = present worth of reductions in transport costs throughout the metropolitan region, which occur because of improved transportation facilities that are implemented when the corridors are available and that would not be implemented without them.

Figure 3. Actual versus predicted values, 1953-1971.

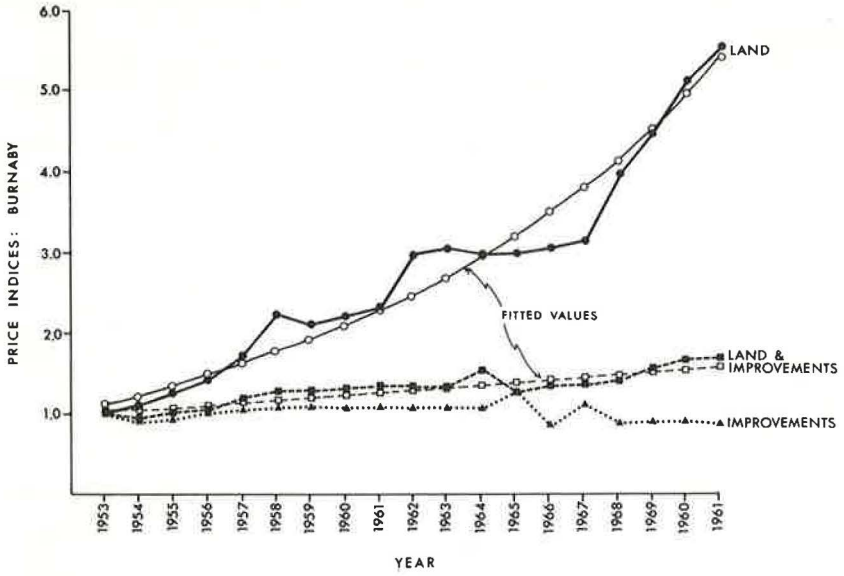


Table 2. Regression equations fitted to property within 0.2 mile of Trans-Canada Highway.

No.	Equation	R^2	F(1, 17)	t-Statistic
3	$V_L(t) = e^{0.11013t}_{0.02729}$	0.4893	16.291	4.036
4	$V_p(t) = e^{0.04106t}_{0.00328}$	0.9024	157.266	12.541
5	$V_L(t) = e^{0.06855t}_{0.01884}$	0.4377	13.233	3.638
6	$V_p(t) = e^{0.02975t}_{0.00354}$	0.8060	70.643	8.405

Figure 4. City "A" without corridors.

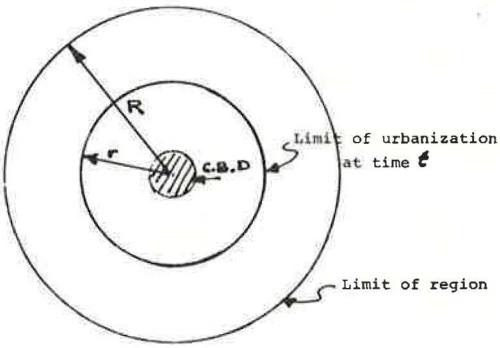
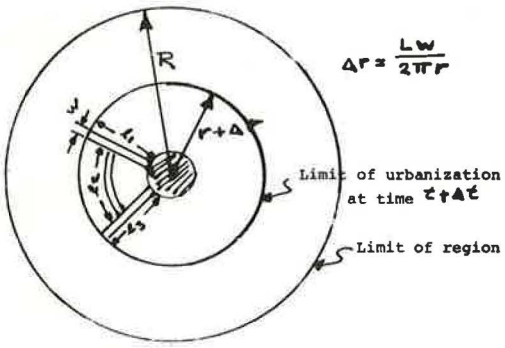


Figure 5. City "B" with corridors.



$\Delta r = \frac{Lw}{2\pi r}$

total corridor area $= w(l_1+l_2+l_3+\ldots) = Lw$

The approach to assessing the value of the various elements in this net benefit equation would be through a transport analysis for elements T_1 and T_c and through an analysis of the cost of services for S. It is only A that might be evaluated through land prices and could be taken as the unit price of agricultural land times the land area put out of agricultural production because of the use of corridors. In his paper, Goldberg appears to recognize S and T_1 as potential benefits of corridors, but he refers to them as "intangible benefits." I suggest that they are both real and tangible and that they have been quantified.

IS IT IMPORTANT WHO HOLDS THE CORRIDOR LAND?

Goldberg has formulated an economic analysis of transportation corridors in such a way that who holds the land appears to be an important question. This bias is introduced by the definition of corridors as relating to acquisition. This concept is also introduced by his idea of "holding costs," which is a term drawn from commercial real estate practice and which may not have any usefulness for purposes of economic evaluation. When we consider the options (with and without corridors, Figs. 4 and 5), it seems clear that the same amount of land is held in both cases. Would it not be desirable to have the methodology of economic analysis applicable to the case where all of the land is held by one agency? Many of those who have studied the question of transportation corridors have suggested procedures for achieving the benefits of corridors without acquisition. Thus, should not a valid method of economic analysis of transport corridors be required to give the same answer irrespective of how the land is held and by whom?

HOW SHOULD WE TREAT TAXES AND SHADOW PRICES?

In an economic analysis of a public enterprise, it is important to handle taxes carefully and to give consideration to the applicability of shadow prices.

The only place in which Goldberg refers to taxes is as follows: "Lacking evidence on possible annual revenues from property ownership, we have chosen to ignore lost taxes and maintenance costs. If the revenue exceeds the latter, we are understating the attractiveness of early purchase." The concept here seems to be that it might be possible to gain some revenue by renting the corridor land but that this will be balanced by taxes that the municipality will not receive and by maintenance costs; therefore, all three items are ignored. Is this an adequate method of considering taxes?

There are a number of interesting and significant tax questions relating to transport corridors. In the first place, consider whether municipal tax revenues are likely to be increased or decreased. If one considers the total municipal tax revenue of the metropolitan region as shown in Figures 4 and 5, then the tax revenues would decrease if the total assessed value of land and improvements in the metropolitan region were to decrease. There is no easy way of determining whether the total land values would, in fact, increase or decrease. Quite possibly, they would stay more or less the same, and, therefore, the total municipal revenue should be about the same, although it might be differently distributed to the several municipalities within the total region.

A more significant question perhaps is whether the ratio of municipal tax revenues to the cost of providing municipal services would be improved. If the corridor scheme does, indeed, improve the efficiency of providing services, then there could be a substantial benefit to the municipalities in terms of the relationship between tax revenue and the cost of services.

Another question is whether the costs are, indeed, net of taxes. This raises the question of the effect of taxes on land price, if one is to use land price in the analysis. Taxes and land prices could be related in a chicken-and-egg fashion, which would make it very difficult to analyze the net of taxes, unless one takes the approach of quantifying the costs of production.

Shadow pricing is another way of considering land price. Indeed, many of the questions we have asked can be rephrased as shadow price questions. Is the market price of land a valid price to use in the analysis, or should a shadow land price be used?

WHAT TYPE OF RESEARCH THRUST IS REQUIRED?

The research thrust suggested by Goldberg is based on the assumption that land price is a useful indicator of economic value. This assumption should be proved before research of the type proposed is likely to be useful. If, on the other hand, the line of thought suggested in this discussion is valid, then research on transportation corridors would take an entirely different thrust. Little confidence would be placed in land prices as an indicator of the economic value of corridors, and research would be directed more to the evaluation of total city efficiency for different transport and land use arrangements.

Reference

11. Baumol, W. Economic Efficiency and Operations Analysis. Prentice-Hall, Englewood Cliffs, N.J., 1965.