Highway Investment as a Regional Development Policy Tool

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ABSTRACT

A technique was developed to estimate the regional development effects of highway investment. The study area was the Province of New Brunswick, Canada. A weak relationship between highway investment and regional development was found to exist. The results indicate that the hypothesis of saturation and shift may be occurring. As it becomes saturated, the highway network exhibits less of a developmental effect and begins to act as an agent to increase personal mobility. The results of the models indicated that highway investment was related to increased mobility in one of the five test regions. No relationship was evident in the other four economic regions in the study area. The analysis also indicated that highway development in New Brunswick progresses through three phases. In the first phase the highway network is not developed to a level at which it is capable of encouraging regional development. In the second phase the network acts as an agent for regional development, whereas in the third phase it becomes an agent for personal mobility.

It is generally believed that in order to reduce regional disparities, government action is required. In 1957 the Gordon Commission on Canada's Economic Prospects indicated that an improved highway network would encourage regional development. This argument has been prevalent in the justification of most, if not all, of the future federal-provincial agreements that provide federal funds to assist regional highway improvements in Canada.

In recent years, the validity of this argument has come under question. It has been suggested that the construction of highway infrastructure does little to encourage regional development.

The hypothesis that a transport system can be saturated to the point where there are diminishing benefits to a regional environment was outlined by Meier (1). In general form the hypothesis states that

The incidence of the transport system on the socio-economic development of regional environments is becoming increasingly saturated at the present time and is shifting to other civilisatory and cultural aspects.

The hypothesis was examined in Western European industrialized nations in a comparison of the nations' own history and a simultaneous comparison with countries in Europe and the Third World that have a lesser developed economic structure. Meier (1) concluded that evidence from Switzerland suggests that the hypothesis is correct; in Switzerland, transport systems were switching from a development asset to a mobility asset.

Historically, it has been assumed that highways have an interregional effect. They serve as a means of transporting people to other regions. This function is giving way to more local influences, providing better access within the region.

The level of effects is also changing. In the past, highways have had effects on the whole society. The hypothesis suggests that the effects of highways are changing so that it is the individual who is benefiting from highway construction. Thus transport facilities are losing their importance as a develop-

ment tool. However, they are increasing in importance as an agent of personal mobility.

RESEARCH METHODS

In order to test the hypothesis of saturation and shift from development functions, a model was developed to identify the variance in a region's economy, which can be explained by investment in the region's highways. The model also estimates the magnitude of the effect of highway investment.

For the purpose of this research, the basic observation unit is the economic region. Following World War II, Canada was divided into a series of 68 economic regions. These regions were subprovincial units with similar characteristics that could be used for estimating the impact of changing economic conditions.

The study area, the Province of New Brunswick, Canada, was divided into five economic regions, with the boundaries falling on county lines. Each region is identified by the major city in the region; namely, Saint John, Moncton, Fredericton, Edmundston, and Bathurst. Although most of the socioeconomic and highway data are recorded as a provincial total, some of the socioeconomic data and all of the highway data can be disaggregated to the regional level. These disaggregated data will be used in the analysis.

The model takes the form: $Y_t = a + bX_t + r$

where Y_t is the economic indicator that measures the performance of a region's economy at time t, X_t is the highway development variable that is a measure of the investment in a region's highways, and r is the residual.

In this model, b represents the magnitude of the effect highway investment has on the economic indicator. To accurately estimate the effects of highway investment, the proper lag period between investment and economic development should be used when entering the highway development variable into the model.

In this study the correct lag period will be determined by altering the model to include a range of lags.

A review of previous research on highway impact analysis revealed that employment within a region is primarily used as the indicator of regional development. For this research the use of employment as the dependent variable is not possible. Neither the employment by industrial classification nor the total employment is available at the New Brunswick regional level throughout the study period.

As a proxy for total regional employment, the per capita income from wages, salaries, and commissions will be used to indicate regional development. Statistics Canada's all-item consumer price index for Saint John was used to deflate the per capita wages, salaries, and commissions into 1971 dollars.

Because highway investment is a regional factor, only that part of the dependent variable that is affected by regional factors should be entered into the model. Shift-share analysis was used to divide the change in socioeconomic activity into two components (2). The aggregate growth component measures the change in a region's socioeconomic activity as the rate of change in the analysis area (the province in this research).

The second component, the competitive component, is actually a measure of the economic activity of a region based on changes particular to that region. If the region grows at the same rate as the province, the region's competitive component will be zero.

The highway development variable will be represented by monetary expenditure on highways that will provide many benefits not realized in other methods such as the use of dummy variables (3) or accessibility measures (4). The history of highway development in New Brunswick is characterized by continuous improvements to the existing infrastructure. Unlike other variables, expenditure on highway construction has the ability to determine the magnitude of these continuous improvements. The New Brunswick Highway Construction Cost Index was used to eliminate the effects of inflation.
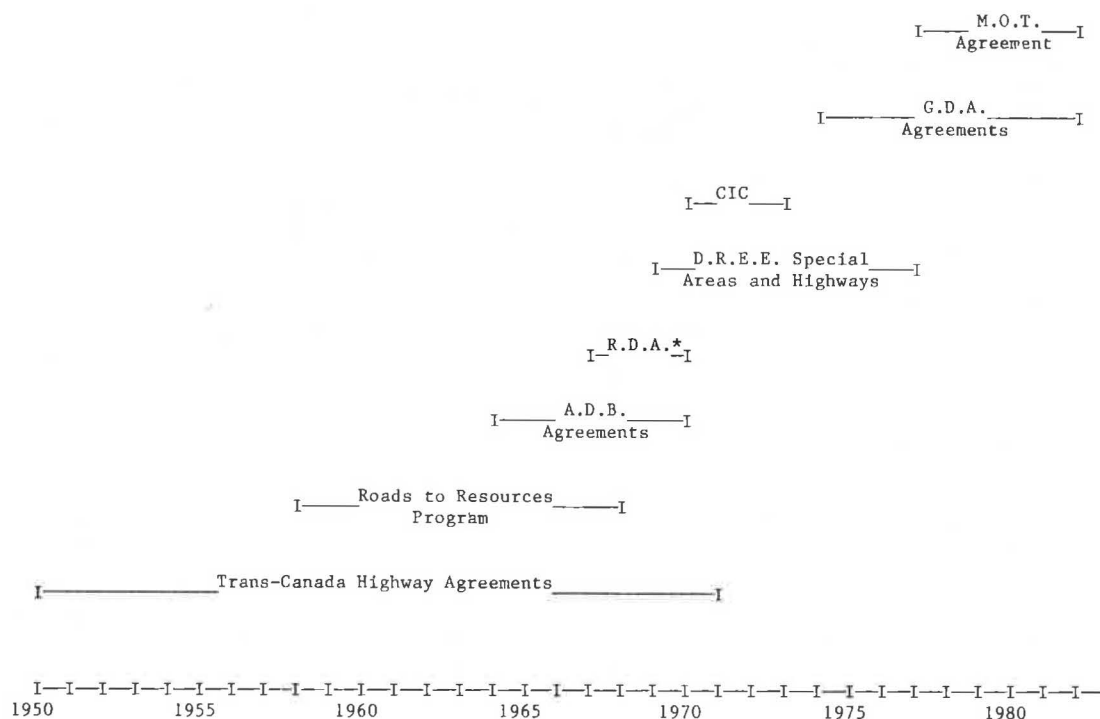
HIGHWAY INVESTMENT IN NEW BRUNSWICK

The total expenditure on highway construction in New Brunswick appears to be directly related to the amount of funding available from the government of Canada. Areas designated by federal assistance programs received a relatively high proportion of the construction, whereas capital construction in other areas did not increase as rapidly.

Since 1951 the Province of New Brunswick has entered into 23 federal cost-sharing agreements under 8 programs. The programs under which these agreements operated are as follows:

1. Trans-Canada highway agreements,
2. Roads to resources programs,
3. Atlantic Development Board (ADB) agreements,
4. Northeast New Brunswick federal-provincial rural development agreements,
5. Department of Regional Economic Expansion (DREE) special areas and highways agreements,
6. Community Improvement Corporation (CIC) agreements,
7. Department of Regional Economic Expansion General Development Agreements (GDA), and
8. Canada-New Brunswick Highway Strengthening/ Improvement (MOT) agreement.

The time frame of each of these agreements is shown in Figure 1.

The fiscal year 1951-1952 was selected as the first year of the study mainly because the construction of the Trans-Canada Highway through New Brunswick was beginning at that time.

FIGURE 1 Federal cost sharing programs.

DATA ANALYSIS

The magnitude of highway investment for each year of the 31-year study period (1951-1982) was available for each region. The magnitude of the per capita wages, salaries, and commissions was not available for the entire study period. In 1957 the Department of National Revenue changed its publishing format to include more statistics. Before 1957, the value of per capita earnings is not published at the regional level. Because of a delay in the publishing process, the 1980 calendar year is the most recent year for which statistics are available. Thus a value for per capita wages, salaries, and commissions can only be determined for 24 years.

With 23 years of economic data (1 year is lost in the shift-share analysis) and 31 years of highway investment, the maximum number of observations possible in the time series is 23.

The data in Table 1 present the calibrated regional development models. In these models the competitive component of the share of per capita earnings is denoted [SWS]. HILAG4 is the magnitude

TABLE 1 Regional Development Models

Regional Model	n	F-value of model	t-value of Regression Coefficient	r^2
Fredericton $SWS = -50.8 + 14.1 \, (HILAG4 \div 10^6)$	21	6.03	2.45	0.24
Moncton No significant model				
Saint John $SWS = -24.8 + 8.9 \, (HILAG4 \div 10^6)$	21	5.02	2.24	0.21
Edmundston No significant model				
Bathurst No significant model				

of highway investment 4 years before the increase in earnings, in constant 1971 dollars.

As outlined in Table 1, models were developed for only two economic regions: Fredericton and Saint John. No significant model was developed for the Moncton, Edmundston, or Bathurst regions.

The model developed for the Fredericton region indicates that an investment in highway construction has a positive effect on the regional economy 4 years later. The magnitude of this effect is that for every $1 million invested in Fredericton's highway network, there is an increase of $14.1 in Fredericton's share of per capita earnings. Thus as highway investment increases in the Fredericton region, the earnings of the region will rise relative to the provincial average.

The model also indicates the influence of factors other than highway construction. If no money was invested in highways, the residents of the Fredericton region would incur a relative loss in earnings of $50.8 per person. Thus $3.6 million of investment are required to maintain the provincial average rate of increase of earnings.

The results in the Saint John region are similar in concept but are different in magnitude. In Saint John, as in Fredericton, an investment in highways has an effect on the region's earnings 4 years later. For every $1 million invested in highway construction in Saint John, there is a relative increase of $8.9 in per capita earnings. Due to the influence of other factors, an investment of $2.8 million is required to maintain the provincial average rate of increase of earnings.

These numbers should not be accepted as exact figures, but should be considered approximations. If more explanatory variables were available to be included in the model, the estimated magnitude of the effects of highway investment would change.

No significant models would be developed for three regions. This may be the result of two possibilities. One possibility is that highway investment has no significant effect on the economic development of the regions. However, because the investment in highways has a significant effect on the economic development of two regions, this possibility does not appear valid. The second possibility is that highway investment does have a significant effect on highway development but this effect is not noticeable because of the absence of other explanatory variables. This possibility also appears to be invalid because of the ability to develop models in two regions. This may indicate that the function of highways is changing within the study period. In the early portion of the study period, highways may have had a substantial effect on regional development. If the saturation point is reached in the latter portion of the study period, the overall development effect of highways would be diluted.

SAINT JOHN REGION

Throughout the 1950s the magnitude of highway investment in the Saint John region remained relatively small. In 1964 a major increase in construction occurred. The construction of the region's major arterial highway from St. Stephen to Sussex resulted in a substantial investment within the region until its completion in 1972.

Subsequent to 1972, the magnitude of the investment in regional highways declined while a major portion of the total investment financed the construction of the Saint John throughway. It could be argued that an investment in the construction of the Saint John throughway, which would serve primarily to increase the ease of traveling through the city of Saint John, would have a smaller development effect than an investment in the construction of a regional highway. It would thus appear that after 1972 there was a decline in the construction of regional highways.

If this decline in the investment in highway construction was due to the approximate completion of the highway network it could be assumed that the saturation point had been reached. To test whether the Saint John regional highway network became saturated in 1972, two models were used. The models were the same as those developed in the previous section except for the time frame. One model was developed using the investment in highway construction before 1972 as the independent variable, and the second model was developed using the investment in highway construction subsequent to 1972 as the independent variable.

The dependent variable for each of the models was Saint John's share of the total per capita wages, salaries, and commissions 4 years after the highway investment was made. If the coefficient representing the magnitude of the development effects of highway investment from the pre-1972 model is statistically greater than that of the all-year model, and if the the same coefficient for the post-1972 model is statistically lower than that of the all-year model, it could be concluded that the regional highway network became saturated in 1972. Therefore, subsequent to 1972, highway investment had smaller developmental effects and the secondary function of highways was changing. If the coefficients were not statistically different it would be concluded that

the saturation point of the highway infrastructure had not yet been reached and that investment in highway construction continues to provide a developmental function.

A summary of the three models is given in Table 2. In these models SWS represents the competitive component of the Saint John region's share of per capita earnings. All three models are statistically significant at a 10 percent level of significance.

TABLE 2   Model Development for the Saint John Region

Model	n	F-value of Model	t-value of Regression Coefficient	r^2
All-year				
SWS = -24.8 + 8.9 (HILAG4 ÷ 10^6)	21	5.02	2.24	0.21
Pre-1972				
SWS = -26.2 + 8.3 (HILAG4 ÷ 10^6)	17	3.31	1.82	0.18
Post-1972				
SWS = -15.0 + 9.8 (HILAG4 ÷ 10^6)	4	9.04	3.01	0.82

A Student's t-test indicated that at a 10 percent level of significance there is no significant difference between the change in the level of economic activity caused by events other than highway investment (the "a" coefficients in the models) in each of the three models. The t-test also revealed that there is no significant difference between the magnitude of the development effect of highway investment. The point of saturation of the highway network had therefore not been reached within the study period, and highway investment continued to play a small developmental role.

FREDERICTON REGION

In the Fredericton region, the increase in highway construction in the late 1950s was due to the construction of the early portion of the Trans-Canada Highway. The increase in construction in the late 1960s resulted in the virtual completion of the Fredericton portion of the Trans-Canada Highway. The increase in construction at that time was a result of the federal contribution of 90 percent of the construction costs.

Following the 1968 fiscal year there was a noticeable decrease in the money invested in the construction of highway infrastructure in the Fredericton region. Although the trend in construction subsequent to 1968 appeared to be generally increasing, this may not have been a result of the need for the investment. In every provincial election year since 1970 the investment in the construction of highways increased dramatically. This suggests that the highway network may have become saturated in 1968, and the general increases in investment subsequent to that point were due to political rather than transport or development reasons.

To test whether the saturation point was reached in the Fredericton region in 1968, two models were developed. One model examined the effects of highway investment on economic development before 1968, and the second model examined the relationship after 1968. If the effects of highway investment after 1968 are significantly lower than the effects when considering all years, it could be concluded that the Fredericton highway network became saturated in 1968.

A summary of the three models is given in Table 3. In these models SWS denotes the component of the Fredericton region's share of per capita earnings.

TABLE 3   Model Development for the Fredericton Region

Model	n	F-value of Model	t-value of Regression Coefficient	r^2
All-year				
SWS = -50.8 + 14.1 (HILAG4 ÷ 10^6)	21	6.03	2.45	0.24
Pre-1968				
SWS = -26.3 + 12.3 (HILAG4 ÷ 10^6)	15	3.77	1.94	0.22
Post-1968				
SWS = -122.2 + 25.1 (HILAG4 ÷ 10^6)	8	3.43	1.85	0.36

The three models are statistically significant at a 10 percent level of significance.

A Student's t-test indicated that at a 10 percent level of significance there was no significant difference in the level of economic activity caused by events other than highway investment in each of the three models. The t-test also indicated that there was no significant difference in the effects of highway investment on regional development in each of the time periods examined. This implies that the saturation point of the Fredericton regional highway network had not yet been reached.

MONCTON, EDMUNDSTON, AND BATHURST REGIONS

In the regions of Moncton, Edmundston, and Bathurst, no relationship between highway investment and economic development was evident. Because a relationship was found in two regions, it appears that highway investment could have an impact on regional development. This indicates that a relationship between highway investment and regional development may have existed before the study period or after the study period.

The hypothesis of saturation suggests that after a certain level of investment, additional investment will have no developmental effects but will affect individual mobility. If this level of investment was reached before the study period, a relationship between a measure of mobility and investment in highway infrastructurte should be evident. If no relationship was evident it would appear that the level of investment in highways has not yet reached a level at which it would cause economic development.

To test whether highway investment is serving to increase personal mobility in any of the three regions, the model developed in the previous section was utilized. The investment in highway construction was used as the indicator of the development of highways. As outlined before, a variety of lead and lag periods was used to determine the proper delay between cause and effect.

The ratio of the total retail sales within a region to the total income of the residents of that region was used to indicate the level of personal mobility. In the short run the average consumer was expected to spend approximately the same percentage of total income on retail goods. Thus, an increase in the ratio of retail sales to total income of a region would indicate that people were traveling to this region to purchase retail goods. Similarly, a decrease in the ratio indicates that people were leaving the region to purchase retail goods.

The results of the three models are given in Table 4. The competitive component of the ratio of total retail sales to total income (expressed as a percentage) of a region is denoted [RS/TI]. A significant relationship was evident in the Moncton region whereas no significant relationship was evident in the Edmundston and Bathurst regions (at a 10 percent level of significance).

TABLE 4   Regional Saturation Models

Regional Model	n	F-value of Model	t-value of Regression Coefficient	r^2
Moncton RE/TI = -3.17 + 0.51 (HILAG4 ÷ 10^6)	20	9.46	3.08	0.34
Edmundston No significant model				
Bathurst No significant model				

The model developed for the Moncton region indicated that there was an increase in the ratio of retail sales to total income relative to the provincial average of 0.51 percent 4 years after an investment of $1 million in highways. Due to external influences, an investment of $6.2 million is required to maintain the average provincial growth.

The statistical correlation between the investment in highway infrastructure and the measure of personal mobility provides evidence that the hypothesis of saturation and shift from development functions is correct. Highway investment did stimulate economic development in two regions; however, mobility was related to investment in the Moncton region. This provides evidence that highway investment in Moncton played a development role before the study period. The validity of these conclusions cannot be determined due to the unavailability of statistics before the study period.

A statistically significant model could not be developed for the Edmundston and the Bathurst regions. Because no relationship was evident between highway investment and regional development or personal mobility, it appears that the level of investment in highways had not yet reached a level at which it would cause development. In time, continued highway investment in these two regions should be correlated with increased regional development.

DISCUSSION AND CONCLUSIONS

The results presented in this paper provide some evidence to support the hypothesis of saturation and shift, and indicate that it is applicable to the study area in New Brunswick. It appears that the highway networks are developed to different levels: the highway network in the Moncton region developed before the study period, the highway network in the Fredericton and Saint John regions were developing to their full potential throughout the study period, and the highway network in the Edmundston and Bathurst regions had not yet reached a significant level of development.

After calibrating models for each of the five economic regions and examining the hypothesis of saturation and shift, several observations on the secondary function of highways can be made. Transportation improvements provide the opportunity for economic development; however, because of their individual characteristics, each economic region may react to the opportunity at different times. Some regions may react quickly, whereas there may be a considerable lag time between cause and effect in other regions. In New Brunswick the lag time between investment in highway infrastructure and the resulting effect appears to be 4 to 5 years.

The secondary effects of investment in highways appears to go through three phases. The first phase is the preliminary development of the regional highway network. At this stage limited development of the highway network has been completed. Although the highway network may adequately serve its primary function, new construction and upgrading does not have the potential to encourage development.

The second phase occurs after the regional highway network has been developed to a certain level. With a sufficient highway network in place, additional highway investment has the ability to encourage economic development.

As the investment in the highway network continues, the region becomes saturated with highways. A point is reached at which any addition to this network does not encourage further economic development. This is the third phase. Investment in the highway network no longer encourages economic development, but serves to increase the mobility of the residents.

The analysis indicated that the Edmundston and Bathurst regions were in the first phase throughout the study period. These regions of the province had been the last to receive a developed highway network, and the investment in highways in these regions was generally lower than in the other regions. With increased federal funding, especially in the Bathurst region, increased highway investment should begin to have a development effect.

The Fredericton and Saint John regions appeared to be in the second phase throughout the study period. Because Fredericton is the provincial capital and Saint John is New Brunswick's major port and largest city, these regions received relatively developed highway networks at an earlier time than the rest of the Province. By 1950 the highway network developed to the point that it could encourage economic development within the region. Throughout the study period, continued investment in highways encouraged further economic development.

Throughout the study period, the Moncton region was in the third phase of development as highways encouraged an increase in personal mobility. Throughout the history of New Brunswick, Moncton has been called the "Hub of the Maritimes." This is a result of the increased transport service activity of the area, as it is mainly a distribution center. Because of Moncton's advanced level of economic development, it would follow that the developmental stage of highways would arrive and depart relatively quickly. By 1950 highway investment had ceased encouraging economic development and had begun to act as an instrument to encourage personal mobility.

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